

65V, 8A Synchronous Step-Down Silent Switcher 2

General Description

The evaluation circuit EVAL-LT8645SA-AZ is a 65V, 8A synchronous step-down second generation Silent Switcher® with spread spectrum frequency modulation featuring the LT8645SA. The evaluation board is designed for 5V output from a 5.6V to 65V input. The wide input range allows a variety of input sources, such as automotive batteries and industrial supplies. The LT8645SA is a compact, ultralow emission, high efficiency, and high speed synchronous monolithic step-down switching regulator. The integrated bypass capacitors optimize all the fast current loops and make it easier to minimize EMI/EMC emissions by reducing layout sensitivity. Selectable spread spectrum mode can further improve EMI/EMC performance. Ultralow quiescent current in Burst Mode® operation achieves high efficiency at very light loads. Fast minimum on-time of 40ns enables high V_{IN} to low V_{OUT} conversion at high frequency.

The LT8645SA switching frequency can be programmed either through oscillator resistor or external clock over a 200kHz to 2.2MHz range. The default frequency of EVAL-LT8645SA-AZ is 2MHz. The SYNC pin on the demo board is grounded (JP1 at BURST position) by default for low ripple Burst Mode operation. To synchronize to an external clock, move JP1 to SYNC and apply the external clock to the SYNC terminal. Select the spread spectrum mode and forced continuous mode (FCM), respectively, by moving the JP1 shunt. [Figure 1](#) shows the efficiency of the circuit at 12V input and 24V input in Burst Mode operation (input

from V_{IN} terminal to bypass the EMI filter). [Figure 2](#) shows the LT8645SA temperature rising on EVAL-LT8645SA-AZ board under different load conditions. The rated maximum load current is 8A, while derating is necessary for certain input voltage and thermal conditions. Low switching frequency can extend the output load capability by reducing the power dissipation. [Figure 3](#) shows the temperature rising at 400kHz switching frequency.

The evaluation board has an EMI filter installed. [Figure 4](#) shows the EMI performance of the board (with EMI filter). The red line in conducted and radiated EMI performance is CISPR25 class 5 peak limit. The figure shows that the circuit passes the test with a wide margin. To achieve EMI/EMC performance, as shown in [Figure 4](#), the input EMI filter is required, and the input voltage should be applied at the VEMI terminal. An inductor can be added in the EMI filter to further reduce the conducted emission. The EMI filter can be bypassed by applying the input voltage at V_{IN} terminal.

The LT8645SA data sheet gives a complete description of the part, operation and application information. The data sheet must be read in conjunction with this user guide for EVAL-LT8645SA-AZ. The LT8645SA is assembled in a 6mm x 4mm LQFN package with exposed pads for low thermal resistance. The layout recommendations for low EMI operation and maximum thermal performance are available in the data sheet section Low EMI PCB Layout and Thermal Considerations.

Performance Summary Specifications are at $T_A = 25^\circ\text{C}$

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|------------------------------------|---------------|---|------|-----|------|-------|
| Input Power Supply with EMI Filter | V_{IN_EMI} | | 5.6* | | 65 | V |
| Output Voltage | V_{OUT} | | 4.85 | 5 | 5.15 | V |
| Maximum Output Current | I_{OUT} | Derating is necessary for certain V_{IN} and thermal conditions | 8 | | | A |
| Switching Frequency | f_{SW} | | 1.85 | 2 | 2.15 | MHz |
| Efficiency | EFF | $V_{IN} = 12V, I_{OUT} = 4A$ | | 93 | | % |

*The minimum input voltage of the evaluation board guarantees 5V output regulation. The minimum input voltage of the LT8645SA is 3V. Refer to the [LT8645SA](#) data sheet for more details.

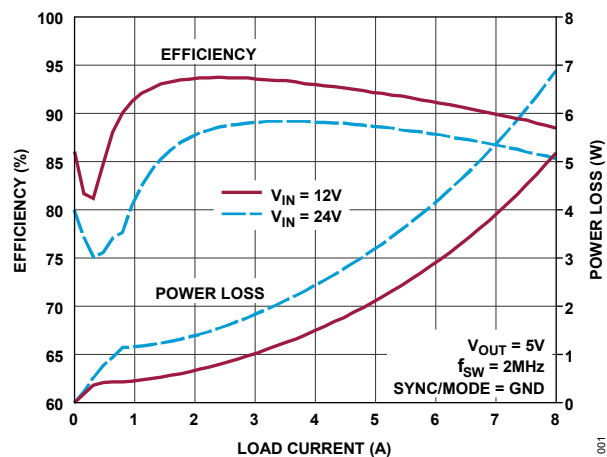


Figure 1. EVAL-LT8645SA-AZ Efficiency vs. Load Current (Input from V_{IN} Terminal)

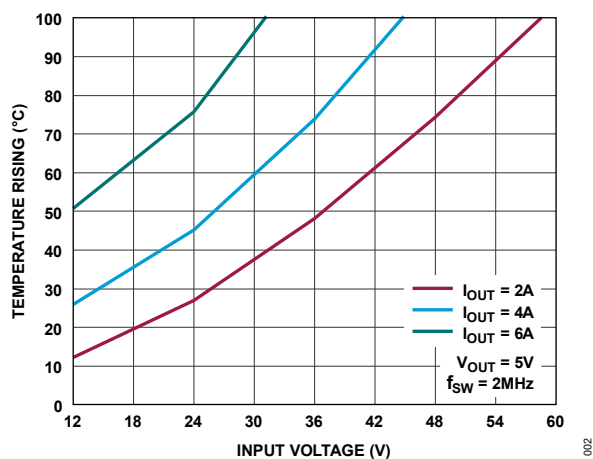


Figure 2. EVAL-LT8645SA-AZ Temperature Rising vs. Input Voltage (2MHz)

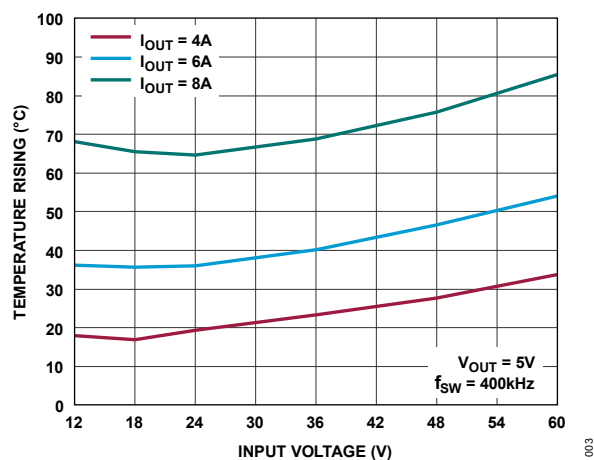
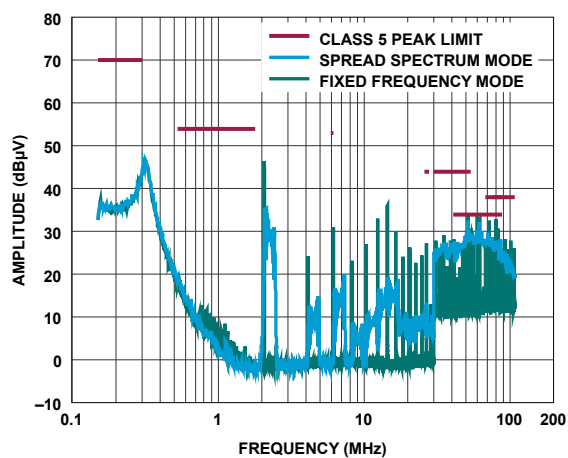


Figure 3. EVAL-LT8645SA-AZ Temperature Rising vs. Input Voltage (400kHz)

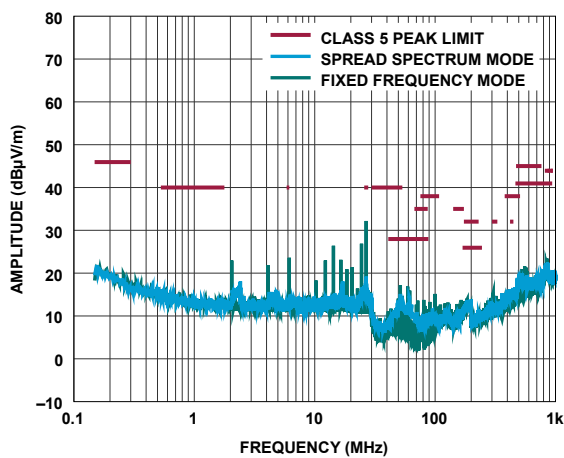
Conducted EMI Performance (CISPR25 Conducted Emission Test with Class 5 Peak Limits)



EVAL-LT8645SA-AZ DEMO BOARD
(WITH EMI FILTER INSTALLED)
24V INPUT TO 5V OUTPUT AT 4A, $f_{SW} = 2\text{MHz}$

004

Radiated EMI Performance (CISPR25 Radiated Emission Test with Class 5 Peak Limits)



EVAL-LT8645SA-AZ DEMO BOARD
(WITH EMI FILTER INSTALLED)
24V INPUT TO 5V OUTPUT AT 4A, $f_{SW} = 2\text{MHz}$

005

Figure 4. Evaluation Board EVAL-LT8645SA-AZ EMI Performance 24V
Input from VEMI, with EMI Filter, $I_{OUT} = 4\text{A}$

Quick Start Procedure

The evaluation circuit EVAL-LT8645SA-AZ is easy to set up to evaluate the performance of the LT8645SA. See [Figure 5](#) for proper measurement equipment setup and follow the procedure below:

NOTE: When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the output voltage ripple by touching the probe tip directly across the output capacitor. See [Figure 6](#) for the proper scope technique. [Figure 7](#) shows the output voltage ripple measured at the output capacitor C9.

1. Place JP1 on BURST position.
2. With power off, connect the input power supply to VEMI and GND. If the input EMI filter is not desired, connect the input power supply to VIN and GND.
3. With power off, connect the load from VOUT to GND.
4. Turn on the power at the input.
NOTE: Make sure that the input voltage does not exceed 65V.
5. Check for the proper output voltage ($V_{OUT} = 5V$).
NOTE: If there is no output, temporarily disconnect the load to make sure that the load is not set too high or is shorted.
6. Once the proper output voltage is established, adjust the load within the operating ranges and observe the output voltage regulation, ripple voltage, efficiency, and other parameters.
7. Add an external clock to the SYNC terminal when using the SYNC function (JP1 on the SYNC position). Choose the R2 to set the LT8645SA switching frequency equal to or below the lowest SYNC frequency. JP1 can also set LT8645SA in spread spectrum mode (JP1 on the spread-spectrum position) or forced continuous mode (JP1 on the FCM position).

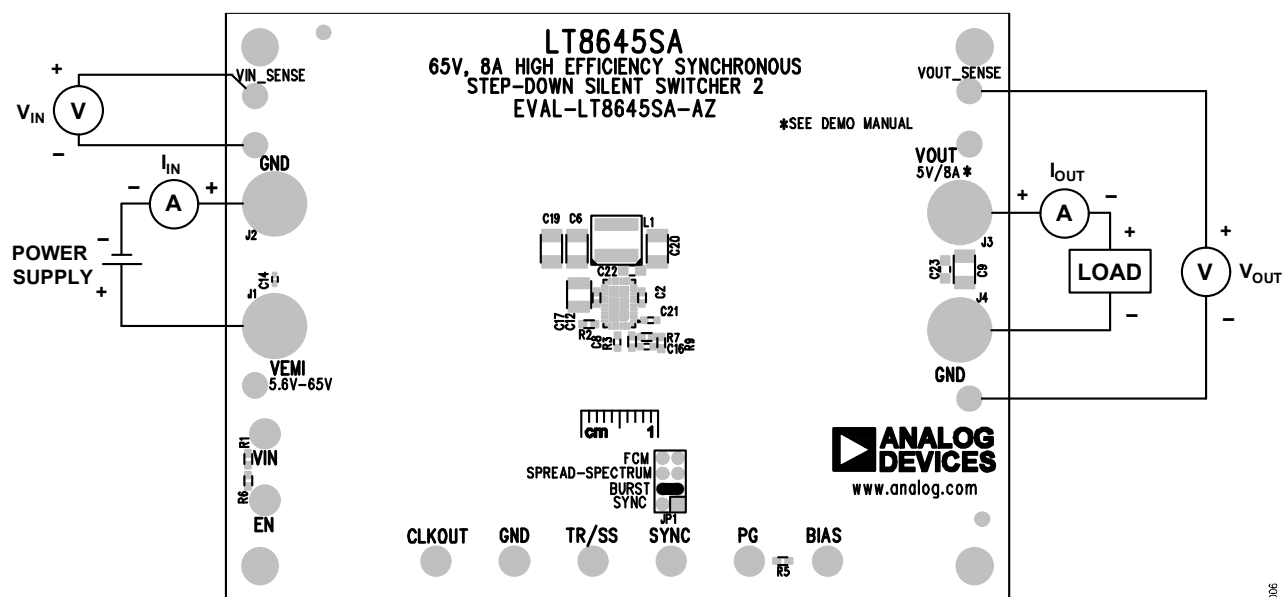


Figure 5. Proper Measurement Equipment Setup

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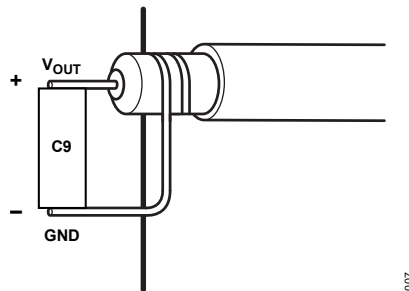


Figure 6. Measuring Output Ripple at Output Capacitor C9

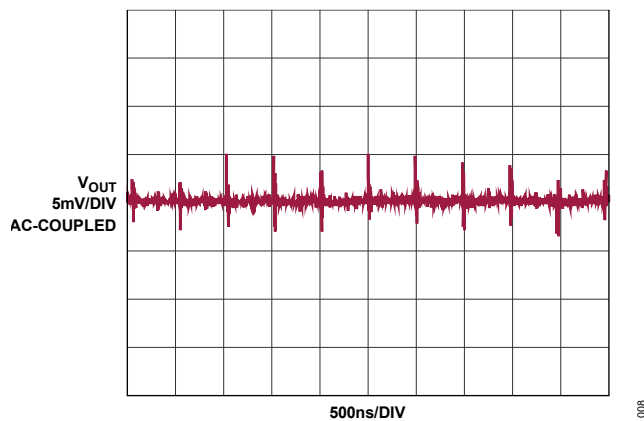
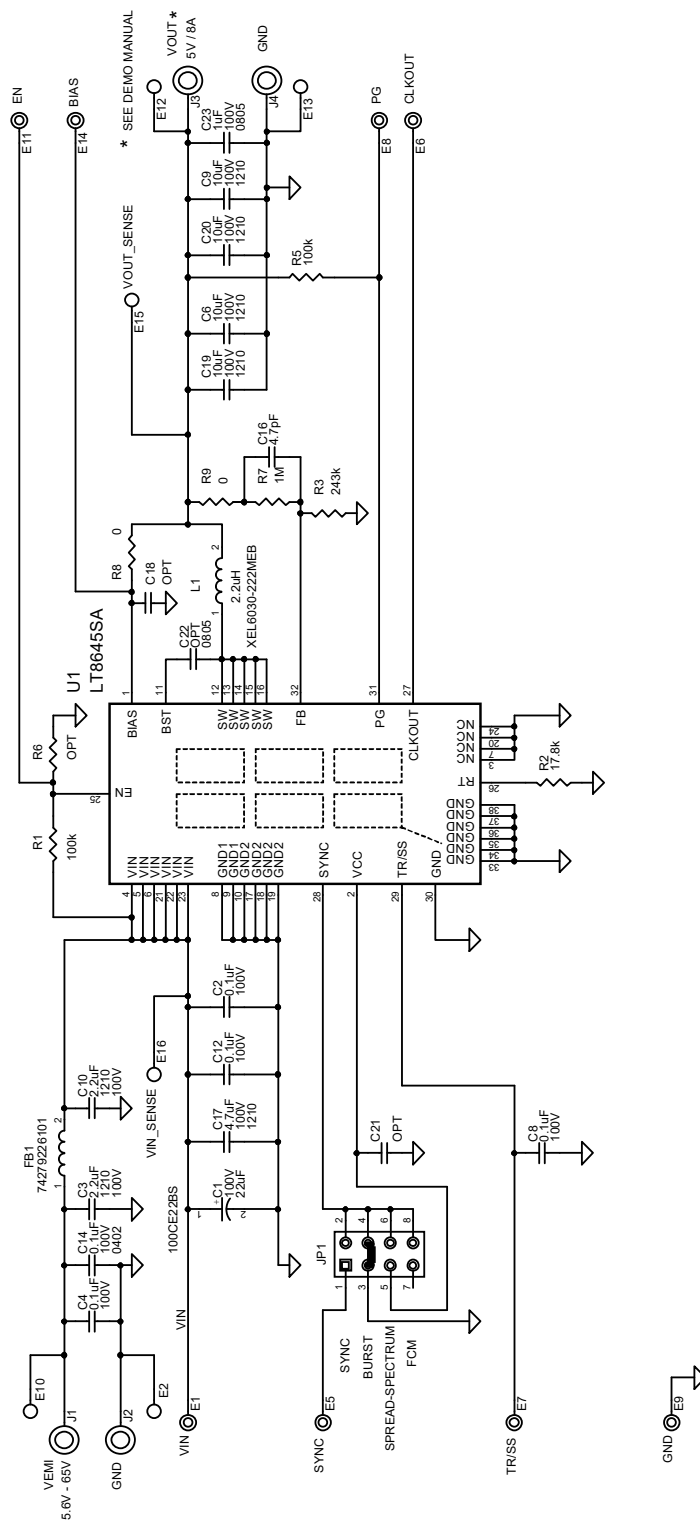


Figure 7. EVAL-LT8645SA-AZ Output Voltage Ripple 12V Input, $I_{OUT} = 8A$, Full BW

Bill of Materials

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER, PART NUMBER |
|---|-----|-----------------------------|--|-----------------------------------|
| REQUIRED CIRCUIT COMPONENTS | | | | |
| 1 | 3 | C2, C8, C12 | Capacitors, 0.1 μ F, X7S, 100V, 10%, 0603 | TDK, CGA3E3X7S2A104K080AB |
| 2 | 3 | C6, C19, C20 | Capacitors, 10 μ F, X7S, 100V, 10%, 1210 | Murata, GRM32EC72A106KE05L |
| 3 | 1 | C16 | Capacitor, 4.7pF, C0G/NP0, 50V, 0603 | AVX, 06035A4R7CAT2A |
| 4 | 1 | C17 | Capacitor, 4.7 μ F, X7S, 100V, 10%, 1210 | TDK, C3225X7S2A475K200AB |
| 5 | 1 | L1 | Inductor, 2.2 μ H, 20%, 10A, 13.97m Ω | Coilcraft, XEL6030-222MEB |
| 6 | 1 | R1 | Resistor, 100k Ω , 5%, 1/10W, 0603 | Vishay, CRCW0603100KJNEA |
| 7 | 1 | R2 | Resistor, 17.8k Ω , 1%, 1/10W, 0603 | Vishay, CRCW060317K8FKEA |
| 8 | 1 | R3 | Resistor, 243k Ω , 1%, 1/10W, 0603 | Vishay, CRCW0603243KFKEA |
| 9 | 1 | R5 | Resistor, 100k Ω , 1%, 1/10W, 0603 | Vishay, CRCW0603100KFKEA |
| 10 | 1 | R7 | Resistor, 1M Ω , 1%, 1/10W, 0603 | Vishay, CRCW06031M00FKEA |
| 11 | 1 | R9 | Resistor, 0 Ω , 1/10W, 0603 | Vishay, CRCW06030000Z0EA |
| 12 | 1 | U1 | IC., Regulator, 32-LQFN | LT8645SAAV#PBF |
| ADDITIONAL EVALUATION BOARD COMPONENTS | | | | |
| 1 | 1 | C1 | Capacitor, 22 μ F, Aluminum, 100V, 20% | Suncon, 100CE22BS |
| 2 | 2 | C3, C10 | Capacitors, 2.2 μ F, X7R, 100V, 10%, 1210 | AVX, 12101C225KAT2A |
| 3 | 1 | C4 | Capacitor, 0.1 μ F, X7S, 100V, 10%, 0603 | TDK, CGA3E3X7S2A104K080A |
| 4 | 1 | C9 | Capacitor, 10 μ F, X7S, 100V, 10%, 1210 | Murata, GRM32EC72A106KE05L |
| 5 | 1 | C14 | Capacitor, 0.1 μ F, X5R, 100V, 10%, 0402 | Murata, GRM155R62A104KE14D |
| 6 | 0 | C18, C21 | Capacitors, Option, 0603 | |
| 7 | 0 | C22 | Capacitor, Option, 0805 | |
| 8 | 1 | C23 | Capacitor, 1 μ F, X7R, 100V, 10%, 0805 | AVX, 08051C105K4T2A |
| 9 | 1 | FB1 | Ferrite Bead, 8A, 1812 | Würth, 74279226101 |
| 10 | 0 | R6 | Resistor, Option, 0603 | |
| 11 | 1 | R8 | Resistor, 0 Ω , 1/10W, 0603 | Vishay, CRCW06030000Z0EA |
| HARDWARE FOR EVALUATION BOARD ONLY | | | | |
| 1 | 8 | E1, E5-E9, E11, E14 | Test Point, Turret, 0.094" | Mill-Max, 2501-2-00-80-00-00-07-0 |
| 2 | 6 | E2, E10, E12, E13, E15, E16 | Test Point, Turret, 0.064" | Mill-Max, 2308-2-00-80-00-00-07-0 |
| 3 | 4 | J1-J4 | Connector, Banana Jack | Keystone, 575-4 |
| 4 | 1 | JP1 | Connector, 2 x 4, 2mm | Würth, 62000821121 |
| 5 | 4 | MP1-MP4 | Standoff, Nylon, 0.50" | Keystone, 8833 |
| 6 | 1 | XJP1 | Connector, Shunt, 2mm | Würth, 60800213421 |

Schematic Diagram



NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS ARE 0603.
ALL CAPACITORS ARE 0603.

Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|--------------------|------------------|-----------------|------------------|
| 0 | 10/25 | Initial release | — |

Notes

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