

LTC7800 Low Quiescent Current High Frequency Step-Down Converter

DESCRIPTION

Demonstration circuit 2786A is a single output high voltage non-isolated synchronous step-down converter that drives an all N-channel MOSFET 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 x 4mm QFN package.

This DC2786A operates over an input voltage range from 8V to 40V, while the LTC®7800 can operate up to 60V. This demo board produces a 3.3V output voltage with up to 10A output current, and is configured with a sense resistor for current sensing. A mode selector allows the DC2786A

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 deadtime which is good for GaN transistors or logic-level MOSFETs to maximize efficiency. The EXTVC 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.

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

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

PARAMETER	CONDITIONS	VALUE	UNITS
Input Voltage Range		8 to 40	V
Output Voltage, V_{OUT}	$V_{IN} = 8\text{-}40\text{V}$, $I_{OUT} = 0\text{A to } 10\text{A}$	3.3	V
Maximum Output Current, I_{OUT}	$V_{IN} = 8\text{-}40\text{V}$, $V_{OUT} = 3.3\text{V}$	10	A
Typical Efficiency	$V_{IN} = 12\text{V}$, $V_{OUT} = 3.3\text{V}$, $I_{OUT} = 10\text{A}$	88.6	%
Peak Efficiency	$V_{IN} = 12\text{V}$, $V_{OUT} = 3.3\text{V}$	89	%
Switching Frequency		2	MHz

Note 1: 200LFM forced airflow is required for $V_{IN} > 24\text{V}$

BOARD PHOTO

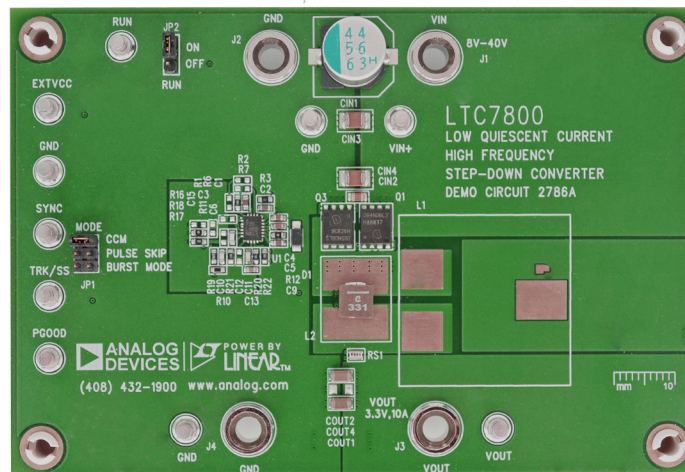


Figure 1. LTC7800; 10A DC2786A Demo Circuit

QUICK START PROCEDURE

Demonstration circuit 2786A is easy to set up to evaluate the performance of the LTC7800. Refer to Figure 2 for the proper measurement equipment setup and follow the procedure below.

1. With power off, connect the input power supply to VIN (8V-40V) and GND (input return).
2. Connect the output loads between VOUT and GND (**Initial load: no load**). Refer to Figure 2.

NOTE: Please use J1, J2 (Not E2, E4) and J3, J4 (Not E5, E7) for input power supply and output load connection.

3. Connect the DVMs to the input and output.
4. Check the default jumper/switch position: JP2 (RUN): OFF
5. Turn on the input power supply and adjust voltage to 12V;

NOTE: Make sure that the input voltage does not exceed 40V.

6. Turn on the switches: JP2: ON.
7. Check for the proper output voltages from VOUT to GND.
8. Once the proper output voltage is established, adjust the loads within the operating range and measure the efficiency, output ripple voltage and other parameters.
9. After completing all tests, adjust the load to 0A, power 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 3 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.

External EXTVCC Option

The EXTV_{CC} pin of the LTC7800 on the DC2786A board can be utilized for better efficiency and better thermal performance. Please follow the below procedure if an external power supply is used to bias the LTC7800 EXTV_{CC} pin (Do not float this pin).

1. Populate R24 with a 0Ω resistor.
2. Apply a DC voltage (recommend 6V – 13V) on EXTV_{CC} and GND turret after the input voltage is established. Make sure EXTV_{CC} < V_{IN}.
3. Turn off the DC bias on the EXTV_{CC} before powering off the input power supply.

QUICK START PROCEDURE

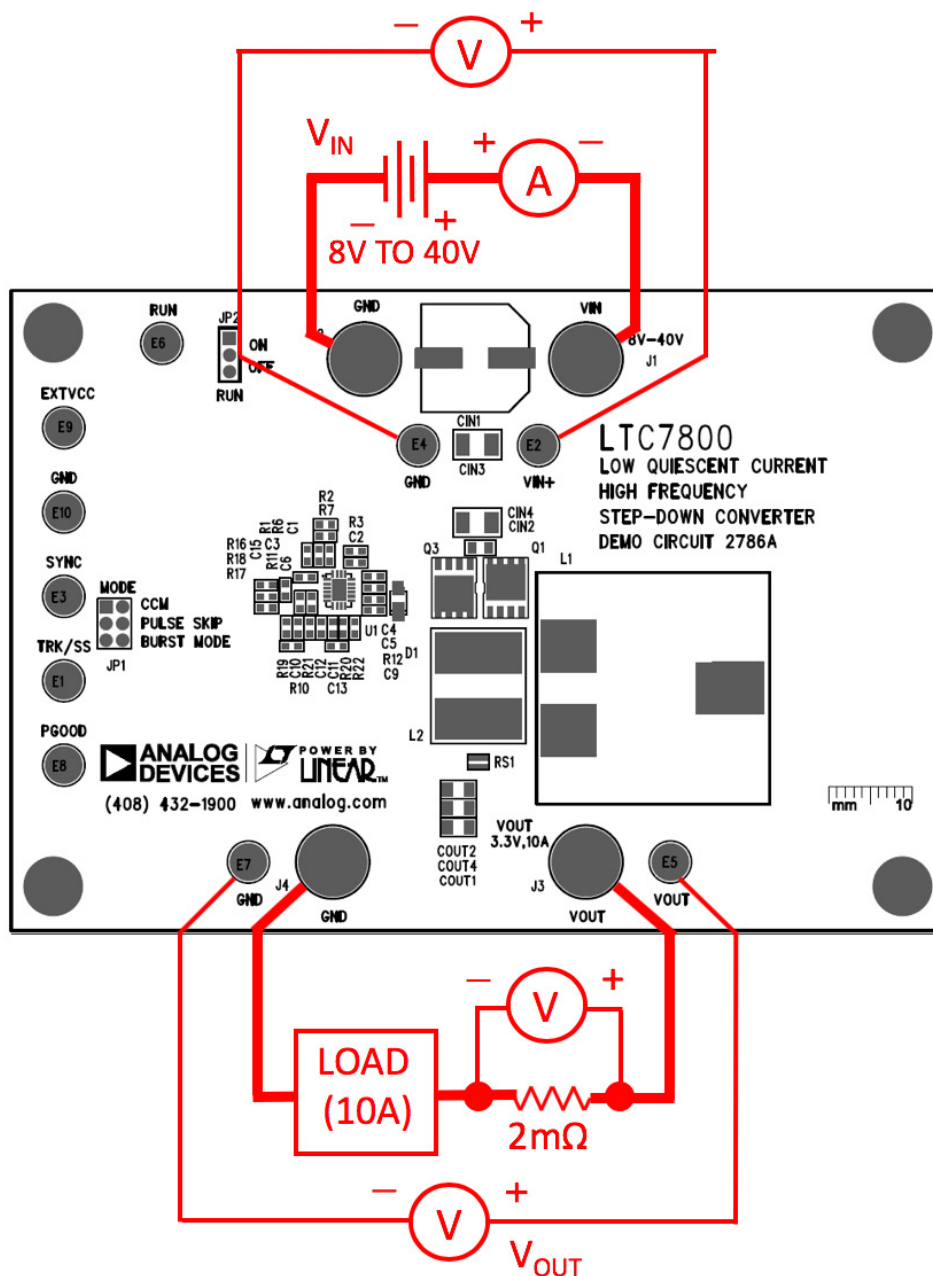


Figure 2. Proper Measurement Equipment Setup

QUICK START PROCEDURE

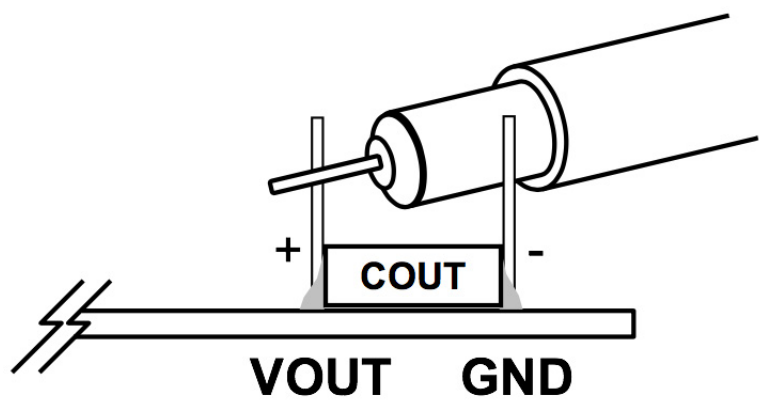


Figure 3. Measuring Output Voltage Ripple

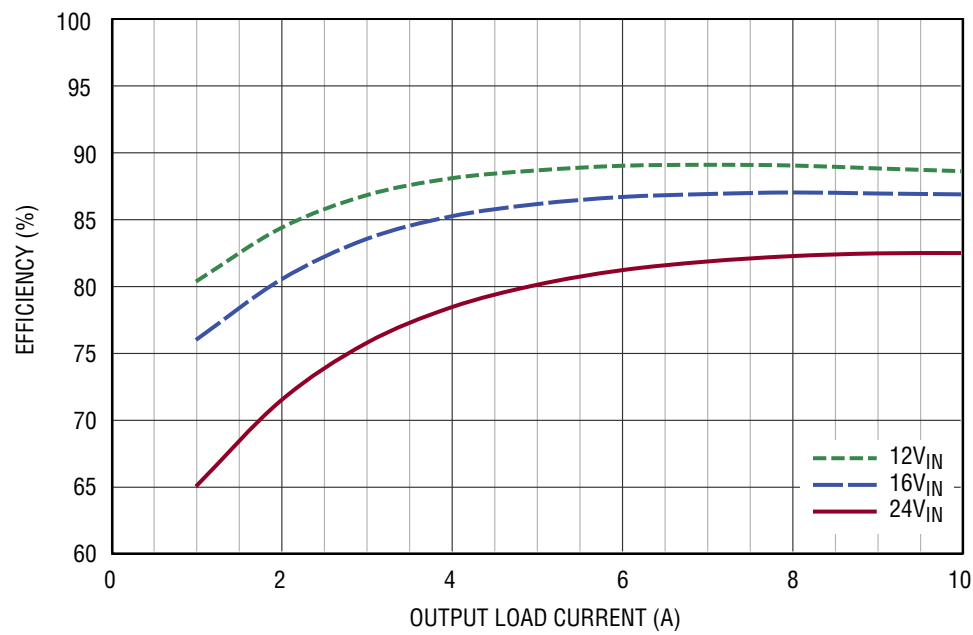


Figure 4. Efficiency vs Load Current at $V_{OUT} = 3.3V$, $f_{SW} = 2MHz$

QUICK START PROCEDURE

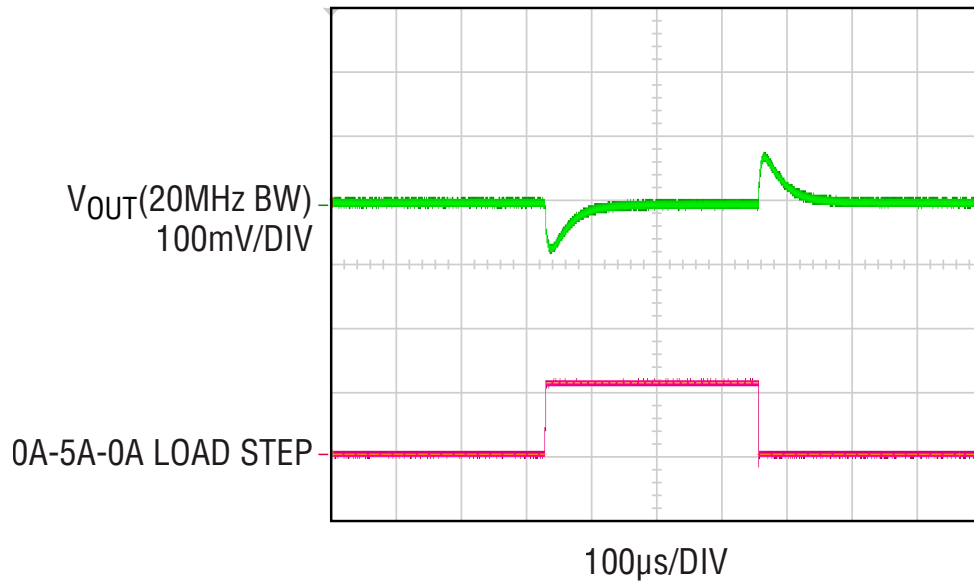


Figure 5. Load Step at $V_{IN} = 12\text{V}$, $V_{OUT} = 3.3\text{V}$, $di/dt = 5\text{A}/\mu\text{s}$

QUICK START PROCEDURE

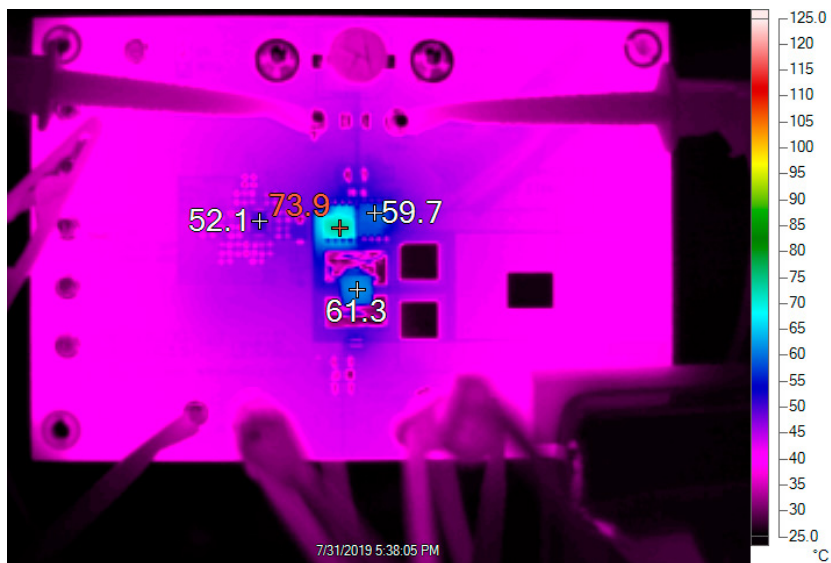


Figure 6. Thermal performance $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 10A$ $T_A = 23^\circ C$, No Airflow



Figure 7. Thermal performance $V_{IN} = 24V$, $V_{OUT} = 3.3V$, $I_{OUT} = 10A$ $T_A = 23^\circ C$, No Airflow

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	CIN1	CAP., 56uF 63V 13X13	SUNCON, 63HVH56M
2	1	CIN2	CAP., 0805 1uF 10% 100V X7S	MURATA, GRM21BC72A105KE01L
3	2	CIN3, CIN4	CAP., 1210 10uF 10% 100V X7S	MURATA, GRM32EC72A106KE05L
4	3	COUT1, COUT2, COUT4	CAP., 1206 100uF 10% 6.3V X5R	MURATA, GRM31CR60J107KE39L
5	4	C1, C2, C7, C9	CAP., 0603 0.1uF 10% 100V X7S	TDK, C1608X7S2A104K080AB
6	2	C4, C14	CAP., 0603 1uF 20% 25V X7R	TDK, C1608X7R1E105M080AE
7	1	C5	CAP., 0603 2.2uF 10% 10V X7R	MURATA, GRM188R71A225KE15D
8	1	C6	CAP., 0603 470pF 5% 50V C0G/NP0	AVX, 06035A471JAT2A
9	1	C8	CAP., 0603 100pF 5% 50V C0G/NP0	AVX, 06035A101JAT2A
10	1	C10	CAP., 0603 4.7pF 5% 25V COG	AVX, 06033A4R7DAT2A
11	1	C11	CAP., 0603 27pF 10% 50V C0G	AVX, 06035A270KAT2A
12	1	C13	CAP., 0603 4700pF 10% 50V X7R	AVX, 06035C472KAT2A
13	1	C15	CAP., 0603 10uF 10V	TDK, C1608X5R1A106K080AC
14	1	D1	DIODE, SCHOTTKY 100V POWERDI123	DIODES INC., DFLS1100-7
15	1	L2	IND., 0.33uH	COILCRAFT, XAL5030-331MEB
16	1	Q1	POWER MOSFET	INFINEON, BSC094N06LS5ATMA1
17	1	Q3	POWER MOSFET	INFINEON, BSC065N06LS5
18	1	RS1	RES, 0805 0.004	SUSUMU, KRL2012E-C-R004-F-T5
19	1	R3	RES, 0603 2.2 OHMS 5%	VISHAY, CRCW06032R20JNEA
20	3	R4, R12, R18	RES, 0603 0 OHM JUMPER	VISHAY, CRCW06030000Z0EA
21	4	R6, R9, R15, R22	RES, 0603 100K OHMS 1%	VISHAY, CRCW0603100KFKEA
22	1	R8	RES, 0603 1K OHMS 5%	VISHAY, CRCW06031K00JNEA
23	1	R10	RES, 0603 49.9 OHMS 1%	VISHAY, CRCW060349R9FKEA
24	1	R14	RES., 1M, 1%, 0603	NIC, NRC06f1004TRF
25	1	R17	RES, 0603 100 OHMS 1%	VISHAY, CRCW0603100RFKEA
26	1	R19	RES, 0603 511K OHMS 1%	VISHAY, CRCW0603511KFKEA
27	1	R20	RES, 0603 6.81K OHMS 1%	VISHAY, CRCW06036K81FKEA
28	1	R21	RES, 0603 162K OHMS 1%	VISHAY, CRCW0603162KFKEA
29	1	R25	RES, 0603 1 OHMS 1%	VISHAY, CRCW06031R00FKEA
30	1	U1	IC., LTC7800, QFN	ANALOG DEVICES, LTC7800EUDC#PBF
Additional Demo Board Circuit Components				
1	0	CIN5	CAP., 0805, OPTION	
2	0	CIN6	CAP., 1210, OPTION	
3	0	COUT3	CAP., 1206, OPTION	
4	0	COUT5	CAP., 7343, OPTION	
5	0	C3, C12	CAP., 0603, OPTION	
6	0	L1	IND., High Current Inductor, OPTION	WURTH, WE7443630420
7	0	Q2, Q4	XSTR, POWER MOSFET, OPTION	
8	0	R16, R24, R1, R2, R5, R7, R11	RES., 0603, OPTION	
9	0	R13	RES., 0805, OPTION	

DEMO MANUAL DC2786A

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Hardware: For Demo Board Only				
1	9	E1, E2, E3, E4, E5, E6, E7, E8, E9	TESTPOINT, TURRET, .095"	MILL-MAX, 2501-2-00-80-00-00-07-0
2	1	JP1	2MM DOUBLE ROW HEADER, 3X2	SAMTEC, TMM-103-02-L-D
3	1	JP2	HEADER, 3 PIN 0.079 SINGLE ROW	SULLINS, NRPN031PAEN-RC
4	4	J1, J2, J3, J4	STUD, TESTPIN	PEM, KFH-032-10
5	8	J1, J2, J3, J4	NUT, BRASS 10-32	ANY, #10-32
6	4	J1, J2, J3, J4	RING, LUG #10	KEYSTONE, #10
7	4	J1, J2, J3, J4	WASHER, TIN PLATED BRASS	ANY, #10
8	1	XJP1, XJP2	SHUNT, 2mm	SAMTEC, 2SN-BK-G
9	4	MH1, MH2, MH3, MH4	STANDOFF, NYLON, SNAP-ON, 0.375"	KEYSTONE, 8832



**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.