LT8390A 60V 2MHz Synchronous Buck-Boost Controller

DESCRIPTION

Demonstration circuit 2598A is a 60V 2MHz synchronous buck-boost controller featuring the LT®8390A. It accepts an input voltage from 4V to 24V (with transient to 60V) and regulates 12V output at up to 4A. DC2598A features high efficiency and 2MHz switching frequency, a high speed for a 4-switch buck-boost controller. It has a PGOOD flag, short-circuit fault protection, ISMON current-monitoring output signal, and spread spectrum frequency modulation (SSFM) or frequency synchronization.

The LT8390A has a wide input voltage range from 4V to 60V. It can regulate an output as a boost, a buck, or a 4-switch boost-buck controller. It has adjustable switching frequency between 600kHz and 2MHz. It has an option for external frequency synchronization or spread spectrum frequency modulation. Its high switching frequency is unique to buck-boost controller ICs. Because of this, it can be used for high power when the input may be above, below, or equal to the output.

DC2598A features an option to turn on spread spectrum by simply changing the position of a jumper from “NO SSFM/SYNC” to “SSFM” (or to “SYNC”).

Small ceramic input and output capacitors are used to save space and cost. There is a protection diode from LED+ to GND to prevent negative ringing during a short-circuit with long wires. Optional EMI input, output, and gate resistor component placeholders exist when a low EMI application is needed.

Under voltage lockout can be adjusted with a few resistors and output voltage can be changed from 12V with FB resistors changes. Please note that higher voltage outputs may require higher voltage MOSFETs and output capacitors.

The LT8390A data sheet gives a complete description of the part, operation and applications information. The data sheet must be read in conjunction with this demo manual for demonstration circuit 2598A. The LT8390AEUFD is assembled in a 28-lead 4mm × 5mm plastic QFN package with a thermally enhanced ground pad. LT8390A is also available in a 28-Lead plastic TSSOP (FE) package. Proper board layout is essential for maximum thermal performance. See the data sheet section “Layout Considerations”.

Design files for this circuit board are available at http://www.analog.com/DC2598A

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

PARAMETER	CONDITION	MIN	TYP	MAX
Input Voltage Range	Operating	4V		60V
Full Load (4A) Input Voltage Range	Component Temp Rise <60°C with No Airflow	7V		23V
Typical Efficiency	12V Input, 12V 4A Output, 2MHz		90%	
Switching Frequency	R3 = 59.0k		2MHz	
Peak Switch Current Limit	R1 = 0.005Ω		10A	
(AC) Output Ripple	12V Input, 12V 4A Output		$70mV_{P-P}$	
Input Under Voltage Lockout (Falling Turn-Off)	R7 = 383k, R8 = 165k		4.0V	
Input Under Voltage Lockout (Rising Turn-On)	R7 = 383k, R8 = 165k		5.0V	
V_{ISMON}	12V 4A Output		1.0V	
Maximum Load Current	12V Input, 12V Output	4	4.5A	

QUICK START PROCEDURE

Demonstration circuit 2598A is easy to set up to evaluate the performance of the LT8390A Follow the procedure below:

1. With the input power supply off, connect the input power supply and output load as shown in the test setup drawing in Figure 1.
2. Connect the EN/UVLO terminal to GND.
3. Make sure that the SSFM jumper is in the correct position – either with SSFM turned ON or OFF. Only place the jumper in the SYNC position if an external SYNC frequency source is connected to the SYNC pin.
4. Turn the input power supply on and make sure the voltage is between 4V and 24V for proper steady state operation.
5. Release the EN/UVLO-to-GND connection.
6. Observe the 12V output voltage, the load current measurement via the ISMON pin voltage and the high efficiency of this small converter.

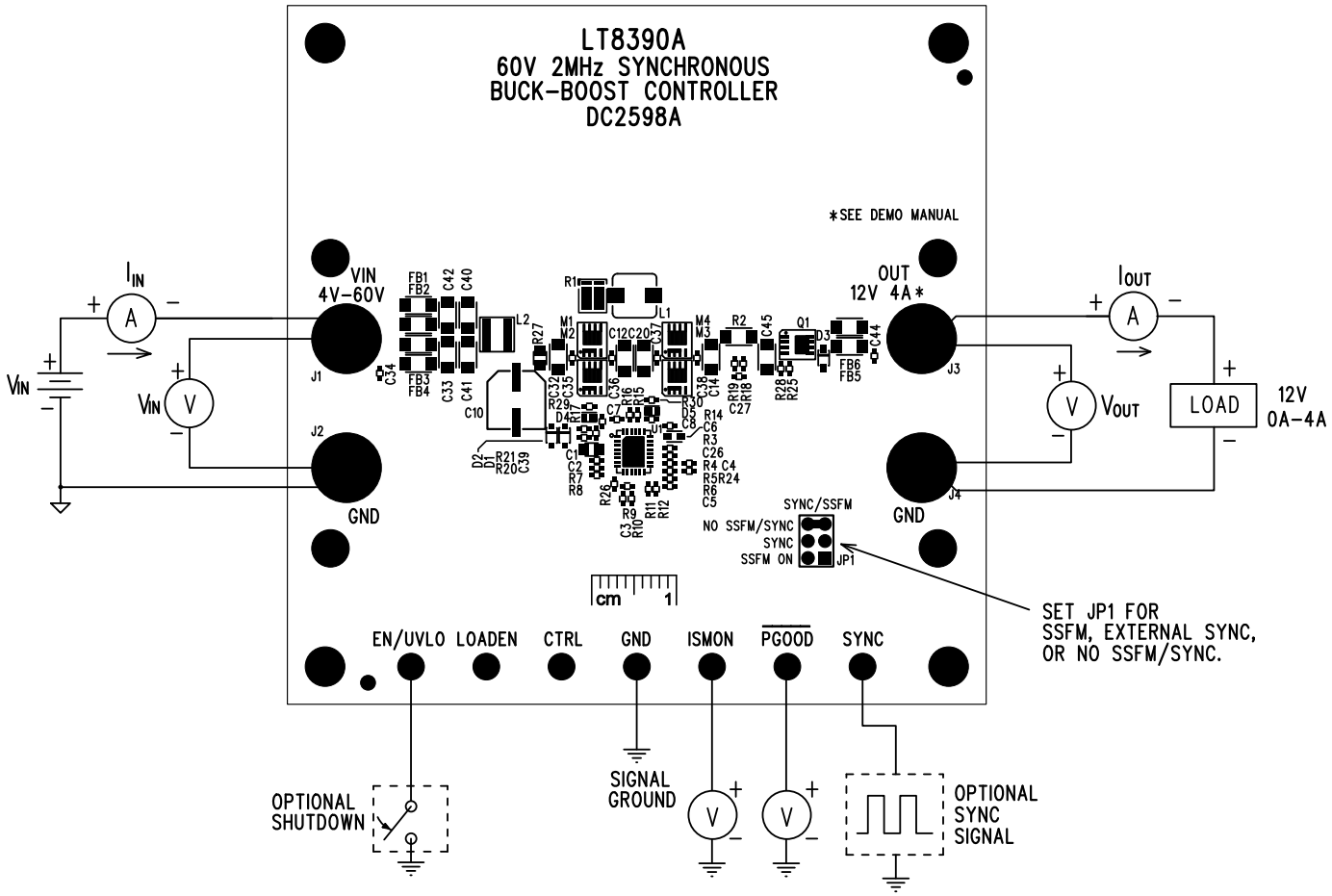


Figure 1. Test Procedure Setup Drawing For DC2598A

QUICK START PROCEDURE

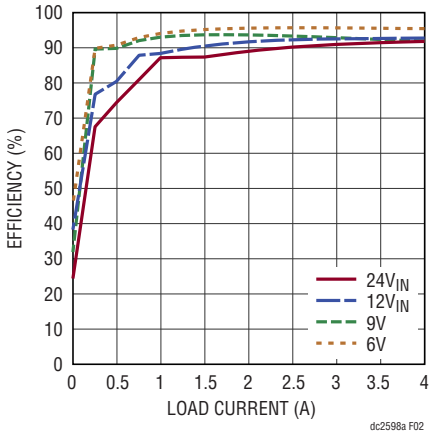


Figure 2. DC2598A, LT8390A 2MHz Buck-Boost Efficiency $12V_{OUT}$

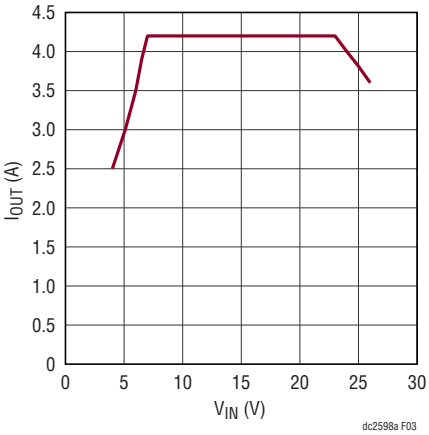


Figure 3. Recommended Maximum DC Current with No Airflow (for DC2598A)

QUICK START PROCEDURE

Figure 4. DC2598A, LT8390A Output Ripple Measured at C45

QUICK START PROCEDURE

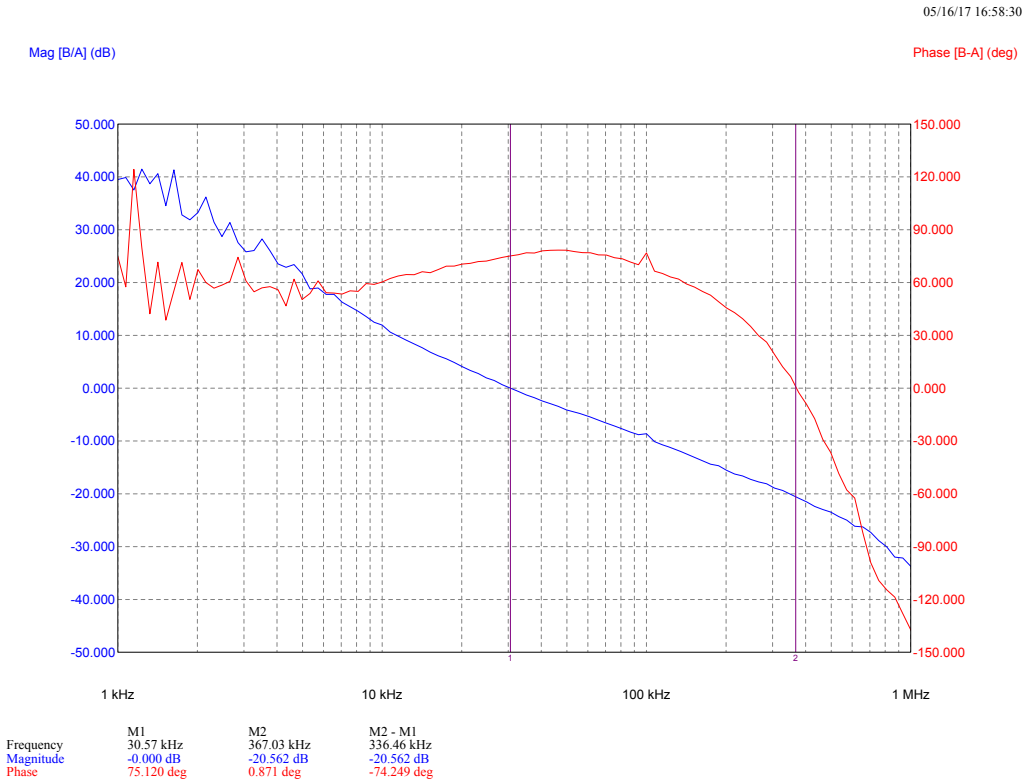
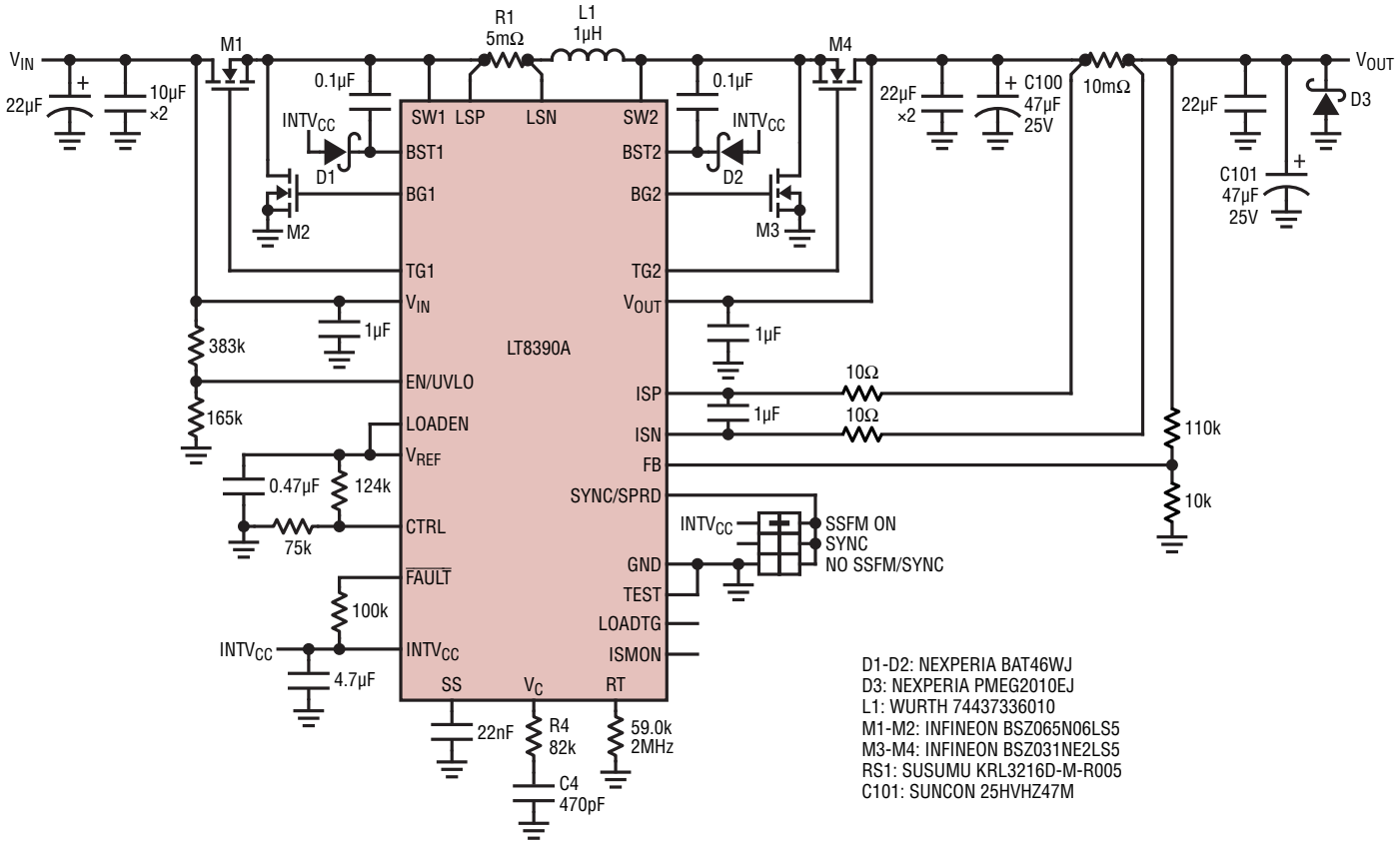


Figure 5. DC2598A, LT8390A Bode Plot 12V Input, 12V 4A Output

QUICK START PROCEDURE

Optimized for Fast Transient Response

DC2598A is assembled as a very small 2MHz buck-boost converter with high efficiency. The ceramic output capacitors are used for a very small solution size overall. However, for large signal transients on the output, more output capacitance may be useful, and matched with new compensation values. The figure below shows an optimized large signal transient response DC2598A with the addition of two aluminum electrolytic output capacitors and updated RC compensation values. Simply add two Suncon 25HVHZ47M 47µF 25V capacitors to the output and change the compensation to R4 = 82k and C4 = 470pF. When these changes are made, the no load to full load (4A) transient has less than ±5% V_{OUT} change.



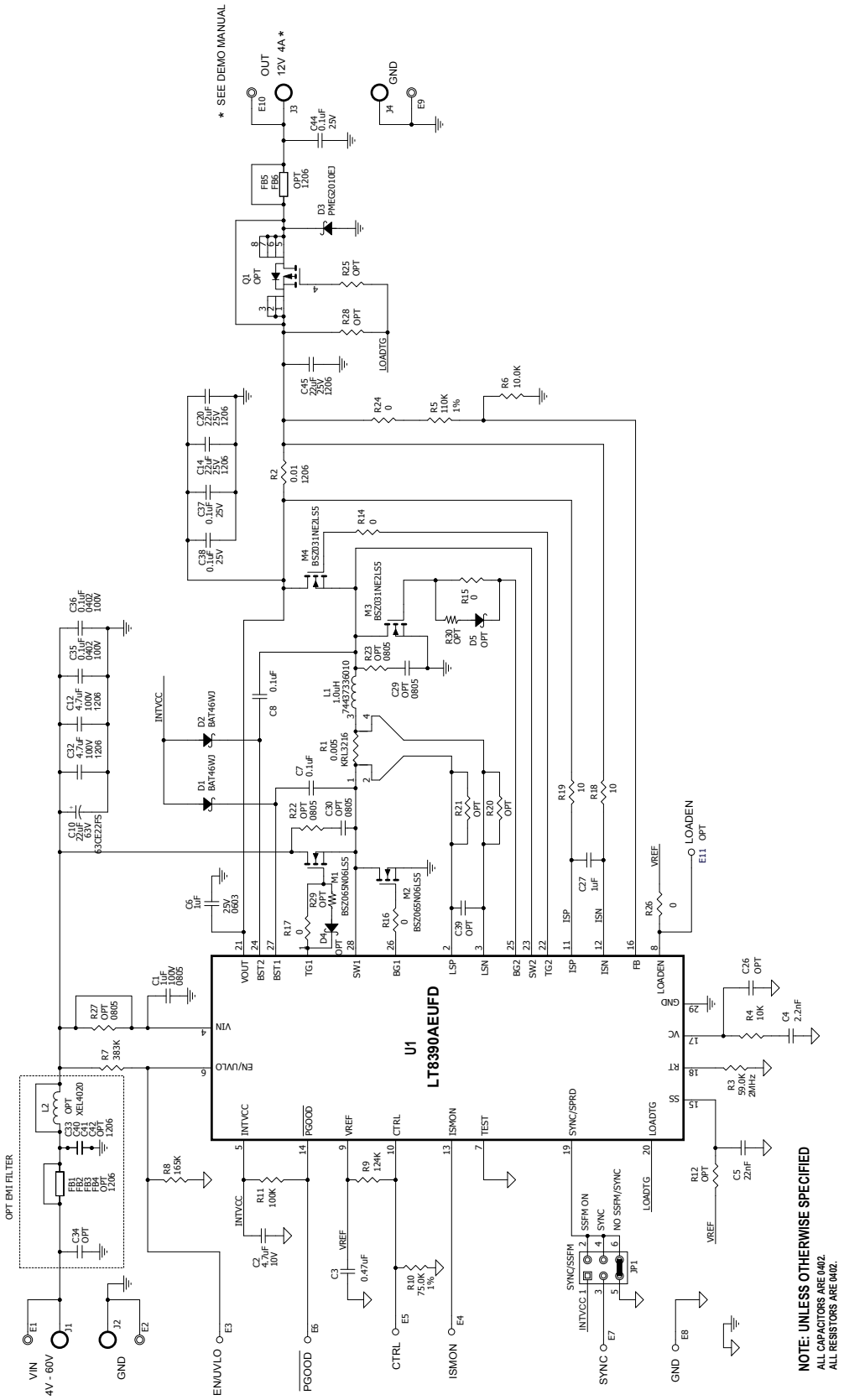
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	CAP., 1µF, X7S, 100V, 10%, 0805	
2	1	C2	CAP., 4.7µF, X5R, 10V, 10%, 0402	TDK, C1005X5R1A475K050BC
3	1	C3	CAP., 0.47µF, X5R, 16V, 10%, 0402	TAIYO YUDEN, EMK105ABJ474KV-F
4	1	C4	CAP., 2200pF, X7R, 25V,1 0%, 0402	MURATA, GRM155R71E222KA01D
6	1	C5	CAP., 0.022µF, X7R, 25V, 10%, 0402	MURATA, GRM155R71E223KA61D
7	1	C6	CAP., 1µF, X7R, 25V, 10%, 0603	KEMET, C0603C105K3RACTU
5	2	C7, C8	CAP., 0.1µF, X7R, 25V, 10%, 0402	AVX, 04023C104KAT2A
8	1	C10	CAP., 22µF, ALUM, 63V, 20%, SMD 6.3mm × 7.7mm	SUN ELECTRONIC INDUSTRIES CORP, 63CE22FS
9	2	C12, C32	CAP., 4.7µF, X7S, 100V, 20%, 1206	AVX, 12061Z475MAT2A
10	3	C14, C20, C45	CAP., 22µF, X5R, 25V, 10%, 1206	MURATA, GRM31CR61E226KE15L
16	2	D1, D2	DIODE, SCHOTTKY, 100V, 250mA, SOD-323F, AEC-Q101	NXP SEMICONDUCTORS, BAT46WJ
25	1	L1	IND., 1µH, Power Shielded, 20%, 7.3A, 6mm × 5.5mm	WURTH ELEKTRONIK, 74437336010
27	2	M1, M2	XSTR., POWER MOSFET, 60V, 40A, TSDSON-8	INFINEON, BSZ065N06LS5ATMA1
29	2	M3, M4	XSTR., POWER MOSFET, 25V, 40A, TSDSON-8	INFINEON, BSZ031NE2LS5ATMA1
31	1	R1	RES., 0.005Ω, ±1%, 1.5W, 3216, AEC-Q200	SUSUMU, KRL3216E-C-R005-F-T1
32	1	R2	RES., 0.01Ω, 1%, 3/4W, 1206, SENSE	SUSUMU, KRL1632E-M-R010-F-T5
33	1	R3	RES., 59k, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW040259K0FKED
34	2	R4, R6	RES., 10k, 1%, 1/16W, 0402	VISHAY, CRCW040210K0FKED
35	1	R5	RES., 110k, 1%, 1/16W, 0402	VISHAY, CRCW0402110KFKED
36	1	R7	RES., 383k, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW0402383KFKED
37	1	R8	RES., 165k, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW0402165KFKED
40	1	R11	RES., 100k, 5%, 1/16W, 0402	VISHAY, CRCW0402100KFKED
45	1	U1	IC, 2MHz SYN. BUCK-BOOST CONTROLLER, 28-PIN QFN	LINEAR TECH., LT8390AEUFD#TRPBF
Optional Electrical Components				
5	3	C37, C38, C44	CAP., 0.1µF, X7R, 25V, 10%, 0402	AVX, 04023C104KAT2A
11	0	C26, C34, C39	CAP., OPTION, 0402	
12	1	C27	CAP., 1µF, X5R, 16V, 10%, 0402	AVX, 0402YD105KAT2A
13	0	C29, C30	CAP., 0805, OPTION	
14	0	C33, C40, C41, C42	CAP., OPTION, 1206	
15	2	C35, C36	CAP., 0.1µF, X5R, 100V, 10%, 0402	MURATA, GRM155R62A104KE14D
17	1	D3	DIODE, SCHOTTKY, 20V, 1A, SOD-323F	NXP SEMICONDUCTORS, PMEG2010EJ
18	0	D4, D5	DIODE, OPTION, SCHOTTKY, SMD	
22	0	FB1, FB2, FB3, FB4, FB5, FB6	IND., OPTION, BEAD, FERRITE, 1206	
26	0	L2	IND., OPTION, XAL4020 SERIES	
30	0	Q1	XSTR., OPTION, PPAK 1212-8	

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
38	1	R9	RES., 124k, 1%, 1/16W, 0402	VISHAY, CRCW0402124KFKED
39	1	R10	RES., 75k, 1%, 1/16W, 0402	VISHAY, CRCW040275K0FKED
41	0	R12, R20, R21, R25, R28, R29, R30	RES., OPTION, 0402	
42	6	R14, R15, R16, R17, R24, R26	RES., 0Ω, 1/16W, 0402, AEC-Q200	VISHAY, CRCW04020000Z0ED
43	2	R18, R19	RES., 10Ω, 5%, 1/16W, 0402	VISHAY, CRCW040210R0FKED
44	0	R22, R23, R27	RES., OPTION, 0805	
Hardware				
19	4	E1, E2, E9, E10	TEST POINT, TURRET, 0.094", MTG. HOLE	MILL-MAX, 2501-2-00-80-00-00-07-0
20	6	E3, E4, E5, E6, E7, E8	TEST POINT, TURRET, 0.064", MTG. HOLE	MILL-MAX, 2308-2-00-80-00-00-07-0
21	0	E11	TEST POINT, OPTION	
23	1	JP1	CONN., HDR, MALE, 2mm × 3,2mm, THT, STR	WURTH ELEKTRONIK, 62000621121
24	4	J1, J2, J3, J4	CONN., BANANA JACK, FEMALE, THT, NON-INSULATED, SWAGE	KEYSTONE, 575-4
28	4	MH1, MH2, MH3, MH4	STANDOFF, NYLON, SNAP-ON, 0.375"	WURTH ELEKTRONIK, 702933000
46	1	XJP1	CONN., SHUNT, FEMALE, 2 POS, 2mm	WURTH ELEKTRONIK, 60800213421

SCHEMATIC DIAGRAM



UG-1318 Rev A

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 NONINFRINGEMENT 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.