

3V Minimum V_{IN} , 12V_{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 $\pm 15\%$ around the programmed oscillator frequency.

The $\overline{\text{PGOOD}}$ status flag indicates when output voltage is within $\pm 10\%$ 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.](#)

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

DEMO MANUAL DC2626A

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

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

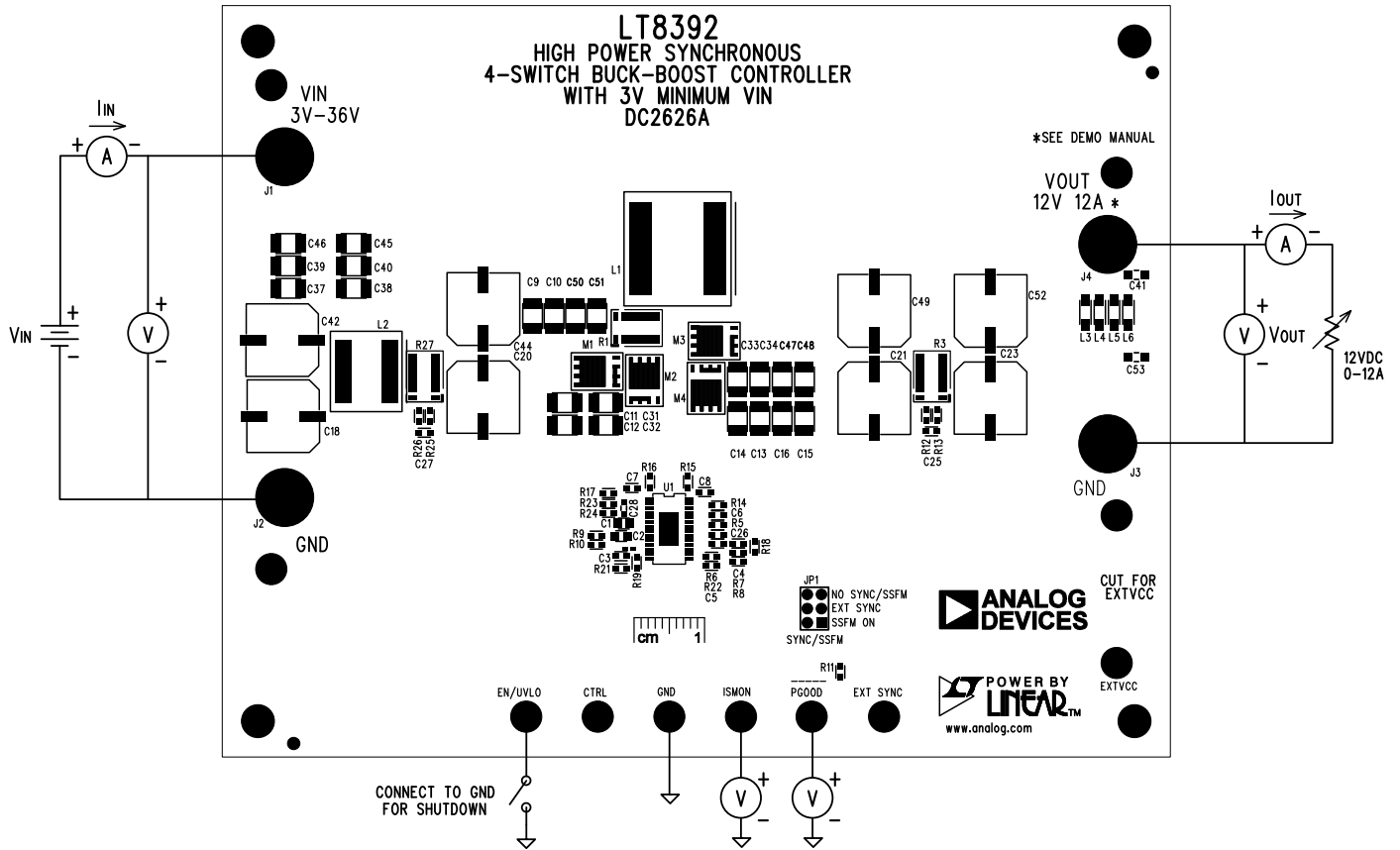


Figure 1. Test Procedure Setup Drawing for DC2626A

TEST RESULTS

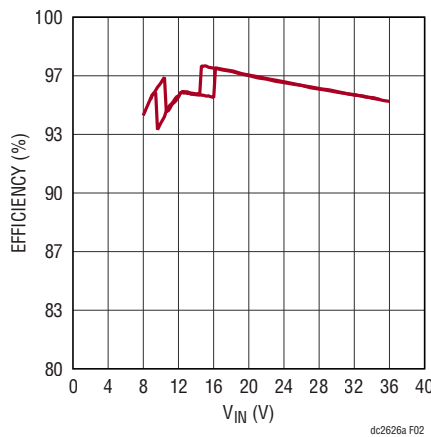


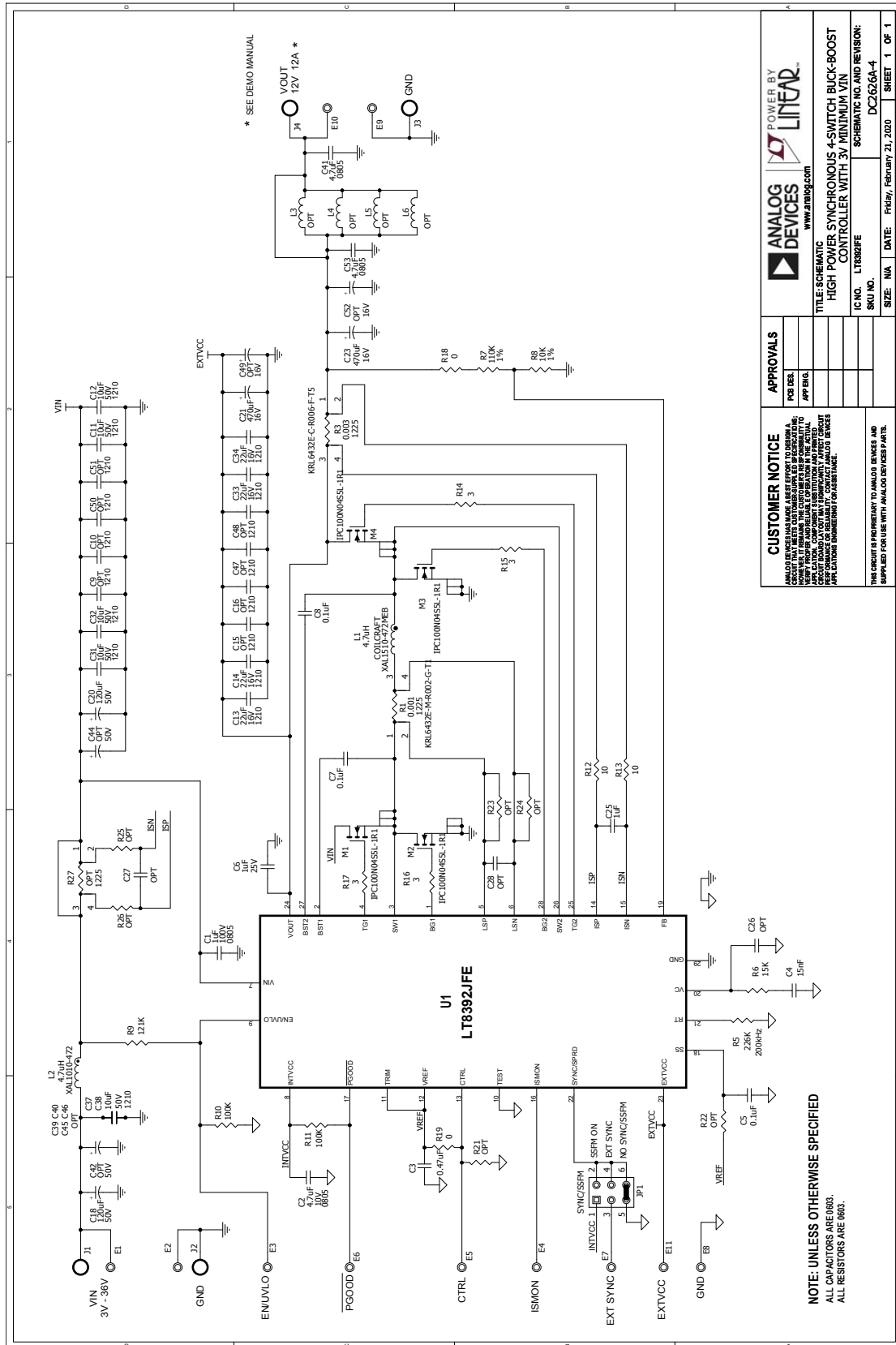
Figure 2. Efficiency vs V_{IN} at Full Load (12A), SSFM On

DEMO MANUAL DC2626A

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	CAP, 1 μ F, X7S, 100V, 10%, 0805	MURATA, GCM21BC72A105KE36L
2	1	C2	CAP, 4.7 μ F, X7S, 10V, 10%, 0805	MURATA, GCM21BCA475KA73L
3	1	C3	CAP, 0.47 μ F, X7R, 16V, 10%, 0603	MURATA, GCM188R71C474KA55D
4	1	C4	CAP, 0.015 μ F, X7R, 25V, 10%, 0603	MURATA, GCJ188R71E153KA01
5	3	C5, C7, C8	CAP, 0.1 μ F, X7R, 16V, 10%, 0603	MURATA, GCJ188R71E104KA12
6	2	C6, C25	CAP, 1 μ F, X7R, 25V, 10%, 0603	MURATA, GCM188R71E105KA64D
7	4	C11, C12, C31, C32	CAP, 10 μ F, X7S, 50V, 10%, 1210	MURATA, GCM32EC71H106KA03L
8	4	C13, C14, C33, C34	CAP, 22 μ F, X7R, 16V, 20%, 1210	MURATA, GCM32ER71C226ME19L
9	2	C18, C20	CAP, ALUM, 120 μ F, 50V 20% 10x10.5mm	PANASONIC, EEHZC1H121P
10	2	C21, C23	CAP, ALUM, 470 μ F, 16V, 20%, 10x10.3mm	CHEMI-CON, HHXA160ARA471MJA0G
11	4	C33, C34, C50, C51	CAP, 10 μ F, X7R, 16V, 10%, 1206	MURATA, GCM31CR71C106KA64
12	2	C37, C38	CAP, 10 μ F, X7S, 50V, 10%, 1210	MURATA, GCM32EC71H106KA03L
13	2	C41, C53	CAP, 4.7 μ F, X7R, 16V, 10%, 0805	MURATA, GCM21BR71C475KA73L
14	1	L1	IND., 4.7 μ H XAL1510	COILCRAFT, XAL1510-472MEB
15	1	L2	IND., 4.7 μ H, XAL1010	COILCRAFT, XAL1010-472MEB
16	4	M1, M2, M3, M4	XSTR., MOSFET, N-CH, 40V, TDSO8	INFINEON, IPC100N04S5L-1R1
17	2	R1	SENSE RES., 0.001 Ω , 3W 2% 1225	SUSUMU, KRL6432E-M-R001-G-T1
18	2	R3	RES., SENSE, 0.003 Ω 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., 10 Ω , 1/10W, 5%, 0603	VISHAY, CRCW060310R0JNEA
26	6	R14, R15, R16, R17, R18, R19	RES., 0 Ω , 1/10W, 0603	VISHAY, CRCW06030000Z0EA
27	4	R14, R15, R16, R17	RES., 3 Ω , 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



		www.analog.com	
CUSTOMER NOTICE ANALOG DEVICES HAS MADE BEST EFFORT TO DESIGN AND TEST THIS SCHEMATIC TO BE FUNCTIONAL. HOWEVER, IT REMAINS THE CUSTOMER'S RESPONSIBILITY TO VERIFY THE SCHEMATIC AND TO PROVIDE THE APPROPRIATE PARTS LIST. ANALOG DEVICES DOES NOT WARRANT ANY PERFORMANCE OR RELIABILITY. CONTACT ANALOG DEVICES APPLICATIONS ENGINEERING FOR ASSISTANCE.			
APPROVALS		TITLE: SCHEMATIC HIGH POWER SYNCHRONOUS 4-SWITCH BUCK-BOOST CONTROLLER WITH 3V MINIMUM VIN	
PSE DES:		IC NO.: LT8392FE	
APP ENCL:		SCHEMATIC NO. AND REVISION: DC2626A-4	
DATE:		SIZE: N/A	
DATE: Friday, February 21, 2020		SHEET 1 OF 1	

NOTE: UNLESS OTHERWISE SPECIFIED ALL CAPACITORS ARE 0603. ALL RESISTORS 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.