AN-2261 LP38869EVAL - 1A FlexCap LDO

1 Introduction

The LP38869EVAL evaluation board is designed to demonstrate the capabilities of the LP38869MH high performance LDO voltage regulator. It is intended to provide a flexible circuit configuration and access to points of interest. The circuit schematic is shown in Figure 8.

Component placement is shown in Figure 2 and Figure 3. The PCB layout is shown in Figure 5 through Figure 7. Test points are provided on the evaluation board for signal monitoring.

2 Operating Range

- Minimum Operating Input Voltage: 2.70V (For 2.50V Pre-Set V_{OUT})
- Maximum Operating Input Voltage: 5.50V
- Output Voltage : 2.50V (Pre-Set Mode) or 3.30V (Adjustable Mode), selectable via SW1-1
- Maximum Operating Output Current: 1A
- Ambient Temperature Operating Range: 0°C to 50°C
- Board Size: 1.90 inches x 2.00 inches

3 Evaluation Board Start-Up

Before applying power to the LP38869EVAL board, all external connections should be verified. The external power supply must be turned off before being connected. Confirm proper polarity to the 'VIN' (TP1) and 'GND' (TP2) terminals before turning the external power supply on. An appropriate load should be connected between the 'VOUT1' (TP3) and 'GND'(TP5) terminals. Under basic evaluation conditions the test points TP4 (VOUT2), TP6 (/RST), TP7 (SS), and TP8 (SET) can be left open. The two switches (SW1-1, and SW1-2) should be in the OFF positions (i.e., switch levers are towards the TI logo). The evaluation board will be in the normal operating mode when input power is applied.

4 $\overline{\text{SHDN}}$

Normal operation is when SW1-2 is in the OFF position (i.e. the switch lever is towards the TI logo at the bottom edge of the board). Moving SW1-2 to the ON position will connect the $\overline{\text{SHDN}}$ pin to ground which will disable the output. There is no Test Point for the $\overline{\text{SHDN}}$ pin. See Figure 4.

5 Soft-Start

Unlike traditional Soft-Start circuits that slow the rise time of the output voltage, the LP38869 Soft-Start circuit slowly increases the available output current. The rise time is controlled by the value of the SS capacitor (C3). The maximum output current can also be limited by placing a resistor in parallel with the SS capacitor, from TP7 to Ground. See the LP38869 datasheet for more details

6 Output Voltage Selection

Normal operation is when SW1-1 is in the OFF position (i.e. the switch lever is towards the TI logo at the bottom edge of the board). With SW1-1 in the OFF position the output voltage will be determined by the internal settings (i.e., 2.50V). Moving SW1-1 to the ON position will connect the LP38869 OUT pin to the SET pin through resistors R3 and R4 which will disable the internally set output voltage (2.50V), and will use the external resistors (R2, R3, and R4) to set the output voltage to the adjustable value of 3.30V. See Figure 4.

6.1 Changing the Output Voltage

The LP38869EVAL board is assembled with R3= 0.0Ω, R4= 31.6 kΩ and R2= 10.0 kΩ, to set the typical output voltage to 3.30V when SW1-1 is in the ON position.

Resistors R2, R3, and R4 may be replaced, as needed, to achieve the desired output voltage as long as the value for R3 and R4 is low enough so that the SET pin bias current flowing through R3 and R4 does not cause any offset in the output voltage.

The following formula is used to determine the typical output voltage:

$$V_{OUT} = (V_{SET} \times (1 + (R4 / R2))) + (I_{SET} \times R4) \quad (1)$$

Keeping the value for R4 less than about 100 kΩ will minimize the effects of I_{SET} and the formula can be simplified to the traditional:

$$V_{OUT} = (V_{SET} \times (1 + (R4 / R2))) \quad (2)$$

For the resistors installed on the LP38869EVAL board:

$$V_{OUT} = (0.8V \times (1 + (31.6\ k\Omega / 10.0\ k\Omega)) = 3.328V \text{ (typical)} \quad (3)$$

Alternately, the following formula can be used to determine the appropriate R4 value for a given R2 value with a $V_{OUT} \geq 0.800V$:

$$R1 = (((V_{OUT} / V_{SET}) - 1) \times R4) \quad (4)$$

The following table suggests some ±1% tolerance values for R4, keeping R2 and R3 held at the installed values of 10.0 k Ω and 0Ω respectively, for a range of output voltages using the typical V_{SET} value of 800 mV. This is not a definitive list, as other combinations R2 and R4 do exist that will provide similar, possibly better, performance.

Target V_{OUT}	R4	R2	Typical V_{OUT}
1.00V	2.49 kΩ	10.0 kΩ	0.999V
1.80V	12.4 kΩ	10.0 kΩ	1.792V
2.50V	21.5 kΩ	10.0 kΩ	2.52V
	Open	10.0 kΩ	2.50V
3.30V	31.6 kΩ	10.0 kΩ	3.32V
5.00V	52.3 kΩ	10.0 kΩ	4.98V

In the Adjustable Mode the resistors used for R4 and R2 should be high quality, tight tolerance, and with matching temperature coefficients. It is important to remember that, although the value of V_{REF} is ensured, the final value of V_{OUT} in the Adjustable Mode is not. The use of low quality resistors for R4 and R2 can easily produce an Adjustable Mode V_{OUT} value that is unacceptable.

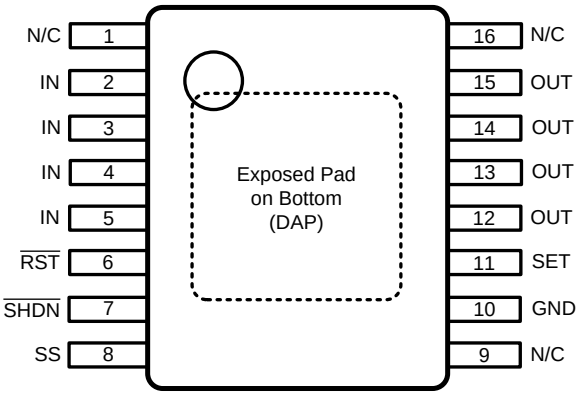

Figure 1. LP38869MH (16 Pin TSSOP-EP) Connection Diagram

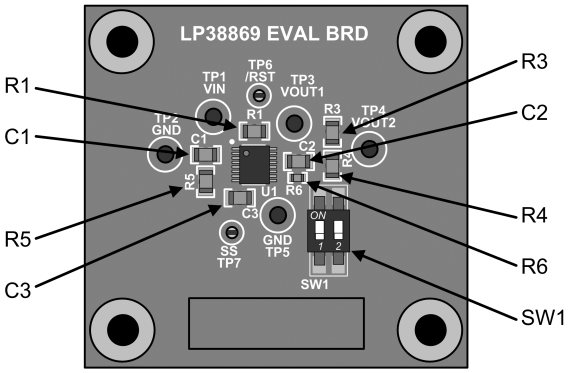

Figure 2. Top Side Parts Placement, as Viewed from the Top

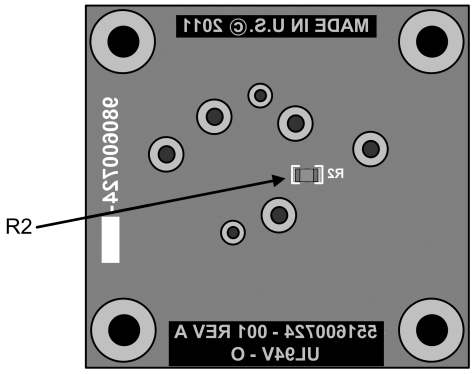

Figure 3. Bottom Side Part Placement, as Viewed from the Top

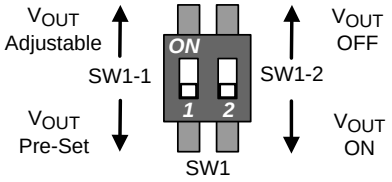

Figure 4. SW1-1 and SW1-2 Functions

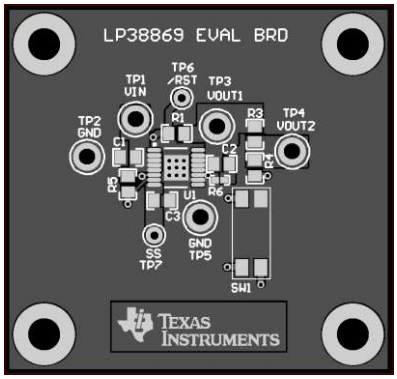

Figure 5. Top Layer as Viewed from Top

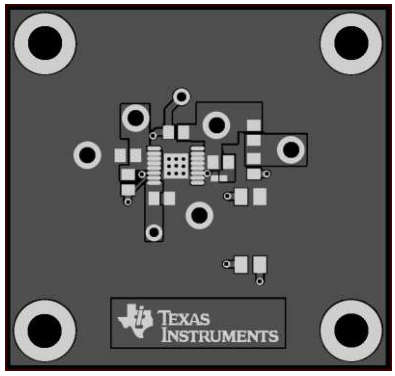

Figure 6. Copper Layer 1 (Top Layer) as Viewed from Top

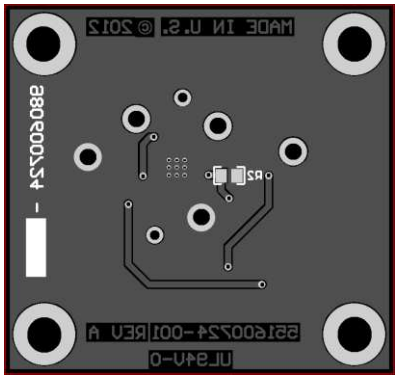

Figure 7. Copper Layer 2 (Bottom Layer) as Viewed from Top

7 Schematic for LP38869EVAL

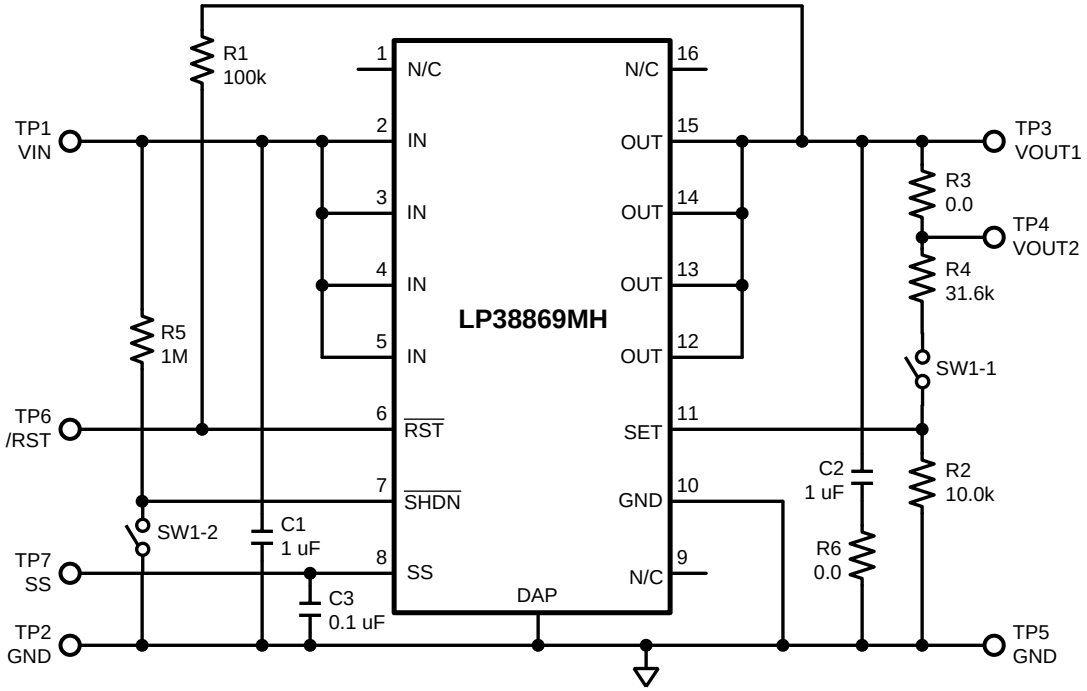

Figure 8. LP38869EVAL Schematic

Table 1. Bill of Materials for LP38869EVAL

Designator	Description	Manufacturer	Manufacturer Part Number	Digi-Key Number
U1	Voltage Regulator, LDO	Texas Instruments	LP38869MH	-
C1, C2	Capacitor: MLCC, 1µF, 25V, +/-10%, X7R, 0805	TDK	C2012X7R1E105K	445-1354-1-ND
C3	Capacitor: MLCC, 0.1µF, 25V, +/-10%, X7R, 0805	MuRata	GRM21BR71E104KA01L	490-1673-1-ND
R1	Resistor: 100 kΩ, 1%, 0.125W, 0805	Panasonic	ERJ-6ENF1003V	P100KCCT-ND
R2	Resistor: 10.0 kΩ, 1%, 0.125W, 0805	Panasonic	ERJ-6ENF1002V	P10.0KCCT-ND
R3	Resistor: 0.0Ω, 0.125W, 0805	Vishay-Dale	CRCW08050000Z0EA	541-0.0ACT-ND
R4	Resistor: 31.6 kΩ, 1%, 0.125W, 0805	Panasonic	ERJ-6ENF3162V	P31.6KCCT-ND
R5	Resistor: 1.00 M Ω, 1%, 0.125W, 0805	Vishay-Dale	CRCW08051M00FKEA	541-1.00MCCT-ND
R6	Resistor: 0 Ω, 5%, 0.063W, 0402	Panasonic	ERJ-2GE0R00X	P0.0JCT-ND
SW1	Switch: DIP, Top Slide, 2 Position, SPST, SMD	C&K	SDA02H1SBD	CKN6056-ND
TP1, TP2, TP3, TP4, TP5, TP8	Terminal: Turret, TH, Double	Keystone	1502-2	1502-2K-ND
TP6, TP7	Test Point: TH, Miniature, White	Keystone	5002	5002K-ND

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