

LT8644S

8V, 16A Synchronous Step-Down Silent Switcher 2

DESCRIPTION

Demonstration circuit 2779A is an 8V, 16A synchronous step-down Silent Switcher® 2 with spread spectrum frequency modulation featuring the [LT®8644S](#). The demo board is designed for 1.2V output from a 2.7V to 8V input. The LT8644S 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 emissions by reducing layout sensitivity. Selectable spread spectrum mode further improves EMI performance, making it perfect solution to the noise sensitive applications.

Peak current mode control with minimum on-time of as low as 20ns allows high step-down conversion even at high frequency. The LT8644S switching frequency can be programmed either via an external resistor or an external clock over a 300kHz to 3.5MHz range. The default frequency of demo circuit 2779A is 2MHz.

The SYNC/MODE pin on the demo board DC2779A is grounded (JP1 at BURST position) by default for low ripple Burst Mode® operation. It can be configured into different operation modes through JP1 and SYNC terminal (Table 1).

Table 1. Operation Mode Configuration

| JP1 Position | SYNC (E5) Input | Operation Mode |
|-----------------|-----------------|--|
| SPREAD-SPECTRUM | N/A | Forced Continuous Mode with Spread-Spectrum |
| BURST | N/A | Low Ripple Burst Mode |
| FCM/SYNC | Floating | Forced Continuous Mode without Spread-Spectrum |
| FCM/SYNC | External Clock | Forced Continuous Mode with Synchronization |

Figure 4 shows the efficiency of the circuit at 3.3V input and 5V input in force continuous mode operation (input from VIN terminal). To get accurate efficiency measurement, measure the input voltage at the VIN_SENSE/GND terminals and measure the output voltage at the VOUT+ SENSE/VOUT- SENSE terminals. Figure 5 shows the LT8644S temperature rise on DC2779A demo board at 3.3V input and 5V input in forced continuous mode.

The LT8644S is assembled in a 4mm × 4mm LQFN package with exposed pads for low thermal resistance. The rated maximum continuous load current is 16A, while derating may be necessary for certain input voltage and thermal conditions.

The demo board has an EMI filter installed. This EMI filter can be included by applying the input voltage at the VEMI terminal. The EMI performance of the board (with EMI filter) is shown on Figure 6. The red lines in EMI Performance are CISPR25 Class 5 limits. The figure shows that the LT8644S circuit passes the test with a wide margin. To achieve EMI performance as shown in Figure 6, the input EMI filter is required and the input voltage should be applied to VEMI terminal, and the test setup can be referred to the CISPR25 standards. If the input is applied to VIN terminal, the EMI filter is bypassed.

The LT8644S data sheet gives a complete description of the part, the operation and application information. The data sheet must be read in conjunction with this demo manual for demo circuit 2779A. 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. Contact ADI applications engineer for support.

[Design files for this circuit board are available.](#)

All registered trademarks and trademarks are the property of their respective owners.

PERFORMANCE SUMMARY Specifications are at $T_A = 25^\circ\text{C}$

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|-----------|-----------------------------------|---|------|------|------|-------|
| V_{IN} | Input Supply Range | | 2.7 | | 8 | V |
| V_{OUT} | Output Voltage | $V_{IN} = 5V$ | 1.18 | 1.2 | 1.22 | V |
| I_{OUT} | Maximum Continuous Output Current | | 16 | | | A |
| f_{SW} | Switching Frequency | | 1.95 | 2 | 2.05 | MHz |
| EFF | Efficiency | $V_{IN} = 5V, V_{OUT} = 1.2V, I_{OUT} = 8A$ | | 90.2 | | % |

QUICK START PROCEDURE

Demonstration circuit 2779A is easy to set up to evaluate the performance of the LT8644S. Refer to Figure 1 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 2 for the proper scope technique.

1. Make sure the Jump JP1 is on the BURST position. Refer to the schematic.
2. With power off, connect the input power supply to V_{IN} and GND. If the input EMI filter is desired, connect the input power supply to V_{EMI} and GND.
3. With power off, connect the load from V_{OUT+} to V_{OUT-} .
4. Connect the voltage meter across the V_{IN_SENSE} and GND for V_{IN} measurement, and V_{OUT+_SENSE} and V_{OUT-_SENSE} for V_{OUT} measurement.
5. Turn on the power at the input.

NOTE: Make sure that the input voltage does not exceed 8V.

6. Check for the proper output voltage ($V_{OUT} = 1.2V$).

NOTE: If there is no output, temporarily disconnect the load to make sure that the load is not set too high or is shorted.

7. 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.
8. An external clock can be added to the SYNC terminal when SYNC function is used (JP1 on the FCM/SYNC position). Please make sure that R2 should be chose to set the LT8644S switching frequency equal to or below the lowest SYNC frequency. When JP1 is in FCM/SYNC position and no external clock is connected to the SYNC terminal of the board, the SYNC/MODE pin is floating and the LT8644S runs in forced continuous mode. JP1 can also set LT8644S in spread spectrum mode (JP1 on the SPREAD-SPECTRUM position).
9. To test the transient response, connect a signal generator to PULSE GEN terminal, and add a desired base load between V_{OUT+} and V_{OUT-} (LOAD shown on Figure 1). Adjust the signal generator with a 2ms period, 5% duty cycle and an amplitude from 1V to 2V to start. Measure the LOAD STEP voltage to observe the current ($I_{LOADSTEP} = V_{LOAD_STEP}/10m\Omega$). Adjust the amplitude of the pulse to provide the desired transient. Adjust the rising and falling edge of the pulse to provide the desired ramp rate. Figure 3 shows a load step from 4A to 12A. The 4A base load is added between V_{OUT+} and V_{OUT-} , while the 8A step load is controlled by the signal generator at PULSE_GEN and measured at LOAD_STEP with 0.01V/A ratio.

QUICK START PROCEDURE

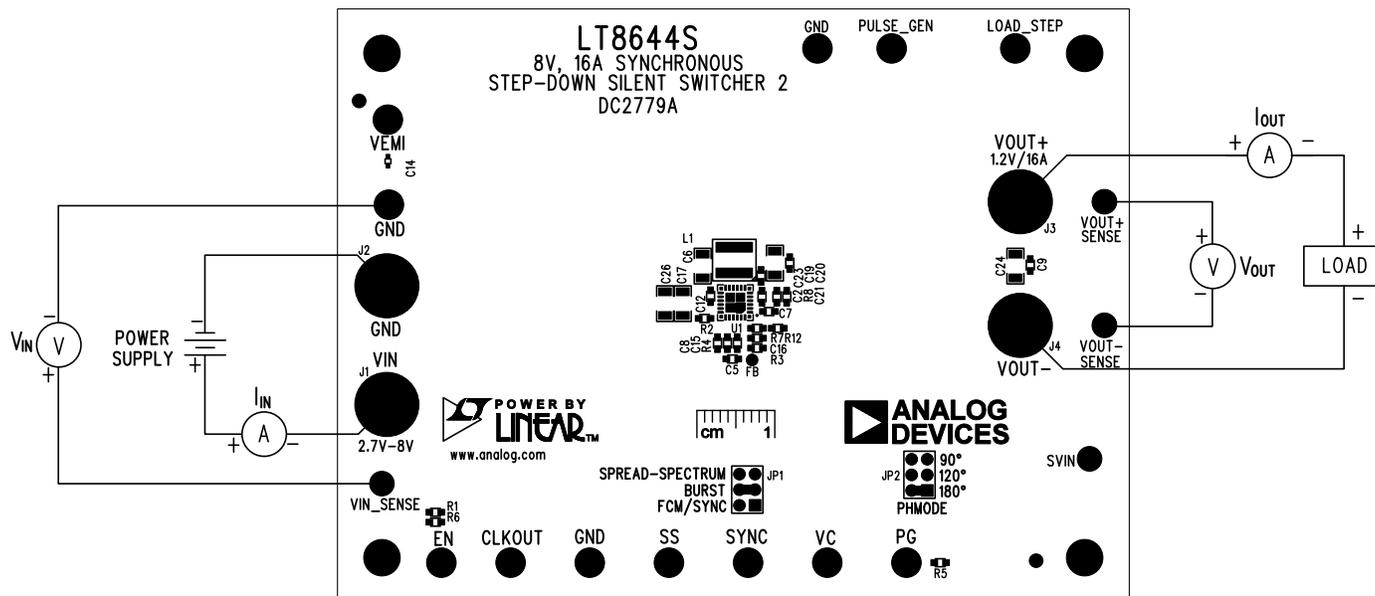


Figure 1. Proper Measurement Equipment Setup

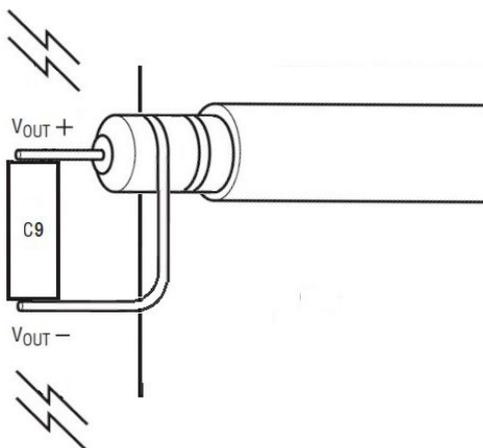


Figure 2. Measuring Output Ripple at Output Capacitor C9

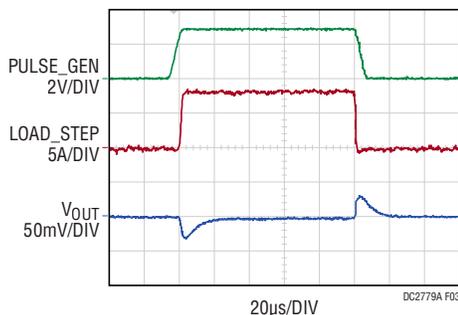


Figure 3. LT8644S Demo Circuit DC2779A Transient Response ($V_{IN} = 5V$, 4A to 12A Load Step)

QUICK START PROCEDURE

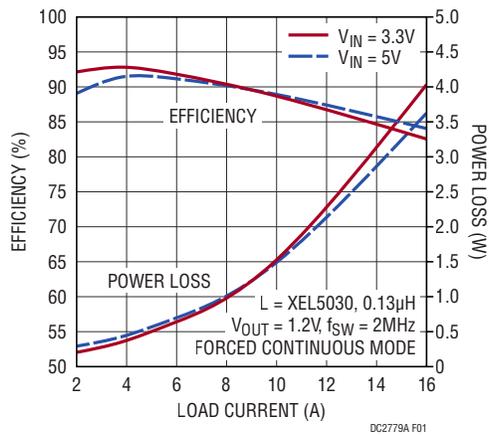


Figure 4. LT8644S Demo Circuit DC2779A Efficiency vs Load Current

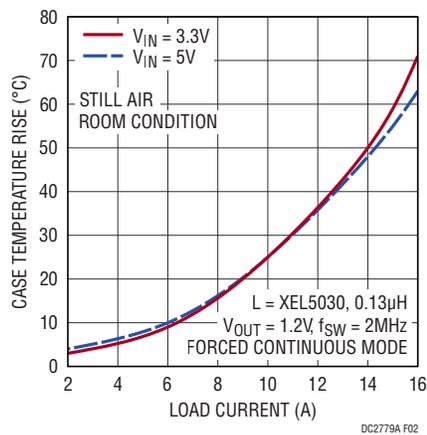
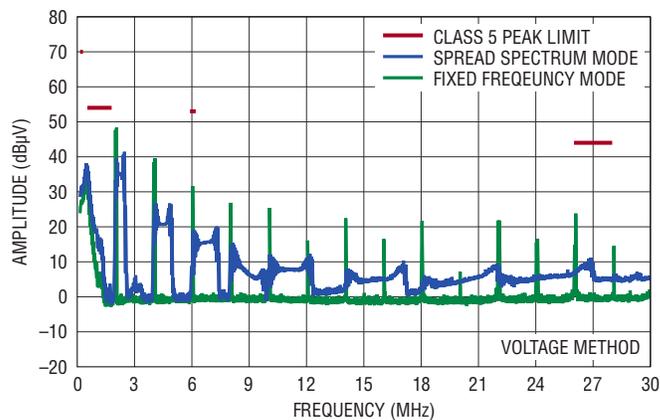


Figure 5. LT8644S Demo Circuit DC2779A Case Temperature Rise vs Load Current

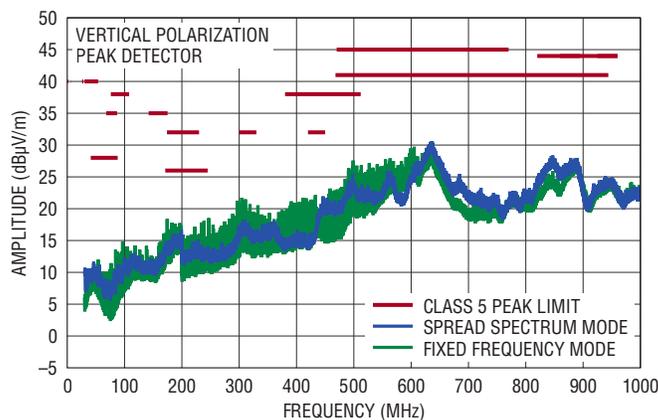
QUICK START PROCEDURE

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

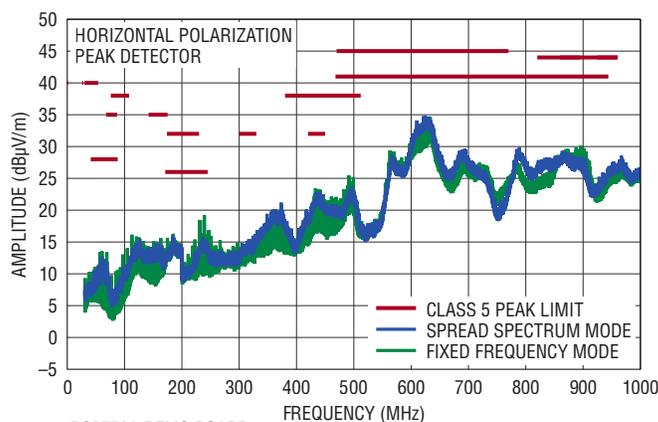


DC2779A F03a

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



DC2779A F03b



DC2779A F03c

DC2779A DEMO BOARD
(WITH EMI FILTER INSTALLED)
5V INPUT TO 1.2V OUTPUT AT 16A, $f_{SW} = 2\text{MHz}$

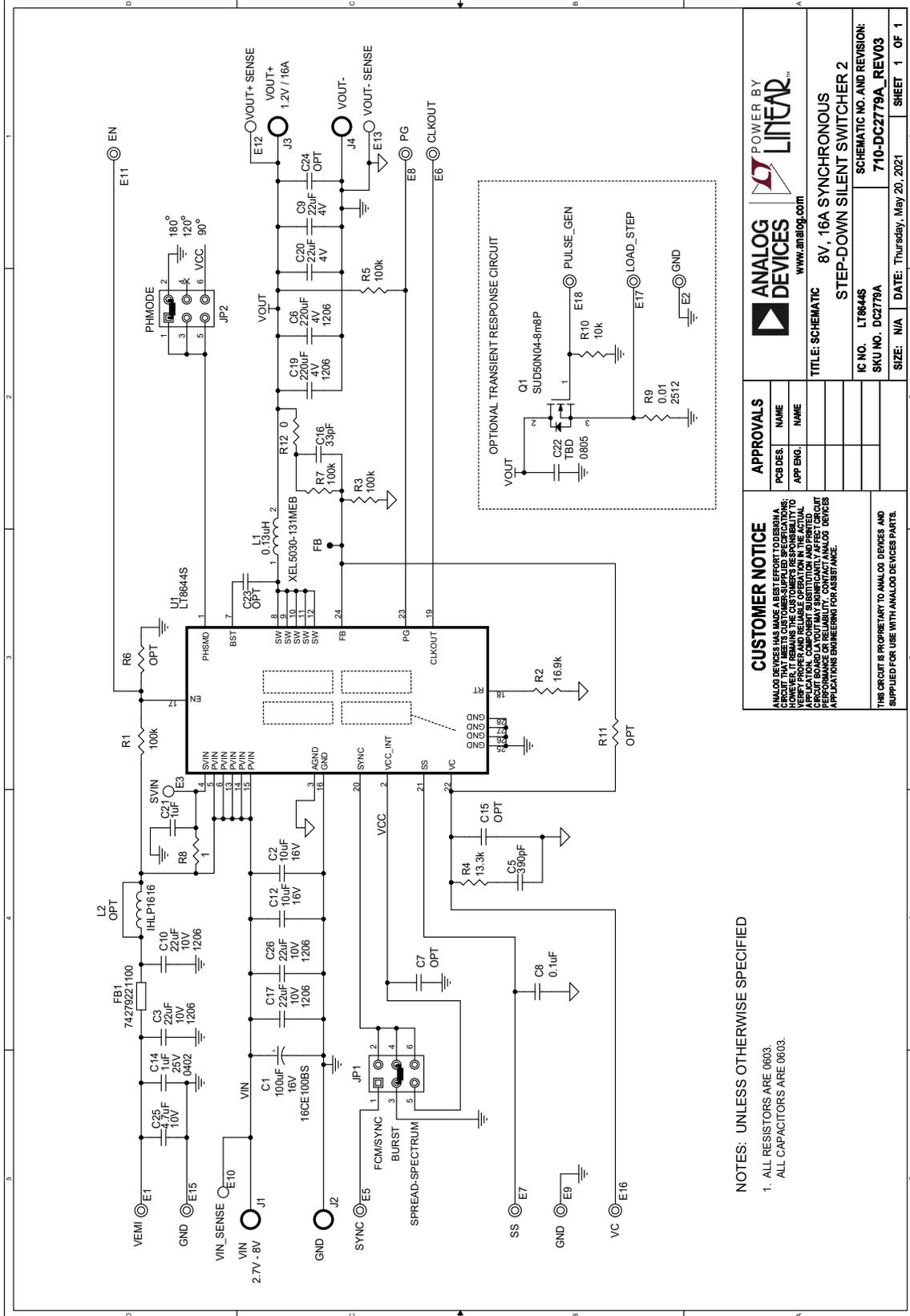
Figure 6. LT8644S Demo Circuit DC2779A EMI Performance

DEMO MANUAL DC2779A

PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|---|-----|-----------------------------|--|---|
| Required Circuit Components | | | | |
| 1 | 2 | C2, C12 | CAP, 10 μ F, X5R, 16V, 10%, 0603 | MURATA, GRM188R61C106KAALD |
| 2 | 1 | C5 | CAP, 390pF, C0G/NP0, 50V, 5%, 0603 | AVX, 06035A391JAT2A |
| 3 | 2 | C6, C19 | CAP, 220 μ F, X5R, 4V, 20%, 1206 | MURATA, GRM31CR60G227ME11L |
| 4 | 1 | C8 | CAP, 0.1 μ F, X7R, 16V, 10%, 0603 | AVX, 0603YC104KAT2A |
| 5 | 2 | C9, C20 | CAP, 22 μ F, X5R, 4V, 20%, 0603 | MURATA, GRM188R60G226MEA0D |
| 6 | 1 | C16 | CAP, 33pF, C0G, 50V, 5%, 0603 | AVX, 06035A330JAT2A |
| 7 | 2 | C17, C26 | CAP, 22 μ F, X7R, 10V, 10%, 1206 | MURATA, GRM31CR71A226KE15L |
| 8 | 1 | C21 | CAP, 1 μ F, X7R, 16V, 10%, 0603 | AVX, 0603YC105KAT2A |
| 9 | 1 | L1 | IND., 0.13 μ H, PWR, 20%, 35A, 1.83m Ω , 5.48mm \times 5.28mm | COILCRAFT, XEL5030-131MEB |
| 10 | 4 | R1, R3, R5, R7 | RES., 100k, 1%, 1/10W, 0603 | VISHAY, CRCW0603100KFKEA |
| 11 | 1 | R2 | RES., 16.9k, 1%, 1/10W, 0603 | VISHAY, CRCW060316K9FKEA |
| 12 | 1 | R4 | RES., 13.3k, 1%, 1/10W, 0603 | VISHAY, CRCW060313K3FKEAC |
| 13 | 1 | R8 | RES., 1 Ω , 1%, 1/10W, 0603 | VISHAY, CRCW06031R00FKEA |
| 14 | 1 | U1 | IC, STEP-DOWN SWITCHER, LQFN-24 (4mm \times 4mm) | ANALOG DEVICES., LT8644SIV#TRMPBF |
| Additional Demo Board Circuit Components | | | | |
| 1 | 1 | C1 | CAP, 100 μ F, ALUM. ELECT., 16V, 20%, 6.3mm \times 5.4mm | SUN ELECTRONIC INDUSTRIES CORP, 16CE100BS |
| 2 | 2 | C3, C10 | CAP, 22 μ F, X7R, 10V, 10%, 1206 | MURATA, GRM31CR71A226KE15L |
| 3 | 0 | C7, C15, C23 (OPT) | CAP, OPTION, 0603 | |
| 4 | 1 | C14 | CAP, 1 μ F, X5R, 25V, 10%, 0402 | MURATA, GRM155R61E105KA12D |
| 5 | 0 | C22 (OPT) | CAP, OPTION, 0805 | |
| 6 | 0 | C24 (OPT) | CAP, OPTION, 1206 | |
| 7 | 1 | C25 | CAP, 4.7 μ F, X7S, 10V, 10%, 0603 | MURATA, GRM188C71A475KE11D |
| 8 | 1 | FB1 | IND., 10 Ω AT 100MHZ, FERRITE BEAD, 25%, 10.5A, 3m Ω , 1206 | WURTH ELEKTRONIK, 74279221100 |
| 9 | 0 | L2 (OPT) | IND., OPTION | |
| 10 | 1 | Q1 | XSTR., MOSFET, N-CH, 40V, 14A, DPAK (TO-252) | VISHAY, SUD50N04-8M8P-4GE3 |
| 11 | 0 | R6, R11 (OPT) | RES., OPTION, 0603 | |
| 12 | 1 | R9 | RES., 0.01 Ω , 1%, 1W, 2512, PWR, METAL, SENSE | VISHAY, WSL2512R0100FEA |
| 13 | 1 | R10 | RES., 10k, 1%, 1/10W, 0603 | VISHAY, CRCW060310K0FKEA |
| 14 | 1 | R12 | RES., 0 Ω , 1/10W, 0603 | VISHAY, CRCW06030000Z0EA |
| Hardware: For Demo Board Only | | | | |
| 1 | 12 | E1, E2, E5-E9, E11, E15-E18 | TEST POINT, TURRET, 0.094" MTG. HOLE, PCB 0.062" THICK | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 2 | 4 | E3, E10, E12, E13 | TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062" THICK | MILL-MAX, 2308-2-00-80-00-00-07-0 |
| 3 | 2 | JP1, JP2 | CONN., HDR, MALE, 2x3, 2mm, VERT. STR, THT | WURTH ELEKTRONIK, 62000621121 |
| 4 | 4 | J1-J4 | CONN., BANANA JACK, FEMALE, THT, NON-INSULATED, SWAGE, 0.218" | KEYSTONE, 575-4 |
| 5 | 4 | MP1-MP4 | STANDOFF, NYLON, SNAP-ON, 0.50" | WURTH ELEKTRONIK, 702935000 |
| 6 | 2 | XJP1, XJP2 | CONN., SHUNT, FEMALE, 2 POS, 2mm | WURTH ELEKTRONIK, 60800213421 |

SCHEMATIC DIAGRAM



| | | | |
|--|-------------------------------------|------------------------------------|--|
| ANALOG DEVICES | | POWER BY LINEAR | |
| www.analog.com | | www.linear.com | |
| TITLE: SCHEMATIC | | | |
| 8V, 16A SYNCHRONOUS STEP-DOWN SILENT SWITCHER 2 | | | |
| IC NO. LT8644S | | SCHEMATIC NO. AND REVISION: | |
| SKU NO. DC2779A | | 710-DC2779A_REV03 | |
| SIZE: N/A | DATE: Thursday, May 20, 2021 | SHEET 1 OF 1 | |
| APPROVALS | | | |
| PCB DES. | NAME | | |
| APP ENG. | NAME | | |
| CUSTOMER NOTICE | | | |
| ANALOG DEVICES HAS MADE A BEST EFFORT TO DESIGN A CIRCUIT THAT MEETS CUSTOMER-SUPPLIED SPECIFICATIONS; HOWEVER, ANALOG DEVICES DOES NOT WARRANT THE PROPER AND RELIABLE OPERATION IN THE ACTUAL APPLICATION. CUSTOMER MUST VERIFY THE ACTUAL PERFORMANCE OF THE CIRCUIT IN THE ACTUAL APPLICATION. CONTACT ANALOG DEVICES APPLICATIONS ENGINEERING FOR ASSISTANCE. | | | |
| THIS CIRCUIT IS PROPRIETARY TO ANALOG DEVICES AND SUPPLIED FOR USE WITH ANALOG DEVICES PARTS. | | | |

NOTES: UNLESS OTHERWISE SPECIFIED
 1. ALL RESISTORS ARE 0603.
 ALL CAPACITORS ARE 0603.



ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS (\$100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.