

## **ADS8401/ADS8405/ADS8411EVM User's Guide**

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This user's guide describes the characteristics, operation, and use of the ADS8401/ADS8405/ADS8411 16-bit parallel analog-to-digital converter evaluation board. A complete circuit description, as well as schematic diagram, layout, and bill of materials, are included.

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## 1 EVM Overview

### 1.1 Features

- Full-Featured evaluation board for the high speed SAR type ADS8401, ADS8405, and ADS8411 16-bit, single channel, parallel interface analog-to-digital converters.
- On board signal conditioning
- On board reference
- Input and output digital buffers
- On board decoding for stacking multiple EVMs

### 1.2 Analog Interface

The ADS8401, ADS8405, and ADS8411 analog-to-digital converters have both a positive and negative analog input pin. The EVM gives the provision to ground the negative input close to the device via SJP3, or to wire in a user ground. The negative input pin, which has a range of –200 mV up to 200 mV, arrives shorted to ground on the EVM via SJP3. A signal to the positive input pin can be applied at connector P1 pin 2 (shown in [Table 1](#)) or at center pin of SMA connector J2.

**Table 1. Analog Input Connector**

Connector.Pin# <sup>(1)</sup>	Signal	Description
P1.2	+IN	Non-inverting input channel
P1.4	Reserved	
P1.6	Reserved	
P1.8	Reserved	
P1.10	Reserved	
P1.12	Reserved	
P1.14	Reserved	
P1.16	Reserved	
P1.18	Reserved	
P1.20	REF+	External reference input

<sup>(1)</sup> All odd numbered pins of P1 are tied to AGND.

### 1.3 Signal Conditioning

The factory recommends the analog input to any SAR type converter be buffered and low pass filtered. This input buffer on the ADS8411/ADS8405/ADS8401EVM utilizes the THS4031 configured as an INVERTING gain of one, as shown in [Figure 1](#). It is important to note the amplifier is not stable at a gain of one, thus, it is configured in for inverting gain of one. The THS4031 was selected for its low noise, high slew rate and fast settling time. The low pass filter resistor and capacitor values are selected such that ADS8411/ADS8405/ADS8401EVM meets the 100 kHz ac performance specifications listed in the data sheet. The series resistor works in conjunction with the capacitor to filter the input signal, and isolates the amplifier from the large capacitive load. The capacitor to ground at the input of the A/D works in conjunction with the series resistor to filter the input signal, and acts like a charge reservoir. This external filter capacitor works with the amplifier to charge the internal sampling capacitor during sampling mode.

The EVM has a provision to offset the input voltage by adjusting a 10 kΩ potentiometer (R25).

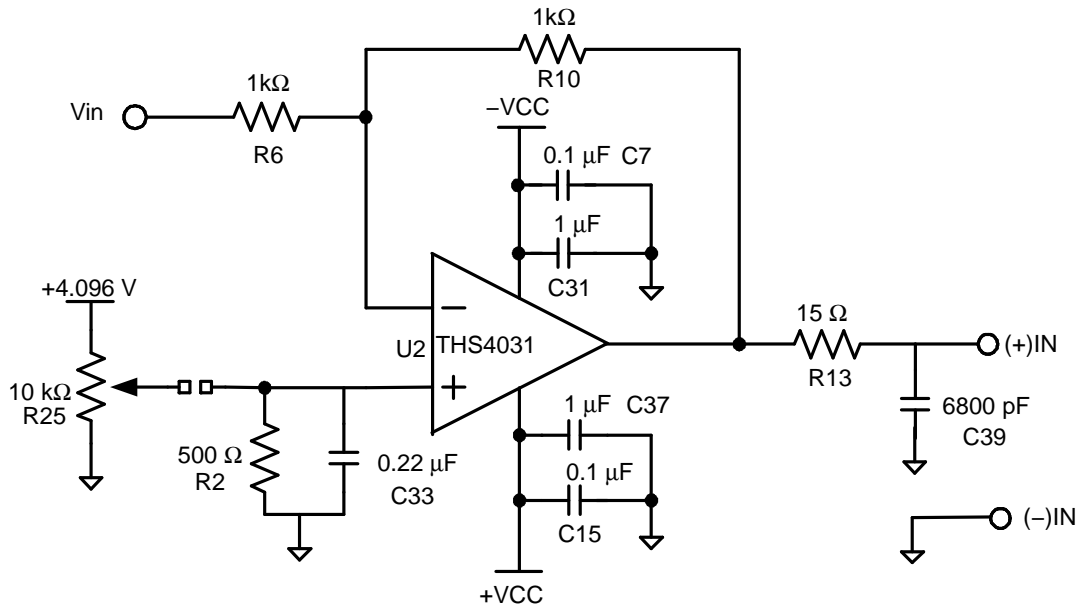


Figure 1. ADS8411 Input Buffer Circuit

## 1.4 Reference

The ADS8401/ADS8405/ADS8411EVM allows users to select from three different reference sources. It provides an onboard 4.096-V reference circuit. Allows for the user to supply a user reference voltage via connector P1 pin 20 or select the on-chip reference voltage. The user reference voltage and onboard reference voltages can be filtered by installing amplifier U1. The ADS8401, ADS8405, and ADS8411 analog-to-digital converters have an integrated onboard reference buffer; therefore, it is not necessary to buffer the voltage externally. The reference buffer (U1) circuit on the EVM is not populated with an amplifier for this reason. The EVM comes installed with on-chip internal reference shorted directly to the reference pin of the converter.

The EVM allows users to select from three reference sources via solder jumper pads SJP1, SJP2, and SJP3. Set SJP1, SJP2, and SJP3 to select from the three reference voltage sources. See Table 2 for jumper settings. See Appendix C for the full schematic.

Table 2. Pad Jumper Setting

Reference Designator	Description	Jumper Setting	
		1–2	2–3
SJP1	Select REF3040 output for reference voltage	Installed <sup>(1)</sup>	Not installed
	Select buffered reference voltage	Not installed	Installed
SJP2	Select internal A/D 4.096 V reference	Installed <sup>(1)</sup>	Not installed
	Select U3, REF3040, as 4.096 V reference	Not installed	Installed
SJP3	Short (-) IN pin to ground	Installed <sup>(1)</sup>	N/A
SJP4	Buffered REF3040 reference voltage	Installed <sup>(1)</sup>	Not installed
	Buffer user supplied reference voltage via P1 pin 20	Not installed	Installed
SJP5	Apply offset voltage to A/D buffer	Not installed	N/A
SJP6	Set negative rail of amplifier U1 to ground	Installed	Not installed
	Set negative rail of amplifier U1 to -V <sub>CC</sub>	Not installed	Installed
SJP7	Set negative supply of amplifier U2 to ground	Installed	Not installed
	Set negative supply of amplifier U2 to -V <sub>CC</sub>	Not installed	Installed <sup>(1)</sup>

<sup>(1)</sup> Factory set condition

## 2 Digital Interface

The ADS8411/ADS8405/ADS8401EVM is designed for easy interfacing to multiple platforms. Samtec plug and socket connectors provide a convenient dual row header/socket combination at P1, P2 and P3 to plug into prototype boards or ribbon cables. Consult Samtec at [www.samtec.com](http://www.samtec.com) or 1-800-SAMTEC-9 for a variety of mating connector options.

**Table 3. Parallel Control Connector P2**

Connector.Pin <sup>(1)</sup>	Signal	Description
P2.1	$\overline{DC\_CS}$	Daughter card Board Select pin
P2.3		
P2.5		
P2.7	A0	Address line from processor
P2.9	A1	Address line from processor
P2.11	A2	Address line from processor
P2.13		
P2.15		
P2.17		
P2.19	BUSY	Busy signal from converter. W4 must be shorted.

<sup>(1)</sup> All even numbered pins of P2 are tied to DGND

Read ( $\overline{RD}$ ), conversion start ( $\overline{CONVST}$ ), and reset ( $\overline{RESET}$ ) signals to the converter can be assigned to two different addresses in memory via jumper settings. This allows for the stacking of up to two ADS8401EVM, ADS8405EVM and/or ADS8411EVMs into processor memory. See [Table 4](#) for jumper settings. Note that the evaluation module does not allow the chip select ( $\overline{CS}$ ) line of the converter to be assigned to different memory locations. It is, therefore, suggested the  $\overline{CS}$  line be grounded or wired to an appropriate signal of the processor.

**Table 4. Pin Jumper Setting for Decoder Outputs**

Reference Designator	Description	Jumper Setting	
		1–2	2–3
W1	Set A[2..0] = 0x1 to generate $\overline{RD}$ pulse	Installed <sup>(1)</sup>	Not installed
	Set A[2..0] = 0x2 to generate $\overline{RD}$ pulse	Not installed	Installed
W2	Set A[2..0] = 0x3 to generate $\overline{CONVST}$ pulse	Installed <sup>(1)</sup>	Not installed
	Set A[2..0] = 0x4 to generate $\overline{CONVST}$ pulse	Not installed	Installed
W3	Set A[2..0] = 0x5 to generate $\overline{RESET}$ pulse	Installed <sup>(1)</sup>	Not installed
	Set A[2..0] = 0x6 to generate $\overline{RESET}$ pulse	Not installed	Installed
W4	Short busy signal to P2 pin 19	Installed <sup>(1)</sup>	N/A

<sup>(1)</sup> Factory set condition

The data bus is available at connector P3. See [Table 5](#) for pin out information.

**Table 5. Data Bus Connector P3**

Connector.Pin <sup>(1)</sup>	Signal	Description
P3.1	D0	Buffered Data Bit 0 (LSB)
P3.3	D1	Buffered Data Bit 1
P3.5	D2	Buffered Data Bit 2

<sup>(1)</sup> All even numbered pins of P3 are tied to DGND.

**Table 5. Data Bus Connector P3 (continued)**

Connector.Pin <sup>(1)</sup>	Signal	Description
P3.7	D3	Buffered Data Bit 3
P3.9	D4	Buffered Data Bit 4
P3.11	D5	Buffered Data Bit 5
P3.13	D6	Buffered Data Bit 6
P3.15	D7	Buffered Data Bit 7
P3.17	D8	Buffered Data Bit 8
P3.19	D9	Buffered Data Bit 9
P3.21	D10	Buffered Data Bit 10
P3.23	D11	Buffered Data Bit 11
P3.25	D12	Buffered Data Bit 12
P3.27	D13	Buffered Data Bit 13
P3.29	D14	Buffered Data Bit 14
P3.31	D15	Buffered Data Bit 15 (MSB)

This evaluation module provides direct access to all the analog-to-digital converter control signals via connector J3, see [Table 6](#).

**Table 6. Pinout for Converter Control Connector J3**

Connector.Pin <sup>(1)</sup>	Signal	Description
J3.1	$\overline{CS}$	Chip select pin, active low
J3.3	$\overline{RD}$	Read pin, active low
J3.5	$\overline{CONVST}$	Convert start pin, active low
J3.7	BYTE	BYTE mode pin, used for 8-bit buses
J3.9	$\overline{RESET}$	Reset pin, active low
J3.11	BUSY	Converter status output. High when a conversion is in process.

<sup>(1)</sup> All even numbered pins of J3 are tied to DGND.

### 3 Power Supplies

The EVM accepts four power supplies.

- A dual  $\pm V_s$  dc supply for the dual supply op amps. Recommend  $\pm 12$  VDC supply.
- A single +5 V dc supply for analog section of the board (A/D + Reference).
- A single +5 V or +3.3 V dc supply for digital section of the board (A/D + address decoder + buffers).

The two ways to provide these voltages are as follows:

1. Wire in voltages at test points on the EVM. See [Table 7](#).

**Table 7. Power Supply Test Points**

Test Point	Signal	Description
TP11	+BVDD	Apply +3.3 VDC or +5 VDC. See respective ADC data sheet for full range.
TP10	+AVCC	Apply +5 VDC
TP12	+VA	Apply +12.0 VDC. Positive supply for amplifier.
TP14	-VA	Apply -12.0 VDC. Negative supply for amplifier.

2. Use the power connector J1, and derive the voltages elsewhere. See [Table 8](#) for the pinouts for this connector.

**Table 8. Power Connector, J1, Pin Out**

Signal	Power Connector – J1		Signal
+VA (+12VA)	1	2	-VA (-12VA)
+AVCC (+5VA)	3	4	N/C
N/C	5	6	AGND
N/C	7	8	N/C
N/C	9	10	+BVCC (+5VD)

## 4 Using the EVM

The ADS8401/ADS8405/ADS8411EVM serves three functions:

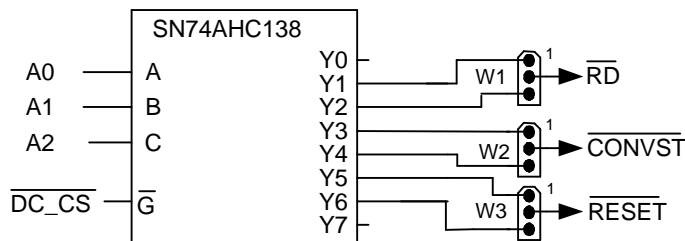
- 1) a reference design
- 2) a prototype board
- 3) a test platform for the software engineer to develop code.

As a reference design, the ADS8401/ADS8405/ADS8411EVM contains the essential circuitry to showcase the analog-to-digital converter. This essential circuitry includes the input amplifier, reference circuit, and buffers. The EVM analog input circuit is optimized for 100 kHz sine wave, therefore users may need to adjust the resistor and capacitor values of the A/D input RC circuit. In AC type applications where signal distortion is concern, polypropylene capacitors should be used in the signal path. In applications where the input is multiplexed, the A/D input resistor and capacitor may need to be adjusted or possibly removed altogether.

As a prototype board, the buffer circuit consists of footprint is a standard 8-pin SOIC and resistor pads for inverting and non-inverting configurations. The ADS8401/ADS8405/ADS8411EVM can be used to evaluate both dual and single supply amplifiers. The EVM comes installed with a dual supply amplifier as it allows the user to take advantage of the full input voltage range of the converter. For applications that require signal supply operation and smaller input voltage range, the THS4031 can be replaced with the single supply amplifier like OPA300 or OPA355. Pad jumper SJP7 should be shorted between pads 1 and 2, as it shorts the minus supply pin of the amplifier to ground. Positive supply voltage can be applied via test pint TP12 or connector J1 pin 1.

As a software test platform, connectors P1, P2 and P3 plug into the parallel interface connectors of the 5-6K interface card. The 5-6K interface card sits on the C5000 and C6000 Digital Signal Processor starter kit (DSK). The ADS8401/ADS8405/ADS8411EVM is then mapped into the processor's memory space. This card also provides an area for signal conditioning. This area can be used to install application circuit(s) for digitalization by the ADS8401, ADS8405 or ADS8411 analog-to-digital converter. Refer to the 5-6K interface card user's guide ([SLAU104](#)) for more information.

For the software engineer the ADS8401/ADS8405/ADS8411EVM provides a simple platform for interfacing to the converter. The EVM provides standard 0.1 inch headers and sockets to wire into prototype boards. The user need only provide in 3 address lines (A2, A1, A0) and address valid line DC\_CS to connector P2, as shown in [Figure 2](#). To choose which address combinations will generate RD, CONVST, and RESET set jumpers as shown in [Table 4](#). Recall chip select (CS) signal is not memory mapped or wired to P2, therefore it must be controlled via general purpose pin or shorted to ground at J3 pin 1. If address decoding is not required, the EVM provides direct access to converter data bus and control I/O via connectors P3 and J3, respectively.



**Figure 2. Decoding Control Signals Using the Address Bus**

## 5 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, 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>
ADS8401	<a href="#">SLAS376</a>
ADS8405	<a href="#">SLAS427</a>
ADS8411	<a href="#">SLAS369</a>
THS4031	<a href="#">SLOS224</a>
OPA627	<a href="#">SBOS165</a>
REF3040	<a href="#">SBVS032</a>
SN74AHC138	<a href="#">SCLS258</a>
SN74AHC245	<a href="#">SCLS230</a>

## Appendix A ADS8401EVM/ADS8405EVM/ADS8411EVM BOM

Table A-1 contains a complete bill of materials for the ADS8401/ADS8405/ADS8411EVM. The schematic diagram is provided in Appendix C. Contact the Product Information Center or e-mail [dataconvapps@list.ti.com](mailto:dataconvapps@list.ti.com) for questions regarding this EVM.

**Table A-1. Bill of Materials**

Item No.	QTY	Value	Reference Designators	MFG	MFG. Part No.	Description
1	1	0 Ω	R24	Panasonic - ECG or alternate	ERJ-3GEY0R00V	Resistor, 0 Ω, 1/16 W, 5%, 0603 SMD
2	1	15 Ω	R1	Panasonic - ECG or alternate	ERJ-6ENF15R0V	Resistor, 15 Ω, 1/10 W, 1%, 0805 SMD
		0	R1 <sup>(1)</sup>	Panasonic - ECG or alternate	ERJ-6GEY0R00V	Resistor 0 Ω, 805
3	1	49.9 Ω	R8	Panasonic - ECG or alternate	ERJ-8ENF49R9V	Resistor, 49.9 Ω, 1/8 W, 1%, 1206 SMD
4	1	NI	R11	Not installed	Not installed	
5	1	5 Ω	R13	Yageo America or alternate	9C08052A4R99FKHFT	Resistor, 4.99 Ω, 1/8 W, 1%, 0805 SMD
		15 Ω	R13 <sup>(1)</sup>	Panasonic - ECG or alternate	ERJ-6ENF15R0V	Resistor, 15 Ω, 1/10W, 1%, 0805 SMD
6	1	75 Ω	R21	Panasonic - ECG or alternate	ERJ-6ENF75R0V	Resistor, 75 Ω, 1/10 W, 1%, 0805 SMD
7	1	100 Ω	R14	Panasonic - ECG or alternate	ERJ-6ENF1000V	Resistor, 100 Ω, 1/10 W, 1%, 0805 SMD
8	1	200 Ω	R4	Panasonic - ECG or alternate	ERJ-6ENF2000V	Resistor, 200 Ω, 1/10 W, 1%, 0805 SMD
9	1	499 Ω	R2	Panasonic - ECG or alternate Panasonic - ECG or alternate	ERJ-6ENF4990V	Resistor, 499 Ω, 1/10 W, 1%, 0805 SMD
10	2	1 kΩ	R6 R10	Panasonic - ECG or alternate	ERJ-6ENF1001V	Resistor, 1 kΩ, 1/10 W, 1%, 0805 SMD
11	5	10 kΩ	R16, R17, R18, R19, R20	Panasonic - ECG or alternate	ERJ-3EKF1002V	Resistor, 10 kΩ, 1/16 W, 1%, 0603 SMD
12	4	1 nF	C3, C5, C11, C23	TDK Corporation or alternate	C3216C0G1H102JT	Capacitor, 1000 pF, 50 V, ceramic, NPO 1206
13	1	4700 pF	C39	WIMA	MKP2 4700/630/5	Capacitor, 4700 pF, polypropylene
		6800 pF	C39 <sup>(1)</sup>	WIMA	MKP2 6800/100/1	Capacitor, 6800 pF, polypropylene
14	10	0.01 μF	C13, C21, C38, C41, C44, C46, C48, C53 C50, C56	TDK Corporation or alternate	C1608X7R1H103JT	Capacitor, 10000 pF, 50 V, ceramic, X7R 0603
15	3	0.01 μF	C10, C18, C20	TDK Corporation or alternate	C2012X7R1H103KT	Capacitor, 10000 pF, 50 V, ceramic, X7R 0603
16	14	0.1 μF	C8, C25, C34, C40, C42, C43, C47, C51, C52, C54, C55, C57, C58, C62	TDK Corporation or alternate	C1608X7R1E104KT	Capacitor, 0.1 μF, 25 V, ceramic, X7R 0603
17	7	0.1 μF	C7, C9, C15, C22, C32, C36, C45	TDK Corporation or alternate	C2012X7R1H104JT	Capacitor, 0.10 μF, 50 V, ceramic, X7R 0805
18	2	0.01 μF	C4, C26	TDK Corporation or alternate	C3216X7R1H103JT	Capacitor, 10000 pF, 50 V, ceramic, X7R 1206
19	1	0.22 μF	C33	TDK Corporation or alternate	C2012X7R1C224KT	Capacitor, 0.22 μF, 16 V, ceramic, X7R 0805
20	4	1 μF	C31, C37, C59, C60	TDK Corporation or alternate	C2012X7R1E105KT	Capacitor, ceramic, 1 μF, 25 V, X7R 0805 T/R
21	2	1 μF	C2, C28	TDK Corporation or alternate	C3216X7R1E105KT	Capacitor, 0.1 μF, 25 V, ceramic, X7R 1206

<sup>(1)</sup> This part is to be used with the ADS8411EVM only.



Table A-1. Bill of Materials (continued)

Item No.	QTY	Value	Reference Designators	MFG	MFG. Part No.	Description
22	4	10 $\mu$ F	C1, C6, C12, C19	TDK Corporation or alternate	C3216X5R1C106MT	Capacitor, 10 $\mu$ F, 16 V, ceramic, X5R 1206
23	3	10 $\mu$ F	C14, C24, C49	Kemet or alternate	T491B106K016AS	Capacitor, tantalum, 10 $\mu$ F, 16 V, 10%, SMT
24	1	22 $\mu$ F	C17	TDK Corporation or alternate	C3216X5R0J226MT	Capacitor, 22 $\mu$ F, 6.3 V, ceramic, X5R 1206
25	2	47 $\mu$ F	C27, C29	Kemet or alternate	T491B476M010AS	Capacitor, tantalum, 47 $\mu$ F, 10 V, 20%, SMT
26	2	NI	C16, R3	Not installed	Not installed	
27	5	NI	C30, C35, C61, C63, R5	Not installed	Not installed	Chip resistor, 1/10 W, 0805
28	1	10 k $\Omega$	R25	Bourns	3214W-1-103E	Trimpot, 10 k $\Omega$ , 4 mm top ADJ SMD
29	2	1 k $\Omega$	RP1, RP3	CTS Corporation	742C163102JTR	Resistor array, 1 k $\Omega$ , 16 terminal, 8 resistor, SMD
30	1	100 $\Omega$	RP2	CTS Corporation	742C163101JTR	Resistor array, 100 $\Omega$ , 16 terminal, 8 resistor, SMD
31	4	BLM21AJ601SN1L	L1, L2, Lc, L4	TDK Corporation or alternate	MPZ2012S601AT	Chip ferrite beads, 600 $\Omega$ at 100 MHz
32	1	OPA627	U1	Not installed	Not installed	
33	1	THS4031	U2	Texas Instruments	THS4031IDR	Amplifier, 100-MHz, low-noise, high-speed
34	1	REF3040	U3	Texas Instruments	REF3040AIDBZT	REF3040, 50 ppm/ $^{\circ}$ C, 50 $\mu$ A in SOT23-3 CMOS voltage reference
35	1	ADS8401	U4	Texas Instruments	ADS8401PFBT	ADS8401, 16 bit, 1.25 MSPS
		ADS8405	U4 <sup>(2)</sup>	Texas Instruments	ADS8405IPFBT	ADS8405, 16 bit, 1.25 MSPS
		ADS8411	U4 <sup>(1)</sup>	Texas Instruments	ADS8411PFBT	ADS8411, 16 bit, 2 MSPS
36	3	SN74AHC245PWR	U5, U6, U7	Texas Instruments	SN74AHC245PWR	Octal bus transceiver, 3-state
37	1	SN74AHC138PWR	U8	Texas Instruments	SN74AHC138PWR	3-line to 8-line decoder/demultiplexer
38	1	SOIC-8	U9	Not installed	Not installed	
39	1	5X2X.1	J1	Samtec Samtec	SSW-105-22-S-D-VS TSM-105-01-T-D-V-P	0.025" SMT socket - bottom side of PWB 0.025" SMT plug - top side of PWB
40	1	SMA_PCB_MT	J2	Johnson Components Inc.	142-0701-301	Right angle SMA connector
41	1	6X2X.1	J3	Samtec Samtec	SSW-106-22-S-D-VS TSM-105-01-T-D-V-P	0.025" SMT socket - bottom side of PWB 0.025" SMT plug - top side of PWB
42	2	10X2x.1	P1, P2	Samtec Samtec	SSW-110-22-S-D-VS TSM-110-01-T-D-V-P	0.025" SMT socket - bottom side of PWB 0.025" SMT plug - top side of PWB
43	1	16X2X.1_SMT_PLUG_&_SOCKET	P3	Samtec Samtec	SSW-116-22-S-D-VS TSM-116-01-T-D-V-P	0.025" SMT socket - bottom side of PWB 0.025" SMT plug - top side of PWB
44	1	SW-PB	S1	Panasonic	EVQ-PJU04K	Switch
45	2		SJP2, SJP3, SJP5	Not installed	Not installed	Pad 2 position jumper
46	5		SJP1, SJP2, SJP3, SJP4, SJP6, SJP7	Not installed	Not installed	Pad 3 position jumper
47	2	2POS_JUMPER	W4, W5	Samtec	TSW-102-07-L-S	2 Position jumper, 0.1" spacing
48	3	3POS_JUMPER	W1, W2, W3	Samtec	TSW-103-07-L-S	3 Position jumper, 0.1" spacing
49	14	TP_0.025	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14	Keystone Electronics	5000K-ND	Test point - Single, 0.025" pin

<sup>(2)</sup> This part is to be used with the ADS8405EVM only.



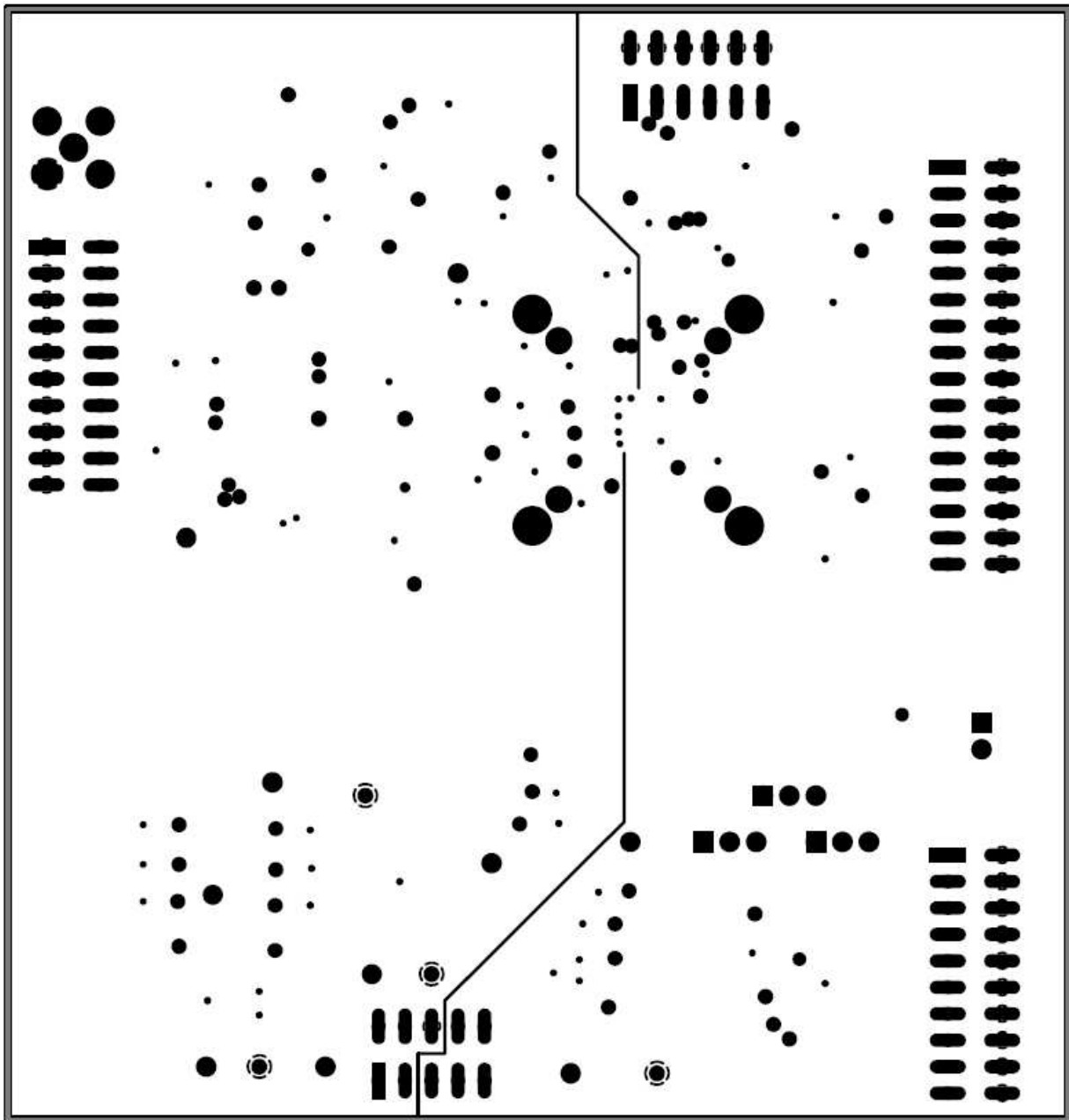


Figure B-2. Ground Plane – Layer 2

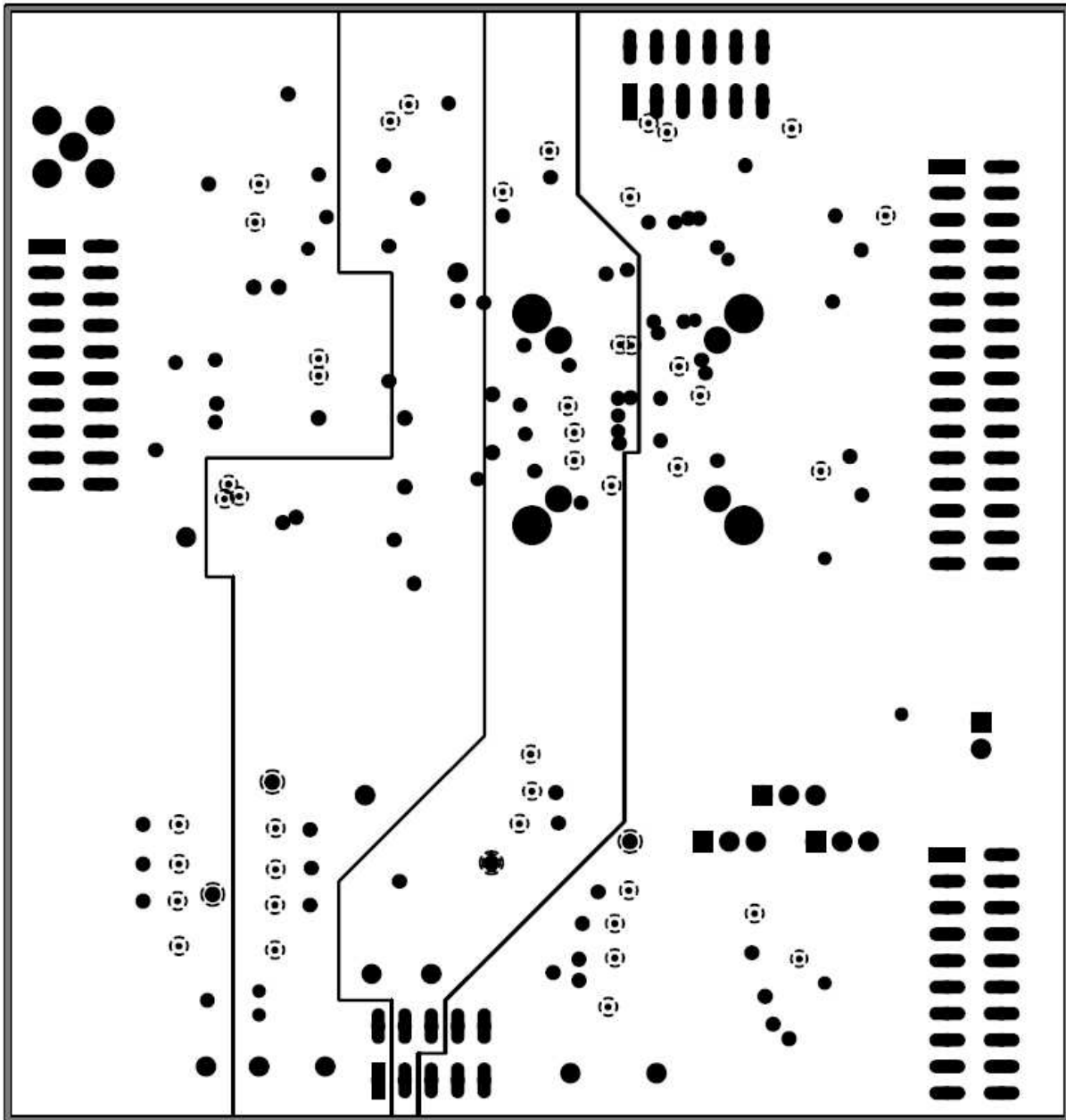


Figure B-3. Power Plane – Layer 3

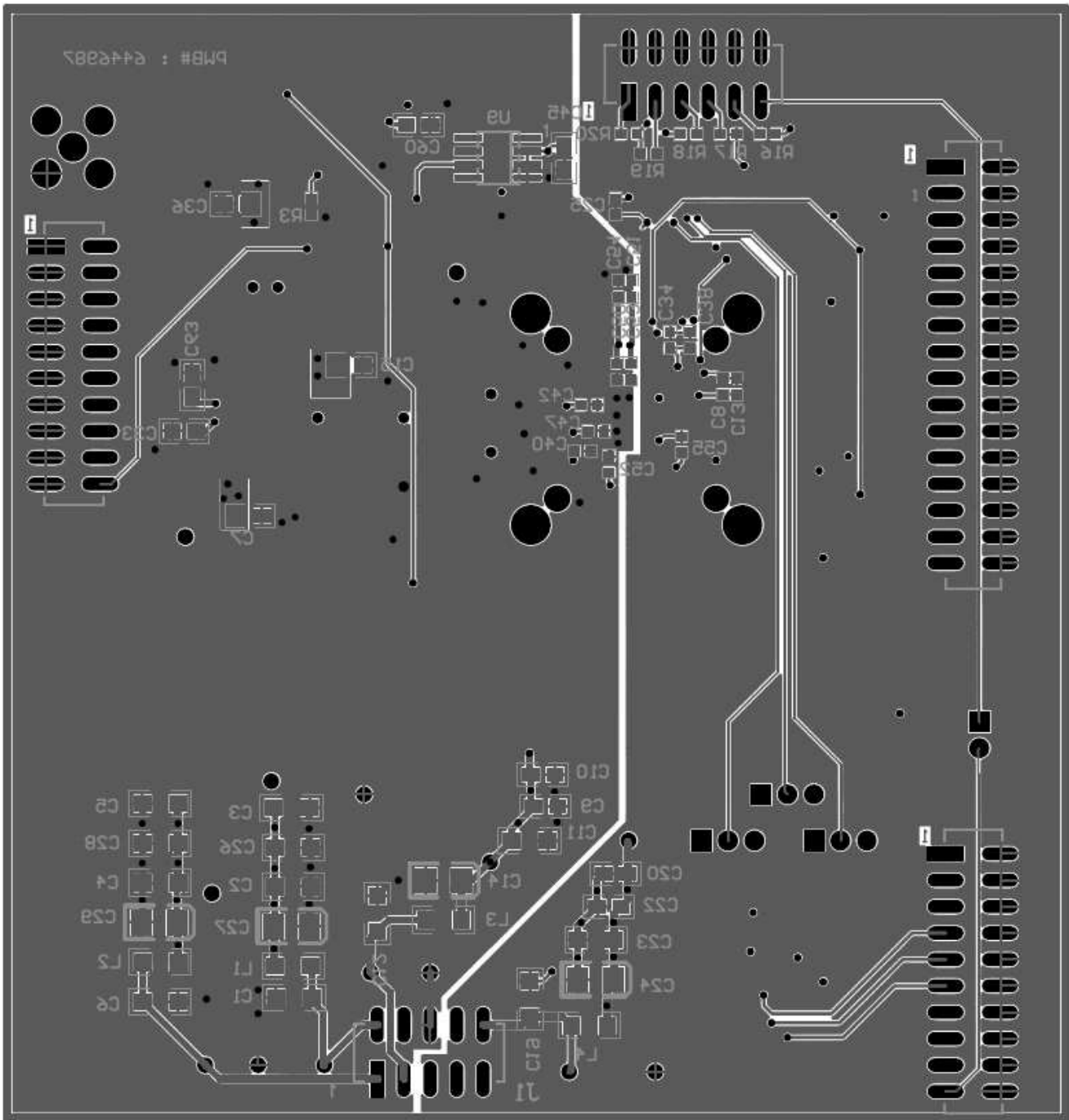
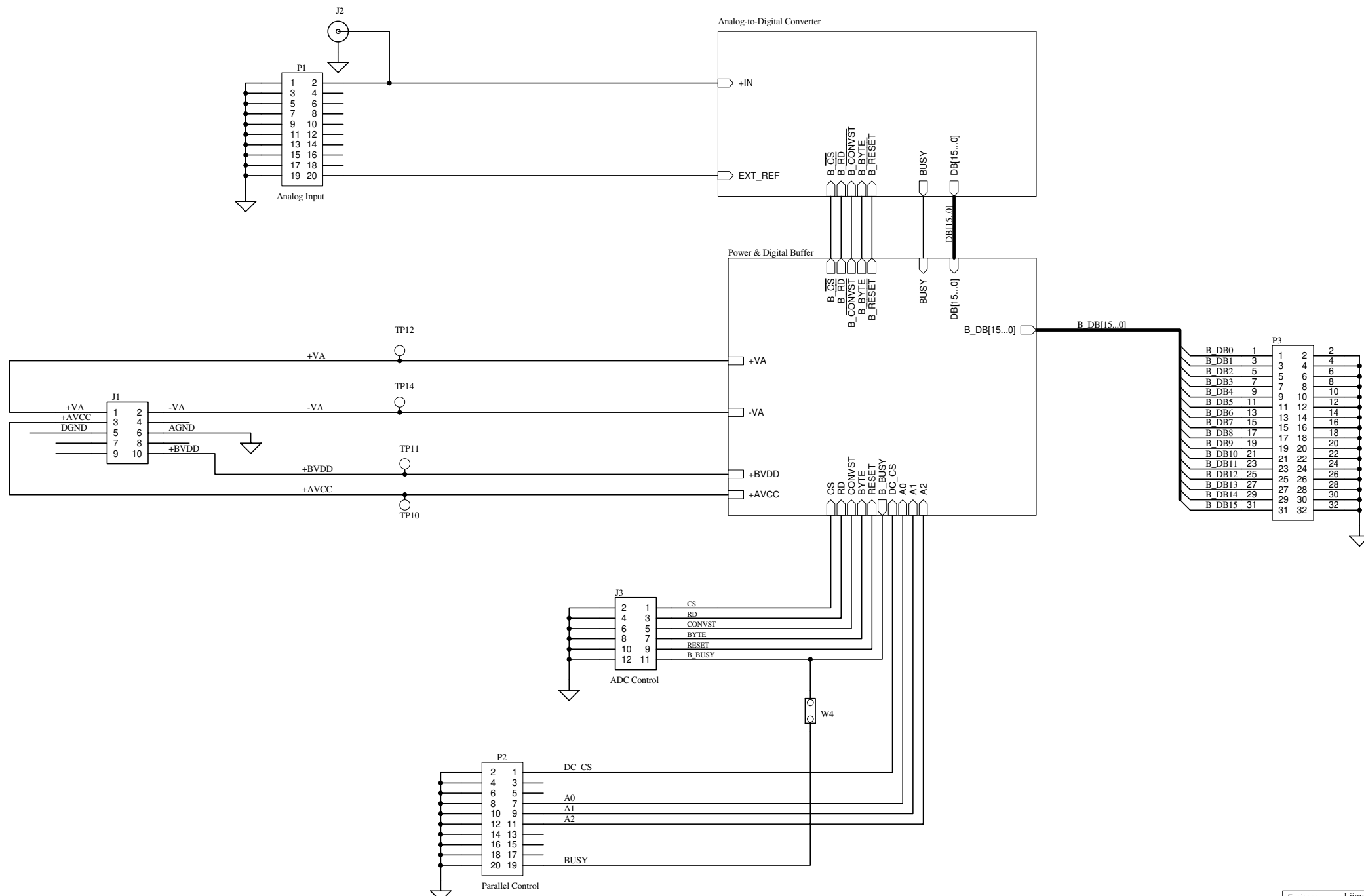


Figure B-4. Bottom Layer – Layer 4

## **Appendix C ADS8401/ADS8405/ADS8411EVM Schematic**

The following pages contain the schematics for the ADS8401EVM, ADS8405EVM, and ADS8411EVM.

Revision History		
REV	ECN Number	Approved



**TEXAS INSTRUMENTS**

12500 TI Boulevard, Dallas, Texas 75243

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 Drawn By: Lijoy Philipose  
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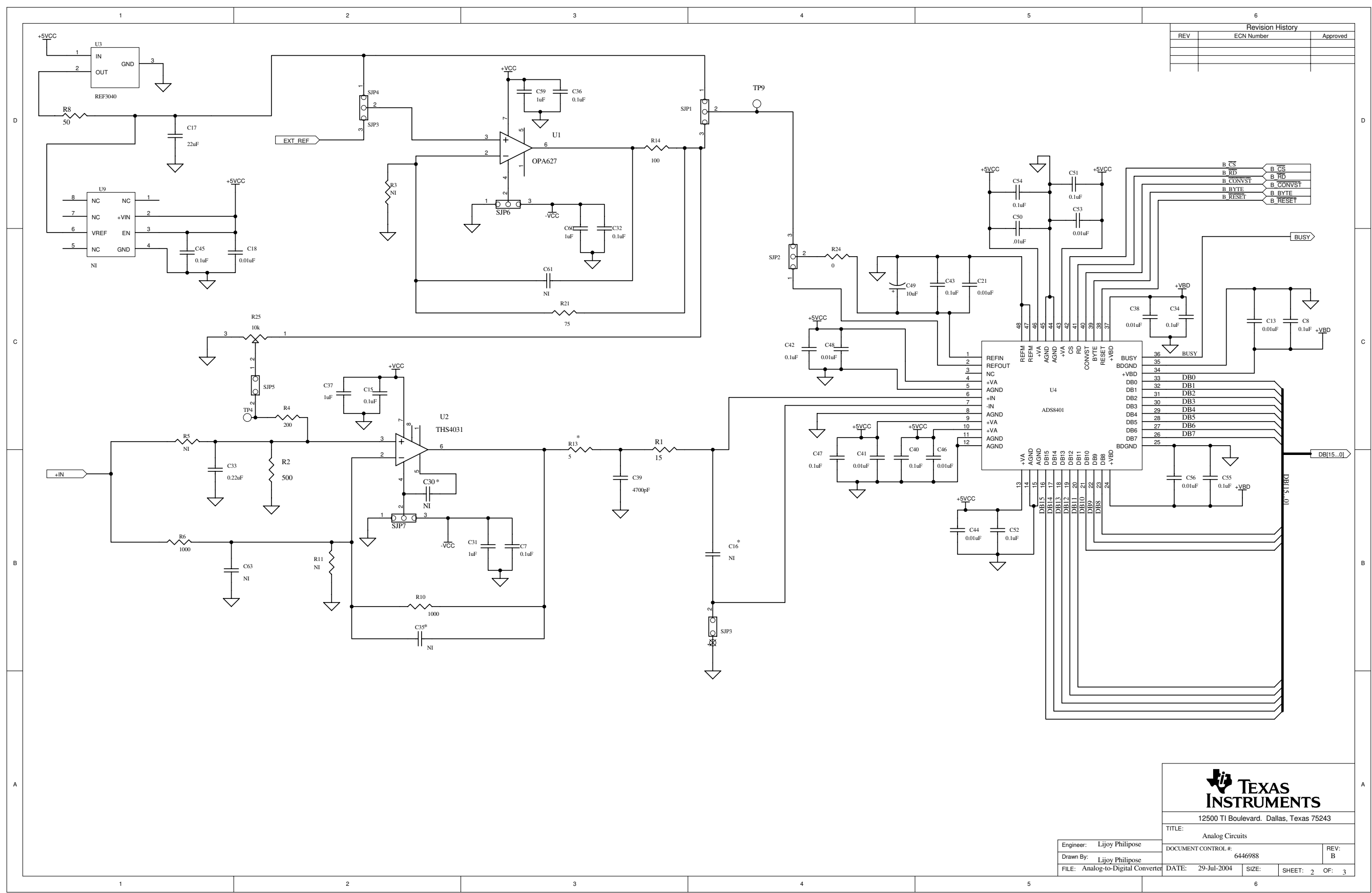
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DATE: 29-Jul-2004

REV: B

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Revision History		
REV	ECN Number	Approved



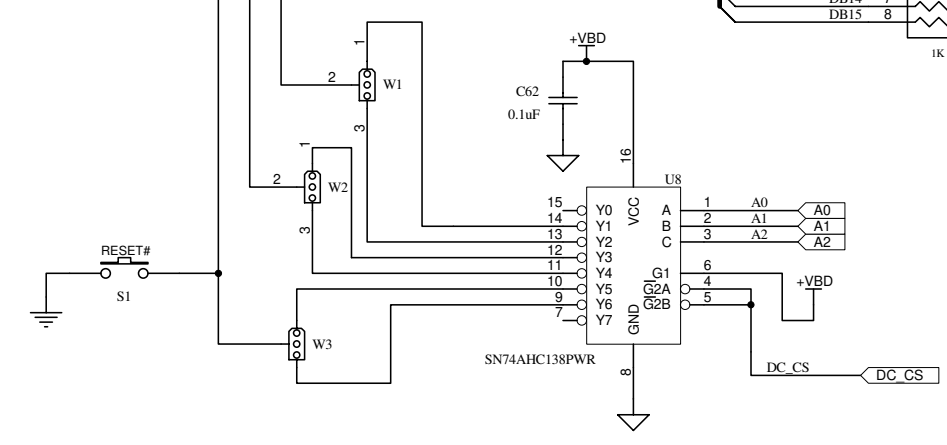
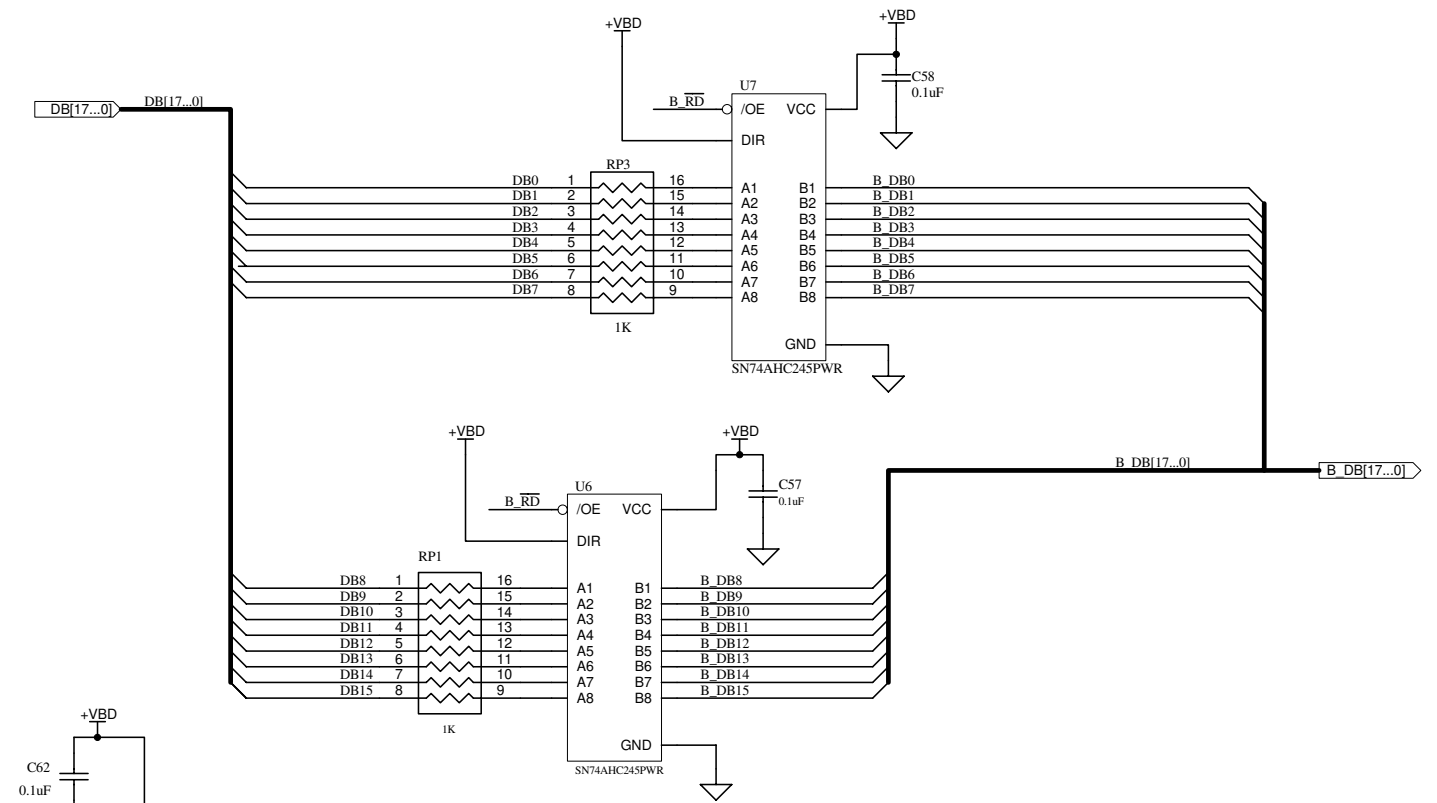
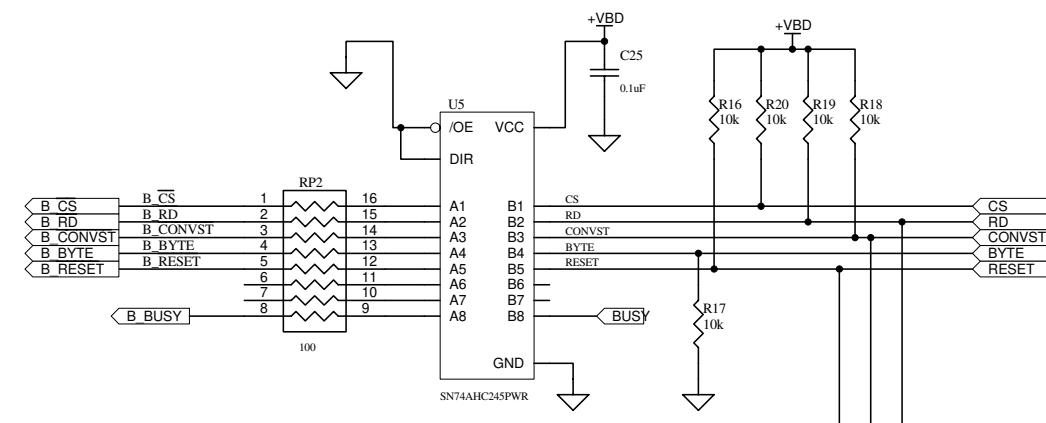
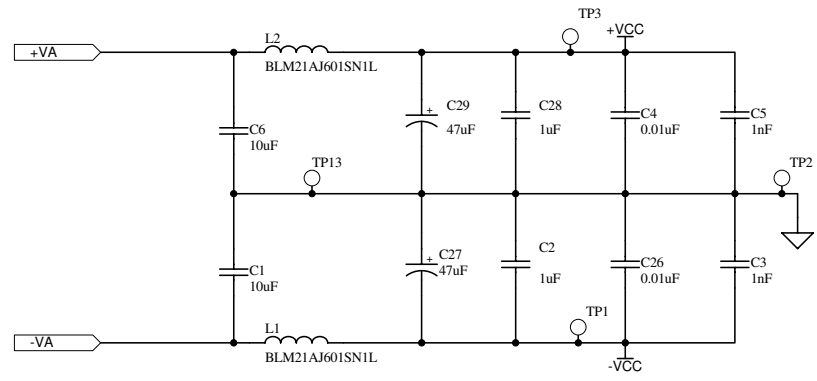
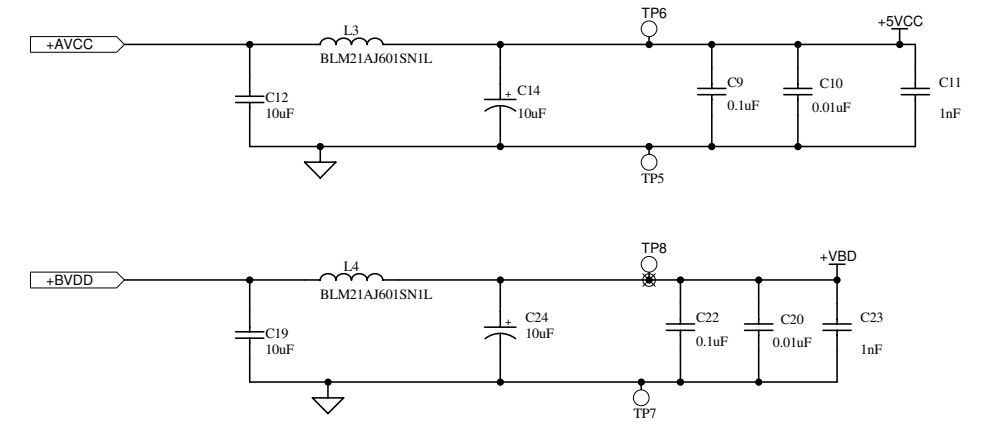
12500 TI Boulevard, Dallas, Texas 75243

TITLE: Analog Circuits

Engineer: Lijoy Philipose	DOCUMENT CONTROL #: 6446988	REV: B
Drawn By: Lijoy Philipose	DATE: 29-Jul-2004	SIZE: SHEET: 2 OF: 3
FILE: Analog-to-Digital Converter		



Revision History		
REV	ECN Number	Approved



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

TITLE: Power Supply & Digital Buffer Circuits

Engineer: Lijoy Philipose  
 Drawn By: Lijoy Philipose  
 FILE: Power & Digital Buffer

DOCUMENT CONTROL #: 6446988

DATE: 29-Jul-2004  
 SIZE: SHEET: 3 OF: 3

REV: B

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