User's Guide

SLVU332–October 2009

TPS61086EVM-526

This user's guide describes the characteristics, operation, and use of the TPS61086 evaluation module (EVM). This EVM contains the Texas Instruments 1.2-MHz, 18.5-V, step-up DC-DC converter TPS61086 with a switch current of 2 A, minimum. The user's guide includes EVM specifications, recommended test setup, the schematic diagram, bill of materials, and the board layout.

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1 Introduction

The TPS61086 is a high-frequency, high-efficiency, DC-to-DC converter with an integrated 2-A, 0.13-Ω power switch capable of providing an output voltage up to 18.5 V. The frequency of 1.2 MHz allows the use of small external inductors and capacitors and provides a fast transient response. The external compensation allows optimizing the application for specific conditions. A capacitor connected to the soft-start pin minimizes inrush current at start-up.

1.1 Description

The TPS61086EVM-526 is designed to operate over the full input voltage range and produces an output voltage of 12 V. The output voltage can be adjusted by changing the feedback resistor divider network. The external compensation is optimized for maximum stability for different inductor and capacitor combinations. If the transient response is not fast enough, it can easily be optimized for the used inductor and capacitor combinations by referring to Section 5.2 in this user's guide.

1.2 Applications

- Handheld devices
- GPS receiver
- Digital still camera
- Portable applications
- DSL modem
- PCMCIA card
- TFT LCD bias supply

1.3 Features

- 2.3-V to 6-V input range
- 12-V, fixed-output voltage, adjustable with resistor change (may require compensation adjustment)
- Power Save mode selectable
- Soft-start adjustable with capacitor change
- Thermal shutdown with autorecovery
- 1.2-MHz switching frequency
- Double-sided, two-active-layer PCB with all components on top side
- Active converter area of approximately 260 mm^2

2 TPS61086EVM-526 Electrical and Performance Specifications

Table 1. TPS61086EVM-526 Electrical and Performance Specifications

	PARAMETER	NOTES AND CONDITIONS	MIN	TYP	MAX	UNIT
INPUT CHARACTERISTICS						
V_{IN}	Input Voltage		2.3		6.0	V
I_{IN}	Input Current	V_{IN} = 3.3 V, I_{OUT} = 300 mA, PWM		1.65	1.8	A
	No Load Input Current	V_{IN} = 3.3 V, I_{OUT} = 0 A, PFM		0.8	2	mA
OUTPUT CHARACTERISTICS						
V_S	Output Voltage	V_{IN} = 3.3 V, I_{OUT} = 100 mA, PWM	11.7	12	12.3	V
	Line Regulation	V_{IN} = 2.3 V to 6 V, I_{OUT} = 100 mA, PWM		15	25	mV
	Load Regulation	I_{OUT} = 100 mA to 300 mA, PWM; V_{IN} = 3.3 V, PWM		3	10	mV
$V_{OUT(PP1)}$	Output Voltage Ripple, PFM	V_{IN} = 3.3 V, I_{OUT} = 4 mA, PFM		60		mV_{PP}
$V_{OUT(PP2)}$	Output Voltage Ripple, PWM	V_{IN} = 3.3 V, I_{OUT} = 300 mA, PWM		20		mV_{PP}

Table 1. TPS61086EVM-526 Electrical and Performance Specifications (continued)

	PARAMETER	NOTES AND CONDITIONS	MIN	TYP	MAX	UNIT
SYSTEMS CHARACTERISTICS						
f_{SW}	Switching Frequency			1.2	1.5	MHz
η_{pk}	Peak Efficiency	V_{IN} = 3.3 V		86%		

3 TPS61086EVM-526 Schematic

Figure 1 is for reference only; see Table 3 for specific values.

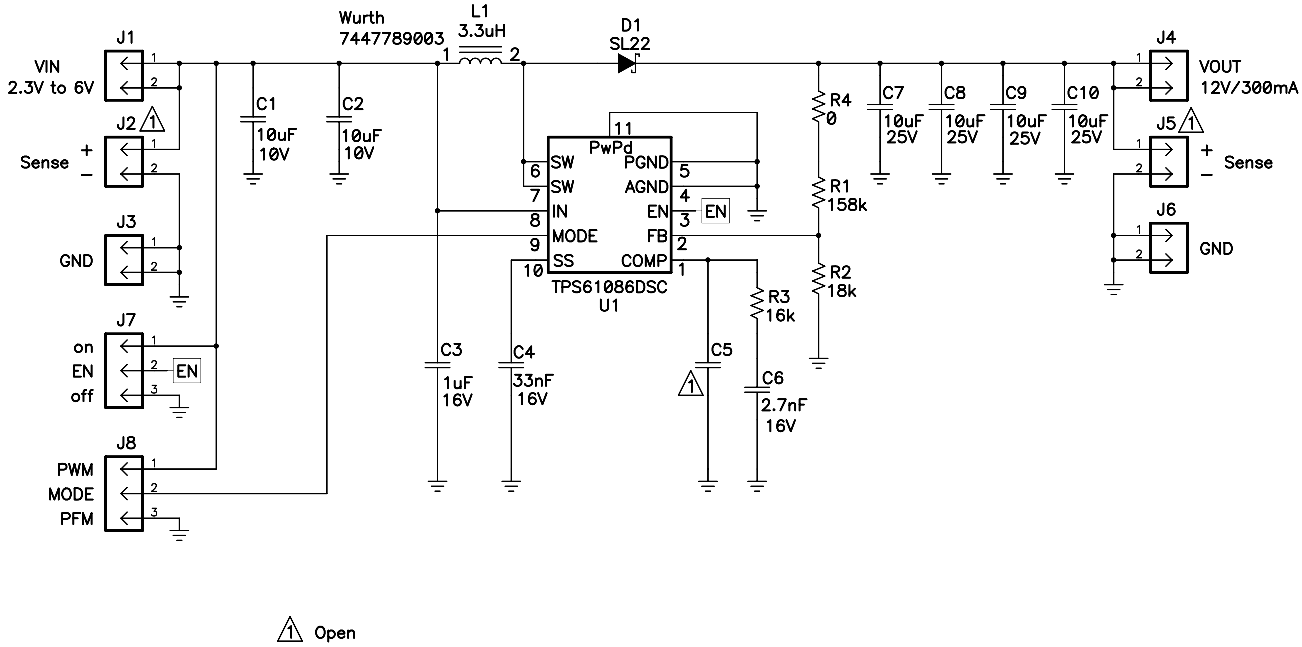

Figure 1. TPS61086EVM-526 Schematic

4 Connector and Test Point Descriptions

4.1 Input Connectors

4.1.1 J1 – VIN

This header is the positive connection to the input power supply. The power supply must be connected between J1 and J3 (GND). Twist the leads to the input supply and keep them as short as possible. The input voltage has to be between 2.3 V and 6 V.

4.1.2 J2 – Input Sense Connector

This header is unpopulated, but is reserved for future use to measure the input voltage directly on the input capacitor. Therefore, a 4-wire power and sense supply can be connected. Twist the leads to the sensing connector.

4.1.3 J3 – GND

This header is the return connection to the input power supply. Connect the power supply between these pins and J1 (VIN). Twist the leads to the input supply and keep them as short as possible. The input voltage must be between 2.3 V and 6 V.

4.2 Output Connectors

4.2.1 J4 – VOUT

This header is the positive connection of the output voltage. Connect the load between J4 and J6 (GND).

4.2.2 J5 – Output Sense Connector

This header is unpopulated, but is reserved for future use to measure the output voltage directly on the output capacitors.

4.2.3 J6 – GND

This header is the return connection of the output voltage. Connect the load between these pins and J4 (VOUT).

4.3 Jumpers

4.3.1 J7 – Enable Jumper

Placing a jumper across pins 1 and 2 ties the EN pin to VIN, thereby enabling the device. Placing a jumper across pins 2 and 3 ties the EN pin to GND, which disables the device.

4.3.2 J8 – MODE Jumper

The middle pin of this jumper connects to the MODE pin of the integrated circuit (IC). Placing a jumper across pins 1 and 2 ties the MODE pin to VIN, thereby forcing the IC into the PWM mode. In this mode, the IC operates with a fixed frequency for minimizing the output voltage ripple for the whole load range.

Placing a jumper across pins 2 and 3 ties the MODE pin to GND, which enables the Power Save mode for low-load currents. This mode maximizes the efficiency of the converter for low-output currents by turning off the switching action, if the output voltage is above the nominal value.

5 Test Setup

5.1 EVM Operation

The user must connect an input power supply set between 2.3 V and 6 V between headers J1 and J3 in order for the EVM to operate. The absolute maximum input voltage is 7 V.

The user can connect a load resistance between J4 and J6. Connect a jumper between pins 1 and 2 of J7 to enable the device and a jumper on J8 to set the used mode.

5.2 Compensation – COMP

The regulator loop can be compensated by adjusting the external components connected to the COMP pin. The COMP pin is the output of the internal transconductance error amplifier.

Standard values of $R_{COMP} = 16\ k\Omega$ and $C_{COMP} = 2.7\ nF$ work for the majority of the applications.

See Table 2 for dedicated compensation networks giving an improved load transient response. The following equations can be used to calculate R_{COMP} and C_{COMP} :

$$R_{COMP} = \frac{110 \times V_{IN} \times V_S \times C_{OUT}}{L \times I_{OUT}} \qquad C_{COMP} = \frac{V_S \times C_{OUT}}{7.5 \times I_{OUT} \times R_{COMP}} \tag{1}$$

with

V_{IN} Minimum input voltage
V_S Output voltage
C_{OUT} Output capacitance
L Inductor value, e.g. 3.3 µH
I_{OUT} Maximum output current in the application

Make sure that R_{COMP} < *120 kΩ* and C_{COMP}> *820 pF*, independent of the results of the above formulas.

Table 2. Recommended Compensation Network Values for Different Output Voltages

L	V_S	V_{IN} ± 20%	R_{COMP}	C_{COMP}
3.3 µH	15 V	5 V	100 kΩ	820 pF
		3.3 V	91 kΩ	1.2 nF
	12 V	5 V	68 kΩ	820 pF
		3.3 V	68 kΩ	1.2 nF
	9 V	5 V	39 kΩ	820 pF
		3.3 V	39 kΩ	1.2 nF

Table 2 gives conservative R_{COMP} and C_{COMP} values for certain inductors, input and output voltages providing a very stable system. For a faster response time, a higher R_{COMP} value can be used to enlarge the bandwidth, as well as a slightly lower value of C_{COMP} to keep enough phase margin. These adjustments must be performed in parallel with the load transient response monitoring of TPS61086.

6 TPS61086EVM-526 Assembly Drawings and Layout

Figure 2 through Figure 4 show the design of the TPS61086EVM-526 printed-circuit board (PCB). The EVM has been designed using a two-layer, 35-µm (1 oz), copper-clad circuit board 6.1 cm × 4.2 cm. All components are on the top side, and all active traces on the top and bottom layers allow the user to easily view, probe, and evaluate the TPS61086 control IC in a practical, double-sided application. Moving components to both sides of the PCB or using additional internal layers can offer additional size reduction for space-constrained systems.

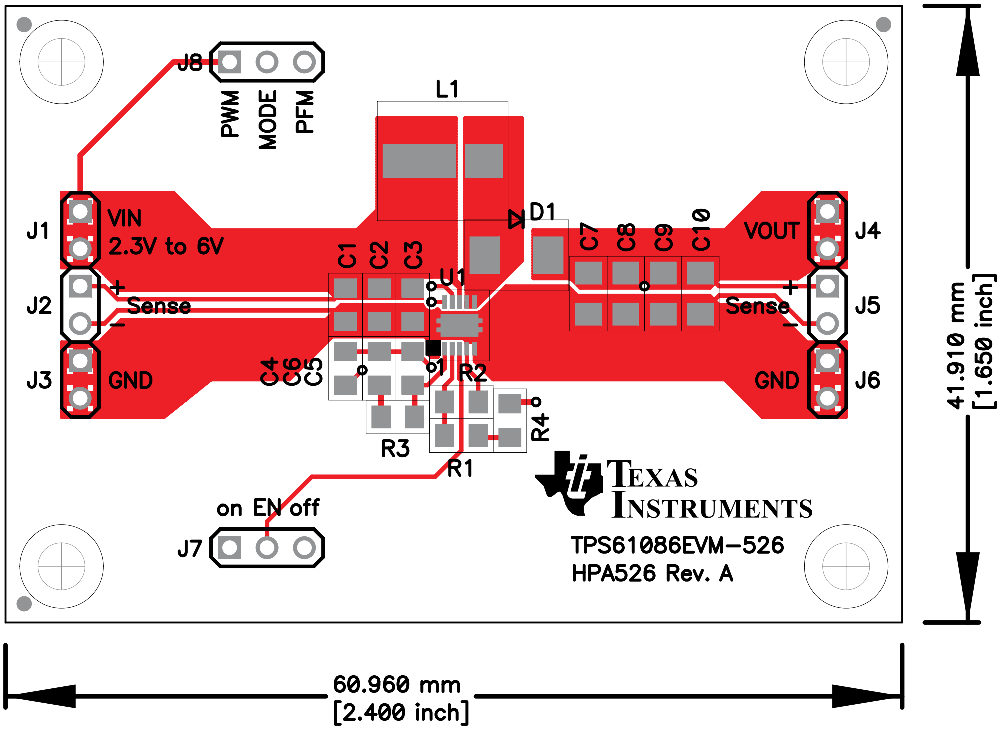

Figure 2. TPS61086EVM-526 Component Placement; Viewed From Top

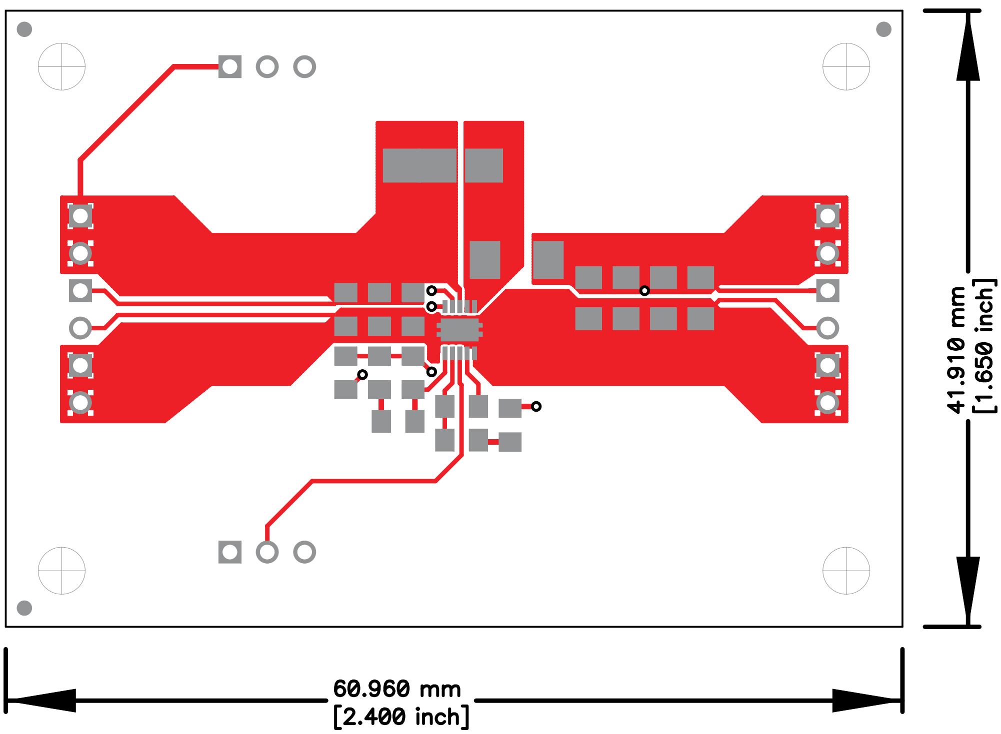

Figure 3. TPS61086EVM-526 Top Copper; Viewed From Top

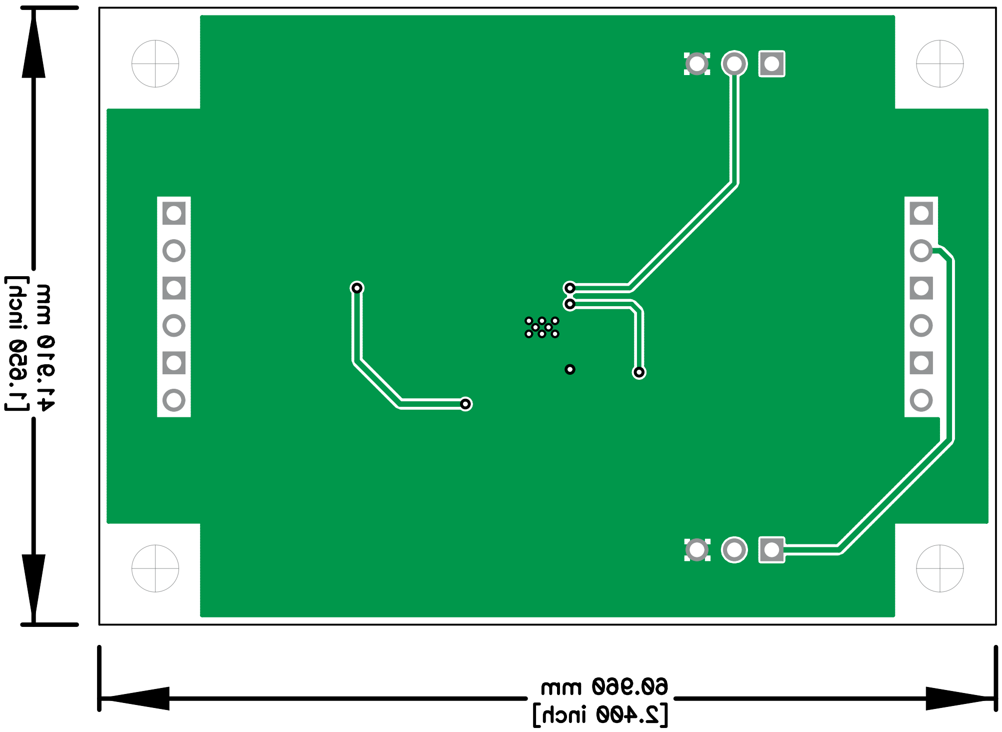

Figure 4. TPS61086EVM-526 Bottom Copper; Viewed From Bottom

7 List of Materials

Table 3 lists the EVM components as configured according to the schematic shown in Figure 1.

Table 3. TPS61086EVM-526 Bill of Materials

RefDes	Value	Description	Size	Part Number	MFR
C1, C2	10 µF	Capacitor, Ceramic, 10V, X7R, 10%	0805	GRM21BR71A106KE51 Alternate: LMK212BJ106KD	Murata Alternate: Taiyo Yuden
C3	1 µF	Capacitor, Ceramic, 16V, X7R, 10%	0805	GRM21BR71C105KA01	Murata
C4	33 nF	Capacitor, Ceramic,16V, X7R, 20%	0805	Std	Std
C5	open	Capacitor, Ceramic, X7R, 20%	0805	Std	Std
C6	2.7 nF	Capacitor, Ceramic,16V, X7R, 20%	0805	Std	Std
C7, C8, C9, C10	10 µF	Capacitor, Ceramic, 25V, X5R, 10%	1206	GRM31CR61E106KA12	Murata
D1	SL22	Diode, Schottky Rectifier, 2A, 20V	DO-214AA	SL22	Vishay
L1	3.3 µH	Inductor, SMT, 3.42A, 24 mΩ	0.288 × 0.288 inch	7447789003	Wurth Elektronik
R1	158k	Resistor, Chip, 1/10W, 1%	0805	Std	Std
R2	18k	Resistor, Chip, 1/10W, 1%	0805	Std	Std
R3	16k	Resistor, Chip, 1/10W, 1%	0805	Std	Std
R4	0	Resistor, Chip, 1/10W, 5%	0805	Std	Std
U1	TPS61086DSC	IC, 600kHz/1.2MHz Step-Up DC-DC Converter	SON-10	TPS61086DSC	TI

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 2.5 V to 6 V and a fixed-output voltage of 12 V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 85°C. The EVM is designed to operate properly with certain components above 125°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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