

# ADS7866EVM/ADS7867EVM/ADS7868EVM

This Users Guide describes the characteristics, operation, and use of the ADS7866/ADS7867/ADS7868 12/10/8-bit, 200/240/280-KSPS, high-speed, serial-interface analog-to-digital (A/D) converter evaluation (EVM) board. A complete circuit description as well as schematic diagram and bill of materials is included.

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## 1 EVM Overview

### 1.1 Features

- Full-featured evaluation module (EVM) for the ADS7866/ADS7867/ADS7868 12/10/8-bit, 200/240/280-KSPS, single-channel, high-speed serial interface A/D converter.
- On board signal conditioning
- On board reference

## 2 Introduction

The ADS7866 is a 12-bit, 200-KSPS serial-interface, analog-to-digital converter (ADC). The ADS7867 is a 10-bit, 240-KSPS serial-interface A/D converter. The ADS7868 is a 8-bit, 280-KSPS analog to digital converter. The devices include a capacitor based SAR A/D converter with inherent sample and hold. The serial interface for each A/D converter is controlled by the two signals chip select and serial shift clock. The input signal is sampled with the falling edge of chip select, and serial shift clock is used as conversion and the serial data output clock.

The devices operate from 1.2 V up to 3.6 V, and are available in SOT23 packages. Low power consumption and a small size make these devices ideally suitable for battery powered, portable applications. The ADS7866/67/68 devices are specified for operation from -40°C to 85°C.

The high level of the digital input to the device is not limited to device VDD. This means the digital input can go as high as 3.6 V when the device supply is 1.2 V. This feature is useful when digital signals are coming from other circuit with different supply levels.

## 3 Analog Interface

The ADS7866/ADS7867/ADS7868 A/D converters have one analog input pin. A signal for the input pin can be applied at connector P1, pin 2 (shown in [Table 1](#)), or applied to the center pin of SMA connector J1. The input range of the converter is set by the power supply voltage applied at pin 1. For example, if VDD = 3.6 V, then V<sub>I</sub> can range from 0 V up to 3.6 V or 3.6 V<sub>PP</sub>.

**Table 1. Analog Input Connector**

Description	Signal Name	Connector.Pin Number		Signal Name	Description
Reserved	N/C	P1.1	P1.2	( + )	VIN
Reserved	N/C	P1.3	P1.4	N/C	Reserved
Reserved	N/C	P1.5	P1.6	N/C	Reserved
Reserved	N/C	P1.7	P1.8	N/C	Reserved
Pin tied to Ground	AGND	P1.9	P1.10	N/C	Reserved
Pin tied to Ground	AGND	P1.11	P1.12	N/C	Reserved
Reserved	N/C	P1.13	P1.14	N/C	Reserved
Pin tied to Ground	AGND	P1.15	P1.16	N/C	Reserved
Pin tied to Ground	AGND	P1.17	P1.18	N/C	Reserved
Reserved	N/C	P1.19	P1.20	EXT_REF	External Reference Input

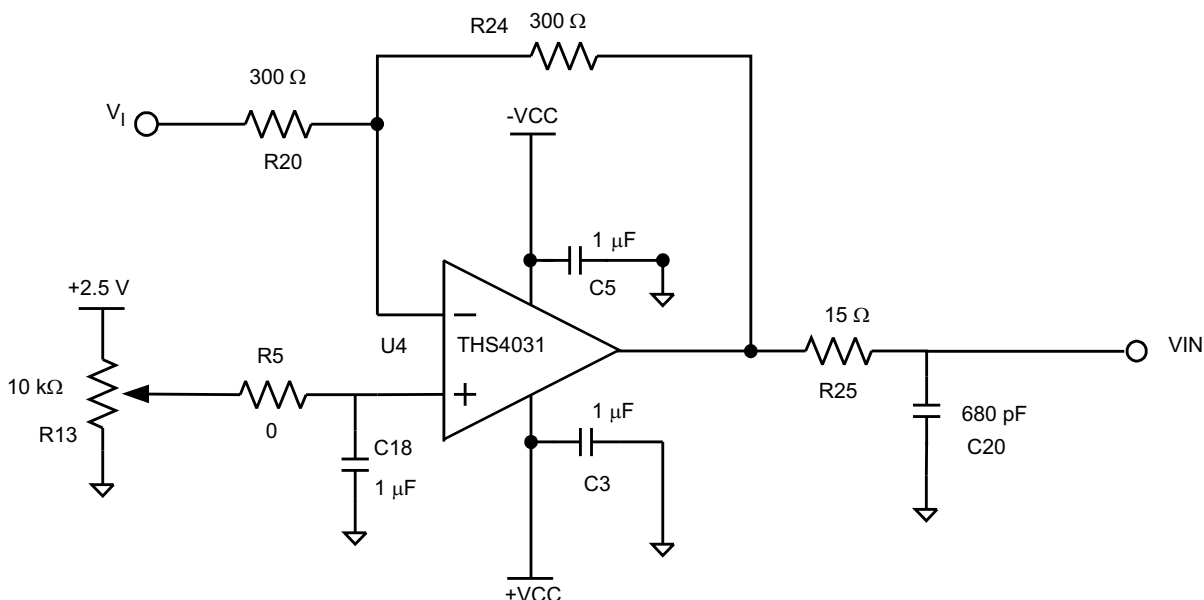
### 3.1 Signal Conditioning

The VIN input to the ADS7866, ADS7867, and ADS7868 should be driven with a low impedance source. In many cases, an input driver is not necessary, but in those cases where the source impedance exceeds 200 Ω, using a buffer helps achieve the rated performance of the converter.

The amplifier circuit shown in [Figure 1](#) is the buffer circuit used on the ADS7866/ADS7867/ADS788EVM. This circuit consists of the THS4031, a high-speed, low noise, low distortion amplifier configured as an inverting gain of one. The circuit shown [Figure 1](#) is optimized to achieve the ac (i.e., SNR, THD, SFDR, etc) specifications listed in the ADS7866/ADS7867/ADS7868 datasheets. Note the input circuit may require adjustments to achieve best performance for specific applications.

The 15-Ω series resistor works with the capacitor, C20, to filter the input signal and isolates the amplifier from the capacitive load. The 680-pF capacitor to ground at the input of the A/D works with the series resistor to filter the input signal, behaves like a charge reservoir, and provides a short to ground for high frequency noise and kickback currents when the device switches from hold to sample mode. This external filter capacitor also works with the amplifier to charge the internal sampling capacitor during sampling mode.

The type of input capacitors used in the signal path can make a few decibels of difference in AC performance. The factory recommends using either polypropylene or C0G type capacitor in the input signal path. The polypropylene capacitor causes the least distortion of the input signal and has excellent long-term stability, but is bulky and expensive. The C0G ceramic is lower cost, comes in smaller packages, and performs well in many applications. C0G capacitors however, tend to be less stable over time and temperature when compared polypropylene capacitors. The 680-pF capacitors installed on the EVM are low cost C0G type manufactured by TDK Corporation.



**Figure 1. Input Buffer Circuit**

### 3.2 Reference

The ADS7866, ADS7867, and ADS7868 reference voltage is derived from the supply voltage internally. Consequently, the supply voltage to these converters should be driven with a low impedance source and be decoupled to ground at the chip. It is recommended that, at least, a 1- $\mu$ F and 10-nF decoupling capacitors be placed close to the chip. The traces from these capacitors to the VDD pin should be wide, low impedance traces.

The converters themselves draw very little current from the supply lines. Therefore, the supply voltage pin for the ADS7866, ADS7867, and ADS7868 can be connected directly to the system supply or to a low noise and low drift reference chip. The EVM provides users the option to power the A/D converter from either the analog supply voltage applied at TP15 or from an onboard 2.5-V reference chip.

**Table 2. Jumper Setting<sup>(1)</sup>**

Reference Designator	Description	Jumper Setting	
		1-2	2-3
SJP1	Set negative supply of U2 to ground.	Installed <sup>(2)</sup>	
	Select negative supply of U2 to -VCC.		Not Installed
SJP2	Set negative supply of U4 to ground.	Not Installed	
	Select negative supply of U4 to -VCC.		Installed <sup>(2)</sup>
W1	Apply CS from P2.1 to the ADC Chip select pin	Installed <sup>(2)</sup>	
	Apply FS from P2.7 to the ADC Chip select pin		Not Installed
W2	Set IOVDD to +3.3VD	Installed <sup>(2)</sup>	
	Set IOVDD to +5VD		N/A - Pin 3 Cut
W3	Set 2.5 V to W4 (pin 3)	Installed <sup>(2)</sup>	
	Set user applied voltage to W4 (pin 3)		Not Installed
W4	Set DUT power supply pin to 5 V	N/A - Pin 1 Cut	
	Set DUT power supply pin to voltage on W3 (pin 2).		Installed <sup>(2)</sup>

(1) These jumper setting are for PWB revision B of the ADS7866EVM/7887EVM/7888EVM.

(2) Factory Installed

## 4 Digital Interface

The ADS7866EVM/ADS7867EVM/ADS7868EVM is designed for easy interfacing to multiple platforms. Samtec part numbers SSW-110-22-F-D-VS-K and TSM-110-01-T-DV-P provide a convenient dual row header/socket combination at P1 and P2. Consult Samtec at [www.samtec.com](http://www.samtec.com) or 1-800-SAMTEC-9 for a variety of mating connector options.

The digital input and output signals for the converter is made available via connector P2 on the ADS7866EVM/ADS7867EVM/ADS7868EVM, see [Table 3](#) for connector pin-out.

**Table 3. Serial Control Connector P2**

Description	Signal Name	Connector.Pin Number		Signal Name	Description
Chip Select	$\overline{CS}$	P2.1	P2.2	N/C	Reserved
Serial Clock	SCLK	P2.3	P2.4	DGND	Ground
Reserved	N/C	P2.5	P2.6	N/C	Reserved
Frame Sync	FS	P2.7	P2.8	N/C	Reserved
Reserved	N/A	P2.9	P2.10	DGND	Ground
Reserved	N/C	P2.11	P2.12	N/C	Reserved
Serial Data Out	SDO	P2.13	P2.14	N/C	Reserved
Reserved	N/C	P2.15	P2.16	N/C	Reserved
Reserved	N/C	P2.17	P2.18	DGND	Ground
Reserved	N/C	P2.19	P2.20	N/A	Reserved

I/O buffer and level translation functions may not be required for some applications. These devices have the high-level digital input that is not limited to the device VDD voltage, but to 4 V. This means the ADC can be powered up at 1.2 V and interfaced to 3.3-V logic directly.

The ADS7866/ADS7867/ADS7868 output low-level and high-level voltages are 0.4 V and VDD - 0.2 V, respectively. If the ADS7866/ADS7867/ADS7868 is powered up at 3.6 V and the host processor is at 1.8 V, then level translation maybe required. The output level translation function (done by U6 on the EVM) may be required depending on the host processor. Check your host processor's data sheet for input logic levels.

## 5 Power Supplies

The EVM accepts four power supplies.

- A dual  $\pm V_S$  dc supply for the dual supply operational-amplifiers. Recommended  $\pm 5$  VDC.
- A single 2.7 to 5-V dc supply for U3, the ADC supply reference (2.5-V, REF3225).
- A single 1.8 to 3.3-V dc supply for digital section of the board (output buffers U6).

There are two ways to provide these voltages.

1. Wire in voltages at test points on the EVM. See [Table 4](#).

**Table 4. Power Supply Test Points**

Test Point	Signal	Description
TP1	+VA	Apply +5 VDC. Positive supply for amplifier.
TP2	-VA	Apply -5 VDC. Negative supply for amplifier.
TP3	+VDD	Apply up to 3.6 VDC. See the ADC data sheet for full range.
TP15	+VCC via W3 and W4	Apply up to 3.6 VDC max and move the jumper at W3 to cover pins 2-3.

2. Use the power connector J2, and derive the voltages elsewhere. The pin out for this connector is shown in [Table 5](#). If using this connector, then set W2 jumper to connect +3.3V<sub>D</sub> from connector to +VDD. A short between pins 1-2 to select +3.3V<sub>D</sub> as the source for the digital I/O buffer voltage supply (+IOVDD) is the factory shipped condition.

**Table 5. Power Connector Pin Out**

Signal	J1 Pin		Signal
+VA (5 V)	1	2	-VA (-5 V)
+5VA	3	4	N/C
DGND	5	6	AGND
N/C	7	8	N/C
+3.3V <sub>D</sub>	9	10	+5V <sub>D</sub>

The voltage applied to the VCC pin of the ADC is controlled by W4. Pin 1 of W4 is cut to prevent the +5VCC from being applied to the ADC. By default, pins 2 and 3 are shorted and the reference voltage selected by W3 is powering the ADC. To monitor device current draw, the shunt jumper can be removed and replaced with a current meter. See [Table 2](#) or the schematic drawings at the end of this user's guide to determine how power is supplied to the various ICs on the board.

## 6 Using the EVM

The ADS7866/ADS7867/ADS7868EVM serves three functions:

1. As a reference design
2. As a prototype board and
3. As software test platform

### 6.1 As a Reference Board

As a reference design, the ADS7866EVM/ADS7867EVM/ADS7868EVM contains the essential circuitry to showcase the A/D converter. This essential circuitry includes the input amplifier, reference circuit, and buffers. The analog input circuit is optimized for 100-kHz input signal; therefore, users may need to adjust the resistor and capacitor values to accommodate higher frequencies and different test systems. In ac-type applications where signal distortion is concern, care should be taken to insure polypropylene or C0G type capacitors are used in the signal path.

The design and layout of this EVM, in conjunction with the ADC data sheet, can be used as the guide when incorporating this ADC into the user system board.

## 6.2 As a Prototype Board

As a prototype board, the buffer circuit consists of resistor pads for configuring the input as either inverting or noninverting configurations. The input circuit can be modified to accommodate user prototype needs, whether it be evaluating another amplifier or limiting noise for best performance. The analog, power, and digital connectors can be made to plug into a standard 0.1 inch breadboard or ribbon cables to interface directly to FPGAs or processors.

## 6.3 As a Software Test Platform

As a software test platform, connectors P1 and P2 plug into the serial interface connectors of the 5-6K interface card. The 5-6K interface card plugs into the TMS320C5000™ DSP and TMS320C6000™ DSP starter kits (DSK). See the 5-6K interface card user's guide ([SLAU104](#)) for more information.

Connectors P1 and P2 also plug into the serial interface connectors of the HPA-MCU Interface Board. The HPA-MCU Interface was designed for use with the TMS320C2000™ series DSP and eZdsp™ starter kits from Spectrum Digital. See the HPA-MCU Interface Board user's guide ([SLAU106](#)) for more information.

## 7 ADS786xEVM BOM

[Table 6](#) contains a complete Bill of Materials for the ADS7866/67/68EVM . The schematic diagram is also provided for reference. Contact the Product Information Center at (972) 644-5580 or e-mail [dataconvapps@list.ti.com](mailto:dataconvapps@list.ti.com) for questions regarding this EVM. When e-mailing, please be sure to include the EVM name in the subject line.

**Table 6. ADS786xEVM Bill of Materials**

Item No.	QTY	Value	Reference Designators	Mfg	Mfg Part number	Description
1	5	NI	R1 R2 R3 R4 R26	NOT INSTALLED	NOT INSTALLED	
2	1	0	R5	Panasonic-ECG or Alternate	ERJ-6GEY0R00V	RES 0.0 OHM 1/10W 5% 0805 SMD
3	5	0	R6 R7 R9 R11 R12	Panasonic-ECG or Alternate	ERJ-3GEY0R00V	RES ZERO OHM 1/16W 5% 0603 SMD
4	2	100	R8 R15	Panasonic-ECG or Alternate	ERJ-3EKF1000V	RES 100 OHM 1/16W 1% 0603 SMD
5	1	140	R16	Yageo America or Alternate	9T06031A1400DBHFT	RES ZERO OHM 1/16W 5% 0603 SMD
6	4	NI	R10 R21 R22 R23	Not Installed	Not Installed	
7	1	10k	R13	Bourns	3214W-1-103E	TRIMPOT 10K OHM 4MM TOP ADJ SMD
8	1	1k	R14	Yageo America or Alternate	9C06031A1001FKHFT	RES 1.00K OHM 1/10W 1% 0603 SMD
9	2	10k	R18 R19	Panasonic ECG or Alternate	ERJ-3EKF1002V	RES 10.0K OHM 1/16W 1% 0603 SMD
10	1	15	R25	Panasonic-ECG or Alternate	ERJ-3EKF15R0V	RES 15.0 OHM 1/16W 1% 0603 SMD
11	2	300	R20 R24	Yageo America or Alternate	9C08052A3000FKHFT	RES 300 OHM 18W 1% 0805 SMD
12	1	0	R28	Panasonic-ECG or Alternate	ERJ-8GEY0R00V	RES ZERO OHM 1/4W 5% 1206 SMD
13	1	NI	C1	Not Installed	Not Installed	
14	4	1uF	C2 C3 C4 C9	TDK Corporation or Alternate	C1608X5R1A105KT	CAP CER 1.0UF 10V X5R 10% 0603
15	2	1uF	C5 C18	TDK Corporation or Alternate	C2012X7R1E105K	CAP CER 1.0UF 25V X7R 0805 T/R
16	1	0.47uF	C8	TDK Corporation or Alternate	C1608X5R1A474K	CAP CER .47UF 10V X5R 10% 0603
17	2	NI	C11 C19	Not Installed	Not Installed	
18	1	0.1uF	C15	TDK Corporation or Alternate	C1608X7R1E104K	CAP CER .10UF 25V X7R 10% 0603

**Table 6. ADS786xEVM Bill of Materials (continued)**

19	1	2.2uF	C17	TDK Corporation or Alternate	C1608X5R1A225MT	CAP CER 2.2UF 6.3V X5R 20% 0603
20	1	10nF	C13	TDK Corporation or Alternate	C1608C0G1H100D	CAP CER 10PF 50V C0G 0603
21	4	10uF	C22 C23 C24 C25	TDK Corporation or Alternate	C2012X5R0J106M	CAP CER 10UF 6.3V X5R 20% 0805
22	4	10uF	C26 C27 C28 C29	TDK Corporation or Alternate	C3216X5R1C106KT	CAP CER 10UF 16V X5R 20% 1206
23	1	680pF	C20	TDK Corporation or Alternate	C1608C0G1H681J	CAP CER 680PF 50V C0G 5% 0603
24	4	1000pF	C36 C37 C38 C39	TDK Corporation or Alternate	C1608C0G1H102J	CAP CER 1000PF 50V C0G 5% 0603
25	3	MMZ2012R601A	L1 L3 L4	TDK Corporation	MMZ2012R601A	FERRITE CHIP 600 OHM 500MA 0805
26	12	NI	C6 C7 C10 C12 C14 C21 C30 C31 C32 C33 C34 C35	NOT INSTALLED	NOT INSTALLED	Multilayer Ceramic - 0805 Size
27	1	REF3225	U3	Texas Instruments	REF3225AIDBVT	low drift reference REF 3225, 3230, 3233, 3240
28	2	THS4031	U2 U4	Texas Instruments	THS4031CD	100-MHz LOW-NOISE HIGH SPEED AMPLIFIER
29	1	DUT	U5	Texas Instruments	ADS7866IDBVR ADS7867IDBVR ADS7868IDBVR	ADS7866 - 12-Bit, 200KSPS ADC ADS7867 - 10-Bit, 240KSPS ADC ADS7868 - 8-Bit, 280KSPS ADC
30	1	SN74LVC1G07	U6	Texas Instruments	SN74LVC1G07DBVR	SINGLE BUS BUFFER GATE WITH OUTPUT ENABLE
31	2		W1 W2	Samtec	TSW-103-07-L-S	3 Position Jumper _ .1" spacing
32	2		W3 W4	Samtec	TMM-103-03-T-S	2mm low profile
33	2	10X2X.1	P1 P2	Samtec	SSW-110-22-S-D-VS	0.025" SMT SOCKET - BOTTOM SIDE OF PWB
34	2			Samtec	TSM-110-01-T-D-V-P	0.025" SMT PLUG - TOP SIDE of PWB
35	1	SMA_PCB_MT	J1	Johnson Components Inc.	142-0701-301	Right Angle SMA Connector
36	1	Power Supply	J2	Samtec	SSW-105-22-S-D-VS	0.025" SMT SOCKET - BOTTOM SIDE OF PWB
37	1			Samtec	TSM-105-01-T-D-V-P	0.025" SMT PLUG - TOP SIDE of PWB
38	2		SJP1 SJP2			
39	10	TP_.025	TP1 TP2 TP3 TP4 TP5 TP6 TP7 TP9 TP12 TP15	Keystone Electronics	5000K-ND	TEST POINT PC MINI .040"D RED
40	5	TP_.025	TP8 TP10 TP11 TP13 TP14	Keystone Electronics	5001K-ND	TEST POINT PC MINI .040"D BLACK

On the ADS7868EVM, item 29 is the ADS7868SDBVT device. On the ADS7867EVM, item 29 is the ADS7867SDBVT device.

## 8 ADS786xEVM LAYOUT

This chapter contains the layout drawings for revision B of the ADS7866EVM, ADS7867EVM, and ADS7868EVM printed circuit board.

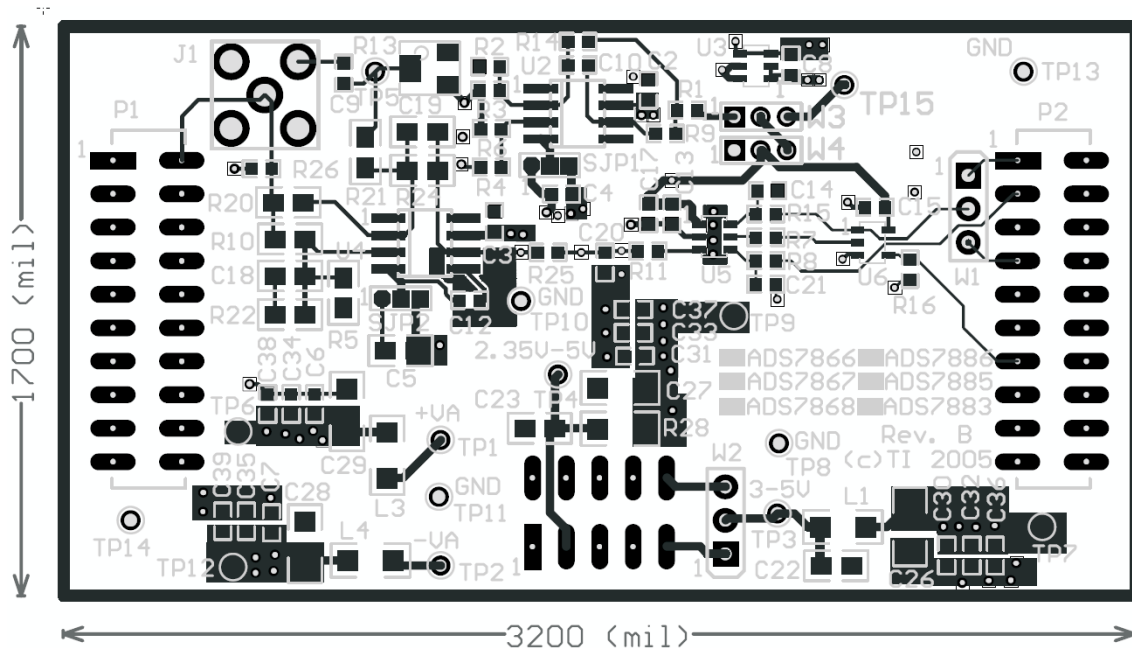


Figure 2. Top - Layer 1

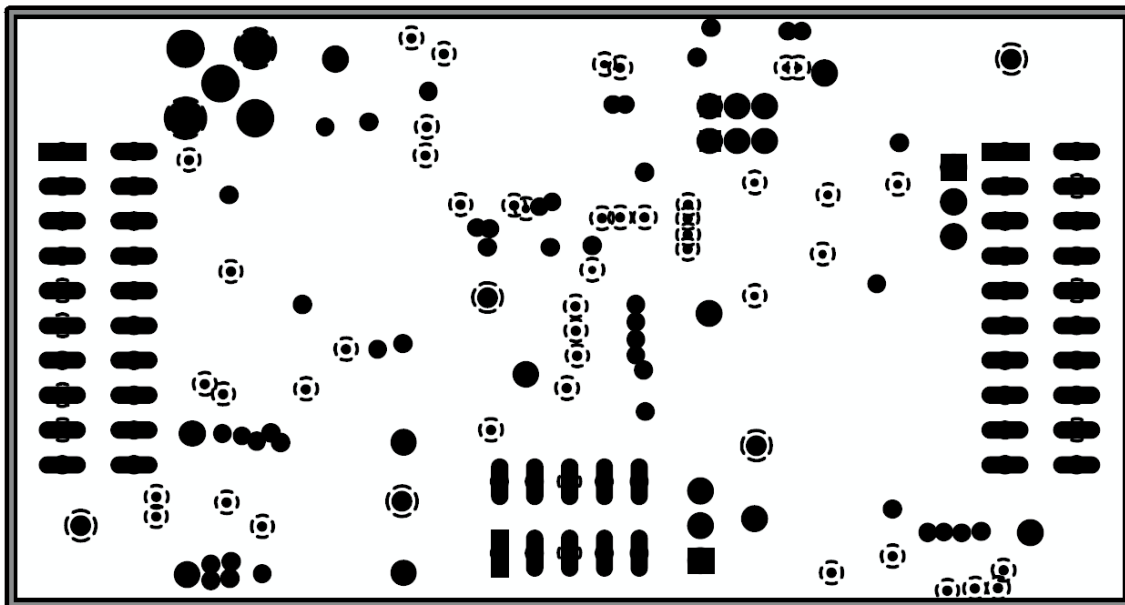


Figure 3. Ground Plane - Layer 2



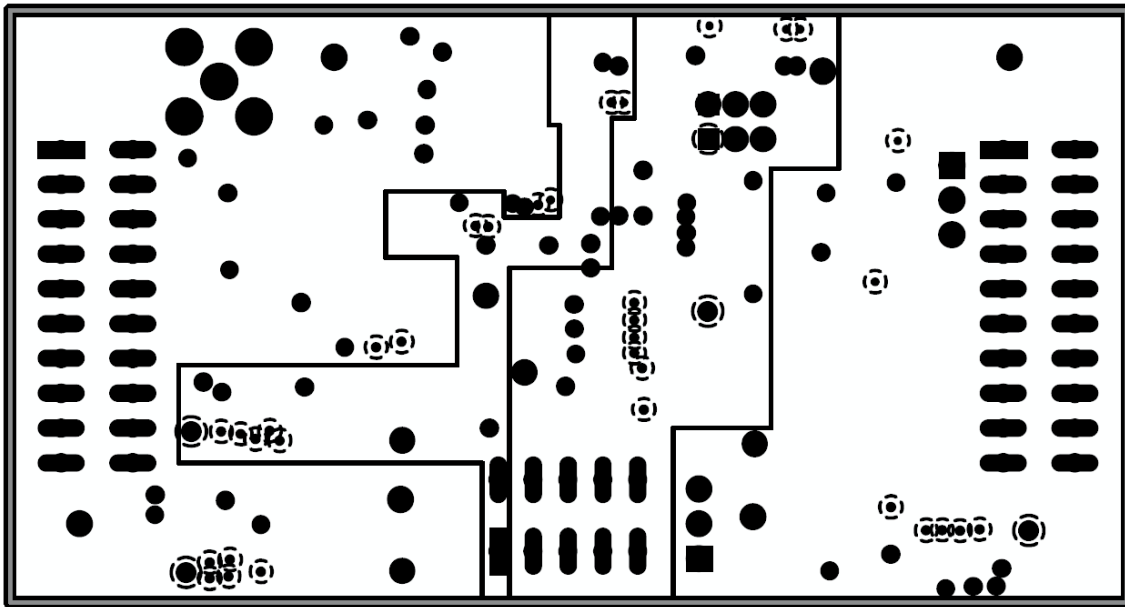


Figure 4. Power Plane - Layer 3

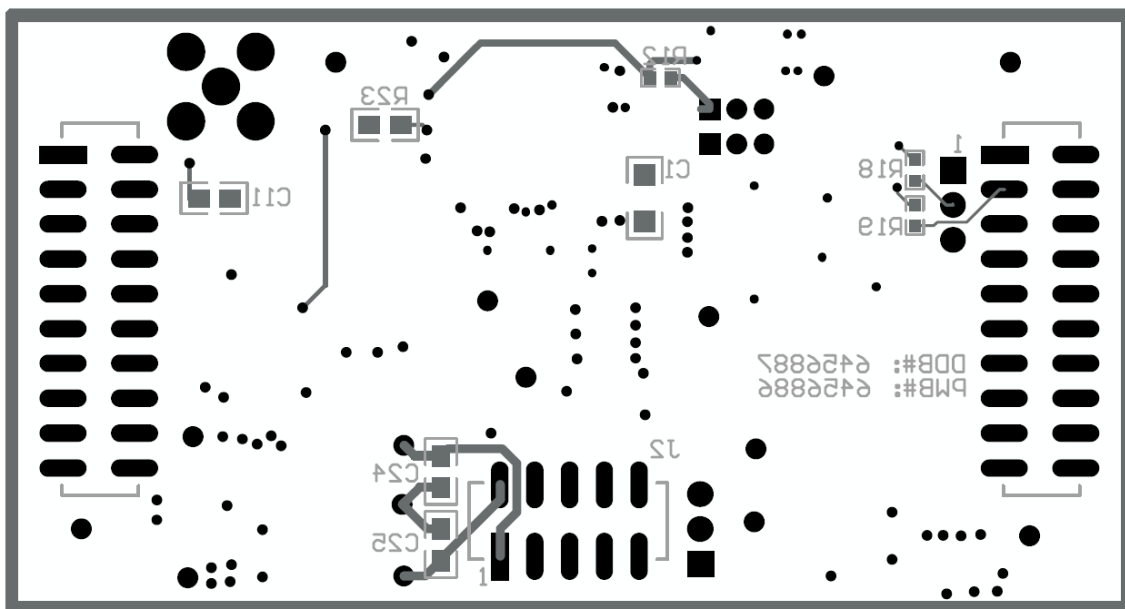
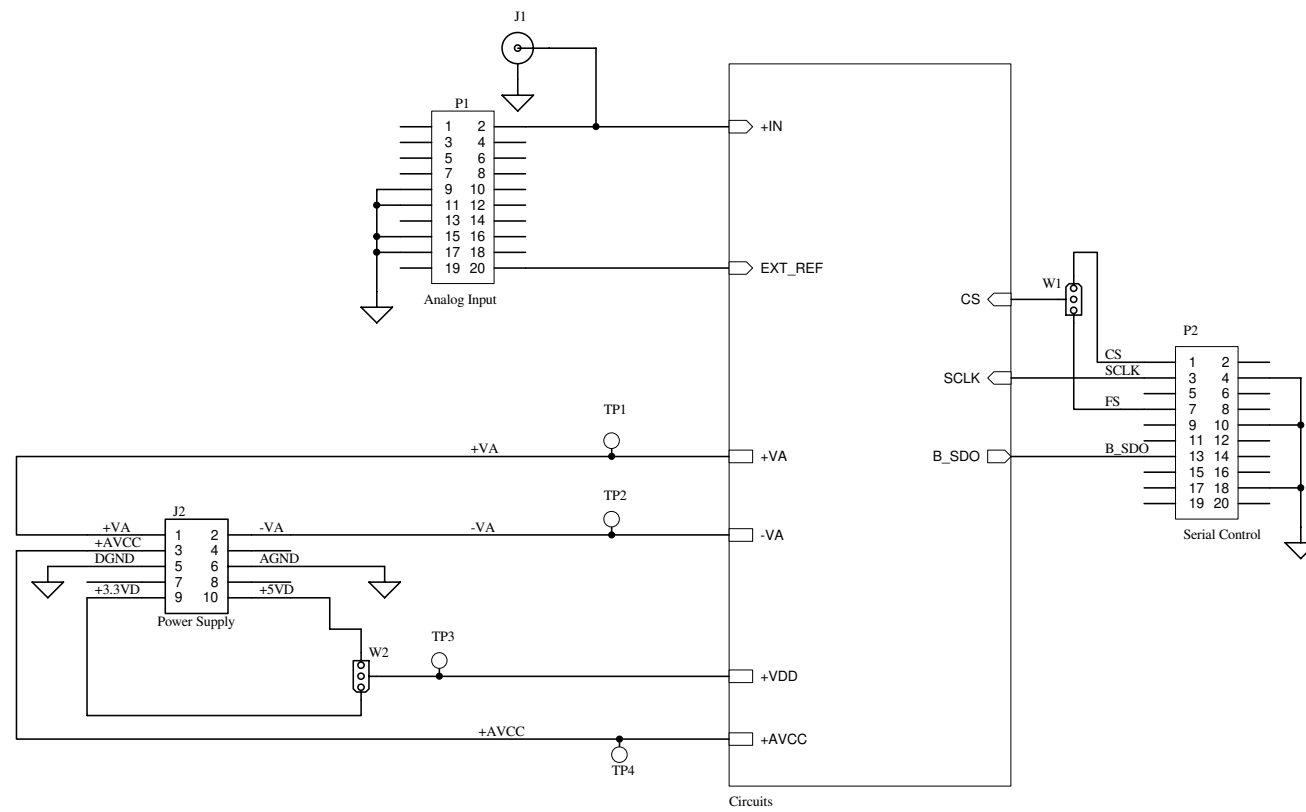


Figure 5. Bottom - Layer 4

9 ADS786xEVM Schematic

Revision History		
REV	ECN Number	Approved

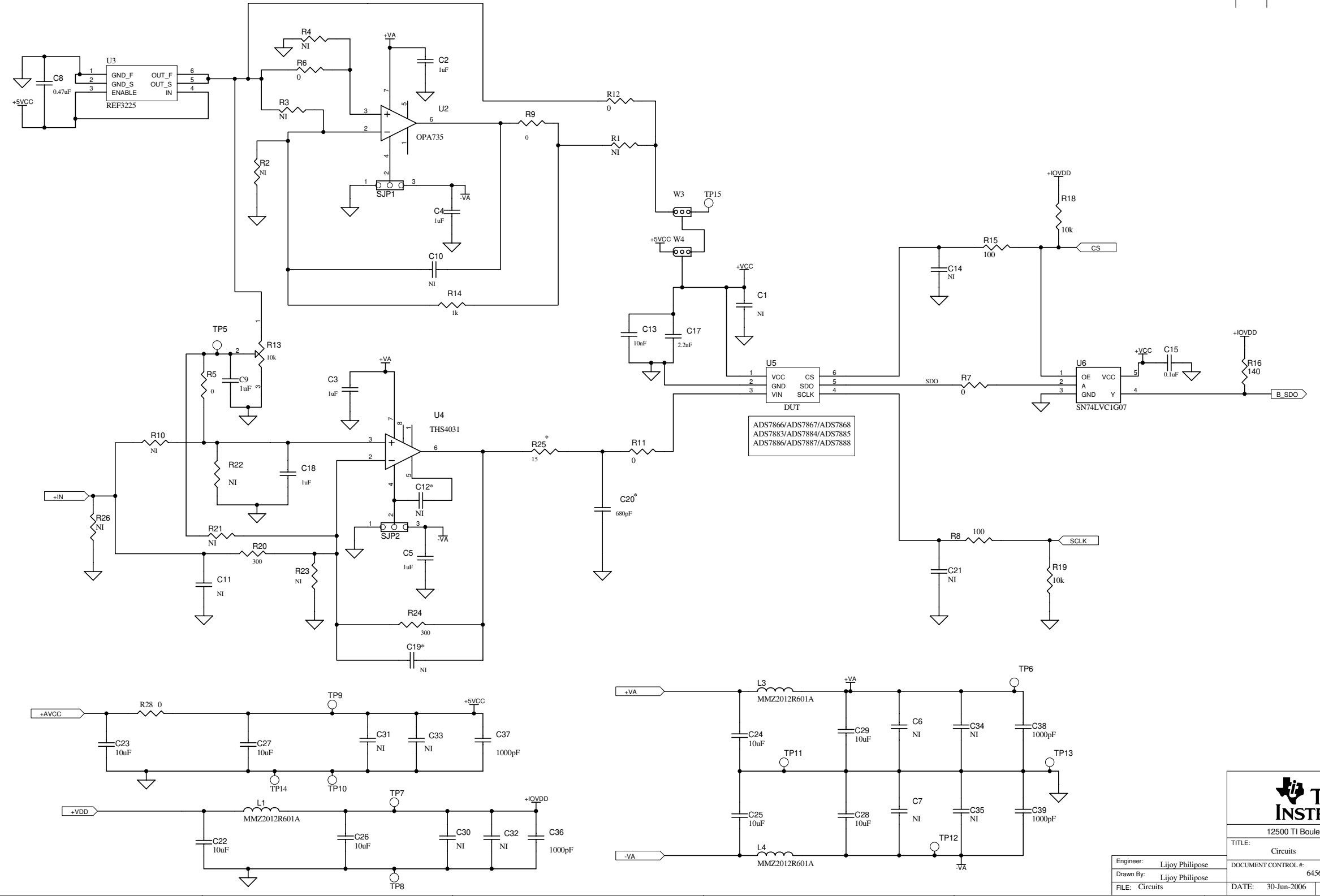


12500 TI Boulevard, Dallas, Texas 75243

TITLE: ADS7866/67/68/86/87/88EVM Block Diagram

Engineer: Lijoy Philipose	DOCUMENT CONTROL #: 6456887	REV: B
Drawn By: Lijoy Philipose	DATE: 30-Jun-2006	SIZE: SHEET: 1 OF: 2
FILE: BlockDiagram.sch		

Revision History		
REV	ECN Number	Approved



**TEXAS INSTRUMENTS**  
 12500 TI Boulevard, Dallas, Texas 75243

TITLE: Circuits  
 DOCUMENT CONTROL #: 6456887  
 DATE: 30-Jun-2006 SIZE: SHEET: 2 OF: 2

Engineer: Lijoy Philipose  
 Drawn By: Lijoy Philipose  
 FILE: Circuits

REV: B

## 10 Related Documentation from Texas Instruments

To obtain a copy of any of the following TI documents, call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center (PIC) at (972) 644-5580. When ordering, please identify this booklet by its title and literature number. Updated documents can also be obtained through our website at [www.ti.com](http://www.ti.com).

<b>Data Sheets:</b>	<b>Literature Number:</b>
ADS7866/ADS7867/ADS7868	<a href="#">SLAS465</a>
OPA227	<a href="#">SBOS110</a>
REF1004C-2.5	<a href="#">SBVS002</a>
SN74AHC1G125	<a href="#">SCLS377</a>
THS4031	<a href="#">SLOS224</a>

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### **EVM WARNINGS AND RESTRICTIONS**

It is important to operate this EVM within the input voltage range of 2.35 V to 5.25 V and the output voltage range of 0.4 V and  $V_{DD} - 0.2$  V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 30°C. The EVM is designed to operate properly with certain components above 30°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
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