

## **AN-1504 LP38853S-ADJ Evaluation Board**

---

---

---

### **1 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.

### **2 General Description**

The LP38853 is a dual-rail adjustable LDO linear regulator capable of supplying 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  $\mu$ 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 LP38853S-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:

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

All trademarks are the property of their respective owners.

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.

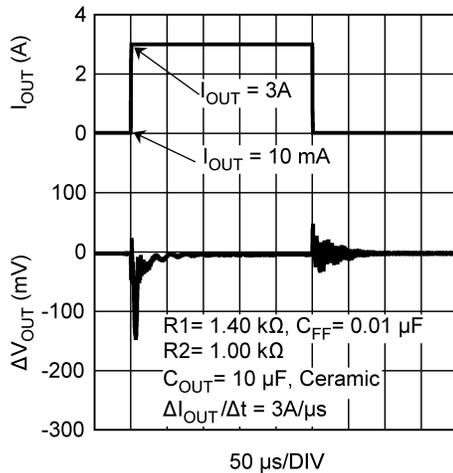


Figure 1. 10mA to 3A Load Transient Response

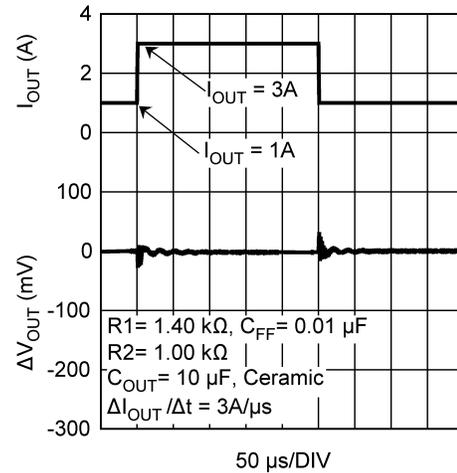


Figure 2. 1A to 3A Load Transient Response

## 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 LP38853 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.

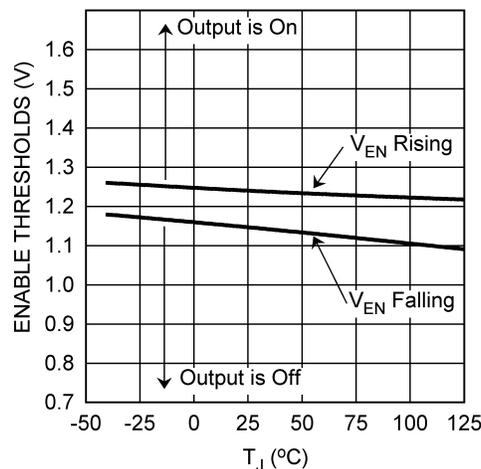


Figure 3. Enable Thresholds

## 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 LP38853S-ADJ Evaluation board is assembled with a 0.01  $\mu\text{F}$  capacitor for  $C_{SS}$ . This sets the soft-start time to approximately 750  $\mu\text{s}$ .

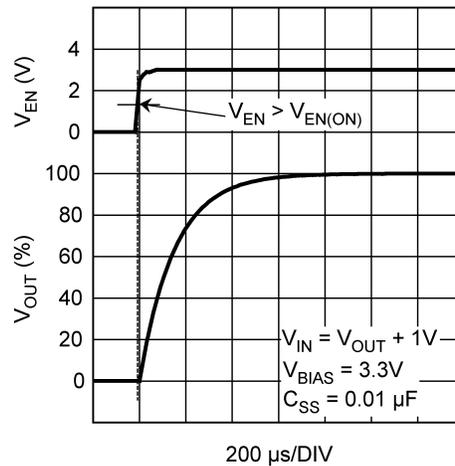


Figure 4.  $V_{OUT}$  Soft-Start

## 8 Power Dissipation

The TO-263 package alone has a junction to ambient thermal resistance ( $\theta_{JA}$ ) rating of 60°C/W. When mounted on the LP38853S evaluation board the  $\theta_{JA}$  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  $T_A = 25^\circ\text{C}$ .

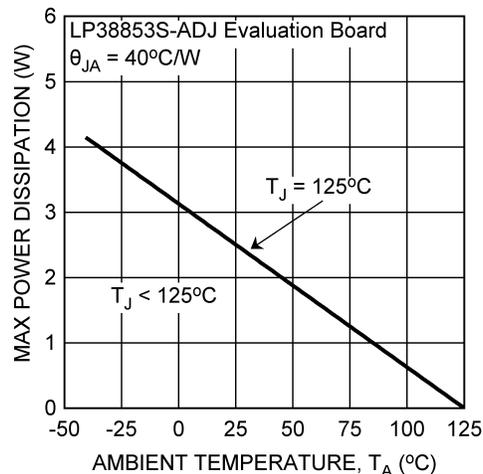


Figure 5. Maximum Power Dissipation vs Ambient Temperature

## 9 Pin Out

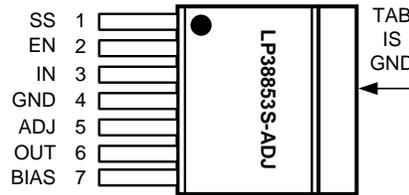


Figure 6. Pin Out

## 10 Schematic Diagram

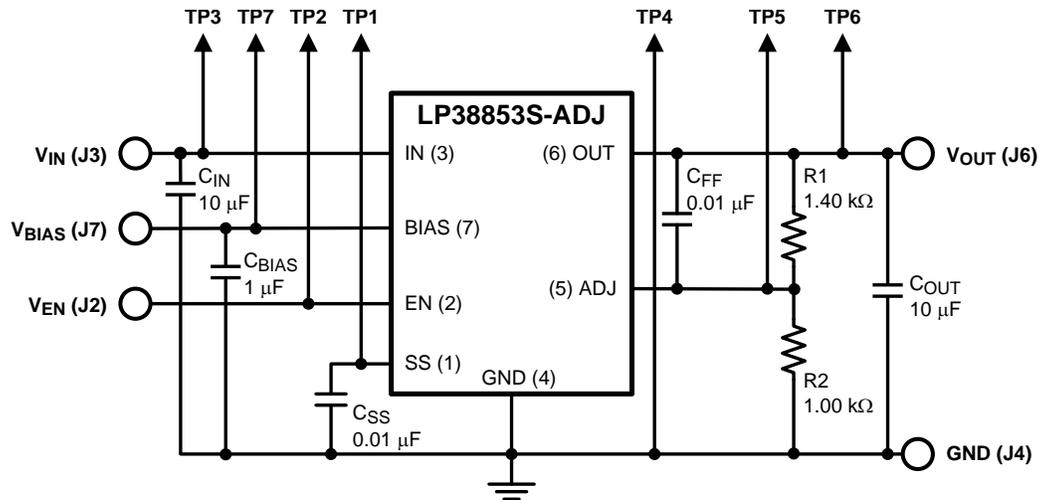


Figure 7. Evaluation Board Schematic.

11 PCB Layout

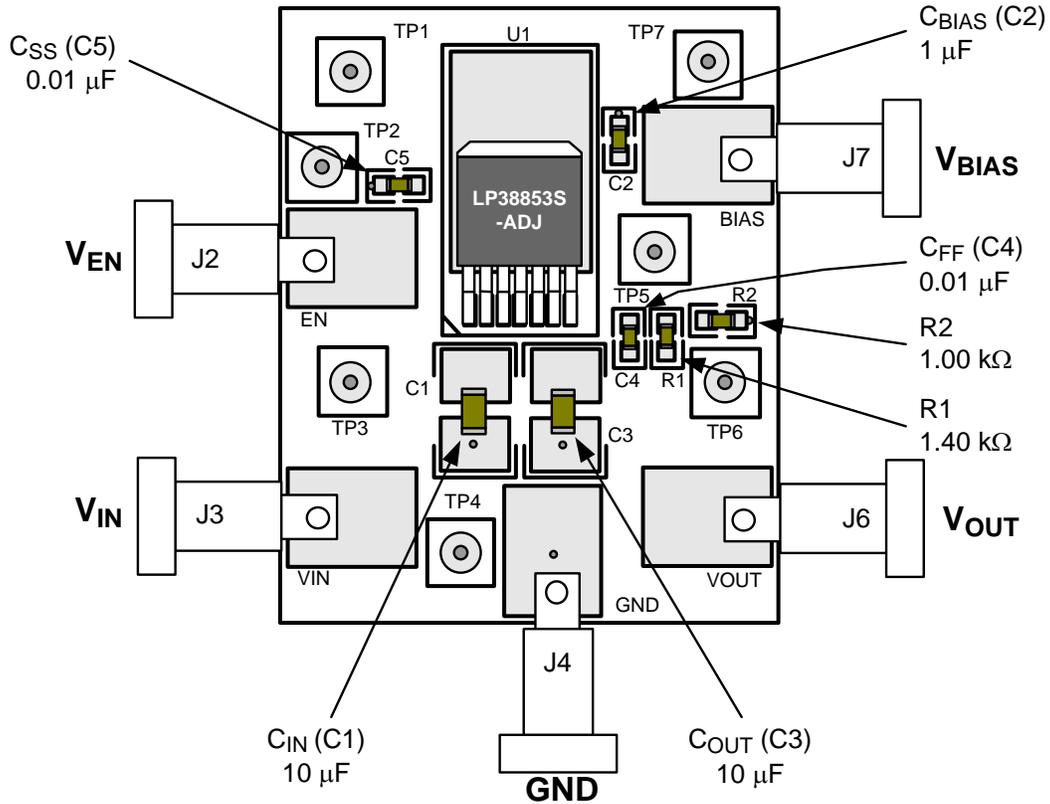


Figure 8. Evaluation Board Component and Pin Layout

**12 Bill of Materials**

ID	Name	Description	Manufacturer	Part Number
U1	U1	LP38853	Texas Instruments	LP38853
C1	C <sub>IN</sub>	Capacitor: 10 $\mu$ F; $\pm$ 10%; MLCC; 10V; X7R; 1210	AVX	1210ZC106KAT2A
C2	C <sub>BIAS</sub>	Capacitor: 1 $\mu$ F; $\pm$ 10%; MLCC; 10V; X7R; 0805		0805ZC105KAT2A
C3	C <sub>OUT</sub>	Capacitor: 10 $\mu$ F; $\pm$ 10%; MLCC; 10V; X7R; 1210		1210ZC106KAT2A
C4	C <sub>FF</sub>	Capacitor: 0.01 $\mu$ F; $\pm$ 10%; MLCC; 10V; X7R; 0805		0805YC103KAT2A
C5	C <sub>SS</sub>	Capacitor: 0.01 $\mu$ F; $\pm$ 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
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
TP1	TP <sub>SS</sub>	Turret Terminal : Mounting Hole Diameter = 0.062"	Keystone	1593-2
TP2	TP <sub>EN</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>			

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)