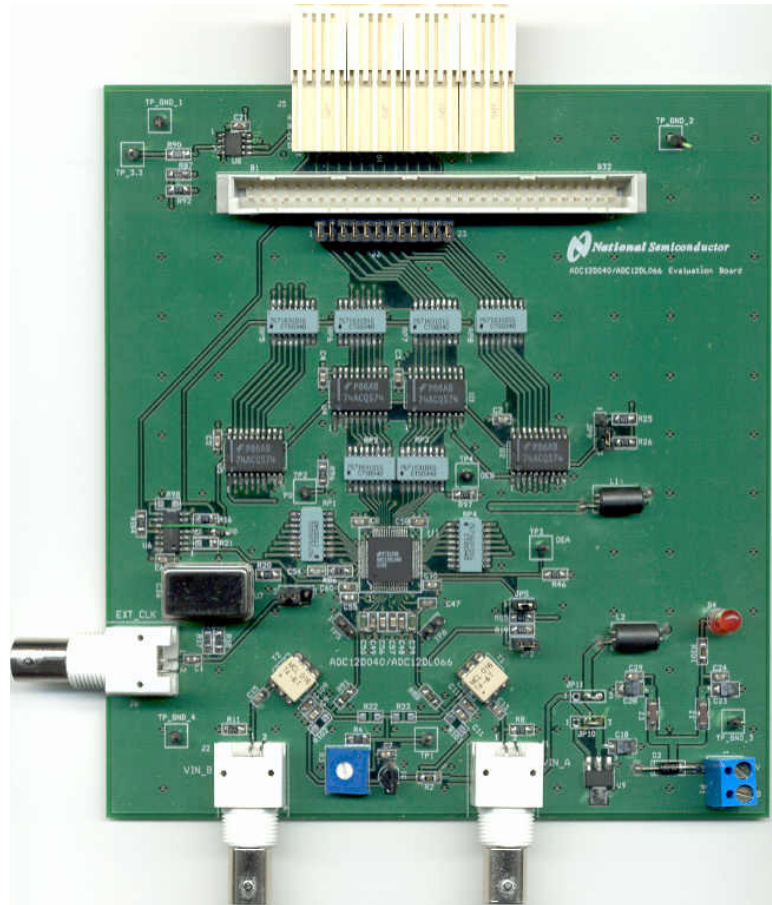**N** *National* *Semiconductor*

Evaluation Board User's Guide
ADC12D040 Dual 12-Bit, 40 MSPS, 5 Volt, 600 mW
ADC11DL066 Dual 11-Bit, 66 MSPS 3.3 Volt, 862 mW
ADC12DL066 Dual 12-Bit, 66 MSPS 3.3 Volt, 862 mW
A/D Converters with Internal Reference and Sample & Hold

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Table of Contents

1.0 Introduction

The ADC12D040EVAL, the ADC11DL066EVAL and the ADC12DL066EVAL Design Kits (consisting of the ADC12D040, ADC11DL066 or the ADC12DL066 Evaluation Board, this User's Guide and the WaveVision4 Data Capture Board and its User's Guide and WaveVision4 software) are designed to ease evaluation and design-in of National Semiconductor's ADC12D040 dual Analog-to-Digital Converter, which can operate at sample rates up to 40 Msps, the ADC11DL066 or the ADC12DL066 dual 12-bit Analog-to-Digital Converters, which operate at sample rates up to 66 Msps. Further reference in this User's Guide to the ADC12D040 is meant to also include the ADC11DL066 and the ADC12DL066 and references to the ADC12DL066 include the ADC11DL066, unless otherwise specified or implied.

The evaluation board can be used in either of two modes. In the Manual mode, suitable test equipment, such as a logic analyzer, can be used with the board to evaluate the ADC12D040 performance.

In the Computer or Automatic mode, evaluation is simplified by connecting the board to National Semiconductor's Data Capture Boards (order number WAVEVSN BRD 4.0), which is connected through a USB communication port to a personal computer running WaveVision4 software. The WaveVision4 program can be downloaded free from the web at http://www.national.com/adc.

The WaveVision4 software operates under Microsoft Windows. The signal at the two the Analog Inputs is digitized and can be captured and displayed on a PC monitor as a dynamic waveform and is also available at the FutureBus connector J5. See schematic of *Figure 2*.

Upon command, the software will perform an FFT on the captured data. This FFT plot also shows dynamic performance in the form of SNR, SINAD, THD, SFDR and ENOB.

The Signal at the Analog Inputs (J1 for input VIN_A and J2 for input VIN_B) are available at differential Test Points TP6 and TP5 respectively. These signals can be viewed with a Differential Probe.

The ADC12D040 can operate with an external reference or with its internal reference. Accordingly, jumper JP2 is used to select use of the ADC internal reference or the separate reference provided on the evaluation board. The internal reference is used with a jumper on JP2. The external reference on the board is used when the jumper on J2 is removed. Provision is made for adjustment of the external Reference Voltage, V_{REF}, with R3. This voltage is regulated with an LM4040-2.5 reference for the ADC12D040, or an LM4140-1.2 reference for the ADC12DL066, and can be set to values between 0.8V to 2.5V for the ADC12D040 and to values between 0.4V and 1.2V for the ADC12DL066.

2.0 Board Assembly

The ADC12D040 evaluation board comes fully assembled and ready for use. Refer to the Bill of Materials for a description of components, to *Figure 1* for major component placement and to *Figure 2* for the Evaluation Board schematic.
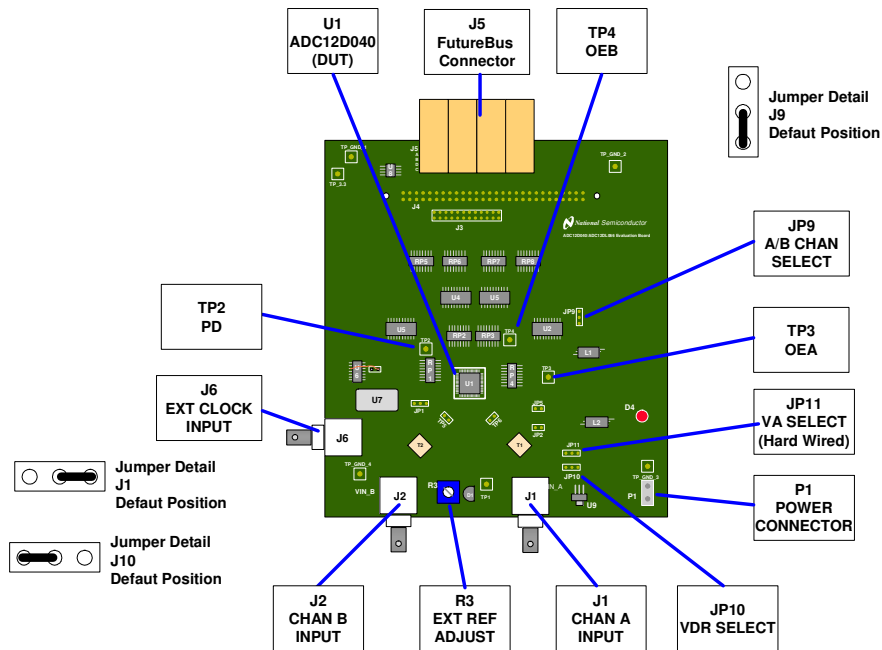

Figure 1. Component and Test Point Locations

3.0 Quick Start

CAUTION: If using the <u>WAVEVSN BRD 4.0</u> Data Capture Board, apply power <u>only</u> to that board <u>or</u> to the ADC12D040 Evaluation Board. Power supplies of these two boards are connected together thought connector J5.

Refer to *Figure 1* for locations of test points and major components. For Stand-Alone operation**:**

1. Connect a clean analog (not switching) +5V power source to Power Connector P1.

2. Set the output amplitude of the clock signal generator, if used, to 3 V_{P-P} for the ADC12D040 or to 2V_{P-P} for the ADC12DL066 and the frequency to the desired sample rate.

3. Use R3 to set the reference voltage (V_{REF}) at TP1 to +2.0V ±0.05 for the ADC12D040 or to 1.0V ±0.03V for the ADC12DL066. To use the ADC internal reference, put a shorting jumper on JP2.

4. Connect a signal source of 2.0 V_{P-P} amplitude for the ADC12D040 or 1.0 V_{P-P} for the ADC12DL066 from a suitable 50-Ohm source (such as the Agilent 8644B synthesizer) to Analog Input BNC connector J1. The ADC input signal can be observed at TP6. **Note:** The signal to J1 should be applied through a bandpass filter to eliminate the noise and harmonics commonly associated with signal sources. Even the best signal generators can not do justice to a 12-bit ADC without such a filter. On the other hand, even a good bandpass filter will not eliminate noise near its center frequency.

5. Put a jumper on JP5 to get an offset binary output from the ADC12D040. Remove any jumper from JP5 for 2's complement output format.

6. Select the WaveVision data format (Offset Binary or 2's Complement) by selecting <u>S</u>ettings from the pull-down menu, then selecting Board <u>S</u>ettings. From there select the desired format.

7. Adjust the input signal amplitude as needed to ensure that the differential signal at TP6 is close to but does not exceed 2.0V_{P-P} for ADC12D040 or 1.0V_{P-P} for ADC12DL066 from each side of TP6 to ground.

8. Check to be sure the correct frequency TTL oscillator is in socket U7, or apply an external 50-Ohm, low jitter, signal source to BNC J6. The amplitude of this signal should be between 2.5 and 3.3 V_{P-P}. If using an external source, remove the oscillator from U7. If using an oscillator at U7, remove the signal source from J6. The presence of a second oscillator source could add noise to the conversion process. Turn on the power.

9. The digitized signal is available at pins A4 through A18 and B4 through B15 of J5. See board schematic of *Figure 2*.

For Computer mode operation:

Note: DO NOT connect power to both this board and to the WAVEVSN BRD 4.0 Data Capture Board. See cautions and note at the beginning of this Section 3.0.

1. Connect the evaluation board to the WaveVision4 Board. See the WaveVision4 User's Guide for board operation.

2. Note the cautions at the beginning of this Section 3.0 before turning on the power to the system.

3. Perform steps 1 through 8 of stand alone quick start, above. Turn on the power.

4. In the WaveVision4 program, select the SETTINGS pull-down menu, then select CAPTURE BOARD SETTINGS.

5. Click on the "Test" button. After the "Communications Successful" message appears below the "Test" button, click on the "Accept" button at the lower right of the dialog box.

6. Press F1 on the computer keyboard to capture and upload data.

4.0 Functional Description

Table 1 describes the function of the various jumpers on the ADC12D040 evaluation board. The Evaluation Board schematic is shown in *Figure 2*.

Jumper	Pins 1 & 2	Pins 2 & 3
JP1	Short to select clock at BNC J6	Short to select clock oscillator at U7
JP2	Open to use external reference Short to use on-chip reference	N/A
JP5	Short for offset binary output Open for 2's complement	N/A
JP9	Short to select Ch B	Short to select Ch A
JP10	Hard-wired for ADC12D040	Hard-wired for ADC12DL066
JP11	Short for output driver supply to be same as the ADC12D040 core supply.	Short for 3.3V supply for the ADC12D040 output drivers. Hard-wired for ADC12DL066

Table 1. Jumper Functions

4.1 Input (signal conditioning) circuitry

The input signal to be digitized should be applied to BNC J1 for testing Channel A of the ADC or to BNC J2 for testing Channel B.

The 50 Ohm inputs J1 and J2 are intended to accept low-noise sine wave signals of 2.0 Volt peak-to-peak amplitude for the ADC12D040 or 1.0 Volt peak-to-peak for the ADC12DL066. To accurately evaluate dynamic performance, the input test signal will have to come from a high quality signal source (such as the Agilent 8644B) <u>and be passed through a high-quality bandpass filter</u> with a 60 dB minimum stop band attenuation. Even the best generators available do not provide a pure enough sine wave to properly evaluate a high resolution ADC. Likewise, even with a good filter, apparent performance will still depend upon the signal source used.

Signal transformers T1 and T2 provide single-ended to differential conversion for the ADC12D040 inputs. The common mode voltage at the ADC input comes from the reference voltage on the eval board through R22 and R23.

Test points TP6 and TP5 may be used to observe the ADC input signals with differential probes. No scope or other test equipment should be connected to TP6 or to TP5 while gathering data.

NOTE: If input frequency components above 50 MHz are required, remove capacitors C14 & C19 and C17 & C20 at the ADC differential input pins. These capacitors are located on the back of the board.

4.2 ADC reference circuitry

These ADCs have an internal reference but can use an external reference as well. An adjustable reference circuit is provided on this board. To use the external voltage reference, leave JP2 open. To use the on-chip voltage reference, short the pins of JP2.

The evaluation board reference circuit will generate a reference voltage that can be adjusted within the nominal range of 0.8 to 2.5 Volts for the ADC12D040 or 0.4 to 1.3 Volts for the ADC12DL066. The ADC12D040 is will operate with V_{REF} in the range of 1.0 to 2.2 Volts, with a nominal value of 2.0 Volts while the ADC12DL066 is will operate with V_{REF} in the range of 0.8 to 1.2 Volts, with a nominal value of 1.0 Volt. The external reference voltage can be monitored at test point TP1 and is set with R3.

4.3 ADC Cock Circuit

The crystal oscillator provided on the evaluation board is selected by shorting pins 2 & 3 of JP1. It is best to remove any external signal generator when using this oscillator to reduce any unnecessary noise.

This board will also accept a clock signal from an external source by connecting that source to BNC J6 and shorting pins 1 & 2 of JP1. A very stable, low jitter source, such as the Agilent 8644B or equivalent, should be used for the clock signal. An a.c. coupled circuit together with a d.c. biased resistive divider is provided so the board can accept a 50 Ohm signal source in the range of 2.2 to 2.5V$_{P-P}$ to drive this input. It is best to remove the oscillator at U7 when using an external clock source, or to remove the external source when using U7, to reduce any unnecessary noise.

4.4 Digital Data Output

When using this evaluation board with a WaveVision4 board, the 12-bit ADC12D040 output from Channel A or Channel B, as selected with JP9, may be monitored at J3.

To cause the ADC outputs to be straight binary, pins 1-2 of JP5 should be shorted together. To cause the ADC outputs to be 2's Complement, no jumper should be placed on JP5.

4.5 Power Supply Connections

When using the WAVEVSN BRD 4.0 Data Capture Board, we recommend that power for the ADC12D040 evaluation board come from the WAVEVSN BRD 4.0 Digital Capture Board.

4.6 Power Requirements

Voltage and current requirements for the ADC12D040 Evaluation Board alone is +5V at 400 mA.

5.0 Software Operation and Settings

The WaveVision software is included with the WAVEVSN BRD 4.0 and the latest version can be downloaded from National's web site at http://www.national.com/adc. To install this software, follow the procedure in the WAVEVSN BRD 4 User's Guide. Once the software is installed, run it and set it up as follows:

1. From the WaveVision main menu, go to Settings, then Board Settings and do the following:

    Select the following from the WaveVision main menu:
    *   WaveVision 4.0 (USB)
    *   Sampling Frequency: Set this to the clock frequency used.
    *   # of Samples: 2K to 32K, as desired
    *   Data Format: Binary or 2's Complement, as selected by JP5. See *Table 1*.

4. Click on 'Accept' when proper selections are made.

5. After the steps outlined in Section 3.0 are completed. click on 'Acquire' then 'Samples' from the Main Menu, or press the F1 key. Select 'Discard' or press the "Escape" key, if a dialog box opens, to start collecting new updated samples.

A plot of the selected number of samples will be displayed. Make sure there is no clipping of data samples. The Samples may be further analyzed by clicking and dragging across a specific area of the plot for better data inspection. See the WaveVision4 Board User's Guide for details.

To view an FFT of the data captured, click on the 'FFT' tab. This plot may be zoomed in upon like the data plot. A display of dynamic performance parameters in the form of SINAD, SNR, THD, SFDR and ENOB will be displayed at the top right hand corner of the FFT plot.

Acquired data may be saved to a file. Plots may also be exported as graphics. See the Data Capture Board User's Guide for details.

If this board is used in conjunction with the WAVEVSN BRD 4.0 Data Capture Board and WaveVision software, a USB cable is needed to connect WAVEVSN BRD 4.0 to the host computer. See the Data Capture Board User's Guide for details.

6.0 Evaluation Board Specifications

Board Size:	5.9" x 6.18" (15.0 cm x 15.7 cm)
Power Requirements:	+5.0V, 340 mA
Clock Frequency Range:	1.0 MHz to 40 MHz (ADC12D040)
	1.0 MHz to 66 MHz (ADC12DL066)
Analog Input	
Nominal Voltage:	2.0V$_{P-P}$ (ADC12D040)
	1.0V$_{P-P}$ (ADC12DL066)
Impedance:	50 Ohms

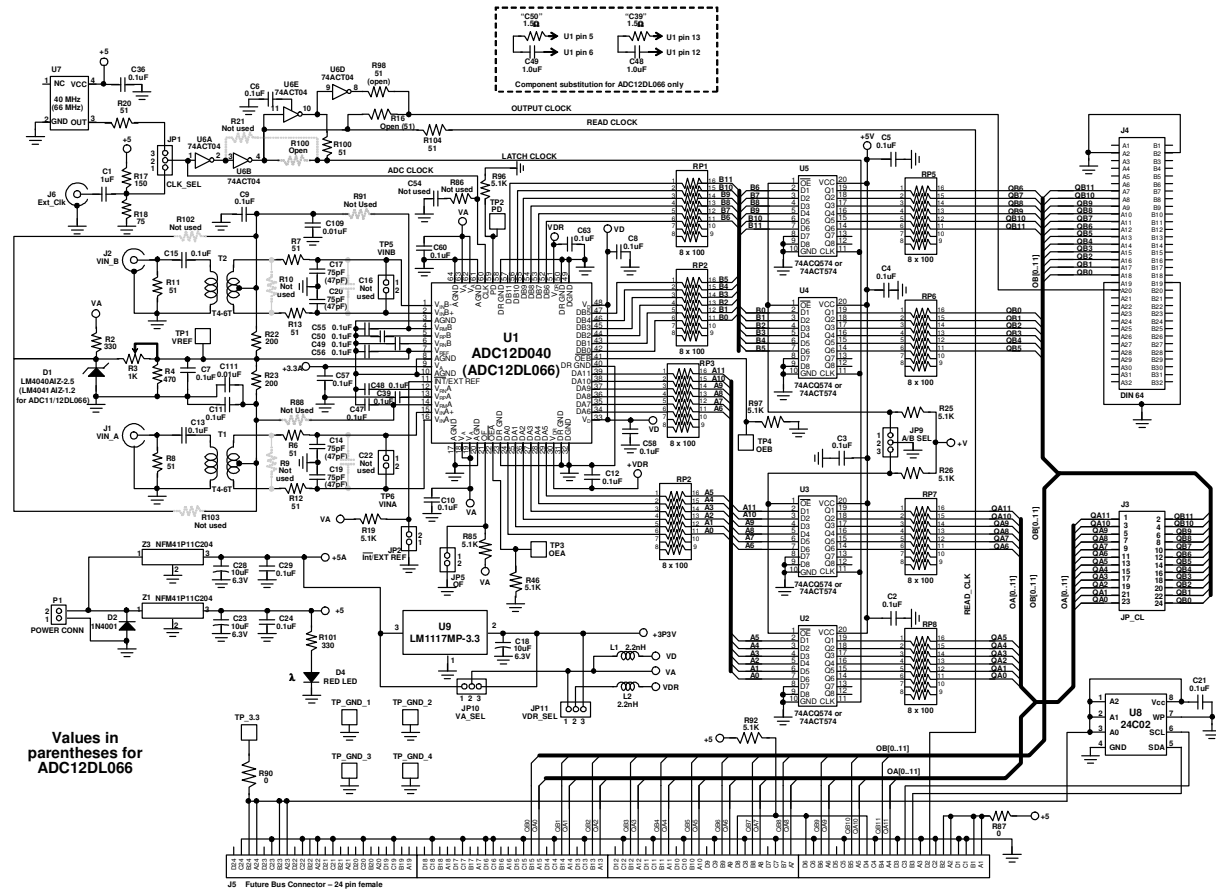**Values in parentheses for ADC12DL066**

Figure 2. ADC12D040 / ADC12DL066 Evaluation Board Schematic

8.0 ADC12D040 / ADC12DL066 Evaluation Board Bill of Materials

Item	Qty	Reference	Part	
1	1	C1	1uF	Size 0805
2	2	C109, C111	0.01uF	Size 0805
3	24	C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C15, C21, C24, C29, C36, C47, C55, C56, C57, C58, C60, C63	0.1uF	Size 0805
4	4	C14, C17, C19, C20	75pF (ADC12D040) 47pF (ADC11/12DL066)	Size 0805 Size 0805
5	3	C18, C23, C28	10uF, 6.3V	Size 1206
6	-	C16, C22, C54	not populated	n/a
7	-	C25, C26, C27, C30, C31, C32, C33, C34, C35, C40, C41, C42, C43, C44, C45, C46, C51, C52, C53, C59, C61, C62	Not used	n/a
8	2	C39, C50	0.1uF (ADC12D040) 1.5Ω resistor (ADC11/12DL066)	Size 0805 Size 0805
9	2	C48, C49	0.1uF (ADC12D040) 1.0uF (ADC11/12DL066)	Size 0805 Size 0805
10	1	D1	LM4040AIZ-2.5 (ADC12D040) LM4041AIZ-1.2 (ADC11/12DL066)	National Semiconductor
11	1	D2	1N4001 or 1N4002 or 1N4003	Various
12	1	D4	Red LED	Various
13	4	JP2, JP5, TP5, TP6	2-Pin Post Headers	DigiKey # A19351-ND
14	2	JP1, JP9	3-pin Post Headers	DigiKey # A19350-ND
15	1	JP11	3-pin Post Header for ADC12D040 Hard-Wired for ADC11/12DL066	DigiKey # A19350-ND n/a
16	-	JP10	Hard wired	n/a
17	3	J1, J2, J6	BNC Connectors	DigiKey # ARF1177-ND
18	1	J3	24-pin Header	DigiKey # S2011-12-ND
19	-	J4	Not Populated	n/a
20	4	J5	Future Bus Connector	Amp # 223514-1
21	2	L1, L2	Wide-Band Choke	DigiKey # M2103-ND or JW Miller # FB20010-3B
22	1	P1	Terminal Block	DigiKey # ED1609-ND
23	1	R3	1K Pot	DigiKey # 3386P-102-ND
24	2	R87, R90	0 Ohms	Size 1206
25	2	R2, R101	330, 5%	Size 1206
26	1	R4	470, 5%	Size 1206
27	10	R6, R7, R8, R11, R12, R13, R16, R20, R100, R104	51, 5%	Size 1206
28	1	R18	75, 5%	Size 1206
29	1	R17	150, 5%	Size 1206
30	2	R22, R23	200, 5%	Size 1206
31	8	R19, R25, R26, R46, R85, R92, R96, R97	5.1k, 5%	Size 1206
32	-	R9, R10, R21, R88, R86, R91, R98, R102, R103	Not populated	n/a
33	-	R1, R5	Not used	n/a
34	8	RP1, RP2, RP3, RP4, RP5, RP6, RP7, RP8	Resistor Pack - 8 x 100	DigiKey # 766-163-R101-ND or DigiKey # 768-163-R101-ND
35	1	TP1, TP2, TP3, TP4, TP_GND_1, TP_GND_2, TP_GND_3, TP_GND_4, TP_3.3	Breakable Header	DigiKey # S1012-36-ND
36	2	T1, T2	Signal Transformer	MiniCircuits Type T4-6T
37	1	U1	ADC12D040CIVS, ADC11DL066CIVS or ADC12DL066CIVS	National Semiconductor
38	4	U2, U3, U4, U5	74AT574SC or 74ACT574SC	Fairchild Semiconductor
39	1	U6	74AC04SC or 74ACT04SC	Fairchild Semiconductor
40	1	U7	40MHz Osc (ADC12D040) 66MHz Osc (ADC11/12DL066)	Pletronics #P1145-3SD-40.00M or DigiKey # CTX120-ND (ADC12D040) or Pletronics #P1145-3SD-66.667M or DigiKey # CTX137-ND (ADC11/12L066)
41	1	U8	24C02	Various
42	1	U9	LM1117MP-3.3	National Semiconductor
43	2	Z1, Z3	Noise Filters	MuRata # NFM41P11C204
44	1	--	4-Pin full-size oscillator socket	DigiKey # A462-ND

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APPENDIX

A1.0 Operating in the Computer Mode

The ADC12D040 Evaluation Board is compatible with the WAVEVSN BRD 4.0 Data Capture Board, making data capture easily controlled from a personal computer operating in the Windows environment. The data samples that are captured can be observed on the PC video monitor in the time and frequency domains, as can a software histogram of the captured data. The FFT analysis of the captured data yields insight into system noise and distortion sources and estimates of ADC dynamic performance such as SINAD, SNR, THD, SFDR and ENOB.

See the WaveVision4 Data Capture Board User's Guide for more information.

A2.0 Summary Tables of Test Points, Jumpers and Connectors

Test Points on the ADC12D040/ADC11DL066/ADC12DL066 Evaluation Board

TP1: V_{REF}	ADC Reference Voltage Test Point.
TP2: PD	Power Down control. Apply a logic high voltage here to power down the A/D Converter.
TP3: OEA	Output Enable for ADC "A". Apply a logic high voltage here to disable outputs "A".
TP4: OEB	Output Enable for ADC "B". Apply a logic high voltage here to disable outputs "B".
TP5: VINB	Differential input signal to ADC "B"
TP6: VINA	Differential input signal to ADC "A"
TP_3.3	3.3 Volt test point from the WaveVison4 Board.
TP_GND_1	Ground. Located in corner nearest TP_3.3
TP_GND_2	Ground. Located in corner nearest board identification silk screen.
TP_GND_3	Ground. Located in corner nearest Power Connector
TP_GND_4	Ground. Located in corner nearest BNC J2.

Connectors and Selection Jumpers on the ADC12D040/ADC11DL066/ADC12DL066 Evaluation Board

J1: BNC Connector	Single-Ended input to ADC "A"
J2: BNC Connector	Single-Ended input to ADC "B"
J3: JP_CL	Put jumpers on all 12 pin pairs to make output bus available on J4 available for converter selected by JP9.
J4: DIN 64	Not used.
J5: Future Bus connector	Future Bus connector for use with WaveVision 4
J6: BNC Connector	External Clock Input

Selection Jumpers on the ADC12D040/ADC11DL066/ADC12DL066 Evaluation Board

JP1: CLK_SEL	Jumper pins 2-3 to select on-board oscillator at U7 or jumper pins 1-2 to select external clock at J6
JP2: INT/EXT REF	Place jumper on these pins to select the internal 1.0V reference; leave jumper off to use external reference.
JP3:	Not Used
JP4:	Not Used
JP5: OF	Place jumper on these pins to select Offset Binary output format; leave jumper off for 2's complement.
JP6:	Not Used
JP7:	Not Used
JP8:	Not Used
JP9: A/B SEL	Jumper pins 2-3 to select ADC Channel "A" or jumper pins 1-2 to select ADC Channel "B"
JP10: VA_SEL	Hard-wired to +5.0V for ADC12D040. Hard-wired to 3.3V for ADC12DL066
JP11: V_{DR}_SEL	Jumper pins 2-3 to select 3.3V for V_{DR} (output driver supply) or jumper pins 1-2 to select ADC supply for V_{DR}. Hard-wired to 3.3V for ADC12DL066

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P1: Connector - Power Supply Connections

P1-1	+5V	Positive Supply voltage (+5V)
P1-2	GND	Power Supply Ground

J3: Latch Outputs

J3 pin number	Signal (when channel enabled)
1, 2	B11(MSB) Ch A, B11(MSB) Ch B
3, 4	B10 Ch A, B10 Ch B
5, 6	B9 Ch A, B9 Ch B
7, 8	B8 Ch A, B8 Ch B
9, 10	B7 Ch A, B7 Ch B
11, 12	B6 Ch A, B6 Ch B
13, 14	B5 Ch A, B5 Ch B
15, 16	B4 Ch A, B4 Ch B
17, 18	B3 Ch A, B3 Ch B
19, 20	B2 Ch A, B2 Ch B
21, 22	B1 Ch A, B1 Ch B
23, 24	B0(LSB) Ch A, B0(LSB)

J5: Future Bus connector for use with WAVEVSN BRD 4.0 Data Capture Board

J5 pin number	Signal
A1, B1, A2, B2	+5 Volts from Data Capture Board
C1 thru C24	Ground
A3, A22, B3, D1, D16	Ground
D2	READ_CLK to clock data into RAM
A4	QA11 - Bit 11 (MSB) output for ADC "A"
B4	QB11 - Bit 11 output for ADC "B"
A5	QA10 - Bit 10 output for ADC "A"
B5	QB10 - Bit 10 output for ADC "B"
A6	QA9 - Bit 9 output for ADC "A"
B6	QB9 - Bit 9 output for ADC "B"
A7	QA8 - Bit 8 output for ADC "A"
B7	QB8 - Bit 8 output for ADC "B"
A8	QA7 - Bit 7 output for ADC "A"
B8	QB7 - Bit 7 output for ADC "B"
A9	QA6 - Bit 7 output for ADC "A"
B9	QB6 - Bit 7 output for ADC "B"
A10	QA5 - Bit 7 output for ADC "A"
B10	QB5 - Bit 7 output for ADC "B"
A11	QA4 - Bit 7 output for ADC "A"
B11	QB4 - Bit 7 output for ADC "B"
A12	QA3 - Bit 7 output for ADC "A"
B12	QB3 - Bit 7 output for ADC "B"
A13	QA2 - Bit 7 output for ADC "A"
B13	QB2 - Bit 7 output for ADC "B"
A14	QA1 - Bit 7 output for ADC "A"
B14	QB1 - Bit 7 output for ADC "B"
A15	QA0 - Bit 7 output for ADC "A"
B15	QB0 - Bit 7 output for ADC "B"
D4, D6, D8	Board ID pins - not used
A23, B23, A24, B24	3.3V from WaveVision4 Data Capture Board
A16 thru A21	Not Used
B16 thru B21	Not Used
D5, D7, D9 thru D15	Not Used
D17 thru D24	Not Used

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The ADC12D040/ADC11DL066/ADC12DL066 Evaluation Boards are intended for product evaluation purposes only and are not intended for resale to end consumers, is not authorized for such use and is not designed for compliance with European EMC Directive 89/336/EEC, or for compliance with any other electromagnetic compatibility requirements.

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