# LT8392
# 3V Minimum $V_{IN}$, 12$V_{OUT}$ High Power Synchronous 4-Switch Buck-Boost Regulator

## DESCRIPTION

Demonstration circuit 2626A is a 4-switch synchronous buck-boost regulator that demonstrates the high power capability of the LT®8392. The output is 12V and the maximum output current is 12A for up to 144W power delivery. The switching frequency is 200kHz and efficiency can exceed 97%.

The steady-state operating input voltage range of DC2626A in which the temperature of the components is less than 90°C is from 9V to 18V. The transient operating input voltage range of DC2626A is from 3V to 36V. The output voltage and EN/UVLO are all programmed by resistor dividers. EN/UVLO is set so the circuit will turn off when the input voltage falls below 3V and will turn on when the input voltage rises above 4V. The PCB has large copper planes and extensive vias for excellent high power thermal performance.

DC2626A features MOSFETs that complement the 5V gate drive of the LT8392 to achieve high efficiency. 40V AEC-Q101 MOSFETs are used on the input and output side of the four-switch topology. Ceramic capacitors are used at both the circuit input and output because of their small size and high ripple current capability. In addition to ceramic capacitors, there are bulk aluminum polymer capacitors on the input and output to make input and output stable during transient period.

The CTRL input is pulled up to the VREF pin through a 0Ω resistor to set the output current limit to its maximum, and an external voltage on CTRL can be used to lower the current limit if the resistor is removed. A capacitor at the SS pin programs soft-start.

To improve the EMI performance, the LT8392 has spread spectrum frequency modulation. With the SYNC/SPRD pin tied to INTVCC, LT8392 spreads its switching frequency ±15% around the programmed oscillator frequency.

The $\overline{\text{PGOOD}}$ status flag indicates when output voltage is within ±10% of the final regulation voltage.

The LT8392's proprietary peak current mode buck-boost architecture ensures DC2626A runs either in discontinuous conduction mode (DCM) or pulse-skipping mode (PSM) without reverse inductor current. Both modes enhance the light load efficiency.

The demo circuit is designed to be easily reconfigured to suit other applications, including the example schematics in the data sheet. Consult the factory for assistance.

High power operation, 3V input voltage operation, 4-switch buck-boost topology, proprietary peak current mode architecture, fault protection and output current monitoring make the LT8392 attractive for high power voltage regulator circuits and also circuits whose input voltage drops to 3V such as cold crank of car battery. It is also suitable for output current regulation such as battery chargers. The LT8392JFE is available in a thermally enhanced 28 lead TSSOP package. The LT8392 data sheet must be read in conjunction with this demo manual to properly use or modify demo circuit DC2626A.

**Design files for this circuit board are available.**

## PERFORMANCE SUMMARY

**Specifications are at $T_A$ = 25°C**

| PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|
| Input Voltage Range ($V_{IN}$) | $V_{OUT}$ = 12V | 3 | | 36 | V |
| Full Load (12A) Input Voltage Range ($V_{IN}$) | Component Temperature <90°C with no airflow | 9 | | 18 | V |
| Output Voltage ($V_{OUT}$) | R7 = 110k, R8 = 10k | 11.5 | 12.0 | 12.5 | V |
| Output Voltage Ripple | $V_{IN}$ = 12V, $V_{OUT}$ = 12V, $I_{OUT}$ = 10A | | 70 | | $mV_{P-P}$ |
| Maximum Output Current | 9V ≤ $V_{IN}$ ≤ 18V, $V_{OUT}$ = 12V | 12 | | | |
| Switching Frequency | R5 = 226k | | 200 | | kHz |
| Efficiency | $V_{IN}$ = 12V, $V_{OUT}$ = 12V, $I_{OUT}$ = 12A, SSFM On | | 95.5 | | % |
| Input EN Voltage | R9 = 121k, R10 = 100k, $EXTV_{CC}$ = $V_{OUT}$, $I_{OUT}$ = 6A | | 4 | | V |
| Input UVLO Voltage | R9 = 121k, R10 = 100k, $EXTV_{CC}$ = $V_{OUT}$, $I_{OUT}$ = 6A | | 3 | | V |
| Output Current Limit ($I_{OUT}$) | R3 = 3mΩ | | 16.6 | | A |
| Peak Switch Current Limit | R1 = 1mΩ | 35 | 50 | 65 | A |
| $V_{ISMON}$ | $V_{OUT}$ = 12V, $I_{OUT}$ = 12A | | 0.97 | | V |

## QUICK START PROCEDURE

The DC2626A is easy to set up to evaluate the performance of the LT8392JFE. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below.

NOTE: Make sure that the voltage applied to VIN does not exceed 40V, which is the voltage rating for input side MOSFETs.

1. Set JP1 at NO SSFM/SYNC to disable SSFM, at SSFM ON to enable SSFM, or at EXT SYNC and connect an external oscillator to EXT SYNC.
2. Connect the EN/UVLO terminal to ground with a clip-on lead. Connect the power supply (with power off), load, and meters as shown.
3. After all connections are made, turn on the input power and verify that the input voltage is between 9V and 18V.
4. Remove the clip-on lead from EN/UVLO. Verify that the output voltage is 12V.

   NOTE: If the output voltage is low, temporarily disconnect the load to make sure that it is not set too high.
5. Once the proper output voltage is established, adjust the input voltage and load within the operating ranges and observe the output voltage regulation, ripple voltage, efficiency and other parameters.

## QUICK START PROCEDURE

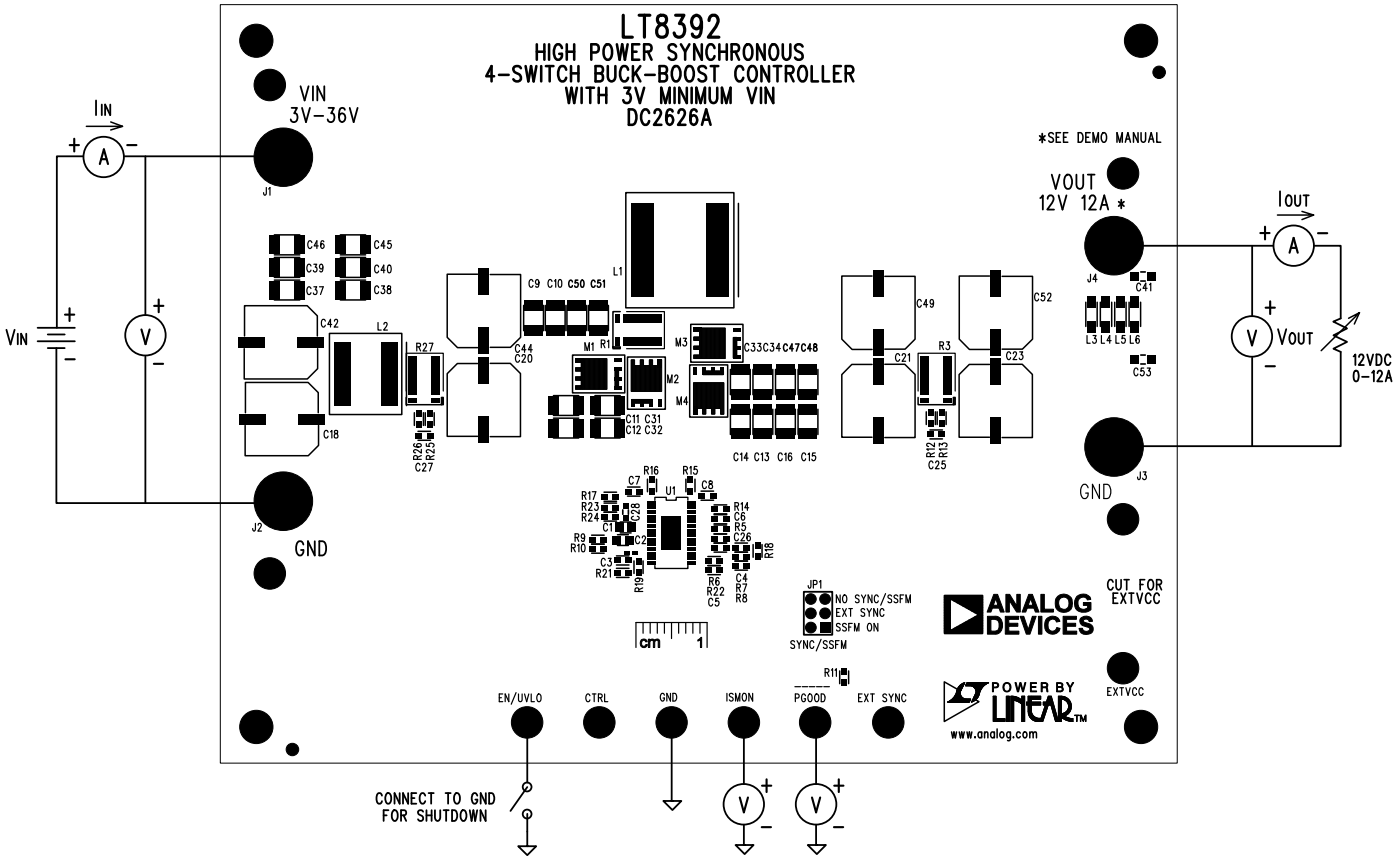



**Figure 1. Test Procedure Setup Drawing for DC2626A**

## TEST RESULTS

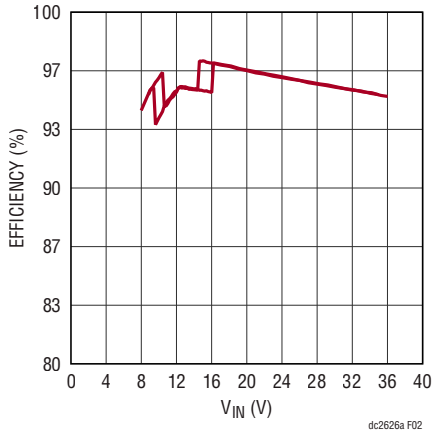
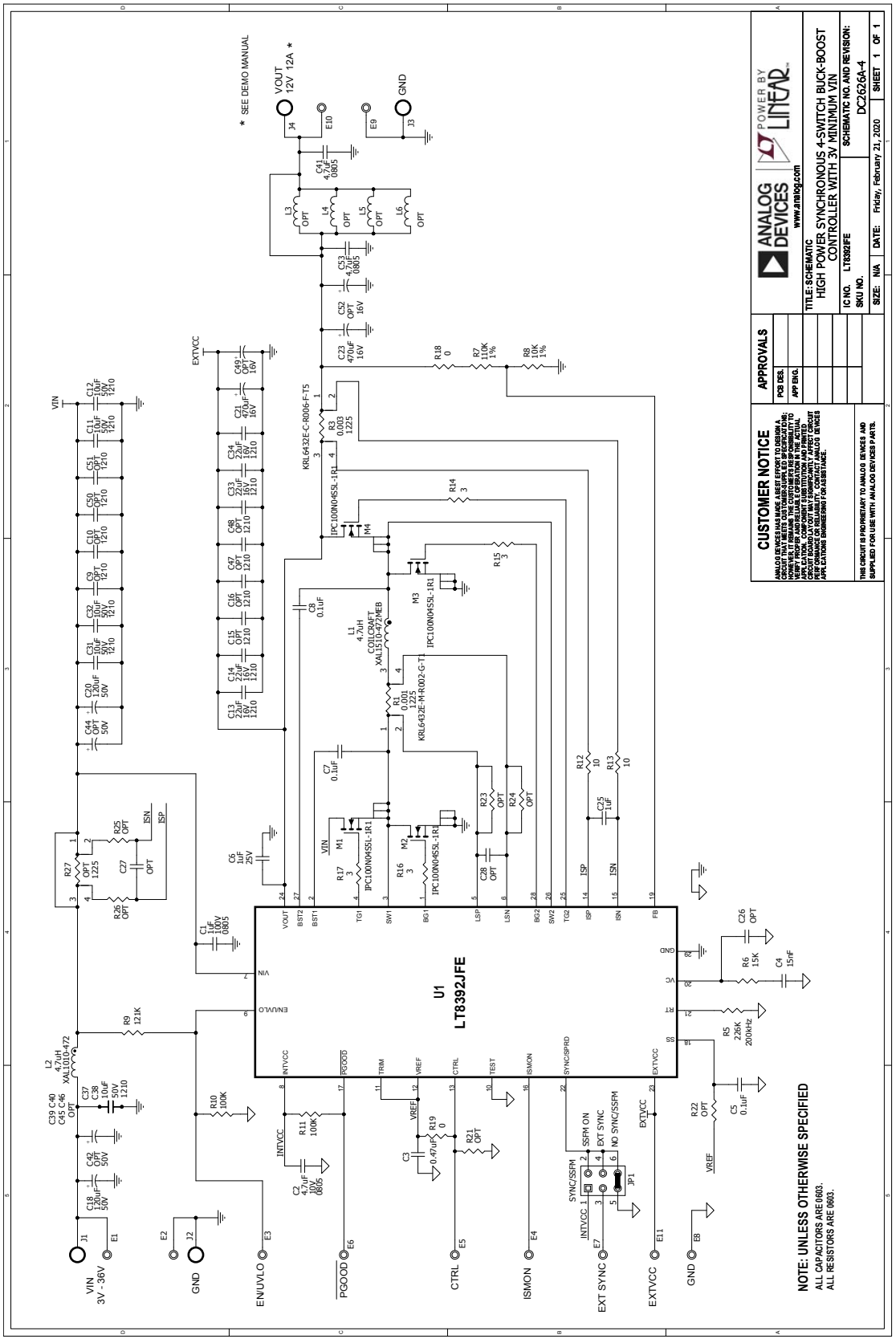



**Figure 2. Efficiency vs $V_{IN}$ at Full Load (12A), SSFM On**

## PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|---|---|---|---|---|
| **Required Circuit Components** | | | | |
| 1 | 1 | C1 | CAP., 1µF, X7S, 100V, 10%, 0805 | MURATA, GCM21BC72A105KE36L |
| 2 | 1 | C2 | CAP., 4.7µF, X7S, 10V, 10%, 0805 | MURATA, GCM21BCA475KA73L |
| 3 | 1 | C3 | CAP., 0.47µF, X7R, 16V, 10%, 0603 | MURATA, GCM188R71C474KA55D |
| 4 | 1 | C4 | CAP., 0.015µF, X7R, 25V, 10%, 0603 | MURATA, GCJ188R71E153KA01 |
| 5 | 3 | C5, C7, C8 | CAP., 0.1µF, X7R, 16V, 10%, 0603 | MURATA, GCJ188R71E104KA12 |
| 6 | 2 | C6, C25 | CAP., 1µF, X7R, 25V, 10%, 0603 | MURATA, GCM188R71E105KA64D |
| 7 | 4 | C11, C12, C31, C32 | CAP., 10µF, X7S, 50V, 10%, 1210 | MURATA, GCM32EC71H106KA03L |
| 8 | 4 | C13, C14, C33, C34 | CAP., 22µF, X7R, 16V, 20%, 1210 | MURATA, GCM32ER71C226ME19L |
| 9 | 2 | C18, C20 | CAP., ALUM, 120µF, 50V 20% 10x10.5mm | PANASONIC, EEHZC1H121P |
| 10 | 2 | C21, C23 | CAP., ALUM, 470µF, 16V, 20%, 10x10.3mm | CHEMI-CON, HHXA160ARA471MJA0G |
| 11 | 4 | C33, C34, C50, C51 | CAP., 10µF, X7R, 16V, 10%, 1206 | MURATA, GCM31CR71C106KA64 |
| 12 | 2 | C37, C38 | CAP., 10µF, X7S, 50V, 10%, 1210 | MURATA, GCM32EC71H106KA03L |
| 13 | 2 | C41, C53 | CAP., 4.7µF, X7R, 16V, 10%, 0805 | MURATA, GCM21BR71C475KA73L |
| 14 | 1 | L1 | IND., 4.7µH XAL1510 | COILCRAFT, XAL1510-472MEB |
| 15 | 1 | L2 | IND., 4.7µH, XAL1010 | COILCRAFT, XAL1010-472MEB |
| 16 | 4 | M1, M2, M3, M4 | XSTR., MOSFET, N-CH, 40V, TDSON-8 | INFINEON, IPC100N04S5L-1R1 |
| 17 | 2 | R1 | SENSE RES., 0.001Ω, 3W 2% 1225 | SUSUMU, KRL6432E-M-R001-G-T1 |
| 18 | 2 | R3 | RES., SENSE, 0.003Ω 3W 1% 1225 | SUSUMU, KRL6432E-C-R003-F-T1 |
| 19 | 1 | R5 | RES., 226k, 1/10W, 1%, 0603 | VISHAY, CRCW0603226KFKEA |
| 20 | 1 | R6 | RES., 15k, 1/10W, 1%, 0603 | VISHAY, CRCW060315K0FKEA |
| 21 | 1 | R7 | RES., 110k, 1/10W, 1%, 0603 | VISHAY, CRCW0603110KFKEA |
| 22 | 1 | R8 | RES., 10k, 1/10W, 1%, 0603 | VISHAY, CRCW060310K0FKEA |
| 23 | 1 | R9 | RES., 121k, 1/10W, 1%, 0603 | VISHAY, CRCW0603121KFKEA |
| 24 | 2 | R10, R11 | RES., 100k, 1/10W, 1%, 0603 | VISHAY, CRCW0603100KFKEA |
| 25 | 2 | R12, R13 | RES., 10Ω, 1/10W, 5%, 0603 | VISHAY, CRCW060310R0JNEA |
| 26 | 6 | R14, R15, R16, R17, R18, R19 | RES., 0Ω, 1/10W, 0603 | VISHAY, CRCW06030000Z0EA |
| 27 | 4 | R14, R15, R16, R17 | RES., 3Ω, 1/10W, 1%, 0603 | VISHAY, CRCW06033R00FKEA |
| 28 | 1 | U1 | I.C., VOLTAGE REGULATOR, 28-TSSOP | ANALOG DEVICES, INC., LT8392JFE#PBF |
| **Additional Demo Board Circuit Components** | | | | |
| 29 | 0 | C26, C27, C28 | CAP., OPTION, 0603 | |
| 30 | 0 | C9, C10, C15, C16, C39, C40, C45, C46, C47, C48, C50, C51 | CAP., OPTION, 1210 | |
| 31 | 0 | C42, C44 | CAP., OPTION, ALUM., 10x10.5mm | |
| 32 | 0 | C49, C52 | CAP., OPTION, ALUM, 10x10.3mm | |
| 33 | 0 | R21, R22, R23, R24, R25, R26 | RES., OPTION, 0603 | |
| 34 | 0 | R27 | RES., OPTION, 1225 | |
| **Hardware: For Demo Board Only** | | | | |
| 35 | 11 | E1-E11 | TESTPOINT, TURRET, 0.094" pbf | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 36 | 4 | J1, J2, J3, J4 | CONN., JACK, BANANA, 0.218" | KEYSTONE, 575-4 |
| 37 | 1 | JP1 | CONN., HEADER, 2X3, 2mm | WURTH ELEKTRONIK, 62000621121 |
| 38 | 1 | XJP1 | SHUNT, 2mm | WURTH ELEKTRONIK, 60800213421 |
| 39 | 4 | MH1-MH4 | STAND-OFF, NYLON 0.375" | WURTH ELEKTRONIK, 702933000 |

# SCHEMATIC DIAGRAM




Rev. 0

**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.

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