

## **AN-1560 LP38852MR-ADJ Evaluation Board**

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### **1 Introduction**

This board is designed to allow the evaluation of the LP38852MR-ADJ voltage regulator. Each board is assembled and tested in the factory. This evaluation board has the SO PowerPAD-8 package mounted, and the output voltage is set to 1.20V.

### **2 General Description**

The LP38852 is a dual-rail adjustable LDO linear regulator capable of supplying up to 1.5A of output current, and incorporates an Enable function as well as a Soft-Start function.

The device has been designed to work with 10  $\mu$ F input and output ceramic capacitors, and 1 $\mu$ F bias capacitor. Footprints areas for  $C_{IN}$  and  $C_{OUT}$  will allow for a variety of sizes.

### **3 Operation**

The input voltage, applied between  $V_{IN}$  and GND, should be at least 1.0V greater than  $V_{OUT}$  and no greater than the applied  $V_{BIAS}$  voltage.

The bias voltage, applied between  $V_{BIAS}$  and GND should be above the minimum bias voltage of 3.0V, and no more than the maximum of 5.5V.

Loads can be connected to  $V_{OUT}$  with reference to GND.

$V_{OUT}$  and  $V_{IN}$  test points are provided on the board to allow accurate measurements directly onto the input and output pins of the device, eliminating any voltage drop on the PCB traces or connecting wires to the load.

### **4 Setting $V_{OUT}$**

The output voltage is set using the external resistive divider R1 and R2. The output voltage is given by the formula:

$$V_{OUT} = V_{ADJ} \times (1 + (R1 / R2)) \quad (1)$$

It is recommended that the values selected for R1 and R2 are such that the parallel value is less than 10 k $\Omega$ . This is to prevent internal parasitic capacitances on the ADJ pin from interfering with the  $F_z$  pole set by R1 and  $C_{FF}$ .

The LP38852MR-ADJ Evaluation board is assembled with a 1.40 k $\Omega$   $\pm$ 1% resistor for R1, and a 1.00 k $\Omega$   $\pm$ 1% resistor for R2. This sets  $V_{OUT}$  to 1.20V.

### **5 Selecting $C_{FF}$**

A capacitor placed across the gain resistor R1 will provide additional phase margin to improve load transient response of the device. This capacitor,  $C_{FF}$ , in parallel with R1, will form a zero in the loop response given by the formula:

$$F_z = (1 / (2 \times \pi \times C_{FF} \times R1)) \quad (2)$$

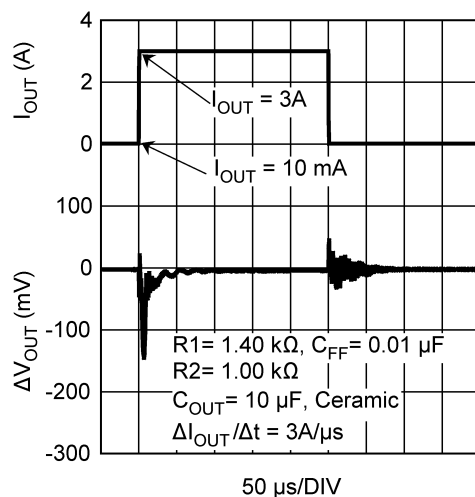
The value for  $C_{FF}$  should be selected to set a zero frequency ( $F_z$ ) between 10 kHz and 15 kHz using the formula:

$$C_{FF} = 1 / (2 \times \pi \times F_z \times R1) \quad (3)$$

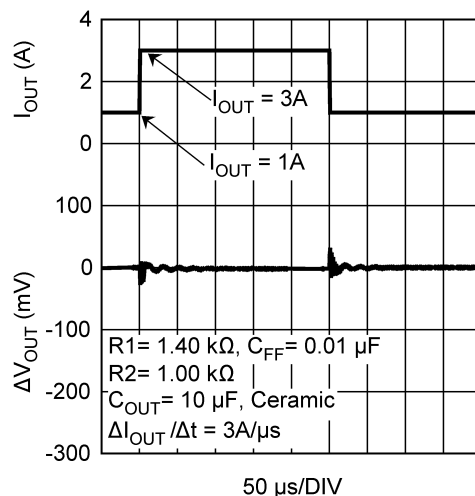
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The closest standard 10% value is usually adequate for  $C_{FF}$ .

The LP38853-ADJ Evaluation board is assembled with a 0.01  $\mu\text{F}$  capacitor for  $C_{FF}$ . This sets  $F_z$  to approximately 11.4 kHz.



**Figure 1. 10mA to 3A Load Transient Response**



**Figure 2. 1A to 3A Load Transient Response**

## 6 Enable Function

ON/OFF control is provided by supplying a logic level signal to the Enable pin. A minimum  $V_{EN}$  value of 1.3V is typically required at this pin to enable the LDO output. The LDO output will be shutdown when the  $V_{EN}$  value is typically 1.0V or less. The  $V_{EN}$  threshold incorporates approximately 100mV of hysteresis.

In applications where the LP38852 is operated continuously the Enable pin can be connected directly to  $V_{BIAS}$ , or left open. The Enable pin has a 200 k $\Omega$  internal resistor to  $V_{BIAS}$ . If the Enable pin is left open, care should be taken to minimize any capacitance on the Enable pin, as any capacitance will introduce an RC delay time on the Enable function.

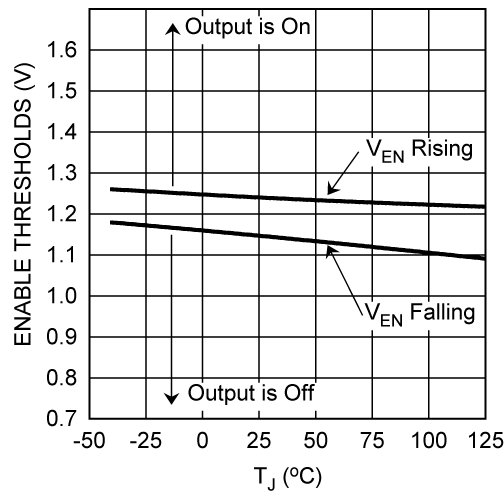


Figure 3. Enable Thresholds

## 7 Soft-Start Function

$V_{REF}$  will rise at an RC rate defined by the internal resistance of the SS pin ( $r_{SS}$ ), and the external capacitor ( $C_{SS}$ ) connected to the SS pin. This allows the output voltage to rise in a controlled manner until steady-state regulation is achieved. Typically, five time constants are recommended to assure that the output voltage is sufficiently close to the final steady-state value. During the soft-start time the output current can rise to the built-in current limit.

The LP38852MR-ADJ Evaluation board is assembled with a 0.01  $\mu$ F capacitor for  $C_{SS}$ . This sets the soft-start time to approximately 750  $\mu$ s.

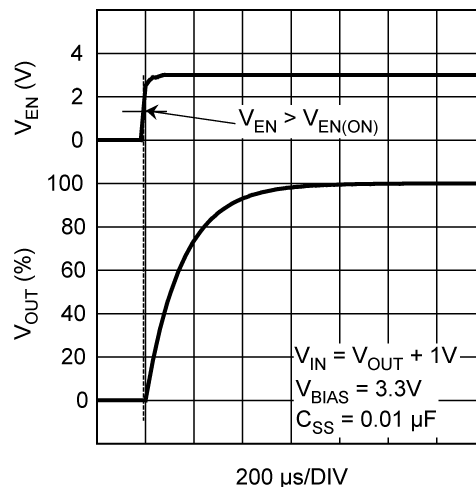


Figure 4.  $V_{OUT}$  Soft-Start

## 8 Power Dissipation

The LP38852MR SO PowerPAD-8 package alone has a junction to ambient thermal resistance ( $\theta_{JA}$ ) rating of  $168^{\circ}\text{C}/\text{W}$ . When mounted on the LP38852MR evaluation board the  $\theta_{JA}$  rating is approximately  $62^{\circ}\text{C}/\text{W}$ .

Although there is only approximately 0.03 square inches (0.1 x 0.3) 1 ounce copper area immediately under the DAP, the top copper surface area is extended to additional copper area on the bottom of the board by four thermal vias.

With the  $62^{\circ}\text{C}/\text{W}$  thermal rating the LP38852MR-ADJ evaluation board will dissipate a maximum of 1.6W with  $T_A = 25^{\circ}\text{C}$ .

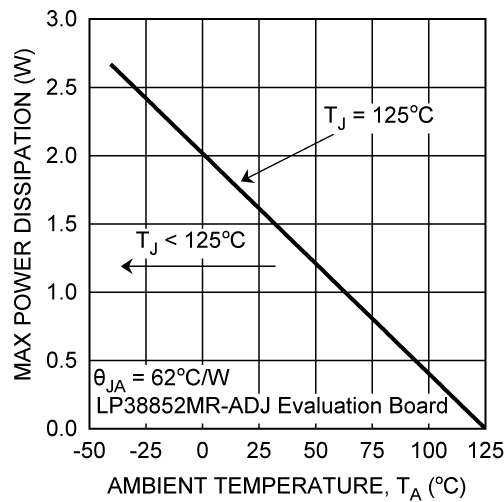
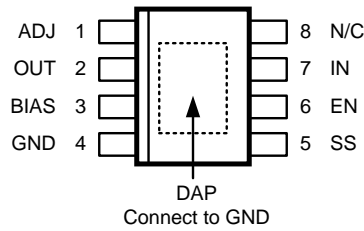


Figure 5. Maximum Power Dissipation vs Ambient Temperature

### 8.1 Connection Diagram



### 8.2 Schematic Diagram

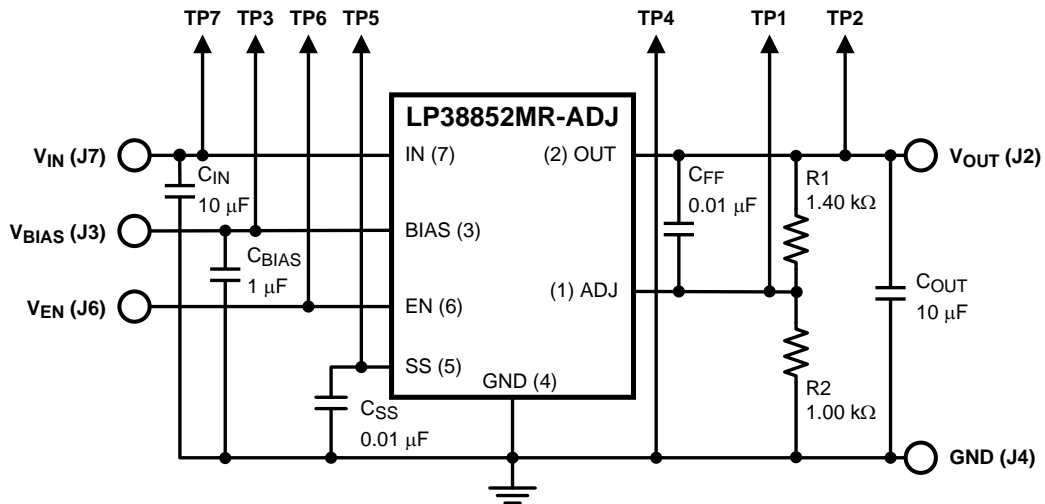


Figure 6. Evaluation Board Schematic

## 9 PCB Layout

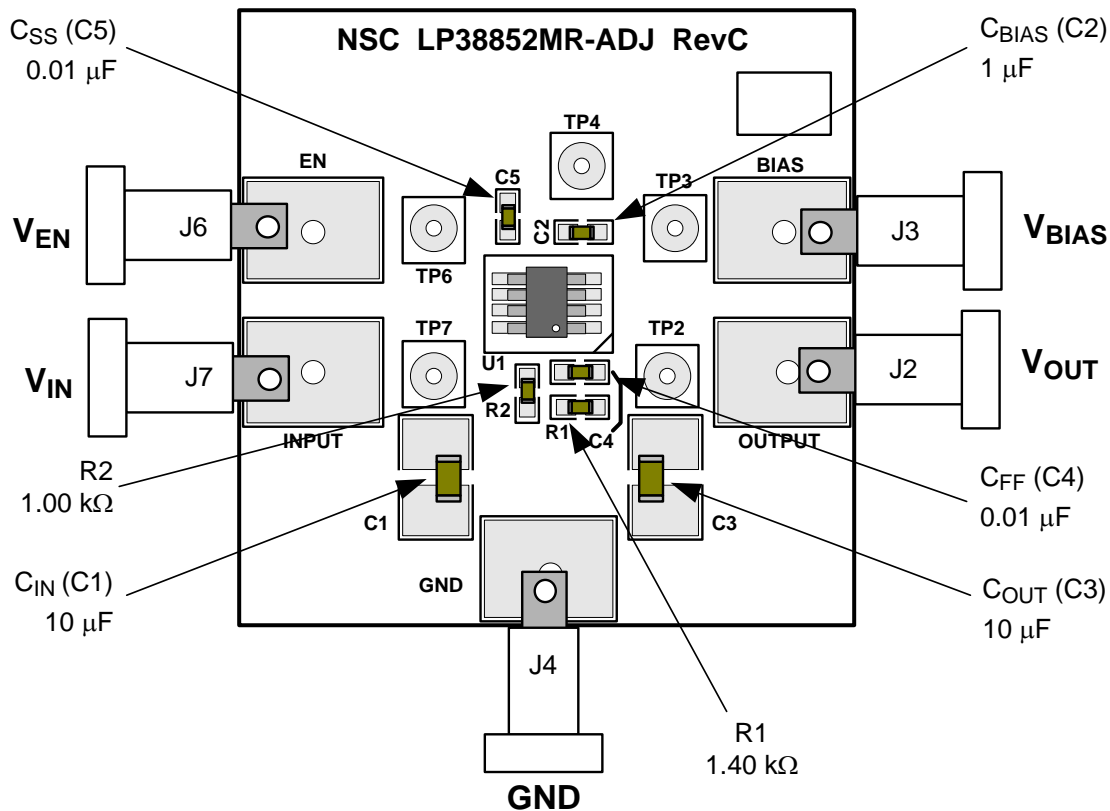


Figure 7. Evaluation Board Component and Pin Layout

## 10 Bill of Materials

ID	Name	Description	Manufacturer	Part Number
U1	U1	LP38852	Texas Instruments	LP38852
C1	C <sub>IN</sub>	Capacitor: 10 μF; ±10%; MLCC; 10V; X7R; 1210	AVX	1210ZC106KAT2A
C2	C <sub>BIAS</sub>	Capacitor: 1 μF; ±10%; MLCC; 10V; X7R; 0805		0805ZC105KAT2A
C3	C <sub>OUT</sub>	Capacitor: 10 μF; ±10%; MLCC; 10V; X7R; 1210		1210ZC106KAT2A
C4	C <sub>FF</sub>	Capacitor: 0.01 μF; ±10%; MLCC; 10V; X7R; 0805		0805YC103KAT2A
C5	C <sub>SS</sub>	Capacitor: 0.01 μF; ±10%; MLCC; 10V; X7R; 0805		0805YC103KAT2A
J2	V <sub>EN</sub>	Banana Jack : Insulated Solder Terminal; White	Johnson Components	108-0901-001
J3	V <sub>IN</sub>	Banana Jack : Insulated Solder Terminal; Red		108-0902-001
J4	GND	Banana Jack : Insulated Solder Terminal; Black		108-0903-001
J6	V <sub>OUT</sub>	Banana Jack : Insulated Solder Terminal; Orange		108-0906-001
J7	V <sub>BIAS</sub>	Banana Jack : Insulated Solder Terminal; Blue		108-0910-001

ID	Name	Description	Manufacturer	Part Number
R1	R1	Resistor: 1.40 k $\Omega$ , $\pm$ 1%; Thick Film; 250 mW; $\pm$ 100 ppm; 0805	VISHAY DALE	CRCW 0805 1401 F
R2	R2	Resistor: 1.00 k $\Omega$ , $\pm$ 1%; Thick Film; 250 mW; $\pm$ 100 ppm; 0805		CRCW 0805 1001 F
TP2	TP <sub>EN</sub>	Turret Terminal : Mounting Hole Diameter = 0.062"	Keystone	1593-2
TP2	TP <sub>SS</sub>			
TP3	TP <sub>IN</sub>			
TP4	TP <sub>GND</sub>			
TP5	TP <sub>ADJ</sub>			
TP6	TP <sub>OUT</sub>			
TP7	TP <sub>BIAS</sub>			

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