LP38853S-ADJ Evaluation Board

National Semiconductor
Application Note 1504
Don Jones
January 2007

Introduction

This board is designed to allow the evaluation of the LP38853S-ADJ Voltage Regulator. Each board is assembled and tested in the factory. This evaluation board has the TO-263 7-lead package mounted, and the output voltage is set to 1.20V.

General Description

The LP38853 is a dual-rail adjustable LDO linear regulator capable of suppling up to 3A of output current, and incorporates an Enable function as well as a Soft-Start function.

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

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.

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 kΩ. 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 LP38853S-ADJ Evaluation board is assembled with a 1.40 kΩ ±1% resistor for R1, and a 1.00 kΩ ±1% resistor for R2. This sets V_{OUT} to 1.20V.

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:

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

The closest standard 10% value is usually adequate for C_{FF}. The LP38853-ADJ Evaluation board is assembled with a 0.01 µF capacitor for C_{FF}. This sets F_Z to approximately 11.4 kHz.

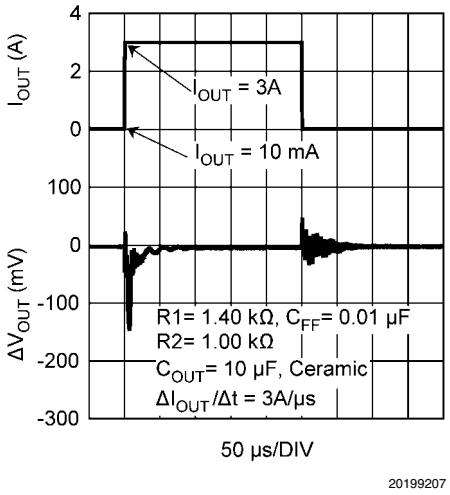


FIGURE 1. 10mA to 3A Load Transient Response

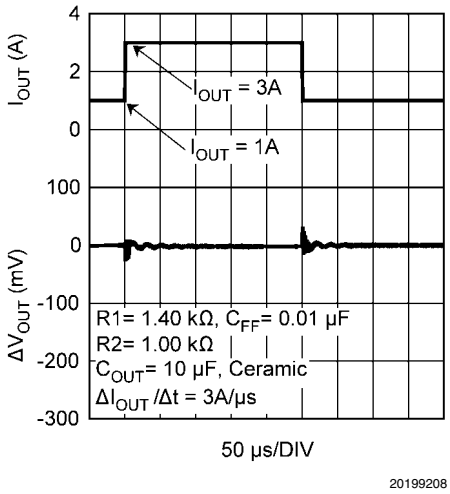


FIGURE 2. 1A to 3A Load Transient Response

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 LP38853 is operated continuously the Enable pin can be connected directly to V_{BIAS}, or left open.

© 2007 National Semiconductor Corporation

Downloaded from Elcodis.com electronic components distributor

The Enable pin has a 200 kΩ 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.

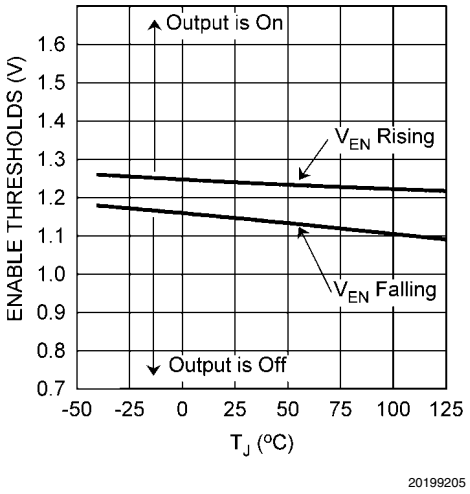


FIGURE 3. Enable Thresholds

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 LP38853S-ADJ Evaluation board is assembled with a 0.01 µF capacitor for C_{SS}. This sets the soft-start time to approximately 750 µs.

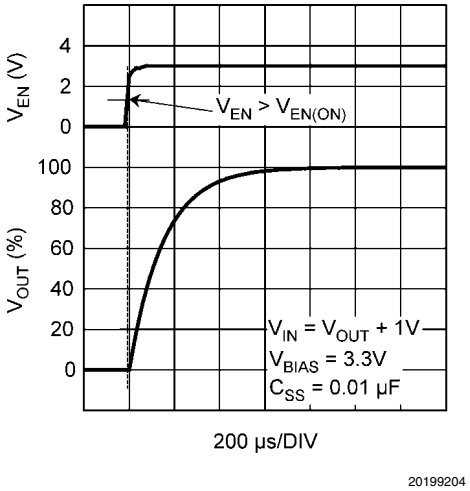


FIGURE 4. V_{OUT} Soft-Start

Power Dissipation

The TO-263 package alone has a junction to ambient thermal resistance (θ_{JA}) rating of 60°C/W. When mounted on the LP38853S evaluation board the θ_{JA} rating is approximately 40°C/W.

Although there is only approximately 0.30 square inches of 1 ounce copper area immediately under the tab, the top copper surface area is extended to additional copper area on the bottom of the board by nine thermal vias.

With the 40°C/W thermal rating the LP38853S-ADJ evaluation board will dissipate a maximum of 2.5W with T_A = 25°C.

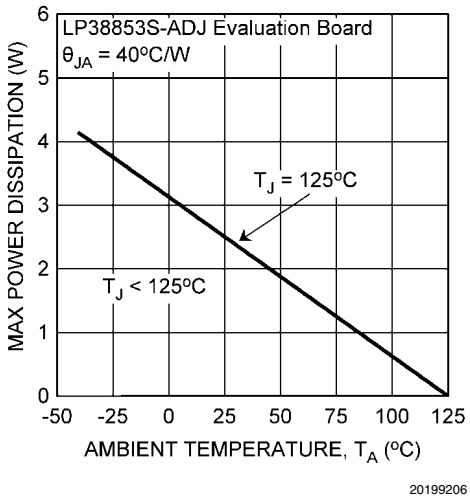
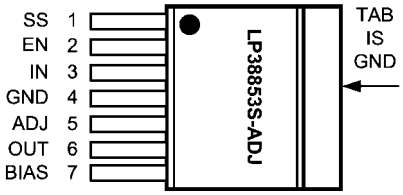


FIGURE 5. Maximum Power Dissipation vs Ambient Temperature

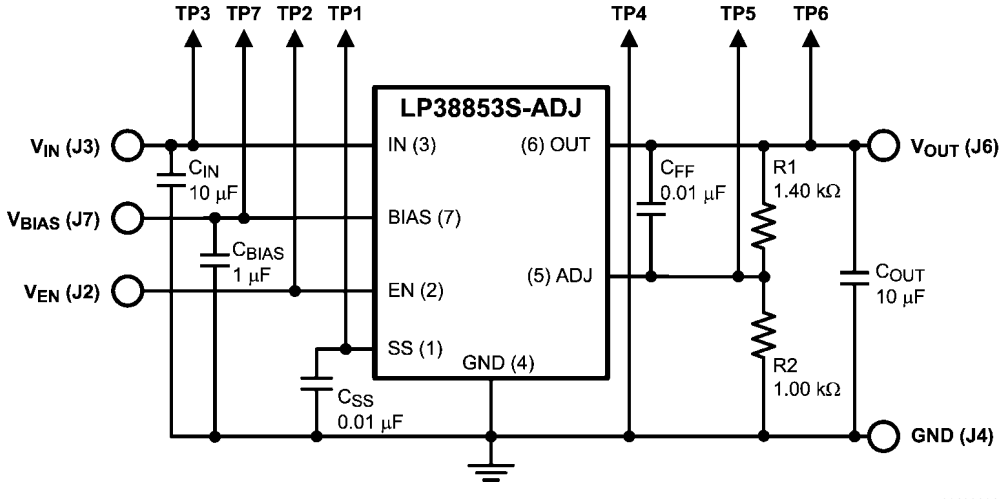
Downloaded from Elcodis.com electronic components distributor

Connection Diagram



20199203

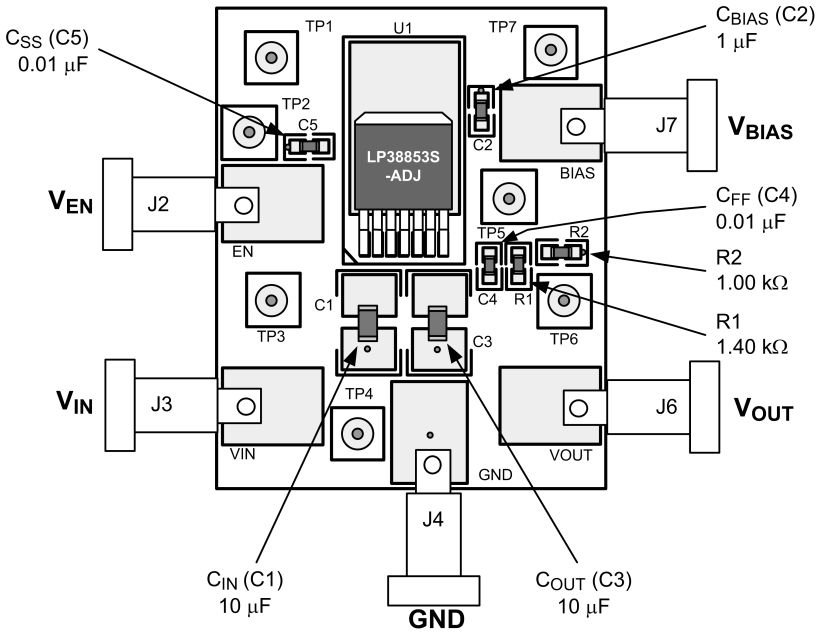
Schematic Diagram



20199201

Evaluation Board Schematic.

PCB Layout



20199202

Evaluation Board Component and Pin Layout

Downloaded from Elcodis.com electronic components distributor

Bill of Materials

ID	Name	Description	Manufacturer	Part Number
U1	U1	LP38853S-ADJ NOPB	National Semiconductor Corporation	LP38853S-ADJ NOPB
C1	C_{IN}	Capacitor: 10 µF; ±10%; MLCC; 10V; X7R; 1210	AVX	1210ZC106KAT2A
C2	C_{BIAS}	Capacitor: 1 µF;, ±10%; MLCC; 10V; X7R; 0805		0805ZC105KAT2A
C3	C_{OUT}	Capacitor: 10 µF;, ±10%; MLCC; 10V; X7R; 1210		1210ZC106KAT2A
C4	C_{FF}	Capacitor: 0.01 µF;, ±10%; MLCC; 10V; X7R; 0805		0805YC103KAT2A
C5	C_{SS}	Capacitor: 0.01 µF; ±10%;, MLCC; 10V; X7R; 0805		0805YC103KAT2A
J2	V_{EN}	Banana Jack : Insulated Solder Terminal; White	Johnson Components	108-0901-001
J3	V_{IN}	Banana Jack : Insulated Solder Terminal; Red		108-0902-001
J4	GND	Banana Jack : Insulated Solder Terminal; Black		108-0903-001
J6	V_{OUT}	Banana Jack : Insulated Solder Terminal; Orange		108-0906-001
J7	V_{BIAS}	Banana Jack : Insulated Solder Terminal; Blue		108-0910-001
R1	R1	Resistor: 1.40 kΩ, ±1%; Thick Film; 250 mW; ±100 ppm; 0805	VISHAY DALE	CRCW 0805 1401 F
R2	R2	Resistor: 1.00 kΩ, ±1%; Thick Film; 250 mW; ±100 ppm; 0805		CRCW 0805 1001 F
TP1	TP_{SS}	Turret Terminal : Mounting Hole Diameter = 0.062”	Keystone	1593–2
TP2	TP_{EN}			
TP3	TP_{IN}			
TP4	TP_{GND}			
TP5	TP_{ADJ}			
TP6	TP_{OUT}			
TP7	TP_{BIAS}			

Downloaded from Elcodis.com electronic components distributor

Notes

Downloaded from Elcodis.com electronic components distributor

Notes

THE CONTENTS OF THIS DOCUMENT ARE PROVIDED IN CONNECTION WITH NATIONAL SEMICONDUCTOR CORPORATION ("NATIONAL") PRODUCTS. NATIONAL MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO THE ACCURACY OR COMPLETENESS OF THE CONTENTS OF THIS PUBLICATION AND RESERVES THE RIGHT TO MAKE CHANGES TO SPECIFICATIONS AND PRODUCT DESCRIPTIONS AT ANY TIME WITHOUT NOTICE. NO LICENSE, WHETHER EXPRESS, IMPLIED, ARISING BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT.

TESTING AND OTHER QUALITY CONTROLS ARE USED TO THE EXTENT NATIONAL DEEMS NECESSARY TO SUPPORT NATIONAL'S PRODUCT WARRANTY. EXCEPT WHERE MANDATED BY GOVERNMENT REQUIREMENTS, TESTING OF ALL PARAMETERS OF EACH PRODUCT IS NOT NECESSARILY PERFORMED. NATIONAL ASSUMES NO LIABILITY FOR APPLICATIONS ASSISTANCE OR BUYER PRODUCT DESIGN. BUYERS ARE RESPONSIBLE FOR THEIR PRODUCTS AND APPLICATIONS USING NATIONAL COMPONENTS. PRIOR TO USING OR DISTRIBUTING ANY PRODUCTS THAT INCLUDE NATIONAL COMPONENTS, BUYERS SHOULD PROVIDE ADEQUATE DESIGN, TESTING AND OPERATING SAFEGUARDS.

EXCEPT AS PROVIDED IN NATIONAL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, NATIONAL ASSUMES NO LIABILITY WHATSOEVER, AND NATIONAL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY RELATING TO THE SALE AND/OR USE OF NATIONAL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS PRIOR WRITTEN APPROVAL OF THE CHIEF EXECUTIVE OFFICER AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

Life support devices or systems are devices which (a) are intended for surgical implant into the body, or (b) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness.

National Semiconductor and the National Semiconductor logo are registered trademarks of National Semiconductor Corporation. All other brand or product names may be trademarks or registered trademarks of their respective holders.

Copyright© 2007 National Semiconductor Corporation

For the most current product information visit us at www.national.com

National Semiconductor Americas Customer Support Center
Email: new.feedback@nsc.com
Tel: 1-800-272-9959

National Semiconductor Europe Customer Support Center
Fax: +49 (0) 180-530-85-86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 69 9508 6208
English Tel: +49 (0) 870 24 0 2171
Français Tel: +33 (0) 1 41 91 8790

National Semiconductor Asia Pacific Customer Support Center
Email: ap.support@nsc.com

National Semiconductor Japan Customer Support Center
Fax: 81-3-5639-7507
Email: jpn.feedback@nsc.com
Tel: 81-3-5639-7560

Downloaded from Elcodis.com electronic components distributor