

## Evaluation Board for the AD7291

### 8-Channel, I<sup>2</sup>C, 12-Bit SAR ADC with Temperature Sensor

#### FEATURES

- Full-featured evaluation board for the [AD7291](#)
- Link options
- On-board analog bias-up circuit
- PC control in conjunction with system demonstration platform (SDP)
- PC software for control

#### EVALUATION BOARD DESCRIPTION

The [EVAL-AD7291SDZ](#) is a full-featured evaluation board, designed to allow the user to easily evaluate all features of the [AD7291](#). The evaluation board can be controlled via the system demonstration platform (SDP) connector (J1). The SDP board allows the evaluation board to be controlled through the USB port of a PC using the [AD7291](#) evaluation software.

On-board components include the [ADP1706](#) low dropout CMOS linear regulator; the [AD8022](#) high speed, low noise amp; and the [AD8066](#) high performance 145 MHz FastFET™ amp.

The evaluation board features analog bias-up circuitry. Bipolar signals are input via the VIN SMB connector and are biased up by the on-board bias-up buffer circuit. The biased up signal is available at the BIASED\_VIN2 SMB and can be applied to any one of the eight VINx SMB connectors using an SMB-SMB cable.

Various link options are described in the Evaluation Board Hardware section. The Link Options section of this user guide should be consulted when configuring the board for standalone operation.

#### DEVICE DESCRIPTION

The [AD7291](#) is a 12-bit, 8-channel successive approximation ADC with an internal temperature sensor. The part operates from a single 3.3 V power supply and features an I<sup>2</sup>C-compatible interface. Each AD7291 provides a 2-wire serial interface compatible with I<sup>2</sup>C interfaces.

The [AD7291](#) offers a programmable sequencer, which enables the selection of a preprogrammable sequence of channels for conversion. The device has an on-chip 2.5 V reference that can be disabled to allow the use of an external reference.

The [AD7291](#) includes a high accuracy band-gap temperature sensor, which is monitored and digitized by the 12-bit ADC to give a resolution of 0.25°C.

Complete specifications for the [AD7291](#) are provided in the [AD7291](#) data sheet, available from Analog Devices, Inc., which should be consulted in conjunction with this data sheet when using the evaluation board.

#### FUNCTIONAL BLOCK DIAGRAM

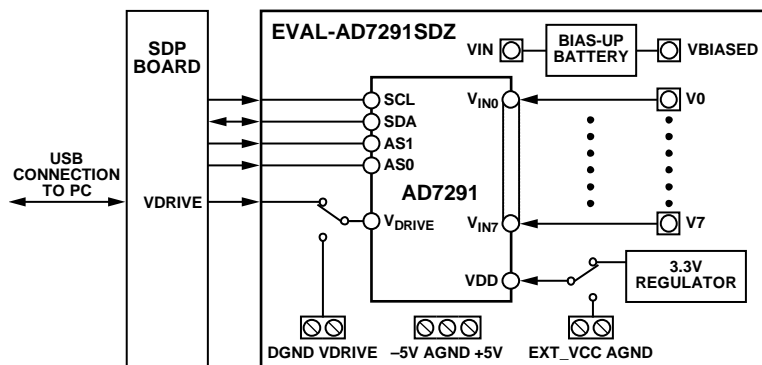


Figure 1.

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**REVISION HISTORY**

**6/11—Rev. 0 to Rev. A**

Changes to Features and Evaluation Board Description

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**3/11—Revision 0: Initial Version**

## EVALUATION BOARD HARDWARE

### POWER SUPPLIES

Care should be taken before applying power and signals to the evaluation board to ensure that all link positions are as required by the operating mode.

When using this evaluation board with the SDP board, apply +5 V, -5 V, and GND to Connector J2.  $V_{DRIVE}$  is supplied by the SDP board, and  $V_{DD}$  is supplied by an on-board regulator. Each supply is decoupled on the [EVAL-AD7291SDZ](#) using 10  $\mu$ F and 0.1  $\mu$ F capacitors. A single ground plane is used on this board to minimize the effect of high frequency noise interference.

**Table 1. Link Options**

Link No.	Position	Function
LK1	Inserted	This link option pulls the <a href="#">AD7291</a> $V_{IN0}$ input to GND via a 10 k $\Omega$ resistor.
LK2	Inserted	This link option pulls the <a href="#">AD7291</a> $V_{IN1}$ input to GND via a 10 k $\Omega$ resistor.
LK3	Inserted	This link option pulls the <a href="#">AD7291</a> $V_{IN6}$ input to GND via a 10 k $\Omega$ resistor.
LK4	Inserted	This link option pulls the <a href="#">AD7291</a> $V_{IN7}$ input to GND via a 10 k $\Omega$ resistor.
LK5	Position A	Connects the $\overline{PD}/\overline{RST}$ pin to $V_{DRIVE}$ voltage.
LK6	Position A	When in Position A, the 3.3 V $V_{CC}$ supply is supplied by the on-board regulator, <a href="#">ADP1706</a> .
LK7	Position A	When in Position A, the $V_{DRIVE}$ supply is taken from the SDP board via VIO_CONNECTOR.
LK8	Inserted	When inserted, the $V_{REF}$ signal is connected to the $V_{REF}$ test point.
LK9	Inserted	When inserted, the buffered internal reference voltage is divided by a factor of 3 and used as the bias input for U10.
LK10	Inserted	This link option pulls the <a href="#">AD7291</a> $V_{IN2}$ input to GND via a 10 k $\Omega$ resistor.
LK11	Inserted	This link option pulls the <a href="#">AD7291</a> $V_{IN3}$ input to GND via a 10 k $\Omega$ resistor.
LK12	Inserted	This link option pulls the <a href="#">AD7291</a> $V_{IN4}$ input to GND via a 10 k $\Omega$ resistor.
LK13	Inserted	This link option pulls the <a href="#">AD7291</a> $V_{IN5}$ input to GND via a 10 k $\Omega$ resistor.
LK14	Inserted	This link option connects +5 V to Pin 1 of J1.
LK20	Position A	In Position A, the buffered internal reference is used as the bias input for U10.
SL1	Position B	Buffered output from SMA Connector V7 is routed to SMB Connector BUFF_V7.
SL2	Position A	In Position A, there is no amplifier included in the Analog Input Channel $V_{IN1}$ path.
SL3	Position B	Buffered output from SMA Connector V0 is routed to SMB Connector BUFF_V0.
SL4	Position B	In Position B, there is an amplifier included on the Analog Input Channel $V_{IN0}$ path.

### LINK OPTIONS

Table 1 shows the position in which all the links are set when the evaluation board is packaged. The links are set so that control signals and  $V_{DRIVE}$  are supplied by the SDP board.

Multiple link (LKx) and solder link (SLx) options must be set correctly to select the appropriate operating setup before using the evaluation board. The default link positions are shown in Table 1 and the functions of these options are outlined in Table 2.

**SOCKETS/CONNECTORS**

There are 16 SMB input sockets relevant to the operation of the [AD7291](#) on this evaluation board. The functions of these sockets are outlined in Table 2.

**Table 2. Socket/Connector Functions**

Socket	Function
BIASED_VIN2	SMB socket for the output of the bias up circuit
BUFF_V0	SMB socket for the buffered V0 input (SL3 must be in Position A and SL4 must be in Position B)
BUFF_V7	SMB socket for the buffered V7 input (SL1 must be in Position A)
EXT_OFFSET	SMB socket for an external bias input, which is applied to U10
J3	V0 SMB socket for a single-ended input that is applied to the $V_{IN0}$ pin of the <a href="#">AD7291</a>
J4	V1 SMB socket for a single-ended input that is applied to the $V_{IN1}$ pin of the <a href="#">AD7291</a>
J5	V6 SMB socket for a single-ended input that is applied to the $V_{IN6}$ pin of the <a href="#">AD7291</a>
J6	V7 SMB socket for a single-ended input that is applied to the $V_{IN7}$ pin of the <a href="#">AD7291</a>
J8	V2 SMB socket for a single-ended input that is applied to the $V_{IN2}$ pin of the <a href="#">AD7291</a>
J9	V3 SMB socket for a single-ended input that is applied to the $V_{IN3}$ pin of the <a href="#">AD7291</a>
J10	V4 SMB socket for a single-ended input that is applied to the $V_{IN4}$ pin of the <a href="#">AD7291</a>
J11	V5 SMB socket for a single-ended input that is applied to the $V_{IN5}$ pin of the <a href="#">AD7291</a>
J12	SMB socket connected to the $V_{REF}$ pin of the <a href="#">AD7291</a> (by default the internal reference is used)
J13	SMB socket connected to the $\overline{PD/RST}$ pin of the <a href="#">AD7291</a>
VIN	SMB socket to connect input to the bias-up circuit
VREF_BUFF	SMB socket for the output of the buffered reference

## EVALUATION BOARD SOFTWARE

### SOFTWARE INSTALLATION

The AD7291 evaluation kit includes self-installing software on a CD. The software is compatible with Windows® XP (SP2) and Windows Vista® (32-bit). If the setup file does not run automatically, you can run **setup.exe** from the CD.

Install the evaluation software before connecting the evaluation board and SDP board to the USB port of the PC to ensure that the evaluation system is correctly recognized when connected to the PC.

1. After installation from the CD is complete, power up the AD7291 evaluation board as described in the Power Supplies section. Connect the SDP board (Connector A) to the AD7291 evaluation board (Connector J1) and then to the USB port of your PC using the supplied cable.
2. When the evaluation system is detected, proceed through any dialog boxes that appear. This completes the installation.

### SOFTWARE OPERATION

To launch the software, complete the following steps:

1. From the **Start** menu, select **Analog Devices – AD7291 > AD7291 Evaluation Software**. The main window of the software is displayed (see Figure 3).
2. If the evaluation system is not connected to the USB port when the software is launched, a connectivity error is displayed (see Figure 2). Connect the evaluation board to the USB port of the PC, wait a number of seconds, and click **Rescan**. Follow the instructions.

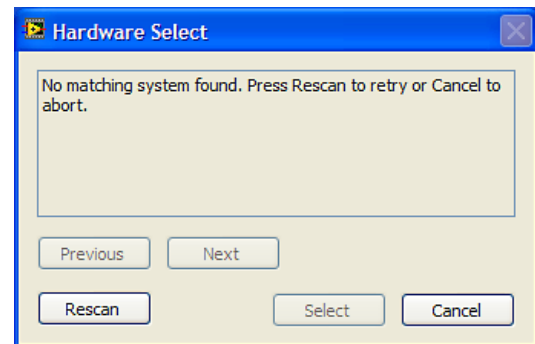


Figure 2. Connectivity Error Alert

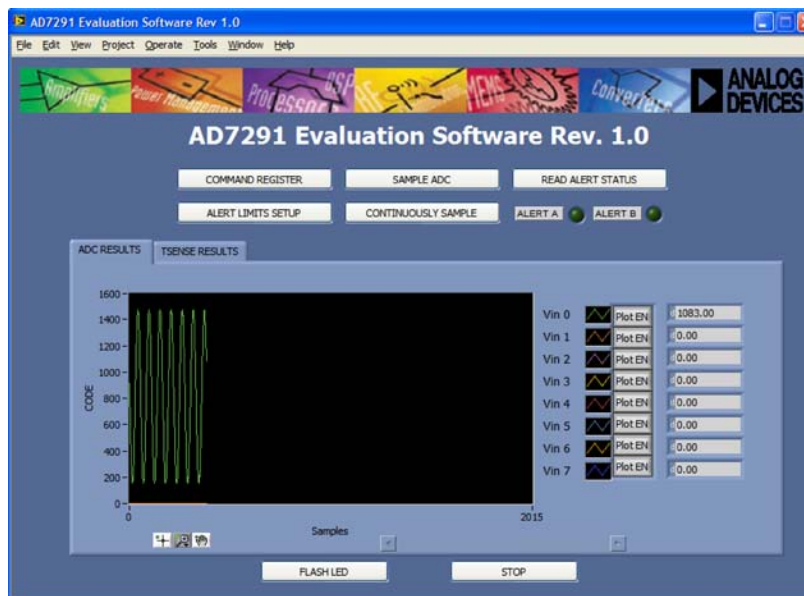


Figure 3. Main Window

## MAIN WINDOW

Figure 4 shows the main window of the [AD7291](#) evaluation software. The device is configured via the **COMMAND REGISTER** button.

Samples can be taken continuously or one at a time, depending on whether **CONTINUOUSLY SAMPLE** or **SAMPLE ADC** is selected.

The [AD7291](#) has nine pairs of limit registers. Each pair stores high and low conversion limits for each analog input channel and the internal temperature sensor, which can be programmed via the **ALERT LIMITS SETUP** button. If a limit is violated, the **ALERT A** or **ALERT B** indicator turns red. Further details on

the alert limits can be ascertained at any time by clicking **READ ALERT STATUS**.

The lower section of the window graphically displays [AD7291](#) data. The tab setting in the data display window allows the user to swap between displaying the ADC analog input channel conversion results and the internal temperature sensor results. Figure 4 depicts continuous analog input channel conversion results for  $V_{IN0}$ . Figure 4 shows the main panel with the **TSENSE RESULTS** tab selected.

Enabling the **FLASH LED** button on this window causes the orange LED1A on the SDP board to flash, which is a useful debug tool.

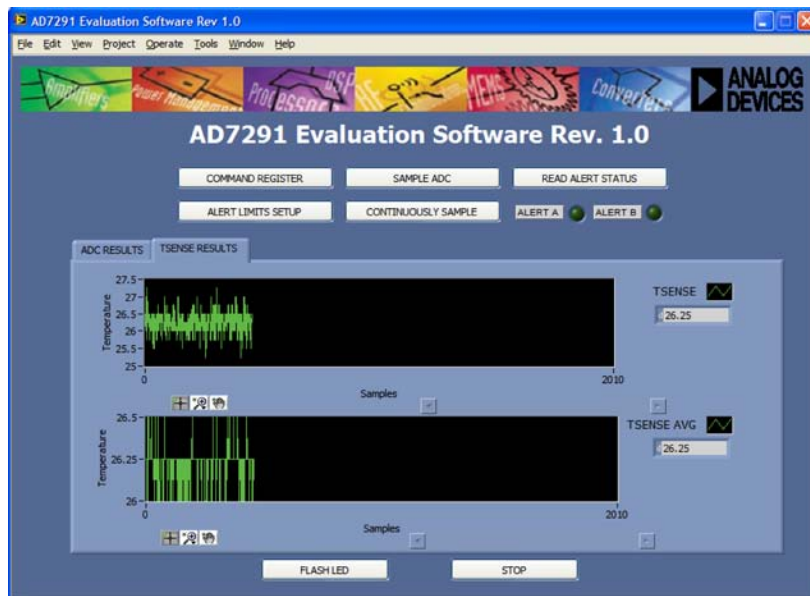


Figure 4. [AD7291](#) Main Window Displaying TSENSE and TSENSE Average Results

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## COMMAND REGISTER

The Command Register section of the [AD7291](#) data sheet should be consulted before configuring the control register settings. To configure the command register, click **COMMAND REGISTER** (see Figure 4).



Figure 5. Command Register

Select the ADC channels required for conversion in the sequence. To enable the internal temperature sensor, select **DB7/TSENSE**.

When **DB5/NOISE DELAYED BIT TRIAL SAMPLING** is enabled, critical sampling intervals and bit trials are delayed when there is activity on the I<sup>2</sup>C bus, thus ensuring improved dc performance of the [AD7291](#).

The active polarity of the ALERT pin is configured as active low if the **DB3/POLARITY OF ALERT PIN** is enabled. Conversely, it is set to active high operation if this bit is disabled.

**DB2/CLEAR ALERT** clears the content of the alert status register. Once the content of the alert status register is cleared, this bit should be reprogrammed to Logic 0 to ensure future alerts are detected.

Enabling the **DB1/RESET** bit in the command register resets the content of all internal registers in the [AD7291](#) to their default values, including the command register itself. Disable this bit once the reset is complete to allow the internal registers to be reprogrammed.

The **DB0/AUTOCYCLE MODE** enables autcycle mode. In autcycle mode, the [AD7291](#) is configured to convert continuously on the selected sequence of channels (both analog input channels and the temperature sensor channel), making it the

ideal mode of operation for system monitoring. While in this mode, the conversion results from the analog input channels are not displayed on the user interface.

Click **WRITE** to update the control register.

## ALERT LIMITS

The [AD7291](#) has nine pairs of limit registers. Each pair stores high and low conversion limits for each analog input channel and the internal temperature sensor. Each pair of limit registers has one associated hysteresis register. To program the alert limits and associated hysteresis register, click **ALERT LIMITS SETUP** on the main window.



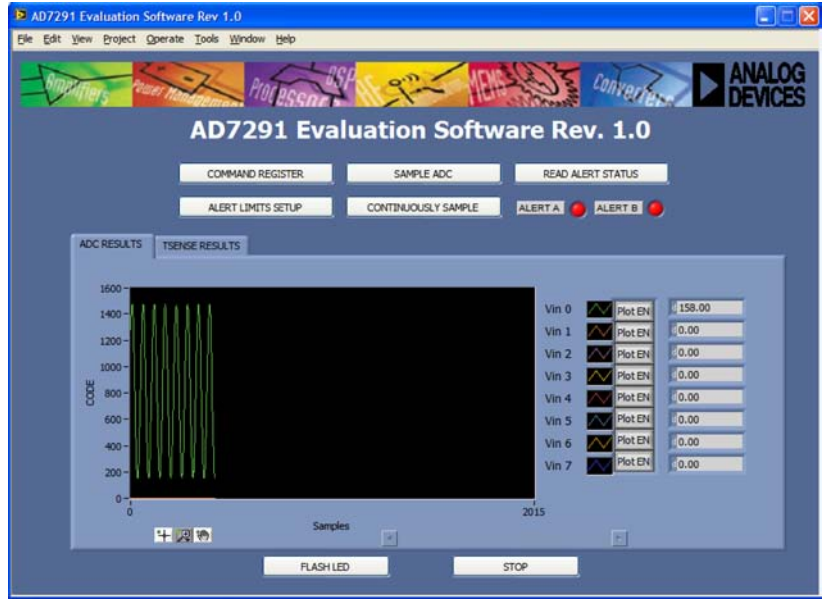
Figure 6. Alert Limits Setup

The [AD7291](#) signals an alert in hardware if the conversion result moves outside the upper or lower limit set by the limit registers. **ALERTA** and **ALERTB** indicators on the main window turn red if a limit is violated, as shown in Figure 7. Alert Register A stores alerts for the analog voltage conversion channels, and Alert Register B stores alerts for the internal temperature sensor.

For further information on the status of the alerts, click **READ ALERT STATUS** on the front panel. For example, Figure 8 depicts an example where the  $V_{IN0}$  low limit, TSENSE AVG high limit, and TSENSE high limit have been violated.

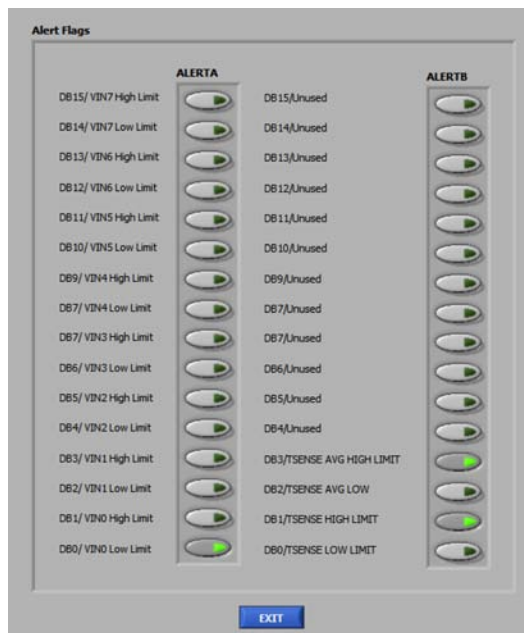
## SAMPLE ADC/CONTINUOUSLY SAMPLE

To gather sample data on the selected channels, click **SAMPLE ADC** or **CONTINUOUSLY SAMPLE**. Both buttons are located on the upper middle area of the main window. To stop sampling, click **CONTINUOUSLY SAMPLE** a second time.



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Figure 7. AD7291 Main Window Showing Triggered ALERT A and ALERT B Indicators



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Figure 8. Read Alert Status



EVALUATION BOARD SCHEMATICS AND ARTWORK

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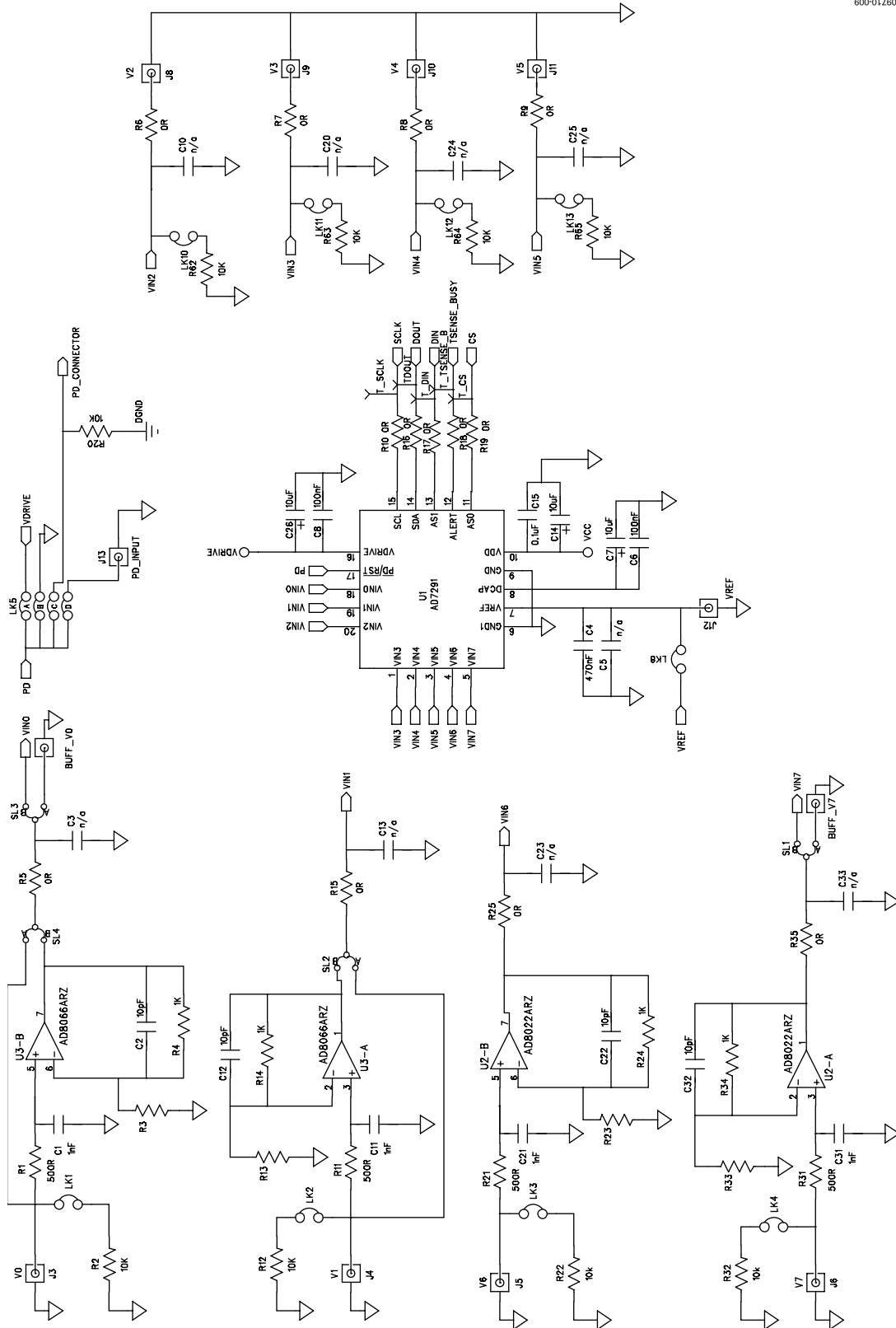


Figure 9. EVAL-AD7291SDZ Schematic 1 of 3

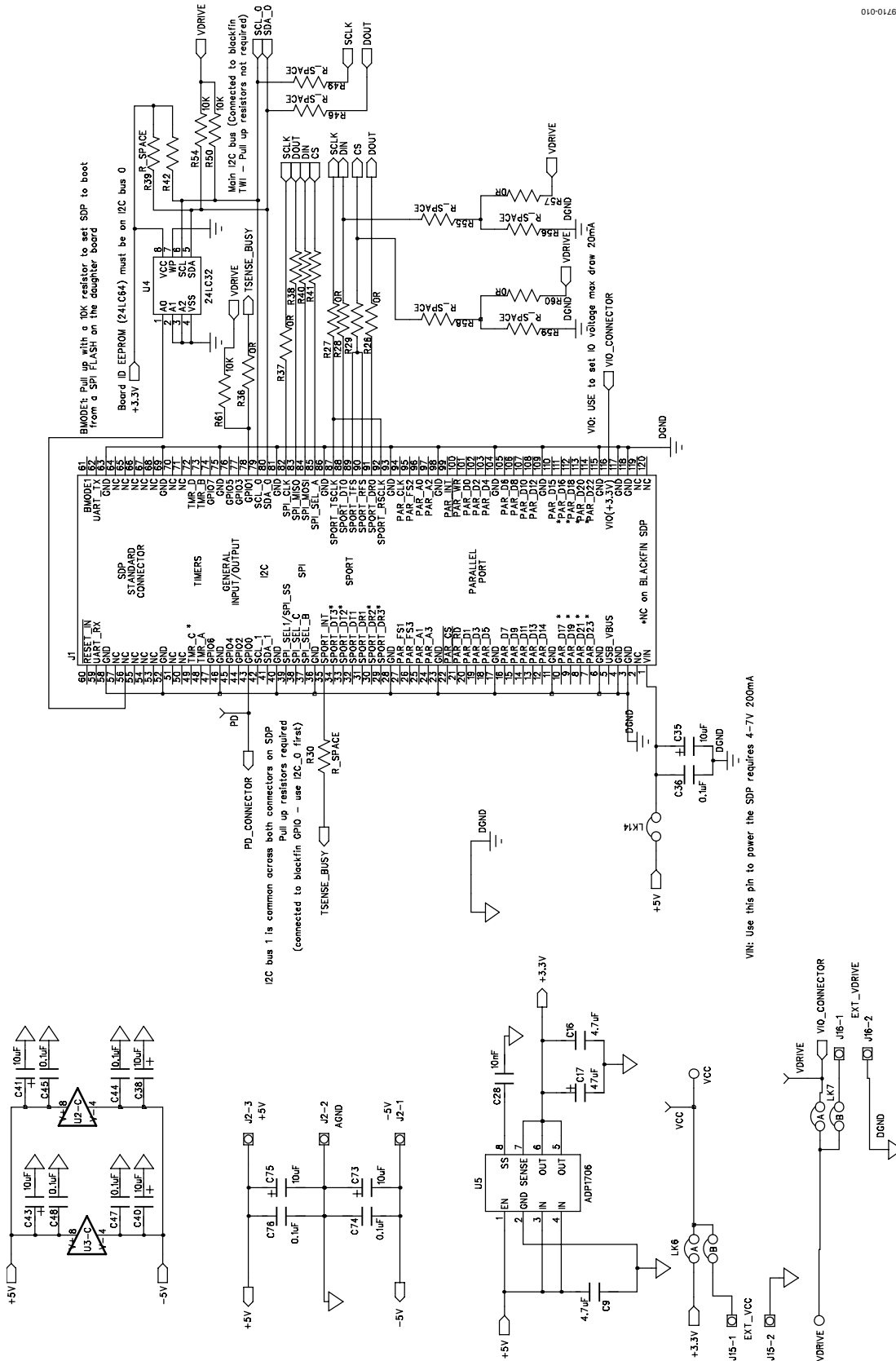
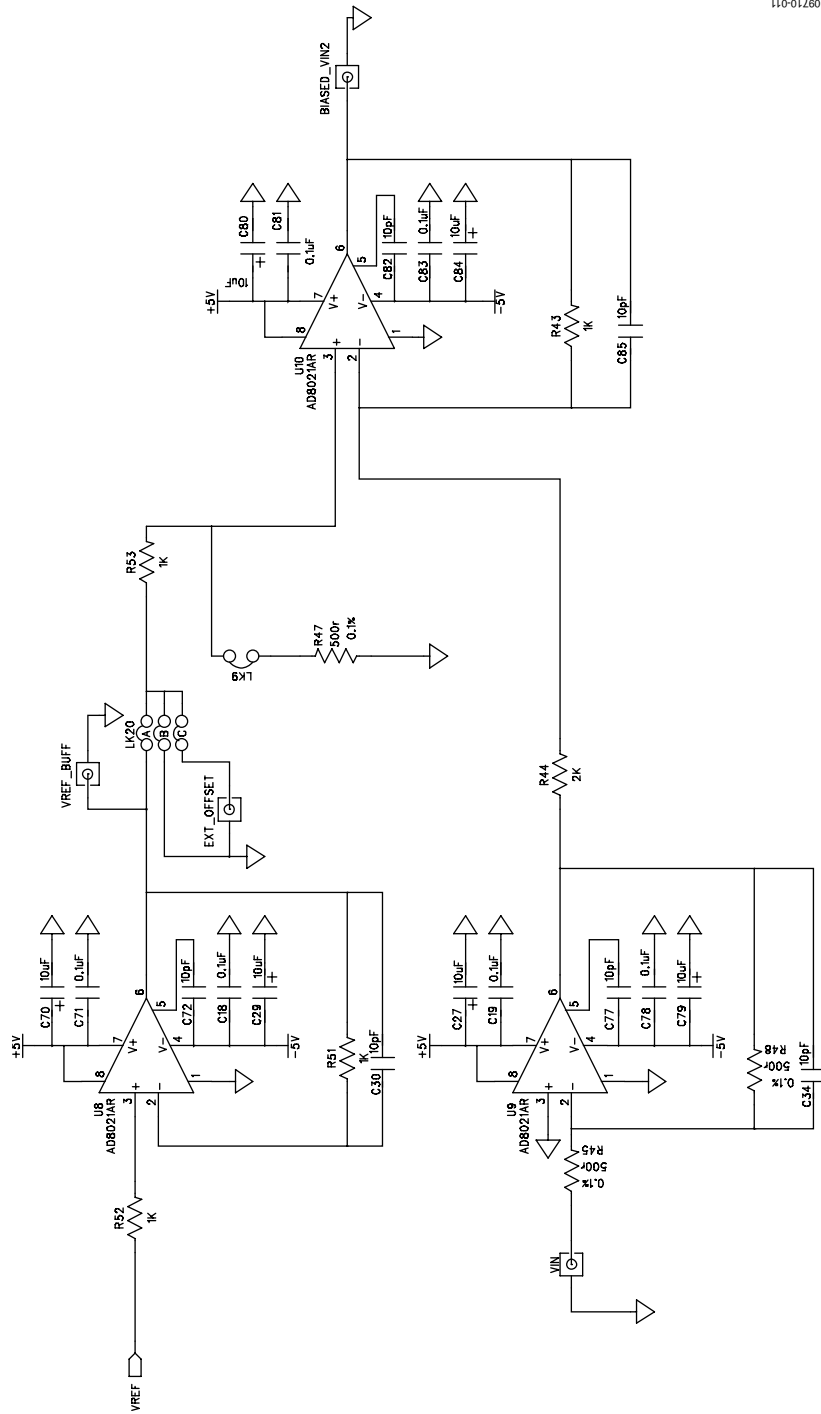


Figure 10. EVAL-AD7291SDZ Schematic 2 of 3



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Figure 11. EVAL-AD7291SDZ Schematic 3 of 3

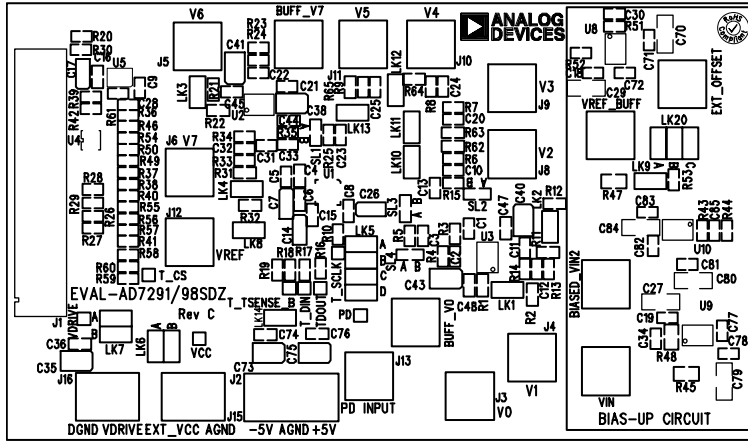


Figure 12. Component Side Artwork

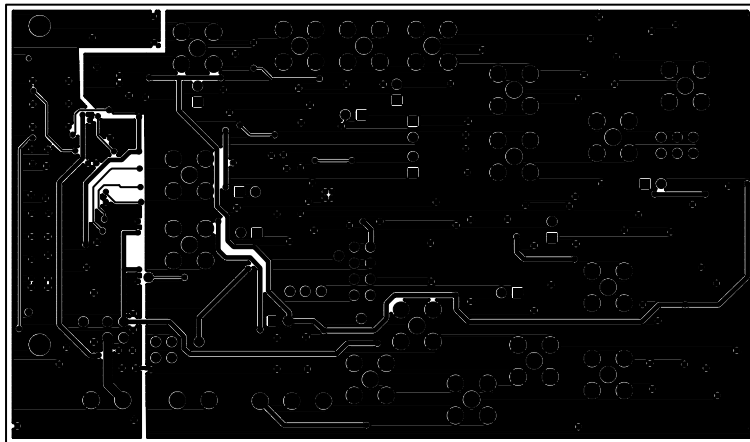


Figure 12. Solder Side Artwork

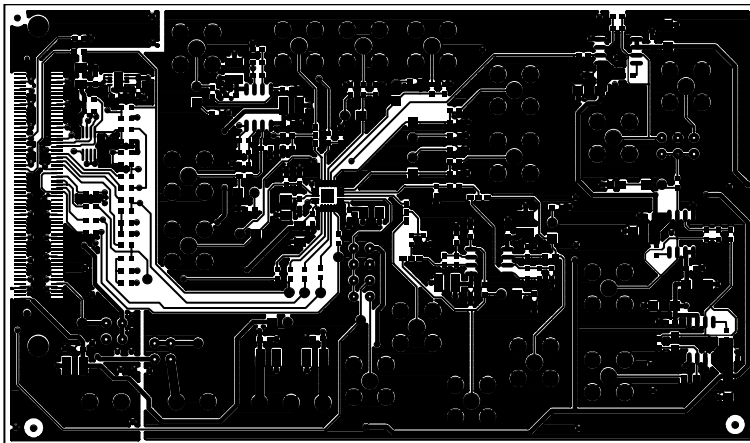


Figure 13. Component Side Silkscreen

## ORDERING INFORMATION

### BILL OF MATERIALS

Table 3.

Reference Designator	Part Type	Value	Tolerance	Part Description	Part Number	Stock Code
C1, C11, C21, C31	Capacitor	1 nF	0.1	50 V X7R multilayer ceramic capacitor	U0603R102KCT	FEC 9406174
C2, C12, C22, C30, C32, C34, C72, C77, C82, C 85,	Capacitor	10 pF	0.05	50 V NPO multilayer ceramic capacitor	06035A100JAT2A	FEC 499110
C3, C5, C7, C10, C13, C20, C23, C24, C25, C33	Not inserted	N/A	N/A	0603 capacitor spacing	N/A	N/A
C4	Capacitor	10 $\mu$ F	0.2	6.3 V X5R ceramic capacitor	C0603C106M9PACTU	FEC 1288201
C6, C8, C15, C36, C44, C45, C47, C48, C74, C76	Capacitor	100 nF	0.05	16 V X7R ceramic capacitor	0603YC104JAT2A	FEC 432210
C9, C16	Capacitor	4.7 $\mu$ F	0.1	10 V X7R multilayer ceramic capacitor 603	C0603C475K8PAC 7867	FEC 1572625
C14, C26	Capacitor	10 $\mu$ F	0.1	10 V SMD tantalum capacitor	TAJA106K010R	FEC 197130
C17	Capacitor	47 $\mu$ F	0.2	SMD tantalum capacitor	TAKA106010R	FEC 1658411
C18, C19, C71, C78, C81, C83	Capacitor	0.1 $\mu$ F	0.1	16 V X7R multilayer ceramic capacitor	B0603R104KCT	FEC 9406140
C27, C29, C70, C79, C80, C84	Capacitor	10 $\mu$ F	0.2	16 V X5R multilayer ceramic capacitor 1206	ECJ-HVB1C106M	Digi-Key PCC2417CT-ND
C28	Capacitor	10 nF	0.1	50 V NPO multilayer ceramic capacitor	06035C103KAZ2A	FEC 7569548
C35, C38, C40, C41, C43, C73, C75	Capacitor	10 $\mu$ F	0.1	16 V SMD tantalum capacitor	AVX TAJB106K016R	FEC 498737
J1	CON-120/ FX8-120S-SV			120-way connector, 0.6 mm pitch	FX8-120S-SV(21)	FEC 1324660
J2	CON/POWER3			3-pin terminal block, 5 mm pitch	CTB5000/3	FEC 151790
J3 to J6, J8 to J13, BUFF_V0, BUFF_V7	SMB			50 W gold plated PCB SMB jack	1-1337482-0	FEC 1206013
J15, J16	CON/POWER			2-pin terminal block, 5 mm pitch	CTB5000/2	FEC 151789
LK1 to LK4, LK8 TO LK14	Jumper			2-pin header and shorting shunt	M20-9990206	FEC 1022247 and 150411
LK5	Jumper			8-pin (4x2) header and shorting shunt	M20-9990206	FEC 1022231 & 150411
LK6, LK7	Jumper			4-pin (2x2) header and shorting shunt	M20-9990206	FEC 1022233 & 150411
LK20	Jumper			6-pin (3x2) header and shorting shunt	M20-9983646	FEC 1022244 % 150411
R1, R11, R21, R31	Resistor	500 $\Omega$	0.01	0603 SMD resistor	MC0.063W06031%499R	FEC 1170758
R2, R12, R20, R22, R32, R50, R54, R61, R62, R63, R64, R65	Resistor	10 k $\Omega$	0.01	0603 SMD resistor	MC0.063W06031%10K	FEC 9330399
R3, R13, R23, R26 to R29, R30, R33, R37, R38, R39, R40, R41, R42, R55, R56, R58, R59	Not inserted	N/A	N/A	0603 resistor space	N/A	N/A
R4, R14, R24, R34, R43, R51, R52, R53	Resistor	1 k $\Omega$	0.01	0603 SMD resistor	MC0.063W06031%1K	FEC 9330380

Reference Designator	Part Type	Value	Tolerance	Part Description	Part Number	Stock Code
R5 to R10, R15 to R19, R25, R35, R36, R46, R49, R57, R60	Resistor	0 $\Omega$	0.01	0603 SMD resistor	MC0.063W06030R	FEC 9331662
R44	Resistor	2k	0.01	0603 SMD resistor	MC0.063W06031%2K	FEC 9330763
R45, R47, R48	Resistor	500 $\Omega$	0.001	0805 SMD resistor	CRCW0805499RFKEA	FEC 1152405
SL1 to SL4	Solder link			two-way solder bridge	N/A	N/A
U1	<a href="#">AD7291</a>			Main device	AD7291BCPZ	AD7291BCPZ
U2	<a href="#">AD8022</a>			Dual op amp	AD8022ARZ	AD8022ARZ
U3	<a href="#">AD8066</a>			Dual op amp	AD8066ARZ	AD8066ARZ
U4	EEPROM			32 k $\Omega$ I <sup>2</sup> C serial EEPROM	24LC32A-1/MS	FEC 1331330
U5	<a href="#">ADP1706</a>			Linear regulator	ADP1706ACPZ-3.3V-R7	ADP1706ACPZ-3.3V-R7
U8, U9, U10	<a href="#">AD8021</a>			Op amp	AD8021ARZ	AD8021ARZ
T_SCLK, PD, T_CS, T_DIN, T_TENSE_B, TDOUT, VCC, VDRIVE	Test point			Black test point	20-2137	FEC 8731128
BIASED_VIN2, EXT_OFFSET, VIN, VREF_BUFF	SMB			50 $\Omega$ SMB jack	SMB1251B1-3GT30G-50	FEC 1111349

**NOTES**

## NOTES

I<sup>2</sup>C refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors).

**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.