

AN-1885 LM22670 Evaluation Board

1 Introduction

The LM22670 evaluation board is designed to demonstrate the capabilities of the LM22670 switching regulator. The LM22670 evaluation board schematic shown in [Figure 1](#) is configured to provide an output voltage of 3.3V up to 3A load current with an input voltage range of 4.5V to 42V. Due to the low $R_{DS(ON)}$ of the integrated N-channel MOSFET and maximum duty-cycle limitations, the minimum input voltage of 4.5V will only provide a 3.3V output voltage for load currents up to 500 mA. For load currents higher than 500 mA, an input voltage of 5.5V or higher is required. The typical operating frequency is 500 kHz. The evaluation board is designed to operate at ambient temperatures up to 50°C.

The performance of the evaluation board is as follows:

- Input Range: 4.5V to 42V
- Output Voltage: 3.3V
- Output Current Range: 0A to 3A
- Frequency of Operation: 500 kHz
- Board Size: 1.5 × 1.5 inches
- Package: PSOP-8

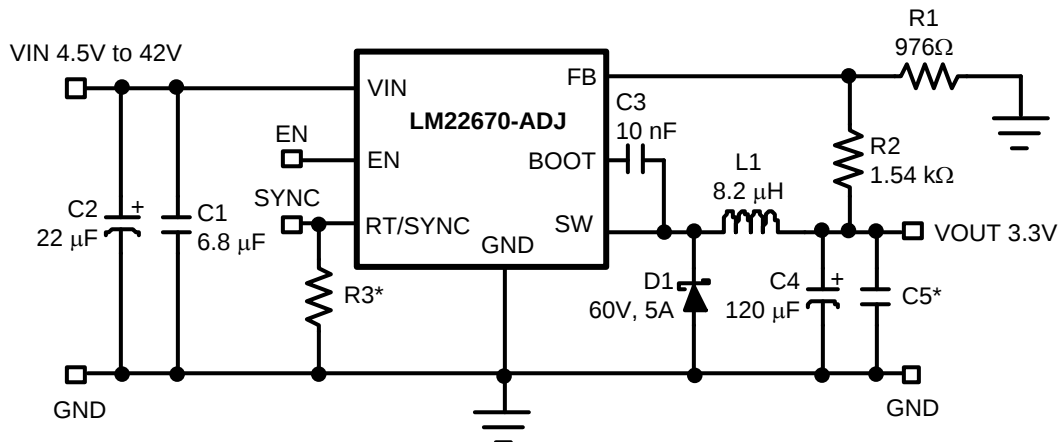
At low input voltages between 4.5V and 6V, a minimum load of approximately 5 mA may be required to reach a regulated 3.3V output voltage. For more details, see *LM22670/LM22670Q 42V, 3A SIMPLE SWITCHER, Step-Down Voltage Regulator with Features* ([SNVS584](#)).

To aid in the design and evaluation of DC/DC buck converter solutions based on the LM22670 switching regulator, the evaluation board can be re-configured for different output voltages.

The evaluation board is designed to highlight applications with a small solution size. This implies that there will be a tradeoff with the area of heat dissipation available. If this evaluation board is operated continuously at a full 3A load, it will get hot. For higher output voltages than the pre-adjusted 3.3V, the total output power as well as the total power conversion losses will increase. It is recommended to use a fan or other source of air flow when evaluating the board at full 3A load or at output voltages greater than 3.3V. Typical evaluation board performance and characteristics curves are shown in [Section 7](#). The PCB layout is shown in [Section 8](#).

Test points are provided to enable easy connection and monitoring of critical signals. When performing over load or short circuit tests, refer to the current limit section of the LM22670 datasheet ([SNVS584](#)) to determine if the circuit is in safe operating mode.

For more information about device function and electrical characteristics, refer to the LM22670 datasheet ([SNVS584](#)).



*component not populated on LM22670EVAL evaluation board

Figure 1. Evaluation Board Schematic

2 Evaluation Board Setup

Before applying power to the LM22670 evaluation board, all external connections should be verified. The external power supply must be turned off and connected with proper polarity to the VIN and GND posts. A load resistor or electronic load should be connected between the VOUT and GND posts as desired. Both the VIN and VOUT connections should use the closest GND posts respective to VIN or VOUT. The output voltage can be monitored with a multi-meter or oscilloscope at the VOUT post.

Once all connections to the evaluation board have been verified, input power can be applied. A load resistor or electronic load does not require connection during startup. If the EN test point is left floating, the output voltage will ramp up when an input voltage is applied. Make sure that the external power supply (input voltage power source) is capable of providing enough current so that the adjusted output voltage can be obtained. Keep in mind that the startup current will be greater than the steady state current.

3 Synchronization and Adjustable Frequency

A SYNC test point is provided to allow synchronization of the LM22670 to an external clock signal. Space for a frequency adjust resistor, R3, is also provided. Refer to the LM22670 datasheet ([SNVS584](#)) for more details about the synchronizing and adjustable frequency features.

4 Precision Enable

The EN test point provided on the LM22670 evaluation board can be used to shut down the LM22670 when connecting this test point to ground.

5 Component Selection

Before changing the default components, refer to *LM22670/LM22670Q 42V, 3A SIMPLE SWITCHER, Step-Down Voltage Regulator with Features* ([SNVS584](#)) for information regarding component selection. The WEBENCH® designer online circuit simulation tool is also available on the [TI website](#).

The output voltage is adjustable with resistors R1 and R2, shown in [Figure 1](#). Any changes to these evaluation board feedback resistors may require changes to the inductor and output capacitor values. It is especially important to change the output capacitor, C4, if the output voltages are adjusted higher than 5V. The Schottky diode, D1, has a voltage rating of 60V to allow for a 42V maximum input voltage. If the input voltage is below 38V, a 40V Schottky diode may be used with a lower forward voltage to improve efficiency. For improved heat dissipation, a Schottky diode in a D2PAK package may be selected for higher efficiency. The input capacitor, C2, is not always required. This capacitor is placed on the evaluation board to make the application robust and minimize input voltage ringing if power is suddenly applied. Capacitor C2 also helps stabilize the transfer function of the converter loop. The input capacitor C1 provides the main contribution to the switch current. Both capacitors are selected with appropriate values intended only for the evaluation of the LM22670. For production designs, the impedance of the power source as well as the ripple current rating of the selected input capacitors need to be taken into consideration and modified accordingly. See the LM22670 datasheet ([SNVS584](#)) for more information.

Output capacitor C5 is not populated but space is provided to add a second output capacitor. This second output capacitor may be used to further reduce output voltage ripple.

6 Bill of Materials

Table 1. LM22670EVAL Bill of Materials

Ref #	Value	Supplier	Part Number
C1	6.8 μ F 50V ceramic	TDK	C4532X7R1H685M
C2	22 μ F 63V electrolytic	Panasonic	EEEFK1J220XP
C3	10 nF 50V ceramic	TDK	C1608X7R1H103K
C4	120 μ F 6.3V 24mohm	Nippon Chemi-Con	APXE6R3ARA121ME61G
C5	Not populated	-	
C6	Not populated; not applicable for LM22670	-	
D1	60V 5A CSMH5-60	Central Semiconductor	CSMH5-60
L1	8.2 μ H 6.25A WE-PD L	Würth	744771008
		Coilcraft	MSS1260-822MX
R1	976 Ω 1%	-	CRCW0603976RFKEA
R2	1.54 k Ω 1%	-	CRCW06031K54FKEA
R3	Not populated	-	
U1		Texas Instruments	LM22670

7 Performance Characteristics

Unless otherwise specified, $V_{IN} = 12V$, $T_A = 25^{\circ}C$.

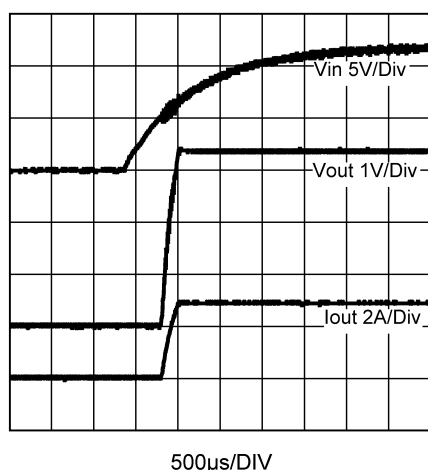


Figure 2. Start-Up Waveforms
(Load Resistor = 1.1Ω)

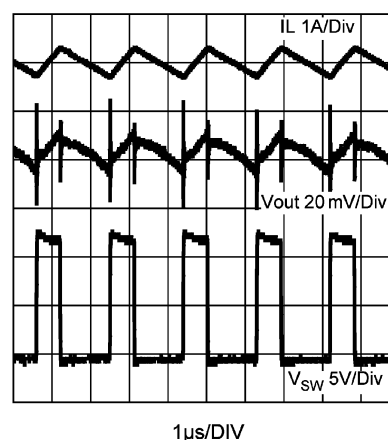


Figure 3. Operation at 3A

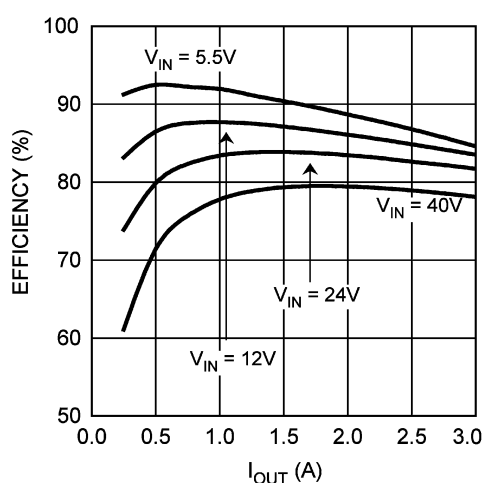


Figure 4. Efficiency vs I_{OUT}

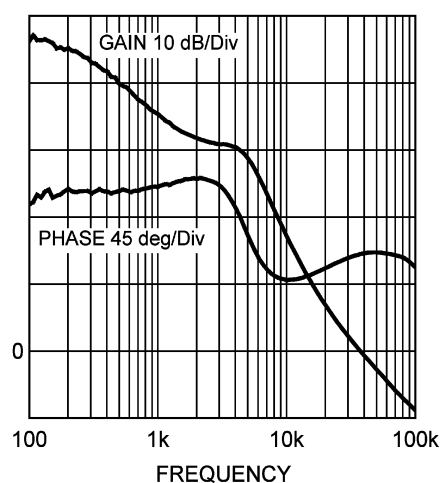


Figure 5. Overall Loop Gain and Phase ($I_{OUT} = 3A$)

8 PCB Layout Diagram

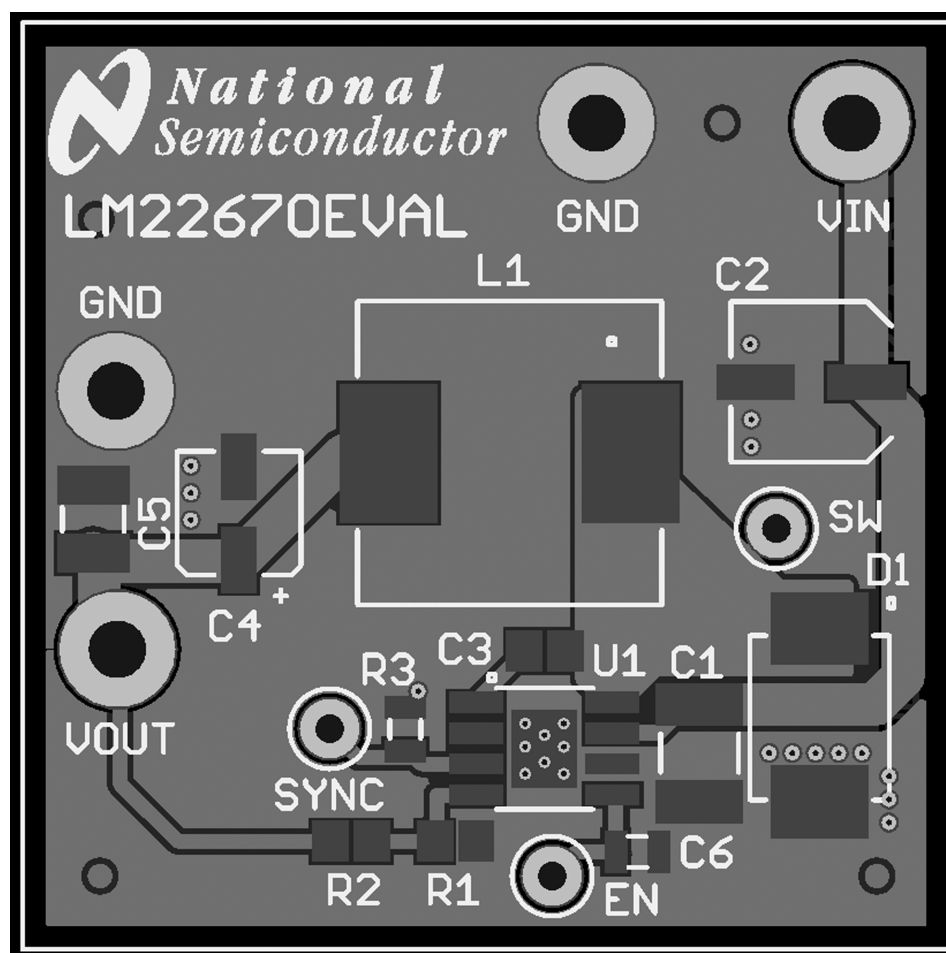


Figure 6. Top Layer

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

Applications

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

TI E2E Community

e2e.ti.com