

3 GSPS Instrumentation ADC/AFE Reference Design



National Semiconductor
RD-143
Data Conversions Applications
September 2007

1.0 Design Description

This reference design platform provides a quick and easy method for evaluating the ADC083000 Analog to Digital Converter along with all the necessary clock generation and conditioning and front end amplifiers. The design includes an FPGA and local processor to provide an interface to National Semiconductor's WaveVision software to allow data capture directly to a PC. The design only requires a signal source, which should include an in-line passive filter, and a USB cable to connect to a PC. The WaveVision software will configure the board and allow the user to make changes to the system. Optionally an external clock source can be used if alternate sample rates are required.

2.0 Features

Functions and Capabilities

On the input side :

- The user can use the on-board clock source or provide their own clock source and operate the ADC under various sampling frequencies
- The analog input has two ports, one for single-ended sources and one for differential sources

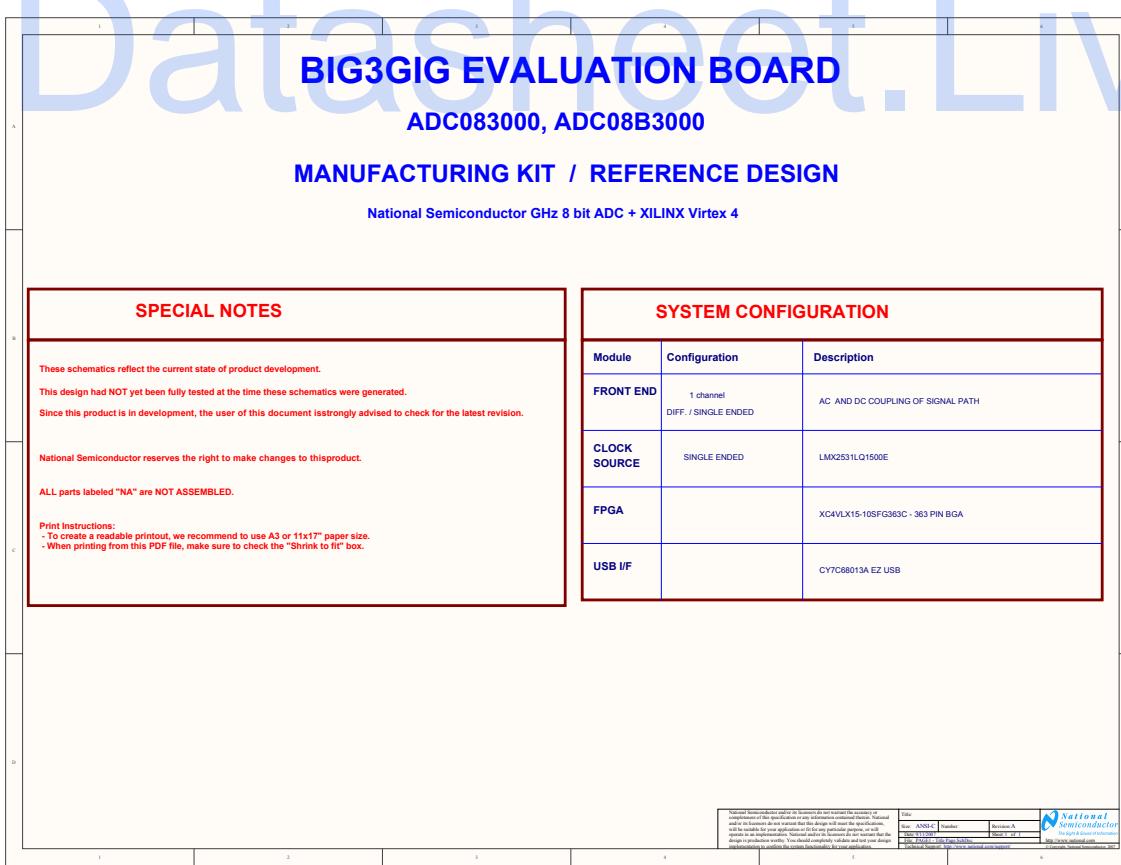
On the output side :

- The USB port is provided to transfer digital data from the ADC to a PC for processing
- The Expansion connector and trigger input allow digital data to be ported to the user's platform for proprietary post processing

Other capabilities :

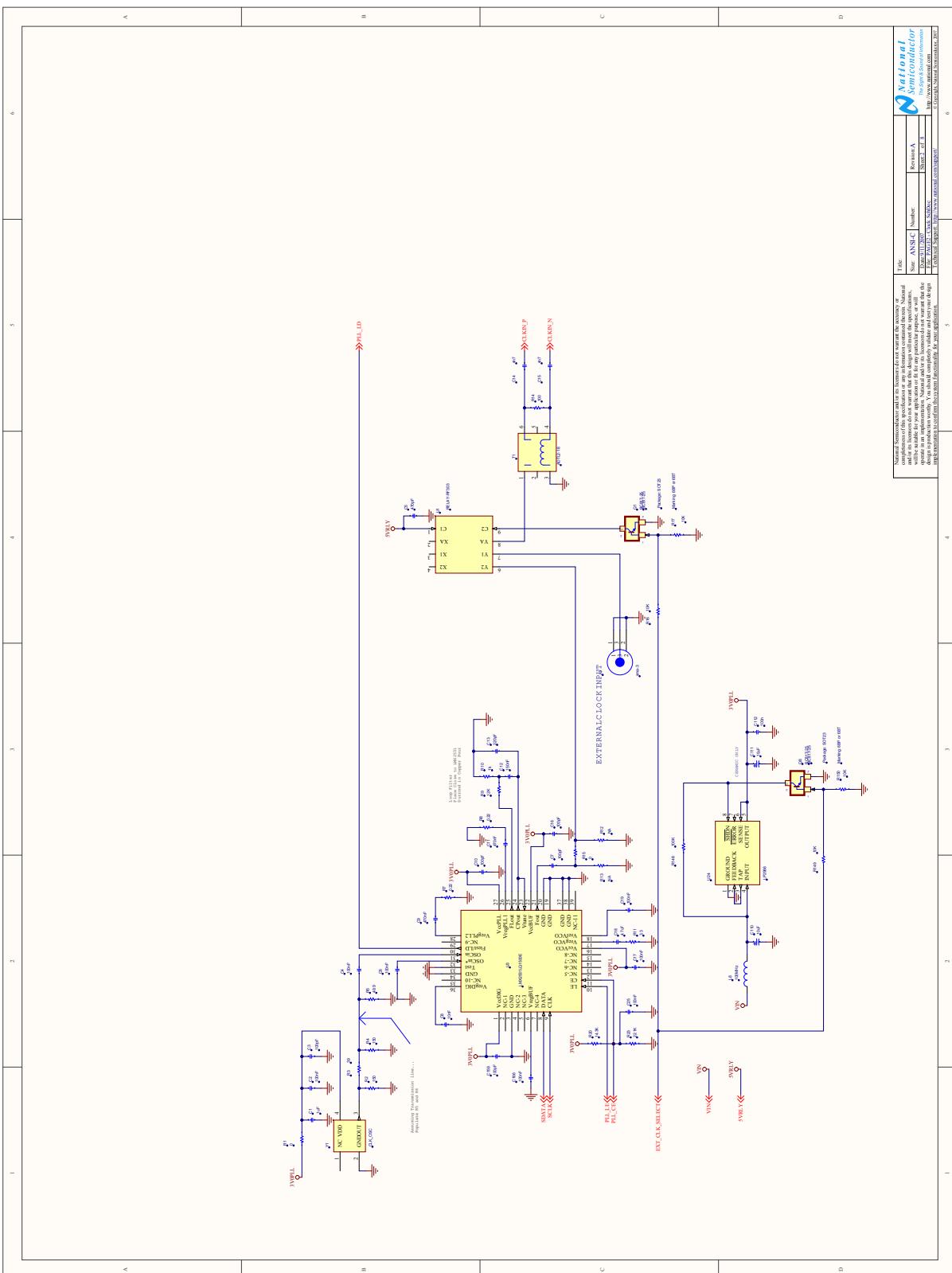
- There is a JTAG port for the FPGA to enable programming and debug of FPGA functions.
- There is a Mictor connector that allows access to the digital data/clock stream by a logic analyzer.

3.0 Schematic

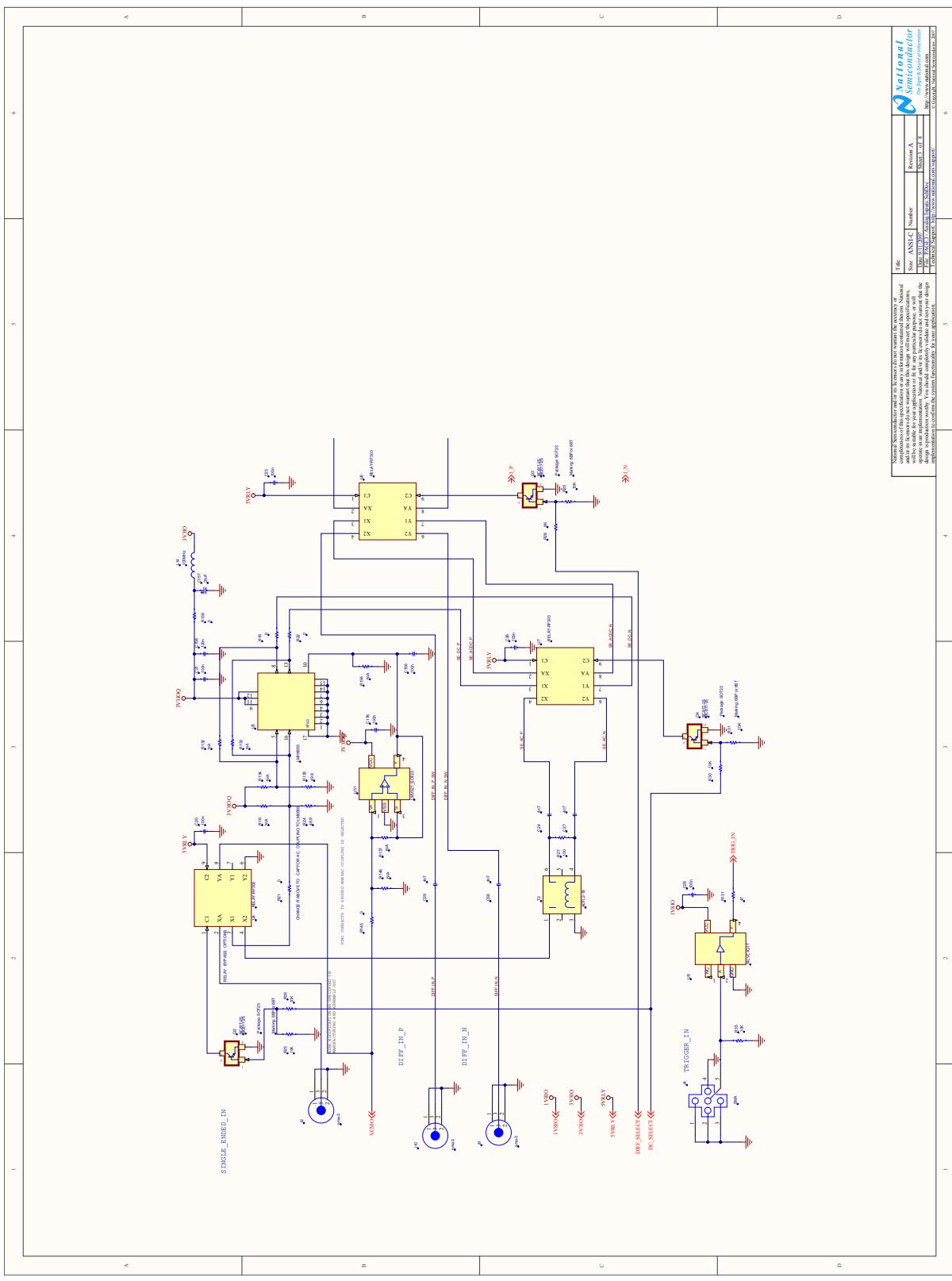


schematic43

FIGURE 1. schematics



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Title: TMS320F28335 Digital Signal Processor
Date: 12/10/2007
S/N: ANSL-C
Number: Revision A
Sheet 2 of 8
Document ID: 100000000000000000
Order Number: TMS320F28335
E-mail: support@ti.com
Phone: 800.272.9000
Fax: 210.359.4000
Web: www.ti.com
http://www.ti.com/sc/ta/tms320f28335
6



schematic45

FIGURE 3. schematics

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Rev. A NSC National Semiconductor
Document 00000000000000000000
Section A
Date 10/04/2000
Part Number RD-143
Title RD-143
Designator N/A
Date 10/04/2000
Comments
Customer Support Help: www.national.com/support
Customer Support Help: www.national.com/rd-143
Engineering Support Help: www.national.com/engineering
Order Support Help: www.national.com/order
E-mail: rd-143@national.com

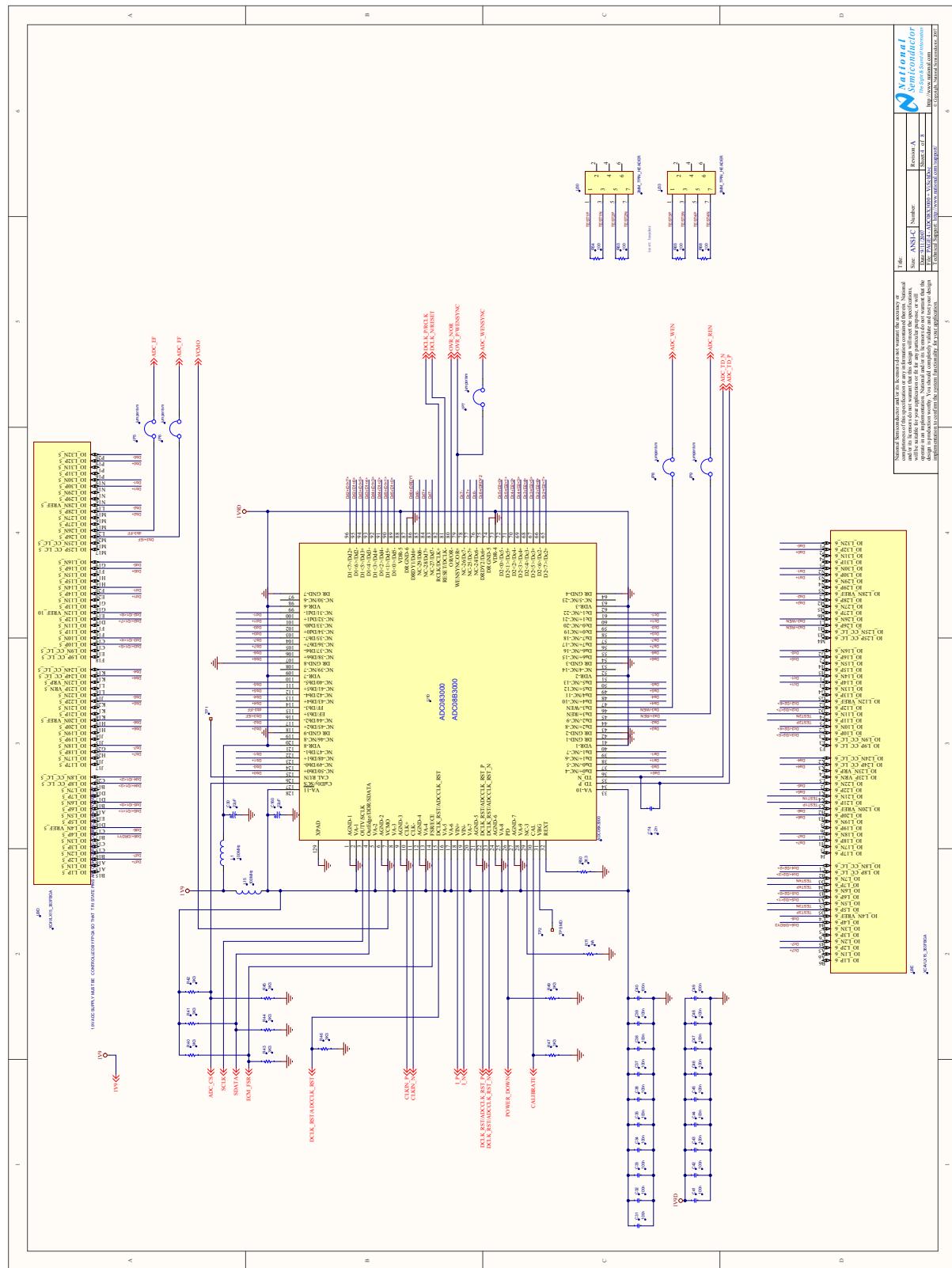


FIGURE 4. schematics

schematic46

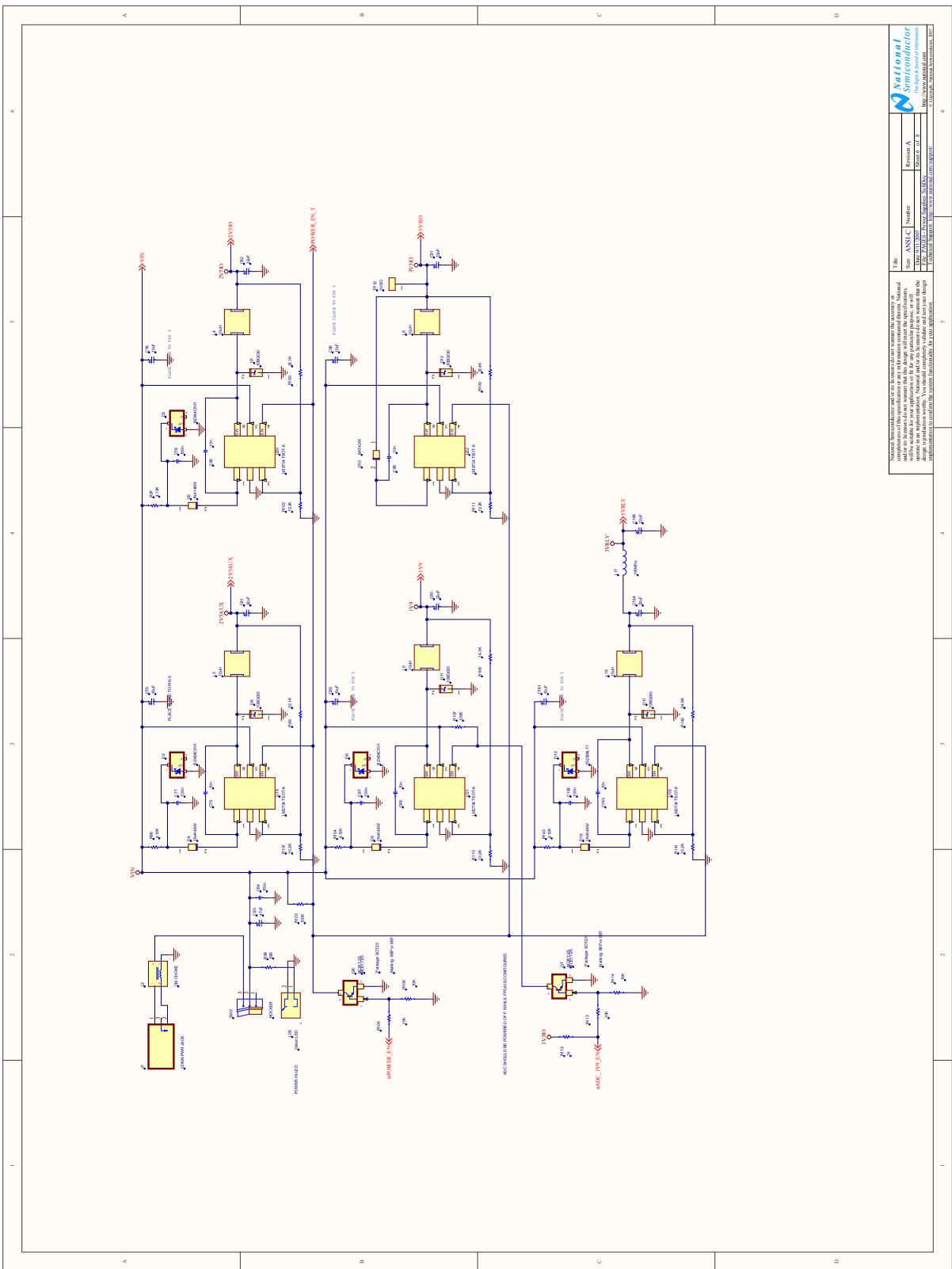


FIGURE 6. schematics

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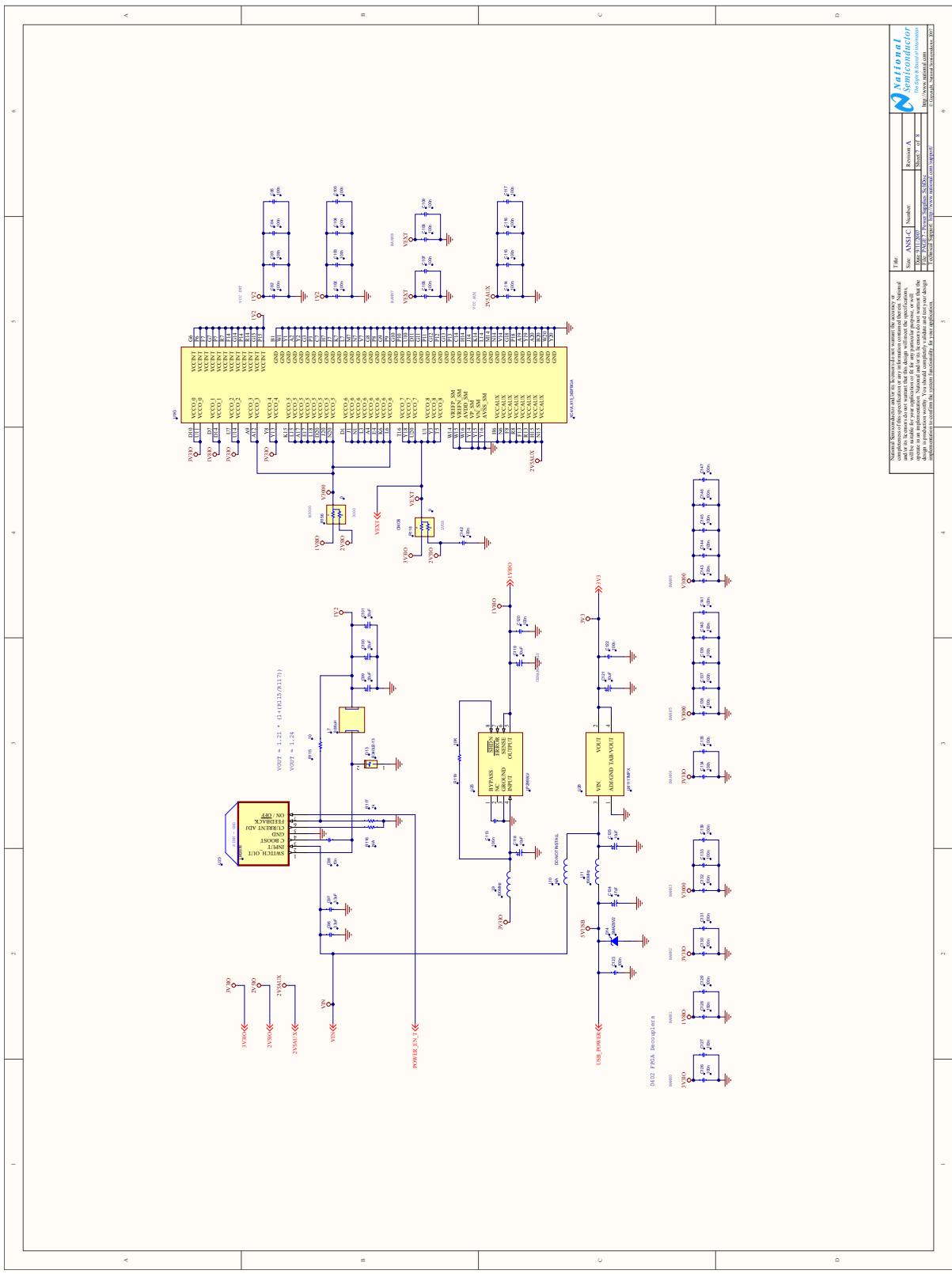
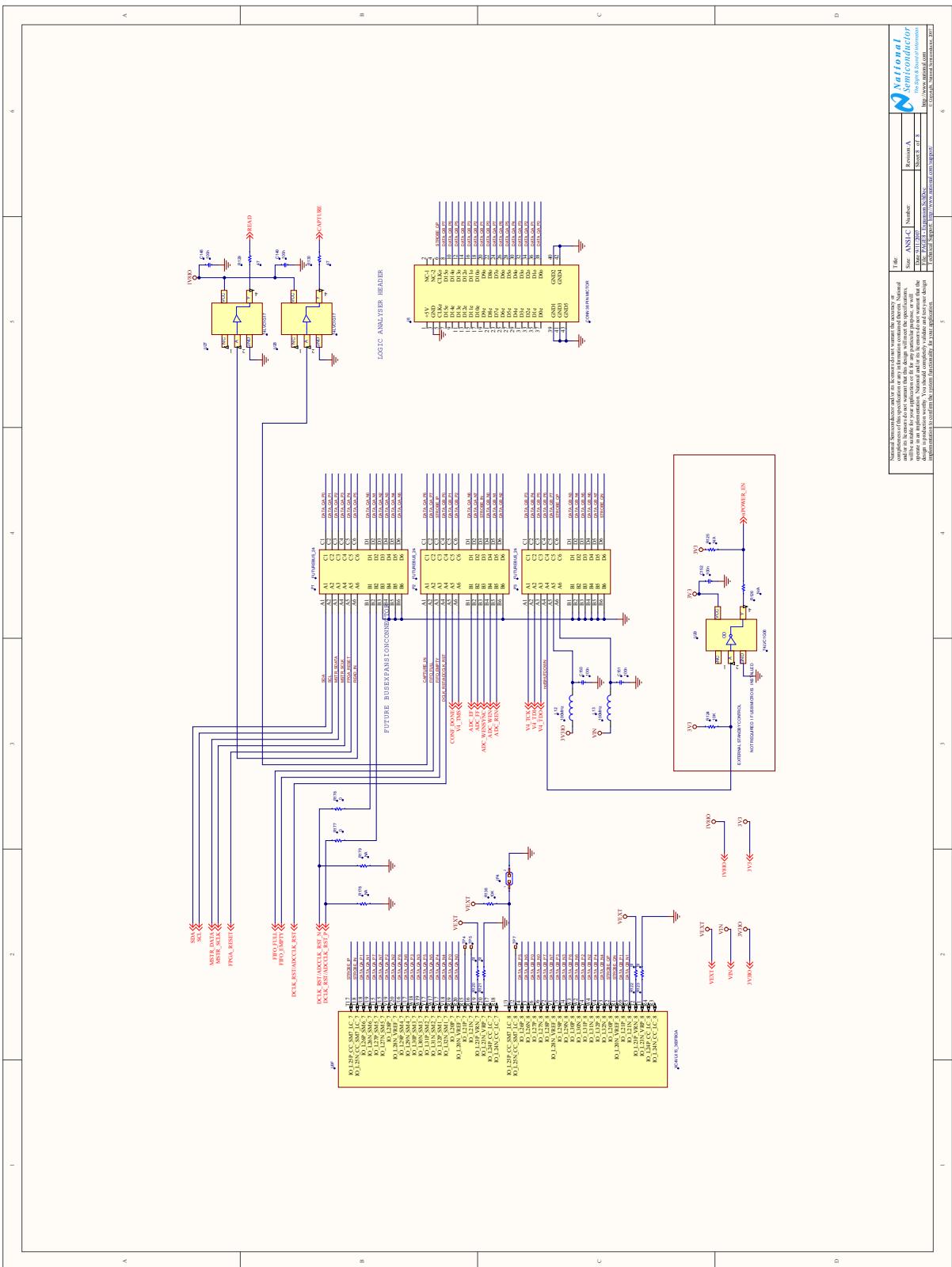


FIGURE 7. schematics

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6

National
Semiconductor
Semiconductor
Division
MAX14550A
Data Sheet
Rev. A
June 2005
Part Number:
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Order Number:
MAX14550A
Description:
MAX14550A
Data Sheet
National
Semiconductor
Corporation
1000 Corporate Park Drive
Santa Clara, CA 95051-1000
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4.0 Bill of Materials

RD-143

NATIONAL SEMICONDUCTOR			
Item	Qty	Total Qty' for Board Build	ADC 08X3000 R2.2 BUILD
Item	Qty	Part Reference	Description
SMT Capacitors			
1	1	C1	1uF
2	72	C2,C4,C6,C7,C19,C20,C21, C23,C25,C26,C28,C31,C32, C33,C34,C35,C36,C37,C38, C39,C40,C41,C42,C43,C44, C45,C46,C47,C48,C49,C50, C51,C52,C53,C54,C55,C57, C60,C63,C64,C65,C66,C67, C68,C69,C70,C71,C72,C73, C77,C78,C84,C87,C112, C113,C20,C122,C123,C148, C149,C150,C151,C152,C156, C158,C162,C166,C172,C173, C174,C175,C176	Capacitor, SMT 0603, MLC, X5R, 10%, 16V Capacitor, SMT 0603, MLC, X7R, 10%, 16V
3	4	C5	100pF
4	1	C6	470pF
5	1	C7	100pF
6	7	C8,C79,C80,C88,C89,C98,	Capacitor, SMT 0603, MLC, X7R, 10%, 16V Capacitor, SMT 0603, MLC, X7R, 10%, 16V Capacitor, SMT 0603, MLC, X7R, 10%, 16V Capacitor, SMT 0603, MLC, X7R, 10%, 16V
7	2	C9,C11	0.47uF
8	1	C12	0.15uF
9	1	C13	220pF
10	6	C14,C15,C24,C27,C29,C56	4n7
11	1	C18	4.7uF
12	8	C30,C81,C82,C90,C91,C160, C164,C166	22uF
13	2	C58,C59	12pF
14	3	C61,C62,C74	2.2n
15	9	C75,C76,C85,C86,C110, C318,C321,C125,C161	10uF
16	2	C83,C124	47uF
17	39	C92,C93,C94,C95,C102, C103,C104,C105,C106,C107, C108,C109,C114,C115,C116, C117,C126,C127,C128,C129, C130,C131,C132,C133,C134, C135,C136,C137,C138,C139, C140,C141,C142,C143,C144, C145,C146,C147,C167	100n
18	2	C96,C97	3.3uF
19	4	C99,C100,C01,C157	33uF
20	2	C111,C119	10uF
21	1	C169	4n7
22	1	C170	0.01uF
23	1	C171	2.2uF
Manufacturer			
Panasonic			
Kemet			
Panasonic			
EPICS Inc			
B4519,A3226K309			
Panasonic			
Panasonic			
Kemet			
T491C106K020AT			
AVX			
Panasonic			
TAC476K020R			
ECJ-0EB1TA104K			
Kemet			
C1206C335K3PACTU			
T491C328K016AT			
C1210C106K4PACTU			
ECJ-IVB1H472K			
C0402C1033JRAC TU			
T491A228SK010AT			

NATIONAL SEMICONDUCTOR					
	Total QTY for Board Build	ADC08X3000 R2.2 BUILD			
Item	Qty	Part Reference	Value	Description	Manufacturer
Diodes					
24	3	D2,D3,D8	BZT84C5V1	DIODE ZENER 5.1V 350MW SOT-2	Diodes Inc
25	4	D4,D5,D9,D16	1N4148W	DIODE SCHOTTKY 75V 400MW SOD-123	Diodes Inc
26	5	D6,D7,D11,D12,D17	10BQ030	DIODE SCHOTTKY 30V 1A DO-214AA	International Rectifier
27	1	D10	BA142W	DIODE SCHOTTKY 30V 200MW SOD-123	Diodes Inc
28	1	D13	BS40LB-13	RECTIFIER SCHOTTKY 40V 3A SMB	Diodes Inc
29	1	D14	SM2Z6V2	DIODE ZENER SMD 6.2V 1W SMA	DIODES INC.
30	1	D15	Z5238BLT1	DIODE ZENER 8.7V 225MW SOT-23	ON Semiconductor
Connectors					
31	1	P4	JUMPER 2X1	HEADER 2X1 0.1" SP MALE STR	Sullins
32	4	I2,I3,I9,I10	SMA-3	CONN JACK SMA 50 OHMS EDGE MOUNT	Emerson
33	1	J4	SMA	CONN SMA RECEPTACLE STRAIGHT PCB GOLD	Amphenol
34	1	J5	CONN 6 PIN SINGL ROW	HEADER 6X1 0.1" SP MALE STR	Sullins
35	1	J6	USB-B	USB Connector Type B, Single Through Hole	Mil-Max
36	1	J7	CONN PWR JACK	CONN PWR JACK 2.5x5.5MM HIGH-CUR	CUI Inc
37	1	J8	CONN 38 PIN MICROR	MICROR VERTICAL RECEPT. 38 POS	AMP/Tyco Electronics
38	3	P1,P2,P3	FUTUREBUS_24	CONN RCEP RTANG 2MM 24POS 30AU	AMP/Tyco Electronics
Ferrites					
39	10	L1,L8,L9,L11,L12,L13,L14,	100MHz	FERRITE CHIP 120 OHM 3000mA 1206	Murata
40	1	L2	CM CHOKE	CHOKE COMMON MODE 170 OHMS PCB	Steward
41	5	L3,L4,L5,L6,L16	10uH	INDUCTOR SHIELD PW/R 10uH 7032	TOK
42	1	L7	8.86uH	INDUCTOR SHIELD PW/R 8.2uH SMD	Coltritronics

NATIONAL SEMICONDUCTOR

DCC0813000 R2.2 BUILD			
Item	Qty	Part Reference	Value
RESISTORS			
43	12	R1.R19,R21,R22,R55,R57, R62,R137,R139,R145,R176,R177	0
44	2	R2,R4	150
45	1	R3	39
46	3	R5,R12,R135	48.9
47	2	R7,R8	0.22
48	1	R9	12K
49	5	R10,R73,R74,R112,R117	1K
50	1	R11	3.3
51	2	R14,R27	100
52	1	R15	0
53	23	R16,R17,R25,R26,R29,R30, R31,R35,R81,R82,R83,R84,	10K
		R85,R94,R106,R113, R114,R119,R124,R138,R149.	
		R150	
56A	1	R20	4.42K
54	1	R108	14.3K
55	3	R23,R29,R100	22.1K
56	1	R28	8K
57	13	R40,R41,R42,R43,R44,R45, R46,R47,R49,R50,R59,R70,	3K3
58	1	R53	4.7K
59	4	R54,R63,R65,R68	100
60	4	R68,R103,R107,R148	100K
61	9	R69,R61,R64,R66,R67,R78, R129,R130,R131	47
62	9	R86,R87,R88,R89,R90,R91, R92,R93,R128	330R
63	4	R96,R97,R104,R110	4.12K
64	1	R98	680
65	5	R101,R102,R110,R111,R141	10.2K
66	1	R109	32.4K
67	1	R115	10
68	4	R120,R121,R122,R123	51
69	1	R142	54.9K
70	1	R175	1M
71	4	U1,U4,U6,U7	RELAY-RF303 RELAY-RF303

NATIONAL SEMICONDUCTOR

Part # ADCO8/3000 R2.2 BUILD				Description	Manufacturer	Manufacturer Part Number
Item	Qty	Part Reference	Value			
[C's]						
72	1	U3	LNX2531LQ1500E	1.5GHz Centre Frequency PLL, 3V	National Semiconductor	LMX2531LQ1500E
73	1	U5	LMH16555	Low Distortion 1.2 GHz Differential Driver	National Semiconductor	LMH16555/NOPB
74	3	U8,U27,U28	7ALVC1G17	IC SCHMITT-TRIG BUFF SOT-23-5	TI	SN74LV1G17DBVR
75	1	U9	XCAV1LX15_363FBGA	VIRTEX4 363 pin FPGAs	Xilinx	XC4VLX15-10SF363C
76	1	U10	ADC08x3000	ADC08x3000 128 PIN Exposed Pad TQFP	National Semiconductor	ADC08x3000CYB/NOPB
77	1	U11	LM3722	5-pin up reset ckt. sot23-5 pkg. LM3722EM5-3.08	National Semiconductor	LM3722EM5-3.08/NOPB
78	1	U12	Cypress C7TC68013A-100A/XC	National Semiconductor	CY7C68013A-100AXC	
79	1	U13	LM95221CIMM	LM95221 Dual Remote Diode Digital Temperature Sensor	National Semiconductor	LM95221CIMM/NOPB
80	1	U15	2IC02/SO8	EEPRON 2 VIRE 2kbit (256 x 8) 8 Pin SOIC	ATMEL	AT24C02BN-10SL-1.8
81	1	U16	7ALVC541	IC OCT BUFF/DRV TRI-ST 20-SSOP	Texas Instruments	SN74LV541A/DR
82	1	U18	7ALVC1G04	IC SINGLE INVERTER-GATE SOT-23-5	Texas Instruments	SN74LV1G04DBVR
83	5	U19,U20,U21,U22,U32	LM2734 TSOT-6	IC PWM STP-DWN REG TA SOT23-6	National Semiconductor	LM2734MKCT-NOPB
84	1	U23	LM2676	IC REG SIMPLE SWITCHER TO-263-7	National Semiconductor	LM2676S-ADJ-NOPB
85	1	U24	LP2986	IC REGULATOR MICROPOWER LDO 8-SOIC	National Semiconductor	LP2986IM-3.6-NOPB
86	1	U25	LP2989LV	IC REGULATOR MICROPOWER LDO 8-SOIC	National Semiconductor	LP2989IM-1.8-NOPB
87	1	U26	LM117MPX	IC REG 3.3V 800mA LDO SOT-223	National Semiconductor	LM117MPX-3.3CT-NOPB
88	1	U29	7ALVC1G06	IC INVERTER BUFF/DRV SOT-23-5	TI	SN74LV1G06DEVR
89	2	U30,U33	2MM-.7PIN_HEADER		Samtec	FTR-107-03-G-S

NATIONAL SEMICONDUCTOR					
Total Qty for Board Build		ADC08X3100 R2.2 BUILD			
Item	Amt	Part Reference	Value	Description	Manufacturer
MISC					
91	4	Ld1,Ld2,Ld3,Ld4	LED_2x1	LED 3MM 2-HIGH GREEN/GREEN PC/MNT	Lumex
92	1	Ld6	GREEN LED	LED 3MM RA FAULT-IND GRN PC/MNT	Lumex
93	7	Q1,Q2,Q3,Q4,Q6,Q7,Q8	BC817/25	TRANSNPNP 500mA 45V SOT23	ON Semiconductor
94	1	SW1	RESET	SWITCH TACT MOM 130GF H=5MM	ITT INDUSTRIES
95	1	SW2	ROCKER	SWITCH ROCKER SMD HORZ AC/BA	ITT Industries/C&K Div
96	2	T1,T2	ADTL2-18	RFT TRANSFORMER SMT 6 PINS upto 1.8GHz	ADTL2-18+
97	1	Y1	60MHz	CCHD-950 SERIES: CMOS ULTRA LOW PHASE NOIS	CCHD-950-25-60
				or	SM7744HV-60.0M
98	1	Y2	2MHz	CRYSTAL 24,000MHz	Crystek
99	1	Y3	OSC (SM)	OSCILLATOR 100,000 MHz SMT	Platonics
100	1	POWER SUPPLY	External Power Supply Output Voltage:12.0V	XPS Power	AED70US12
101		ALTERNATIVE POWER SUPPLY	External Power Supply Output Voltage:12.0V	ELPAC	FW3012-760F
DO NOT SOLDER THE FOLLOWING TO BOARD					
90	1	U31	LM321_SOT23	LM321 Low Power Single Op-Amp	National Semiconductor
102	1	L10	NA	FERRITE CHIP 120 OHM 300mA 1206	BLM31PG12/SN1L
103	2	R12,R13	NA	RES 0 OHM 116W 5% 0402 SMD	ERJ-2GE0R0X
104	14	R18,R71,R75,R77,R116	NA	RES 0 OHM 110W 5% 0603 SMD	ERJ-3GEY0R00V
		R125,R126,R132,R133,R134,			
		R136,R146,R178,R179			
105	1	R76	NA	RES 0 OHM 110W 5% 0603 SMD	ERJ-3GEY0R00V
106	4	R56,R59,R118,R156	0	RES 0 OHM 110W 5% 0603 SMD	ERJ-3GEY0R00V
107	1	U14	XCF08P_VQ48 N/A	Xilinx Configuration Flash ROM (8Mbit) JTAG	XCF08P_VQ48 C
108	5	J5,J6,J7,J8,J9	jumper/jsm	bridge jumper	

5.0 Board Photos



boardphoto2

FIGURE 14. ADC083000 Board Photo

6.0 Quick Start

Quick Start IMPORTANT NOTE :

Install the Wavevision Software before connecting this product to the PC.

1. Connect the 12V DC power source (included with the development board) to the power input
2. Push the Power Switch to the ON position and check that the Green LED between the switch and the power connector illuminates.
3. Connect the USB cable (included) from the USB port to a PC. If this is the first time the board has been connected, Windows may install the drivers for this product at this time.
4. Obtain a stable analog source capable of supplying the desired frequencies at up to 8 dBm. Using a band pass filter, connect this source signal to the single ended input (J2). The exact level needed from the generator will depend upon the insertion loss of the filter used.
5. Start the Wavevision Software
6. Once loaded, the “Firmware Download” Progress bar should be displayed.
7. Upon Firmware Download completion, the control panel for the board should automatically be displayed on the PC and the CLK LED on the front panel should be on and blinking at a 50% duty cycle indicating the ADC has locked onto the clock signal.

8. Set the signal source for the analog input to 8 dBm at the desired frequency. Observe that the Out of Range, (OVR) LED is illuminated. If this LED is not on, increase the input signal source until it is. Now, reduce the signal source level until the OVR LED just turns off.

9. Re-Calibrate the ADC using the button in the lower part of the System Settings window. This should be done after about 20 seconds or more after initial power up.

10. From the Wavevision window pull-down menu select Acquire and then Samples. The system will then capture the input waveform and display the results in the time domain.

11. For FFT Analysis click the FFT Tab.

7.0 Hardware Description

Board Assembly

The ADC083000DEV development Board comes as a plain board with rubber standoffs and requires no assisted cooling due to its low power consumption. The ADC on board is controlled entirely through software.

Functional Description

Input circuitry

The analog input signal to be digitized should be applied to the “Analog Single-Ended Input” or the “Analog Differential Input” SMA connectors. These inputs are intended to accept low-noise analog signals. To accurately evaluate the dynamic performance of this converter, the input analog signals will

have to pass through a high-quality and pass filter with at least 10-bit equivalent noise and distortion characteristics. The single-ended input is converted to differential signals on board via a transformer connected as a balun and provides the single-ended to differential conversion for the ADC. The differential PCB traces to the ADC input pins have a characteristic differential impedance of 100 Ohms. No scope or other test equipment should be connected anywhere in the signal path while gathering data. The Trigger input is buffered and connected to the FPGA. The intent of this input is to allow users to expand the existing capabilities of the current system by providing an input for external triggering of a data capture. The Trigger input has no functionality in the provided FPGA firmware. A JTAG header is available for FPGA programming and debug. The FPGA JTAG interface is also available at the Expansion Bus interface. See the Developer's Guide for further information.

ADC reference

The ADC083000 has an internal reference that can not be adjusted. However, the Full-Scale (differential) Range may be adjusted with the Software Control Panel.

ADC clock

The ADC clock is supplied on board and is fixed at 1.5GHz. An external clock signal may be applied to the ADC through the SMA Connector labeled as "Clock Input". The balun-transformer (T1) converts the single ended clock source to a differential signal to drive the ADC clock pins. Note that it is very important that the ADC clock should be as free of jitter as possible or the apparent SNR of the ADC device will be compromised.

Digital Data Output

The digital output data from the ADC is connected to a Xilinx Virtex4 FPGA. Up to 4K Bytes of data per channel can be stored and then uploaded over the USB interface to the Wavevision software. The FPGA logic usage is low allowing further code to be written and tested for product development. A Mictor connector allows for analysis of the digital data and clock stream on the FPGA output.

Expansion Bus Interface

The Expansion Bus interface provides an alternative method to data capture, ADC and FPGA control versus the USB interface. The connector uses FutureBus components and the pin mapping for the connector is tabulated in Section 12.2. From the pin mapping you can see that the Expansion Bus can control the on-board EEPROM, the USB controller, the FPGA, multiple ADC synchronization. See the Developer's Guide for further information.

Power Requirements

The power supply requirement for the ADC083000DEV Evaluation Board is 12V at 800mA. Most of the regulators on board are switching regulators for increased power efficiency. The board typically draws around 500mA but it is always good practice to have extra power reserve in the power supply over the typical power requirements. A Universal 100-240V AC input to 12V DC Brick Power Supply is included with the development board.

Power Supply Connections

Power to this board is supplied through the power connector. It is advised that only the supplied PSU is used with this board. The ADC supply voltage has been set to 1.9V, ± 50 mV using on board regulators.

8.0 Test Results

Obtaining Best Results

Obtaining the best results with any ADC requires both good circuit techniques and a good PC board layout. For layout information for this product please contact your nearest National Semiconductor representative.

Clock Jitter

When any circuitry is added after a signal source, some jitter is almost always added to that signal. Jitter in a clock signal, depending upon how bad it is, can degrade dynamic performance. We can see the effects of jitter in the frequency domain (FFT) as "leakage" or "spreading" around the input frequency.

Notes

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