

LTC7800EUDC High Frequency Synchronous Buck Converter with GaN Transistors

DESCRIPTION

Demonstration circuit 2736A is a single output high voltage nonisolated synchronous step-down converter that drives all GaN transistor power stage. It features the **LTC®7800**, a low quiescent current high frequency (programmable fixed frequency from 320kHz up to 2.25MHz) synchronous step-down DC/DC controller housed in a small 3mm × 4mm QFN package.

This DC2736A operates over an input voltage range from 30V to 55V, while the LTC7800 can operate up to 60V. This demo board produces a 12V output voltage with up to 20A output current, and is configured with a sense resistor for current sensing. A mode selector allows the DC2736A to operate in forced continuous operation, pulse-skipping or Burst Mode® operation during light loads.

The LTC7800 features two integrated 5V gate drivers with 20ns dead time which is good for GaN transistors or logic-level MOSFETs to maximize efficiency. The EXT_{V_{CC}} pin permits the LTC7800 to be powered from the output of the switching regulator or other available source, reducing power dissipation and improving efficiency. Please refer to the LTC7800 data sheet for a complete description of the part operation and application information.

Design files for this circuit board are available at
<http://www.linear.com/demo/DC2736A>

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

PERFORMANCE SUMMARY Specifications are at T_A = 25°C

PARAMETER	CONDITIONS	VALUE
Input Voltage Range		30V to 55V
Output Voltage, V _{OUT}	V _{IN} = 30V – 55V, Single Output, I _{OUT} = 0A to 20A	12V
Maximum Output Current, I _{OUT}	V _{IN} = 30V – 55V	20A
Typical Efficiency	V _{IN} = 48V, Single Output, V _{OUT} = 12V, 20A Load	96%
Default Switching Frequency		500kHz

QUICK START PROCEDURE

Demonstration circuit 2736A is easy to set up to evaluate the performance of the LTC7800. Refer to Figure 1 for the proper measurement equipment setup and follow the procedure below.

1. With board not connected, adjust the input power supply to 48V, then turn off the input power supply. Make sure the input power supply is capable of 10A at 30V.
2. With power off, connect the input power supply to V_{IN} and GND terminal of the board.
3. Connect the output load between V_{OUT} and GND (Initial load: no load). Refer to Figure 1.
4. Connect the DVMs to the input and output.
5. Check the default jumper/switch position: JP7: ON; JP13: CCM.
6. Turn on the input power supply.

NOTE: The input voltage range for the board is 30V to 55V.

7. Check for the proper output voltage from V_{OUT} to GND. The output voltage should be between 11.76V to 12.24V.
8. Once the proper output voltage is established, adjust the loads within the operating range (0A to 20A) and observe the output voltage regulation, ripple voltage and other parameters.
9. After completing all tests, adjust the load to 0A, turn off the input power supply.

Notes:

1. When measuring the output or input voltage ripple, do not use the long ground lead on the oscilloscope probe. See Figure 2 for the proper scope probe technique. Short, stiff leads need to be soldered to the (+) and (–) terminals of an output capacitor. The probe's ground ring needs to touch the (–) lead and the probe tip needs to touch the (+) lead.
2. Please set the electronic load in *CR (constant resistance) mode* for the evaluation of the board. The default setup of the 2736A board is to have EXT V_{CC} pin connected to V_{OUT} . Some electronic load outputs negative voltage when doing output overcurrent test of the board, which exceeds the absolute maximum rating –0.3V on EXT V_{CC} pin of LTC7800.

External EXT V_{CC} Option

By default, the EXT V_{CC} pin of LTC7800 on DC2736A board is connected to the output of the converter with R69 (0 Ω) for good efficiency and good thermal performance. Please follow the below procedure if an external power supply is used to bias the LTC7800 EXT V_{CC} pin (Do not float this pin).

1. Remove R69 on the board.
2. Apply a DC voltage (recommend 5.5V – 13V) on EXT V_{CC} and GND turret after the input voltage is established. Make sure EXT V_{CC} < V_{IN} .
3. Turn off the DC bias on the EXT V_{CC} before powering off the input power supply.

QUICK START PROCEDURE

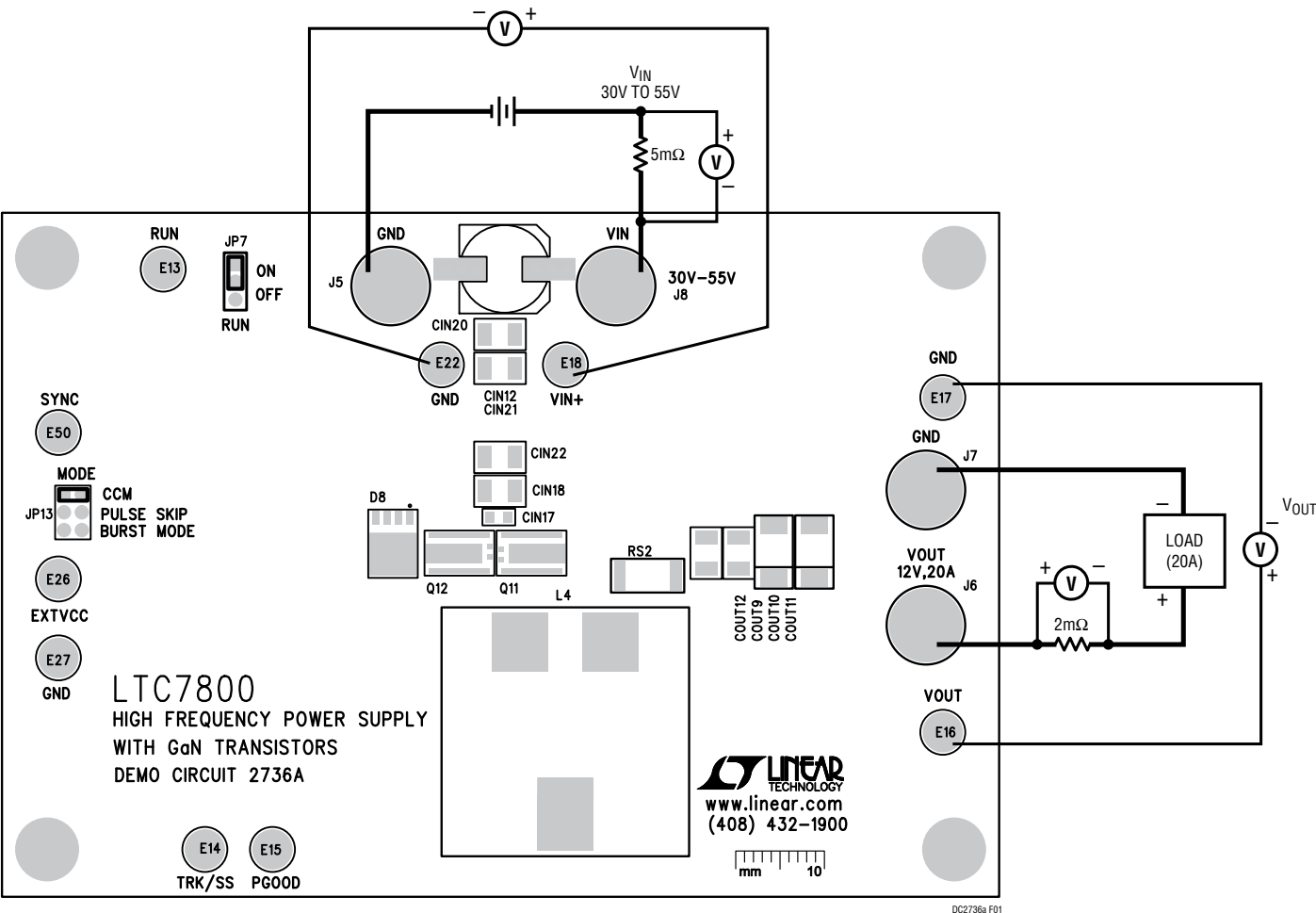


Figure 1. Proper Measurement Equipment Setup

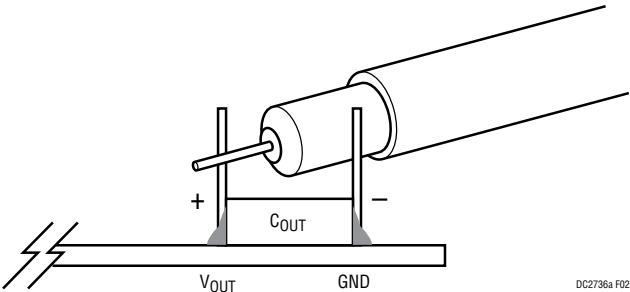


Figure 2. Measuring Output Voltage Ripple

DEMO MANUAL DC2736A

QUICK START PROCEDURE

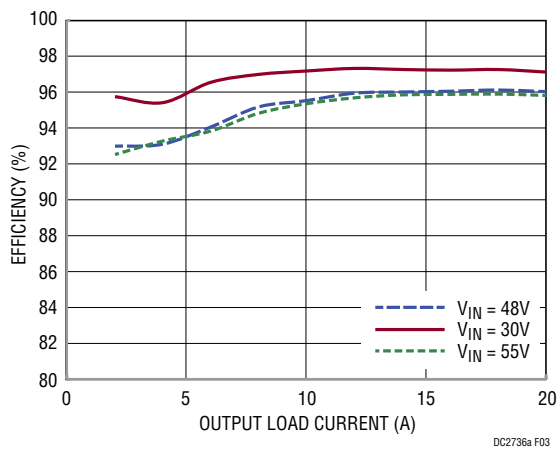


Figure 3. Efficiency vs Load Current at $V_{OUT} = 12V$, $f_{sw} = 500kHz$

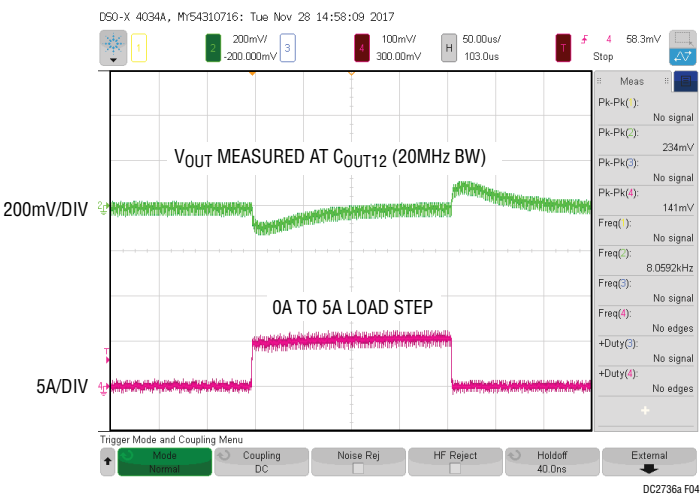


Figure 4. Transient Response at $V_{IN} = 48V$, $V_{OUT} = 12V$, $f_{sw} = 500kHz$

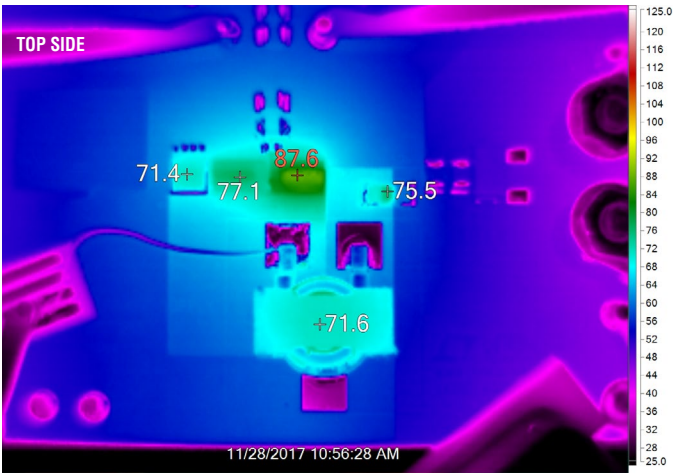


Figure 5. Thermal Performance at $V_{IN} = 48V$, $V_{OUT} = 12V$, $I_{OUT} = 20A$, $T_A = 23^{\circ}C$, in Free Air

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	8	CIN12, CIN13, CIN14, CIN15, CIN18, CIN19, CIN21, CIN22	CAP, 1210 10 μ F 20% 100V X7S	MURATA, GRM32EC72A106K
2	2	CIN16, CIN17	CAP, 0805 1 μ F 20% 100V X7S	MURATA, GRM21BC72A105KE01L
3	2	CIN20, CIN40	CAP, 33 μ F 80V 10.3 $\times$ 10.3	PANASONIC, EEHZA1K330P
4	4	COUT9, COUT12, COUT13, COUT14	CAP, 1210 22 μ F 10% 16V X7R	TDK, C3225X7R1C226K
5	2	COUT10, COUT16	FAB, PRINTED CIRCUIT BOARD	PANASONIC, 16TQC150MYF
6	3	C17, C18, C26	CAP, 0603 0.1 μ F 10% 100V X7R	MURATA, GRM188R72A104KA35D
7	1	C19	CAP, 0603 4700pF 10% 50V X7R	AVX, 06035C472KAT2A
8	1	C21	CAP, 0603 3300pF 10% 50V X7R	AVX, 06035C332KAT2A
9	1	C22	CAP, 0603 330pF 10% 50V X7R	AVX, 06035C331KAT2A
10	2	C23, C34	CAP, 0603 1 μ F 20% 16V X7R	TDK, C1608X7R1C105M
11	1	C24	CAP, 0603 22pF 10% 50V X7R	AVX, 06035C220KAT2A
12	1	C25	CAP, 0603 2.2 μ F 10% 10V X5R	AVX, 0603ZD223KAT2A
13	1	C29	CAP, 0603 100pF 5% 50V NPO	AVX, 06035A101JAT2A
14	1	D8	DIODE, 12A, 100V SO-8 FL	ON SEMI, NTS12100EMFST1G
15	1	D12	DIODE, Power DI-123	DIODES, INC, DFSL1100-7
16	1	L4	IND, 2 μ H	COILCRAFT, SER2011-202L
17	4	Q11, Q12, Q13, Q14	GaN TRANSISTOR	GaN SYSTEMS, GS61008P
18	1	RS2	RES, 1.5m Ω 2512	PANASONIC, ERJM1WTF1M5U
19	2	R43, R61	RES, 0603 10 Ω 1%	VISHAY, CRCW060310R0FKEA
20	1	R44	RES, 0603 2.2 Ω 5%	VISHAY, CRCW06032R20JNEA
21	6	R48, R55, R56, R68, R69, R70	RES, 0603 0 Ω JUMPER	VISHAY, CRCW06030000Z0EA
22	1	R50	RES, 0603 48.7k Ω 1%	VISHAY, CRCW060348K7FKEA
23	1	R57	RES, 0603 140k Ω 5%	VISHAY, CRCW0603140KJNEA
24	1	R58	RES, 0603 1M 5%	VISHAY, CRCW06031M00JNEA
25	1	R60	RES, 0603 10k Ω 1%	VISHAY, CRCW060310K0FKEA
26	1	R64	RES, 0603 10k Ω 1%	VISHAY, CRCW060310K0FKEA
27	1	R67	RES, 0603 34k Ω 1%	VISHAY, CRCW060334K0FKEA
28	1	R71	RES, 0603 237 Ω 1%	VISHAY, CRCW0603237RFKEA
29	2	R73, R86	RES, 0603 100k Ω 5%	VISHAY, CRCW0603100KJNEA
30	1	R85	RES, 0603 1k Ω 1%	VISHAY, CRCW06031K00FKEA
31	1	R87	RES, 0603 1 Ω 5%	VISHAY, CRCW06031R00JNEA
32	1	U3	IC, LTC7800EUD	LINEAR TECH, LTC7800EUDC#PBF

DEMO MANUAL DC2736A

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Additional Demo Board Circuit Components				
1	0	COUT11, COUT15	OPTIONAL 7343	
2	0	C27, C33	OPTIONAL 0603	
3	0	D9, D10	OPTIONAL SOD1608	
4	0	D11	OPTIONAL CD0603-1005	
5	0	R47, R65, R74, R88, R139	OPTIONAL 0603	
Hardware: For Demo Board Only				
1	1	E13 TO E16, E18, E26, E50	TESTPOINT, TURRET, 0.095"	MILL-MAX, 2501-2-00-80-00-00-07-0
2	1	JP7	HEADER, 3 PIN 0.079 SINGLE ROW	SULLINS, NRPN031PAEN-RC
3	1	JP13	2MM DOUBLE ROW HEADER, 3X2	SAMTEC, TMM-103-02-L-D
4	4	J5 TO J8	STUD, TESTPIN	PEM KFH-032-10
5	8	J5 TO J8 X2	NUT, BRASS 10-32	ANY #10-32
6	4	J5 TO J8	RING, LUG #10	KEYSTONE (8205)
7	4	J5 TO J8	WASHER, TIN PLATED BRASS	ANY #10 EXT BZ TN
8	1	XJP13+2mm CTRS	SHUNT, 2mm	SAMTEC, 2SN-BK-G
9	4		STAND-OFF, NYLON 0.50" TALL	KEYSTONE, 8833 (SNAP ON)



DEMO MANUAL DC2736A



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.