

**LT8210**

# High Voltage, High Efficiency Synchronous Buck-Boost Converter with Input to Output Pass-Thru

## DESCRIPTION

Demonstration circuit 2814A-B is a high voltage, high efficiency synchronous buck-boost DC/DC converter with an input voltage range of 9V to 80V. It can supply a 2.5A maximum load current with an output range of 24V to 34V. The demo board features the [LT8210EUJ](#) controller. The constant frequency current mode architecture allows a phase-lockable frequency of up to 400kHz, while an optional input or output current feedback loop provides support for applications such as battery charging. With a wide input range, wide output range, and seamless transfers between operation modes, the LT8210 is ideal for industrial, automotive, medical, military, and avionics applications.

The converter has four modes of operation: burst, pulse skip, forced continuous mode, or pass-thru. Pass-thru is a feature that passes the input directly to the output when

the input voltage is within a user programmable window. Switching losses drop to zero and efficiency is maximized. For input voltage above or below the pass-thru window, the buck or boost regulation loops maintain the output at the set maximum or minimum values, respectively. Reverse input protection to -40V is also implemented on this demo board.

The available versions of the DC2814A are:

**DC2814A-A:** 8V to 40V<sub>IN</sub>, 80V<sub>IN</sub> Surge (60s), Operates Down to 3.5V<sub>IN</sub> after Start-Up, V<sub>OUT</sub> = 8V to 16V at 3A

**DC2814A-B:** 9V to 36V<sub>IN</sub>, 80V<sub>IN</sub> Surge (60s), V<sub>OUT</sub> = 24V to 36V at 2.5A

**DC2814A-C:** 26V to 80V<sub>IN</sub>, V<sub>OUT</sub> = 36V to 56V at 2A

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

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## PERFORMANCE SUMMARY Specifications are at T<sub>A</sub> = 25°C

PARAMETER	CONDITIONS	UNITS
Input Voltage Range		9V to 36V Continuous, 80V Surge (60 Seconds)
Output Voltage, V <sub>OUT</sub>	V <sub>IN</sub> = 9V to 80V, I <sub>OUT</sub> = 0A to 2.5A	24V to 34V
Maximum Output Current, I <sub>OUT</sub>	V <sub>IN</sub> = 9V to 80V, V <sub>OUT</sub> = 24V to 34V	2.5A
Default Operating Frequency		385kHz (R <sub>T</sub> = 16.9k)
Typical Efficiency	18V <sub>IN</sub> , 24V <sub>OUT</sub> (Boost), 2.5A 24V <sub>IN</sub> , 24V <sub>OUT</sub> (Buck-Boost), 2.5A 30V <sub>IN</sub> , 30V <sub>OUT</sub> (Pass-Thru) 2.5A 38V <sub>IN</sub> , 34V <sub>OUT</sub> (Buck-Boost), 2.5A 40V <sub>IN</sub> , 34V <sub>OUT</sub> (Buck), 2.5A	95% 94% 99% 93% 97%

## QUICK START PROCEDURE

Demonstration circuit 2814A-B is easy to set up to evaluate the performance of the LT8210. Refer to the following procedure:

1. With power off, connect the input power supply to  $V_{IN}$  (9V to 36V) and GND (input return).
2. Connect the 24V to 34V output load between  $V_{OUT}$  and GND.
3. Connect the DVMs to the input and the output.
4. Turn on the input power supply and then check for the proper output voltages.  $V_{OUT}$  should be 24V to 34V.

5. Once the proper output voltages are established, adjust the loads within the operating range and observe the output voltage regulation, ripple voltage and other parameters.
6. The input voltage may be raised up to 80V for short periods of time.

Note: When measuring the output or input voltage ripple, do not use the long ground lead on the oscilloscope probe. See Figure 1 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.

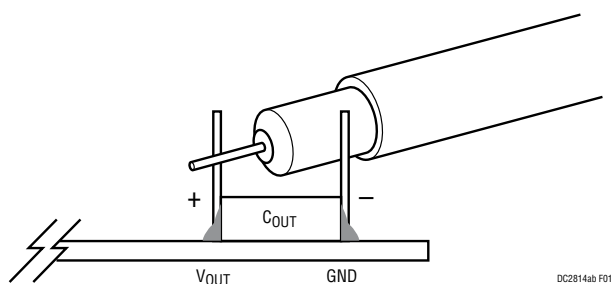


Figure 1. Measuring Output Voltage Ripple

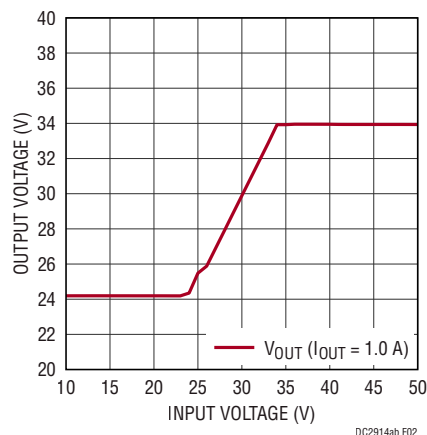
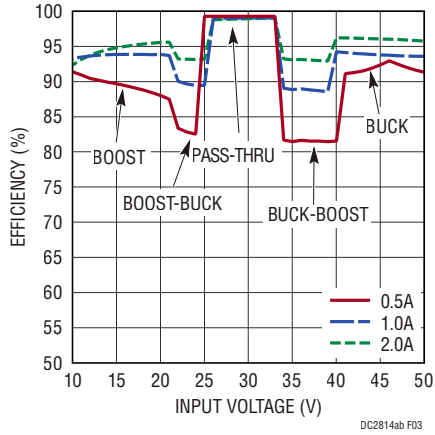
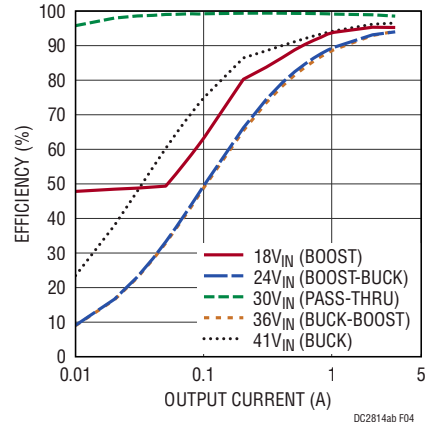


Figure 2. Output Voltage vs Input Voltage

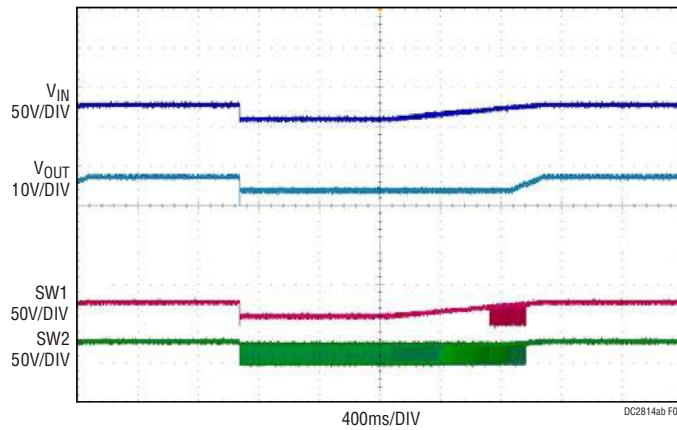
**QUICK START PROCEDURE**



**Figure 3. Efficiency vs Input Voltage**

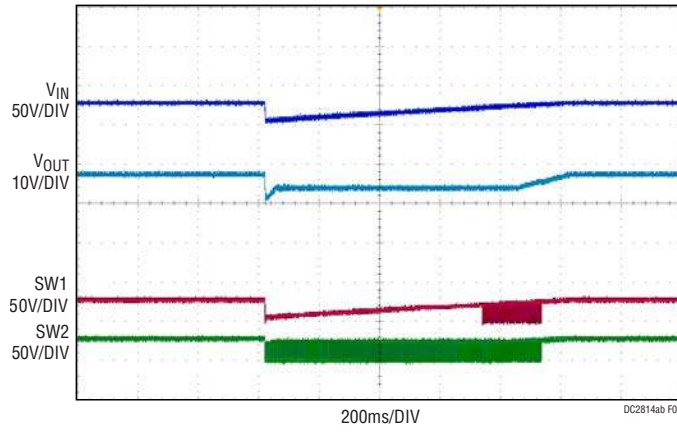


**Figure 4. Efficiency vs Output Current**

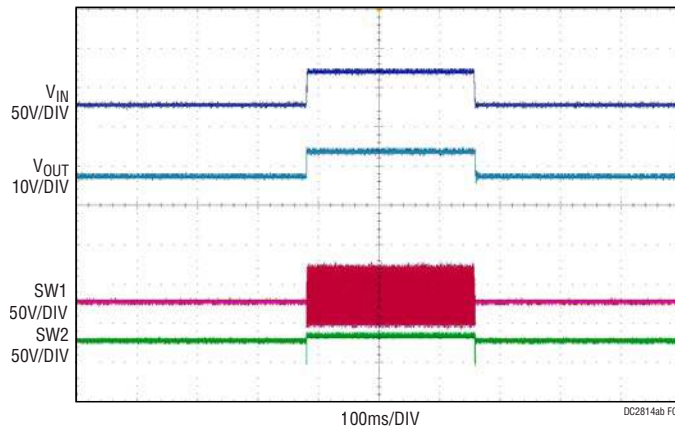


**Figure 5. DO-160 – Engine Starting Undervoltage (Z) ( $I_{OUT} = 2.5A$ )**

## TEST RESULTS

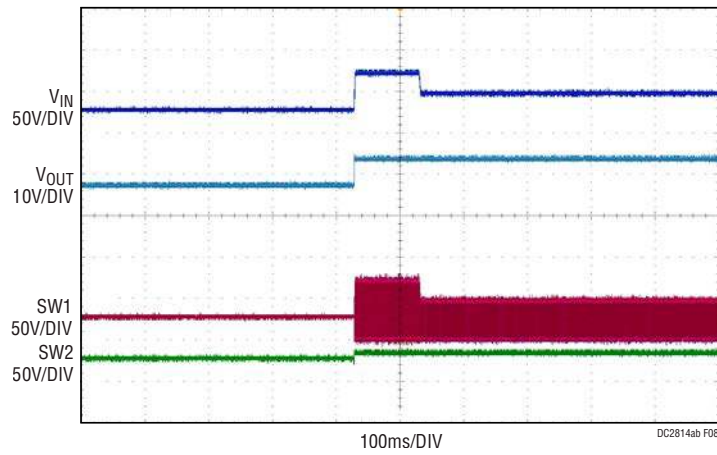


**Figure 6. MIL1275D – Starting Disturbance (Engine Cranking)  
( $I_{OUT} = 2.5A$ )**

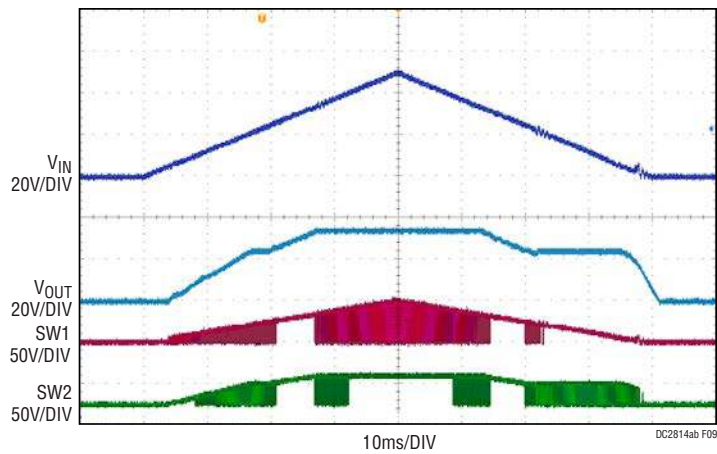


**Figure 7. MIL1275D – Positive Surge 70V for 275ms ( $I_{OUT} = 2.5A$ )**

**TEST RESULTS**



**Figure 8. DO-160 – Abnormal Surge Voltage (Z) ( $I_{OUT} = 2.5A$ )**



**Figure 9.  $V_{IN}$  Range ( $I_{OUT} = 2.5A$ )**

## TEST RESULTS

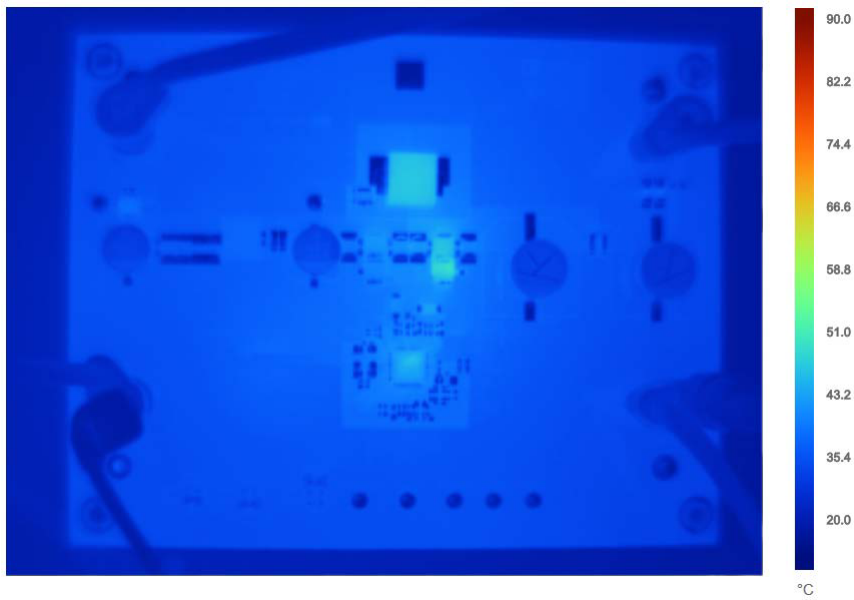


Figure 10. DC2814A-B Thermal Performance at 18V<sub>IN</sub> (Boost), 24V<sub>OUT</sub>, 2.5A Load Current

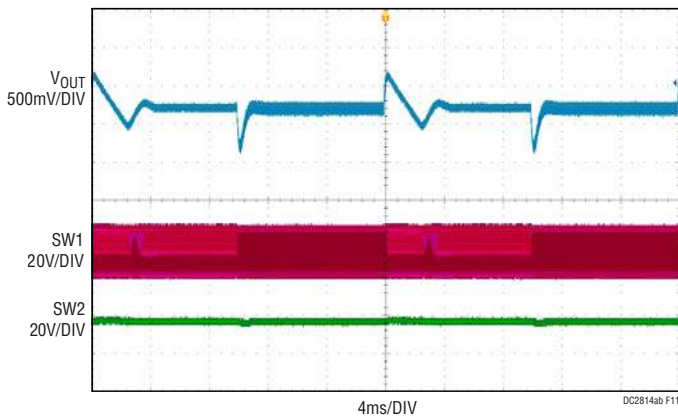


Figure 11. DC2814A-B Load Transients at 18V<sub>IN</sub> (Boost), 24V<sub>OUT</sub>, 0.25A to 2.25A Load Current

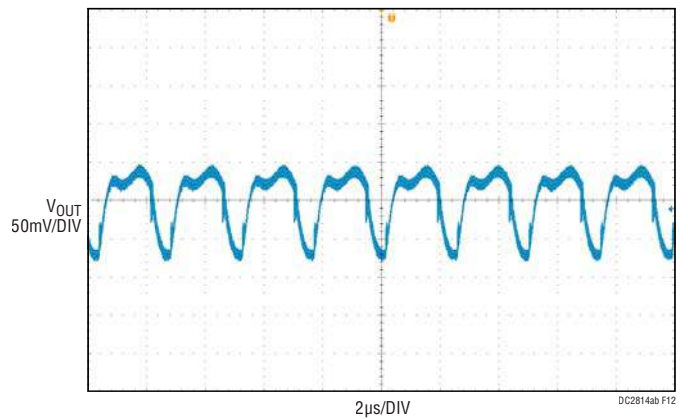


Figure 12. DC2814A-B Output Voltage Ripple at 18V<sub>IN</sub> (Boost), 24V<sub>OUT</sub>, 2.5A Load Current

**TEST RESULTS**

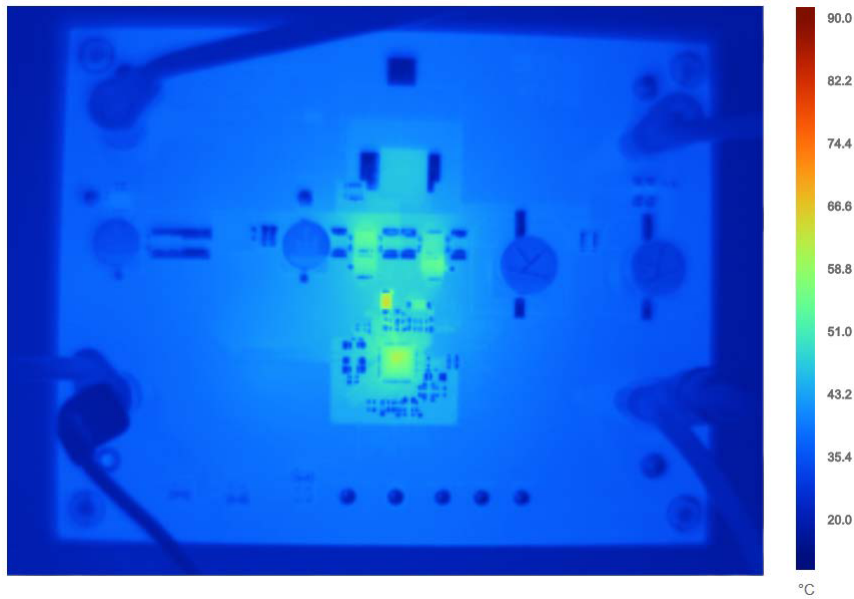


Figure 13. DC2814A-B Thermal Performance at 24V<sub>IN</sub> (Buck-Boost), 24V<sub>OUT</sub>, 2.5A Load Current

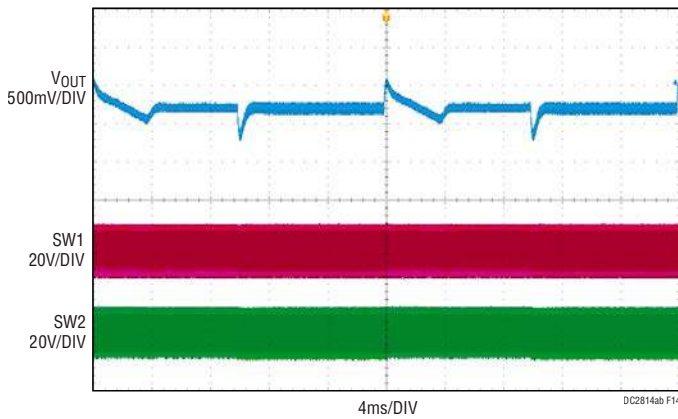


Figure 14. DC2814A-B Load Transients at 23V<sub>IN</sub> (Buck-Boost), 24V<sub>OUT</sub>, 0.25A to 2.25A Load Current

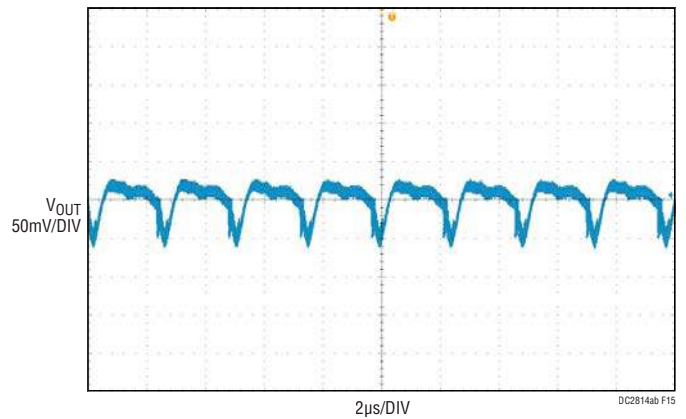


Figure 15. DC2814A-B Output Voltage Ripple at 24V<sub>IN</sub> (Buck-Boost), 24V<sub>OUT</sub>, 2.5A Load Current

## TEST RESULTS



Figure 16. DC2814A-B Thermal Performance at 30V<sub>IN</sub> (Pass-Thru), 30V<sub>OUT</sub>, 2.5A Load Current

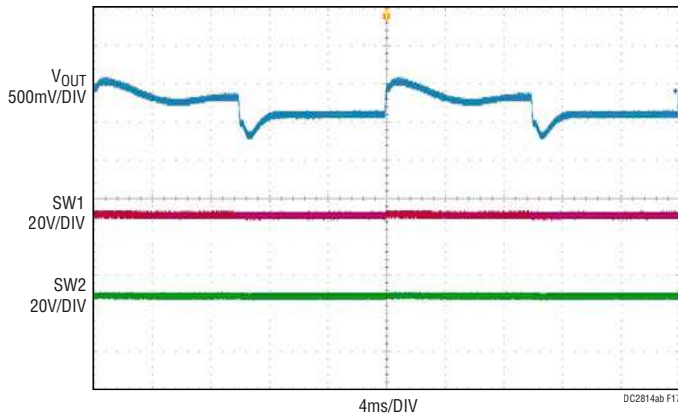


Figure 17. DC2814A-B Load Transients at 30V<sub>IN</sub> (Pass-Thru), 30V<sub>OUT</sub>, 0.25A to 2.25A Load Current

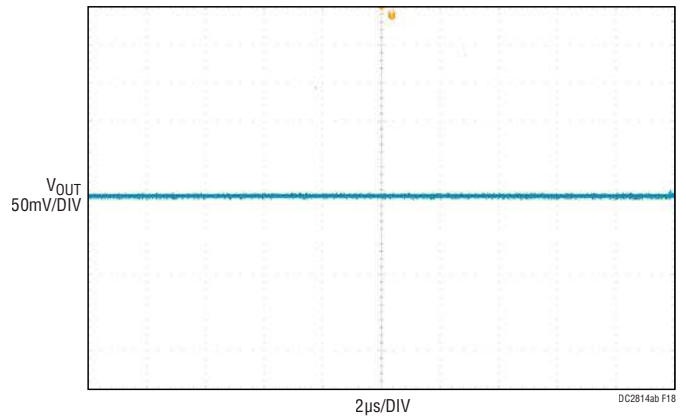


Figure 18. DC2814A-B Output Voltage Ripple at 30V<sub>IN</sub> (Pass-Thru), 30V<sub>OUT</sub>, 2.5A Load Current



TEST RESULTS

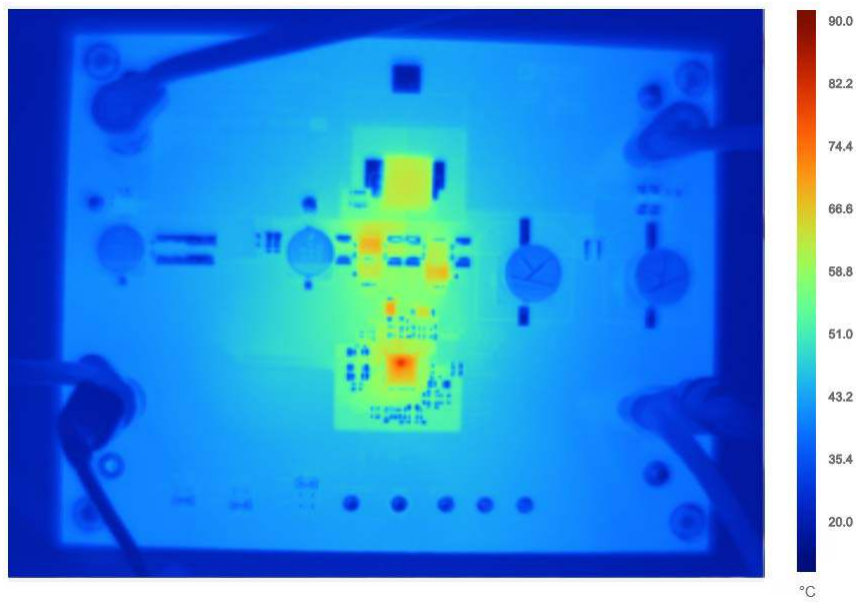


Figure 19. DC2814A-B Thermal Performance at 38V<sub>IN</sub> (Buck-Boost), 34V<sub>OUT</sub>, 2.5A Load Current

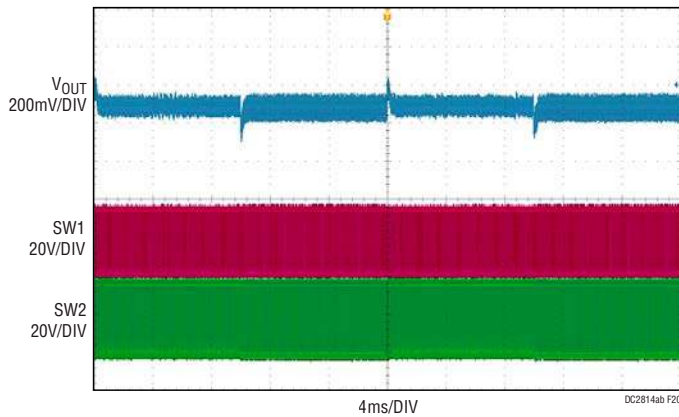


Figure 20. DC2814A-B Load Transients at 38V<sub>IN</sub> (Buck-Boost), 34V<sub>OUT</sub>, 0.25A to 2.25A Load Current

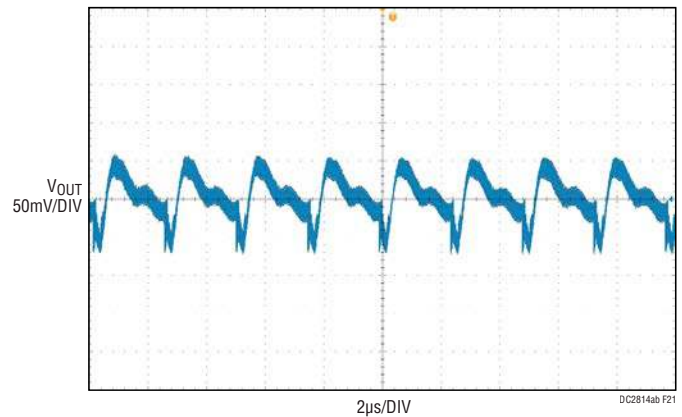


Figure 21. DC2814A-B Output Voltage Ripple at 38V<sub>IN</sub> (Buck-Boost), 34V<sub>OUT</sub>, 2.5A Load Current

## TEST RESULTS

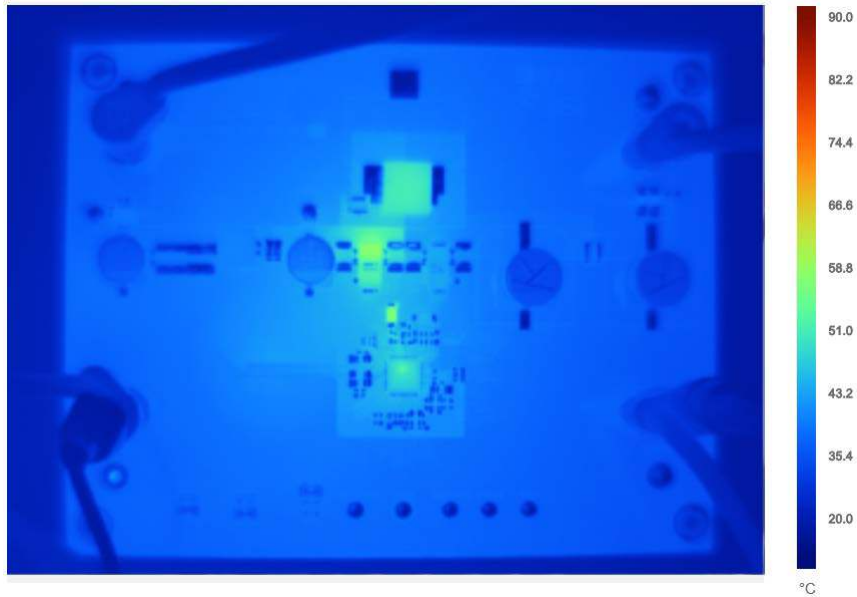


Figure 22. DC2814A-B Thermal Performance at 40V<sub>IN</sub> (Buck), 34V<sub>OUT</sub>, 2.5A Load Current

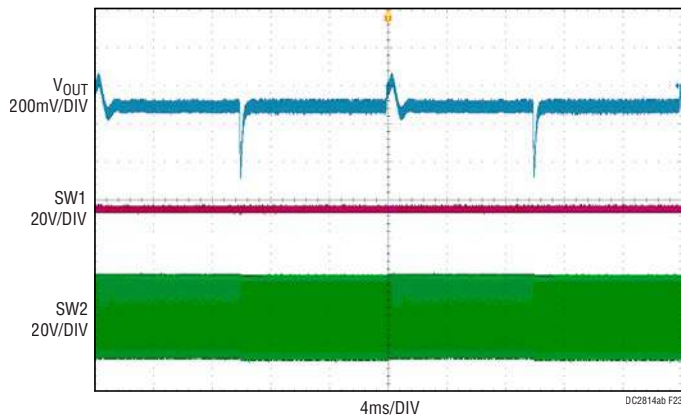


Figure 23. DC2814A-B Load Transients at 40V<sub>IN</sub> (Buck), 34V<sub>OUT</sub>, 0.25A to 2.25A Load Current

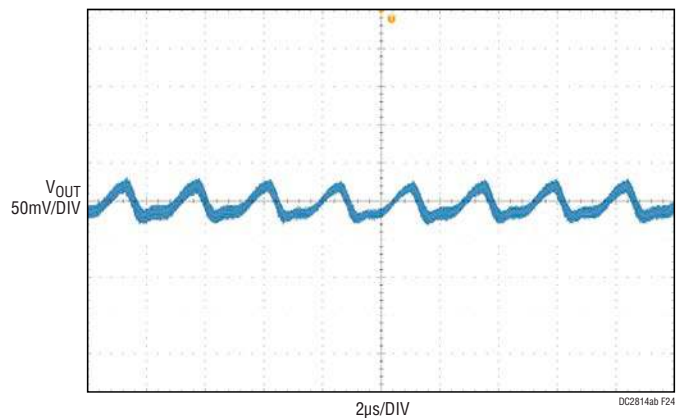


Figure 24. DC2814A-B Output Voltage Ripple at 40V<sub>IN</sub> (Buck), 34V<sub>OUT</sub>, 2.5A Load Current

## PARTS LIST

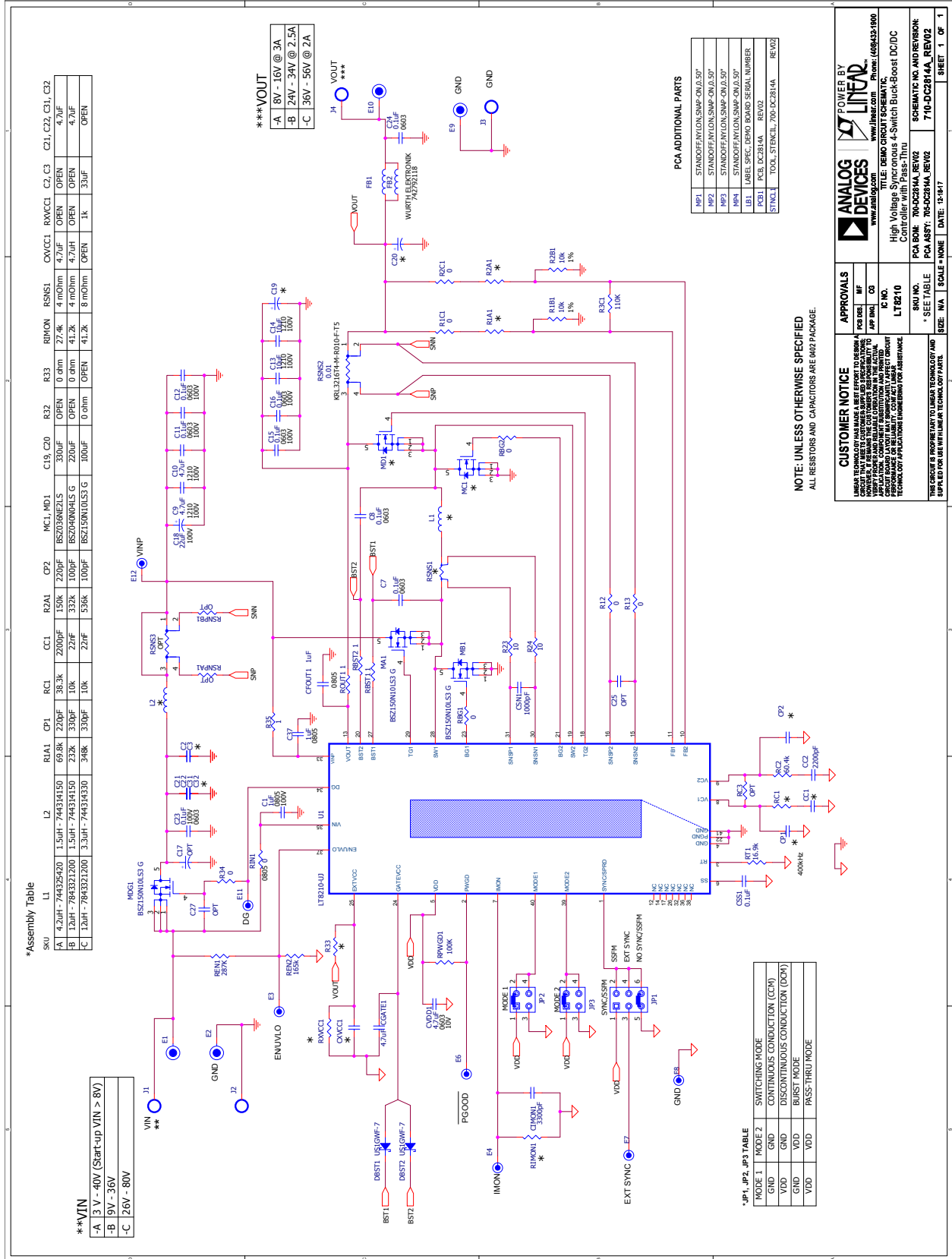
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	2	C1, CFOUT1	CAP, 1µF, X7S, 100V, 10%, 0805, SOFT TERM	MURATA GRJ21BC72A105KE11L TDK C2012X7S2A105K125AE
2	5	C7, C8, C11, C12, C23	CAP, 0.1µF, X7S, 100V, 10%, 0603	TAIYO YUDEN HMK107C7104KA-T TDK C1608X7S2A104K080AB
3	6	C9, C10, C21, C22, C31, C32	CAP, 4.7µF, X7S, 100V, 20%, 1210	TDK C3225X7S2A475M200AB
4	2	C13, C14	CAP, 10µF, X7S, 50V, 10%, 1210	TDK C3225X7S1H106K250AB
5	3	C15, C16, C24	CAP, 0.1µF, X7R, 50V, 10%, 0603, AEC-Q200	TDK CGA3E2X7R1H104K080AA
6	1	C18	CAP, 22µF, ALUM ELECT, 100V, 20%, 8x10.2mm SMD, AEC-Q200	PANASONIC EEETG2A220UP
7	2	C19, C20	CAP, 220µF, ALUM ELECT, 50V, 20%, SMD	SUN ELECTRONIC INDUSTRIES CORP 50CE220KX
8	1	C37	CAP, 1µF, X7S, 100V, 10%, 0805, SOFT TERM	AVX 08053C105KAT2A MURATA GRJ21BC72A105KE11
9	1	CC1	CAP, 0.022µF, X7R, 16V, 10%, 0402	AVX 0402YC223KAT2A MURATA GRM155R71C223KA01D
10	1	CC2	CAP, 2200pF, X7R, 16V, 10%, 0402	AVX 0402YC222KAT2A KEMET C0402C222K4RACTU MURATA GRM155R71C222KA01D
11	1	CGATE1	CAP, 4.7µF, X5R, 10V, 10%, 0402	TDK C1005X5R1A475K050BC
12	1	CIMON1	CAP, 3300pF, X7R, 16V, 10%, 0402	AVX 0402YC332KAT2A MURATA GRM15XR71C332KA86D
13	1	CP1	CAP, 330pF, X7R, 50V, 10%, 0402	AVX 04025C331KAT2A KEMET C0402C331K5RACTU NIC NMC0402X7R331K50TRPF
14	1	CP2	CAP, 100pF, NP0, 25V, 5%, 0402	AVX 04023A101JAT2A
15	1	CSN1	CAP, 1000pF, X7R, 16V, 10%, 0402	AVX 0402YC102KAT2A MURATA GRM155R71C102KA01D
16	1	CSS1	CAP, 0.1µF, X7R, 25V, 10%, 0402	AVX 04023C104KAT2A TAIYO YUDEN TMK105B7104KV-FR
17	1	CVDD1	CAP, 4.7µF, X5R, 10V, 10%, 0603	TDK CGB3B1X5R1A475K055AC
18	1	CXVCC1	CAP, 4.7µF, X5R, 16V, 20%, 0603	TDK C1608X5R1C475M080AC
19	2	DBST1, DBST2	DIODE, RECT, 400V, 1A, SOD123F, AEC-Q101	DIODES INC US1GW-F7
20	4	E1, E2, E9, E10	TEST POINT, TURRET, 0.094", MTG HOLE	MILL-MAX 2501-2-00-80-00-00-07-0
21	7	E3, E4, E6, E7, E8, E11, E12	TEST POINT, TURRET, 0.064", MTG HOLE	MILL-MAX 2308-2-00-80-00-00-07-0
22	2	FB1, FB2	IND, 600Ω AT 100MHz, FERRITE BEAD, 25%, 2.5A, 70mΩ, 1206	WURTH ELEKTRONIK 742792118
23	4	J1, J2, J3, J4	CONN, BANANA JACK, FEMALE, THT, NON-INSULATED, SWAGE	KEYSTONE 575-4
24	1	JP1	CONN, HDR, MALE, 2x3, 2mm, VERT, STR, THT	SAMTEC TMM-103-02-L-D
25	2	JP2, JP3	CONN, HDR, MALE, 2x2, 2mm, VERT, STR, THT, 10µ" Au	SAMTEC TMM-102-02-L-D
26	1	L1	IND, 12µH, PWR, 20%, 1212, AEC-Q200	WURTH ELEKTRONIK 7843321200
27	1	L2	IND, 1.5µH, PWR, 20%, 13A, 4.3mΩ, 7050	WURTH ELEKTRONIK 744314150
28	1	LB1	LABEL SPEC, DEMO BOARD SERIAL NUMBER	BRADY THT-96-717-10
29	3	MA1, MB1, MDG1	XSTR, MOSFET, N-CH, 100V, 40V, PG-TSDSON-8	INFINEON BSZ150N10LS3 G INFINEON BSZ150N10LS3GATMA1

# DEMO MANUAL DC2814A-B

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
30	2	MC1, MD1	XSTR, MOSFET, N-CH, 40V, 40A, PG-TSDSON-8	INFINEON BSZ040N04LS G INFINEON BSZ040N04LSGATMA1
31	4	MP1, MP2, MP3, MP4	STANDOFF, NYLON, SNAP-ON, 0.50"	KEYSTONE 8833
32	1	PCB1	PCB, DC2814A	PHASE 3 600-DC2814A
33	1	R1A1	RES, AEC-Q200, 232k $\Omega$ , 1%, 1/16W, 0402	VISHAY CRCW0402232KFKED
34	3	R1B1, R2B1, RC1	RES, 10k $\Omega$ , 1%, 1/16W, 0402	VISHAY CRCW040210K0FKED NIC NRC04F1002TRF
35	8	R1C1, R2C1, R12, R13, R33, R34, RBG1, RBG2	RES, 0 $\Omega$ , 1/16W, 0402	ROHM MCR01MZPJ000 VISHAY CRCW04020000Z0ED NIC NRC04Z0TRF YAGEO RC0402JR-070RL
36	1	R2A1	RES, 332k $\Omega$ , 1%, 1/16W, 0402	NIC NRC04F3323TRF VISHAY CRCW0402332KFKED
37	2	R23, R24	RES, 10 $\Omega$ , 1%, 1/16W, 0402, AEC-Q200	NIC NRC04F10R0TRF VISHAY CRCW040210R0FKED
38	4	R35, RBST1, RBST2, ROUT1	RES, 1 $\Omega$ , 1%, 1/16W, 0402	VISHAY CRCW04021R00FKED
39	1	RC2	RES, 60.4k $\Omega$ , 1%, 1/16W, 0402	NIC NRC04F6042TRF VISHAY CRCW040260K4FKED
40	1	REN1	RES, 287k $\Omega$ , 1%, 1/16W, 0402, AEC-Q200	VISHAY CRCW0402287KFKED
41	1	REN2	RES, 165k $\Omega$ , 1%, 1/16W, 0402, AEC-Q200	VISHAY CRCW0402165KFKED
42	1	RIMON1	RES, 41.2k $\Omega$ , 1%, 1/16W, 0402, AEC-Q200	VISHAY CRCW040241K2FKED
43	1	RIN1	RES, 0 $\Omega$ , 1/8W, 0805	VISHAY CRCW08050000Z0EA YAGEO RC0805JR-070RL
44	1	RPWGD1	RES, 100k $\Omega$ , 1%, 1/16W, 0402, AEC-Q200	NIC NRC04F1003TRF VISHAY CRCW0402100KFKED
45	1	RSNS1	RES, 0.004 $\Omega$ , 1%, 1W, 1206, 4-TERM, SENSE, AEC-Q200	SUSUMU KRL3216T4-M-R004-F-T1
46	1	RSNS2	RES, 0.01 $\Omega$ , 1%, 1W, 1206, 4-TERM, SENSE, AEC-Q200	SUSUMU KRL3216T4-M-R010-F-T5
47	1	RT1	RES, 16.9k $\Omega$ , 1%, 1/10W, 0603, AEC-Q200	NIC NRC06F1692TRF PANASONIC ERJ3EKF1692V VISHAY CRCW060316K9FKEA
48	1	STNCL1	TOOL, STENCIL, 700-DC2814A	ANALOG DEVICES 830-DC2814A
49	1	U1	IC, 100V, BUCK-BOOST CONTROLLER, QFN-40 (6x6)	ANALOG DEVICES LT8210EJ#PBF ANALOG DEVICES LT8210EJ#TRPBF
50	3	XJP1, XJP2, XJP3	CONN, SHUNT, FEMALE, 2-POS, 2mm	SAMTEC 2SN-BK-G

SCHEMATIC DIAGRAM



**\*Assembly Table**

SKU	L1	L2	RIA1	CP1	CC1	R2A1	CP2	MCI, MD1	C19, C20	R32	R33	RIMON	RSN61	CVCC1	RAVCC1	C2, C3	C12, C22, C31, C32
A	4.2µH - 744325420	1.5µH - 744341150	69.8K	220pF	38.3K	2200pF	150K	BSZ036N2LS	330µF	OPEN	0 ohm	27.4k	4 mOhm	4.7µF	OPEN	OPEN	4.7µF
B	12µH - 7843321200	1.5µH - 744341150	232K	330pF	10K	227pF	332K	BSZ040N4LS G	220µF	OPEN	0 ohm	41.2k	4 mOhm	4.7µF	OPEN	OPEN	4.7µF
C	12µH - 7843321200	3.3µH - 744341330	348K	330pF	10K	227pF	538K	BSZ150N10LS3 G	100µF	0 ohm	OPEN	41.2k	8 mOhm	OPEN	1k	33µF	OPEN

**\*\*VIN**

A	3 V - 40V (Start-up VIN > 8V)
B	9V - 36V
C	26V - 80V

**\*\*VOUT**

A	18V - 16V @ 3A
B	24V - 34V @ 2.5A
C	36V - 56V @ 2A

**PCA ADDITIONAL PARTS**

W91	STANDOFF,AVION,SNIP-ON,0.50"
W92	STANDOFF,AVION,SNIP-ON,0.50"
W93	STANDOFF,AVION,SNIP-ON,0.50"
W94	STANDOFF,AVION,SNIP-ON,0.50"
UB1	LABEL SPEC. DEMO BOARD SERIAL NUMBER
PCB1	PCB, DC2814A, REV02
STNCL	TOOL, STENCIL, 700-DC2814A, REV02

NOTE: UNLESS OTHERWISE SPECIFIED ALL RESISTORS AND CAPACITORS ARE M02 PACKAGE.

**CUSTOMER NOTICE**  
 THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.

**APPROVALS**

PCB DES.	WF
APP NAME	CG

**IC NO.** L78210

**CONTROL PART NUMBER** 71N-DC2814A, REV02

**SCHEMATIC NO. AND REVISOR** 71N-DC2814A, REV02

**DATE:** 12-16-11

**SIZE:** A4 1 SCALE=NONE

**SHEET 1 OF 1**

**POWER BY ANALOG DEVICES LINEAR**  
 www.analog.com Phone: (408)435-1000  
 www.linear.com

**TITLE:** DEMO CIRCUIT SCHEMATIC  
**CONTROL PART NUMBER** 71N-DC2814A, REV02  
**High Voltage Synchronous 4-Switch Buck-Boost DC/DC Converter**

**\*JP1, JP2, JP3 TABLE**

MODE 1	MODE 2	SWITCHING MODE
MODE 1	MODE 2	SWITCHING MODE
MODE 1	MODE 2	CONTINUOUS CONDUCTION (CCM)
MODE 1	MODE 2	DISCONTINUOUS CONDUCTION (DCM)
MODE 1	MODE 2	BURST MODE
MODE 1	MODE 2	PASS-THRU MODE



## 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.