National Semiconductor

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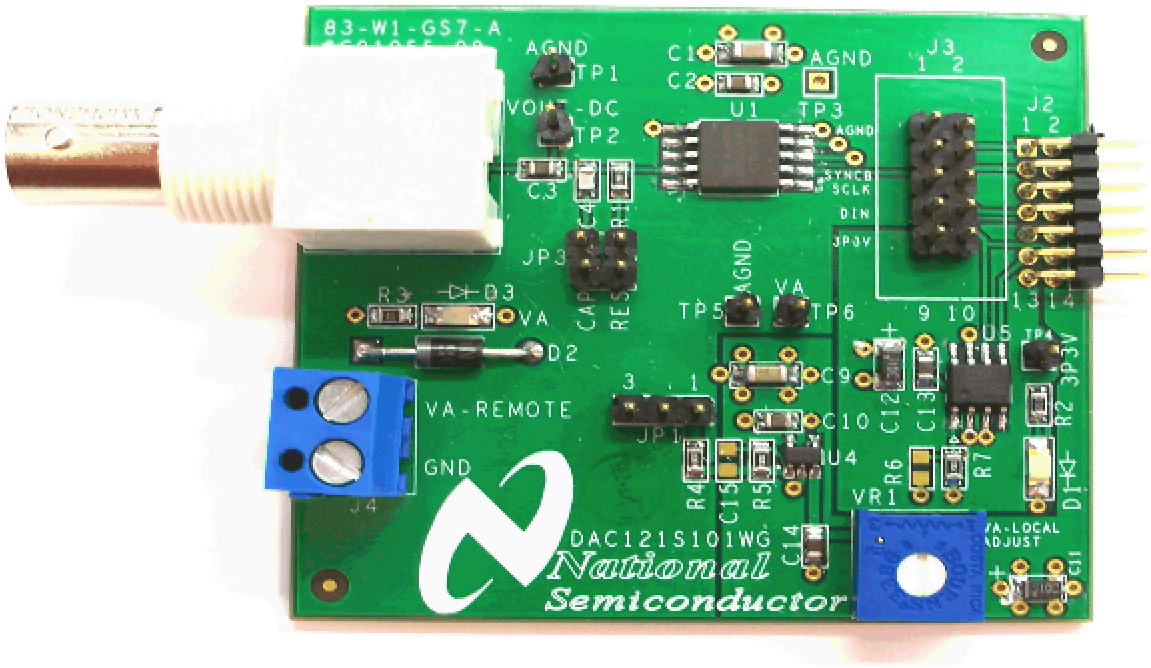
Evaluation Board User's Guide

DAC121S101CVAL

12-Bit Micro Power Digital-to-Analog Converter with Rail-to-Rail Output



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1.0 Introduction

The DAC121S101CVAL Design Kit (consisting of the DAC121S101WG Evaluation Board and this User's Guide) are designed to ease evaluation and design-in of the National Semiconductor DAC121S101WG 12-bit Micro-Power Digital-to-Analog Converters with Rail-to-Rail Output. This device will be referenced throughout this document as the DAC121S101WG.

The evaluation board can be used in either of two modes. In the Stand-Alone mode, suitable test equipment, such as a pattern generator and signal analyzer, can be used with the board to evaluate the DAC121S101WG performance.

In the Computer mode, data capture and evaluation is simplified by connecting this board to National Semiconductor.s Data Capture Board (order number WAVEVSN BRD 4.0) with a custom interface cable (part number WV4DACIFCABLE at www.national.com). The Data Capture (WV4) Board is connected to a personal computer running WaveVision software through a USB port. The WaveVision4 software runs on Microsoft Windows, and the latest version can be downloaded from the web at http://www.national.com/adc.

Note: WaveVision Software version 4.2 or later is required to evaluate this part with the WV4 Evaluation System.

The WaveVision software allows the user to drive the DAC121S101WG with a variety of preset waveforms and custom waveforms. The software also allows the user to select the clock frequency of the serial interface.

Data transmitted to the DAC121S101WG via a serial interface is converted to an analog waveform by U1, the DAC121S101WG.

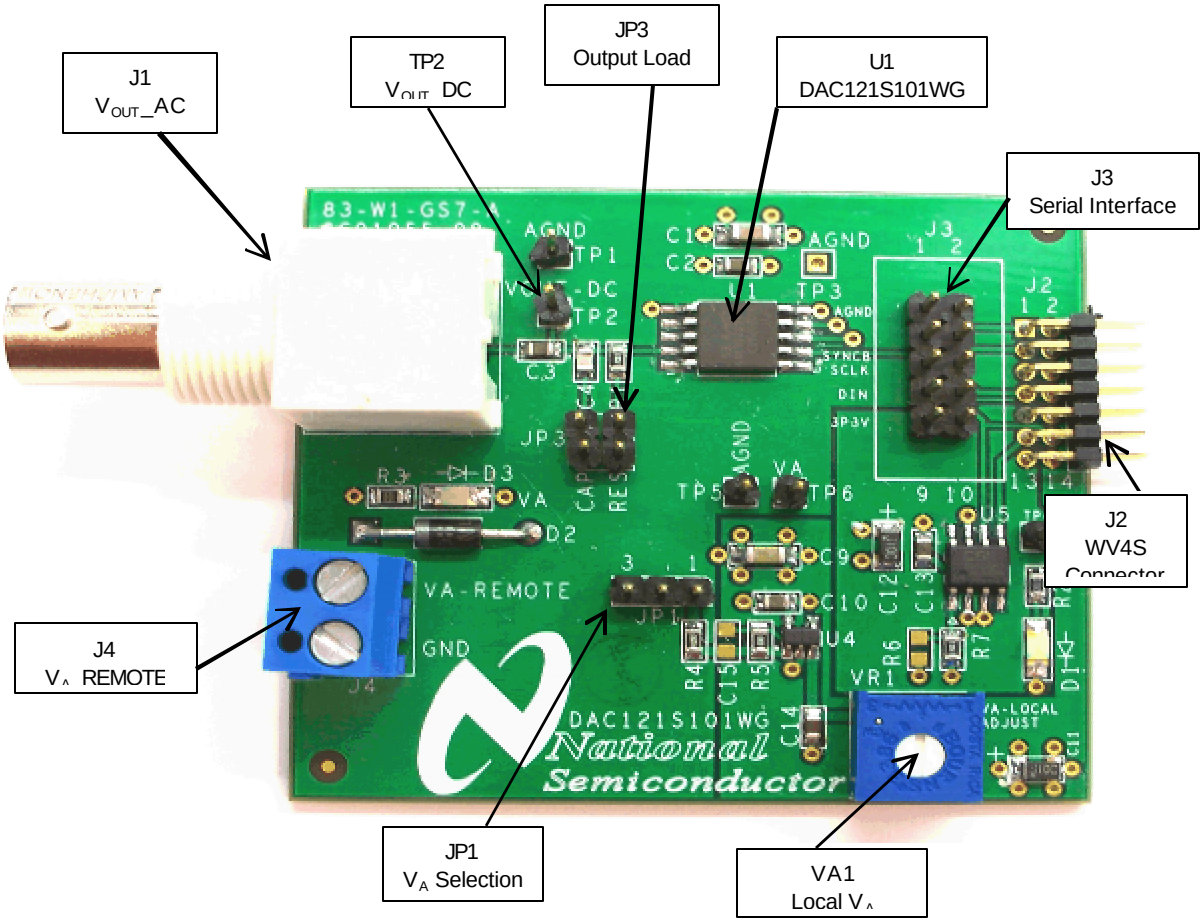


Figure 1: Component and Test Point Locations

2.0 Board Assembly

The DAC121S101WG 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 4* for the Evaluation Board schematic.

3.0 Quick Start

The DAC121S101WG evaluation board may be used in the Stand-Alone mode or Computer mode. In Stand-Alone mode, a Pattern Generator is used to drive the DAC121S101WG, and a Signal Analyzer is used to evaluate the analog output signal. In Computer Mode, a WaveVision4 Board is used to drive the DAC121S101WG and a Signal Alalyzer is used to evaluate the analog output signal.

3.1 Stand-Alone Mode

Refer to *Figure 1* for locations of test points and major components.

1. Connect a clean analog (not switching) +5V power source to Power Connector J4 on the DAC121S101WG board and turn on the power. Place a jumper across pins 2 and 3 of JP1 to select VA_REMOTE.
2. Create the digital waveforms seen in *Figure 2* with your Logic Generator. Ensure that SCLK doesn.t exceed 30MHz. Refer to .Section 4.1: Serial Interface. and the DAC121S101QML Datasheet for further details.

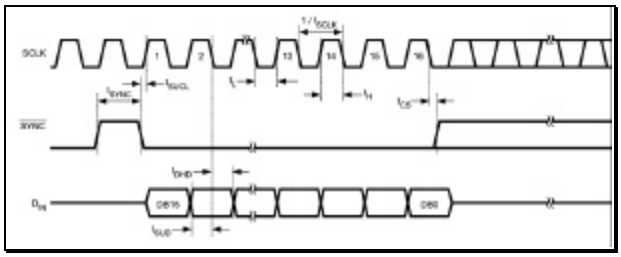


Figure 2: Digital Input Timing Diagram
(*Refer to Appendix 2.0 for an enlarged version*)

3. Connect your Logic Generator to Serial Interface header J3. Refer to *Figure 3* below for connection details.

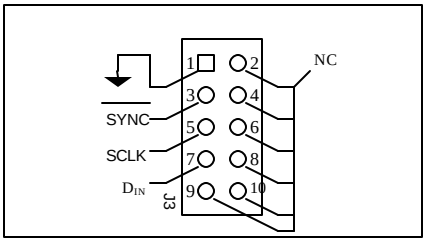


Figure 3: J3 Serial Interface Header

4. The Analog Output signal can be seen DC coupled at TP2, or AC coupled at BNC connector J1. See the board schematic of *Figure 4* for details.
5. Select the desired output load by adding jumpers to JP3. Connecting a jumper across pins 1 and 2 connects a 200pF load capacitance to ground. Connecting a jumper across pins 3 and 4 selects a 2k? resistive load. See *Table 1* for jumper configurations.

3.2 Computer Mode

Refer to *Figure 1* for locations of test points and major components.

1. Run the WaveVision4 program. While the program is loading, continue below.
2. Connect the “WV4DACIFCABLE” cable between J3 of the DAC121S101WG evaluation board and J3 of the WV4 board. Note: the ”WV4DACIFCABLE” is available at www.national.com.
3. Connect a USB cable between the WaveVision4 Board and the PC running the WaveVision4 software.
4. Connect a clean analog (not switching) +5V power source to Power Connector J1 on the WaveVision4 Board.
5. Place a jumper across pins 2 and 3 of JP1 on the DAC121S101WG board to select VA_REMOTE.
6. Using a jumper cable, connect TP9 of the WaveVision4 board to TP6 of the DAC121S101WG board.
7. Using another jumper cable, connect TP10 of the WaveVision4 board to TP4 of the DAC121S101WG board. *See Section 4.4 for detailed Power Supply Information.*
8. Perform steps 4 and 5 of section 3.1 above.
9. Refer to section 5.0 on Software Operation and Settings.

4.0 Functional Description

Table 1 describes the function of the various jumpers on the DAC121S101WG evaluation board. The Evaluation Board schematic is shown in *Figure 4*.

Jumper	Pins 1 & 2	Pins 2 & 3
JP1	Select VA_LOCAL from VR1 adjust	Select VA_REMOTE from J4
JP2	Not used	

Jumper	Pins 1 & 2	Pins 3 & 4
JP3	Select 200pF Output Load Capacitance	Select 2k? Output Load Resistance

Table 1: Jumper Configurations

4.1 Serial Interface

In Computer Mode, the serial interface is driven by the WaveVision4 board. The WaveVision4 software allows the user to drive the DAC121S101WG with various digitized signals. Refer to .Software Operation and Settings. for further information.

In Stand-Alone Mode, The serial interface must be driven by an external device. The three-wire interface (SCLK, SYNC, D_{IN}) is compatible with SPI, QSPI and MICROWIRE, as well as most DSPs. See the Timing Diagram (*Figure 2*) for information on a write sequence.

The maximum digital input level of the three-wire interface is independent of the analog supply voltage (V_A). The range of all digital inputs is 0V to 5.25V regardless of V_A.

A write sequence begins by bringing the SYNC line low. Once SYNC is low, the *Binary* data on the D_{IN} line is clocked into the 16-bit serial input register on the falling edges of SCLK. On the 16th falling clock edge, the last data bit is clocked in and the programmed function (a change in the mode of operation and/or a change in the DAC register contents) is executed. At this point the SYNC line may be kept low or brought high. In either case, it must be brought high for the minimum specified time before the next write sequence as a falling edge of SYNC will initiate the next write cycle.

Since the SYNC and D_{IN} buffers draw more current when they are high, they should be idled low between write sequences to minimize power consumption.

Please refer to the DAC121S101QML datasheet for more information.

4.2 DAC Reference Circuitry

The supply voltage for the DAC121S101WG serves as its voltage reference, and does not need to be supplied separately. The analog output range of the DAC121S101WG can be scaled by adjusting the supply voltage (V_A). This voltage can be set anywhere from +2.7V to +5.5V.

4.3 Analog Output

The analog output of this Eval board is available at the BNC connector, J1. The output at J1 is AC coupled. The board also provides a DC coupled output at TP2.

If you are using a spectrum analyzer to look at the output of the DAC121S101WG, the AC coupled output (J1) is recommended.

For very low frequency (i.e. less than 1kHz), use TP2 to see the output signal DC coupled. For an AC coupled output at low frequencies, simply replace the AC coupling capacitor at C3 with a larger capacitor.

4.4 Power Supply Connections

The DAC121S101WG board must be powered by an external supply or the local WaveVision4 board supply. In Stand-alone mode, the DAC121S101WG board must be powered by an external supply. In either case, remember that the supply voltage and reference voltages are tied together on the DAC121S101WG.

If you wish to supply V_A externally, connect a DC voltage supply to connector J4 and place a jumper across pins 2 and 3 of JP1 to select V_A_REMOTE. This voltage (V_A) can be set anywhere from +2.7V to +5.5V. Note: For computer mode, +3.3V must be supplied to the DAC121S101WG board at TP4.

Since the supply voltage (V_A) serves as the reference for the DAC121S101WG, ensure a clean power supply is used.

If you wish to use the local supply from the WaveVision4 Board, place a jumper across pins 2 and 3 of JP1. Using a jumper cable, connect TP9 of the WaveVision4 board to TP6 of the DAC121S101WG board. This connection will supply +5V to V_A on the DAC121S101WG board. Using another jumper cable, connect TP10 of the WaveVision4 board to TP4 of the DAC121S101WG board.

5.0 Software Operation and Settings

The WaveVision software is included with the WaveVision4 board and the latest version can be downloaded from National's web site at http://www.national.com/adc . WaveVision software version 4.2 or later is required to evaluate this device with the WV4 system.

To install this software, follow the procedure in the WAVEVSN BRD 4.0 User's Guide. Once the software is installed, run it and set it up as follows:

Note: Before continuing, ensure that the WaveVision Hardware is setup according to Section 3.2.

1. From the WaveVision main menu, go to Settings, then Capture Settings to open the System Settings dialog.
2. Under board type, select WaveVision4 (USB).

3. Turn on the power to both boards, then click on the **"Test"** button and await the firmware download. *After the firmware has downloaded, WaveVision will open up a control panel for the DAC121S101WG*.

4. Click on the **"Accept"** button to close the System Settings Dialog.

5. From the DAC121S101WG Control Panel, configure the digital waveform to be converted by the DAC. *Please see the WaveVision4 User.s Manual for detailed instructions. The ability to drive preset waveforms or custom data is provided.*

6. Press the **"Start"** button to begin driving the digital waveform to the DAC.

The WaveVision4 Board will continuously send the waveform out to the DAC121S101WG until the **"Stop"** button is pressed. Please refer to *Section 4.3* for details on measuring the Analog Output of the DAC. The Digital Waveform is plotted in the main WaveVision window for added convienience. This waveform may be further analyzed by clicking on the magnifying glass icon, then clicking and dragging across a specific area of the plot for better data inspection. See the WaveVision4 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 WaveVision4 Board User's Guide for details.

6.0 Evaluation Board Specifications

Board Size:	2.44" x 2.19" (6.2 cm x 5.6 cm)	
Power Requirements	Min: +2.7V , 3mA	Max: +5.5V, 5 mA
Max Clock Frequency:	20 MHz	
Analog Output		
AC Coupled Output Range:	$-(V_A/2)$ to $(V_A/2)$	
Impedance:	User Selectable: 2K?, 200pF, or 8 .	

7.0 Hardware Schematic

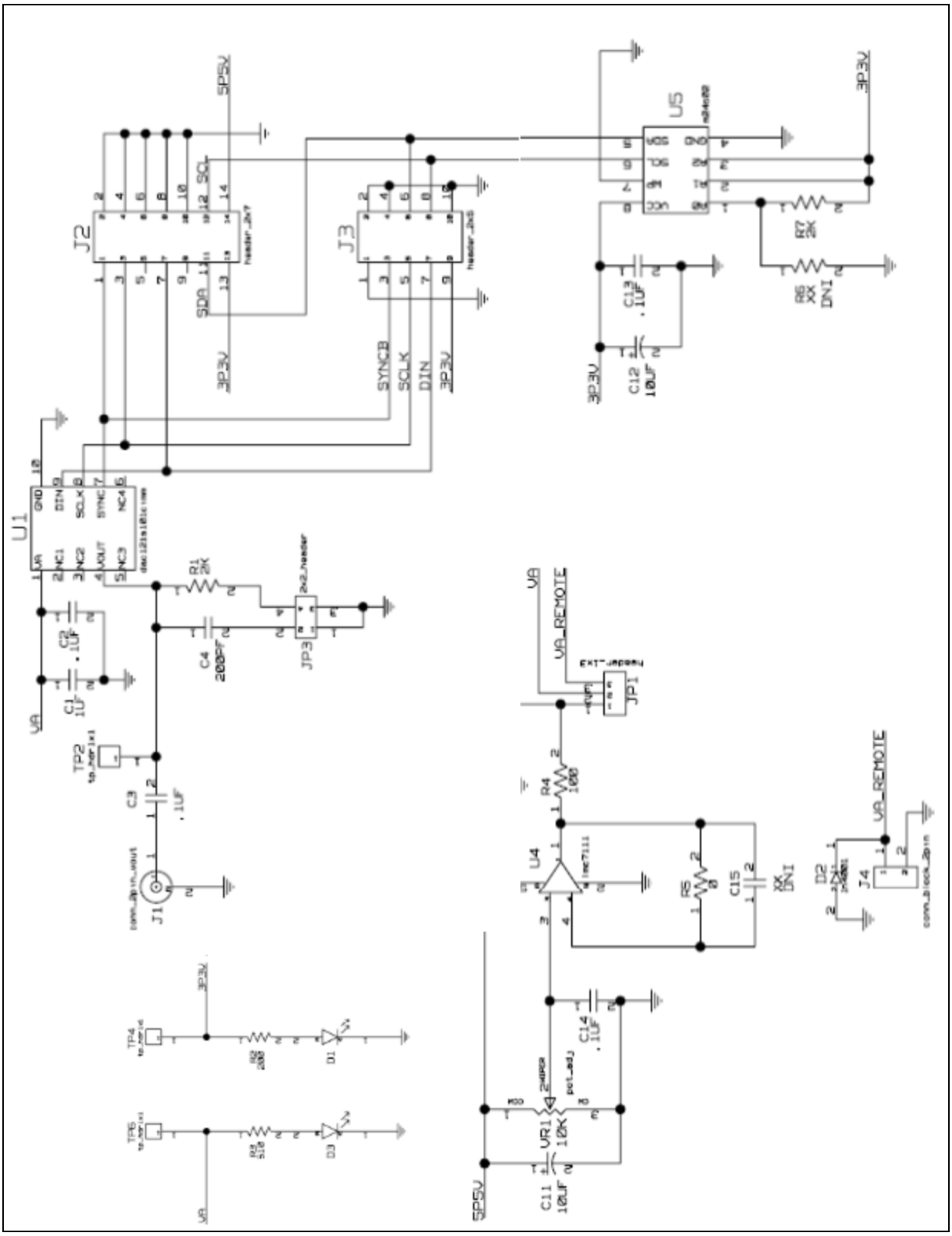


Figure 4: DAC121S101WG Evaluation Board Schematic

8.0 Evaluation Board Bill of Materials

Qty.	Reference	PCB Footprint	Source	Source Part #	Rating	Value
1	C1	sm/c_1206			10V	NS
2	C15,C2	sm/c_0805			10V	NS
5	C3,C6,C10, C13,C14	sm/c_0805			10V	0.1uF
1	C4	sm/c_0805			10V	200pF
2	C9,C5	sm/c_1206			10V	1uF
2	C11,C12	sm/ct_3216_12			10V	10uF
1	D1	sm/led_21	Digikey	516-1440-1-ND		RED LED
1	D2	DAX2/DO41	Digikey	1N4001GICT-ND		1N4001
1	D3	sm/led_21	Digikey	516-1440-1-ND		NS
1	JP1	blkcon.100/vh/tm1sq/w.100/3	Digikey	A26513-40-ND		VA SELECTION
1	JP3	blkcon.100/vh/tm2oe/w.200/4	Digikey	A26529-40-ND		LOAD_SEL
1	J1	rf/bnc/r1.350_21	Digikey	ARF1177-ND		VOUT_ac
1	J2	blkcon/2mm/ra/tm2oe/w2mm/14	Digikey	S2200-07-ND		HEADER 7X2
1	J3	BLKCON.100/…/shroud	Digikey	A26529-40-ND		HEADER 5X2
1	J4	term_block/.200/2pos	Digikey	ED1609-ND		VA_REMOTE
1	R1	sm/r_0805				2K
1	R2	sm/r_0805				200
2	R6,R3	sm/r_0805				NS
3	R4,R5,R7	sm/r_0805				0
3	TP1,TP3,TP5	blkcon.100/vh/tm1sq/w.100/1	Digikey	5011K-ND		AGND
1	TP2	blkcon.100/vh/tm1sq/w.100/1	Digikey	5011K-ND		VOUT_DC
1	TP4	blkcon.100/vh/tm1sq/w.100/1	Digikey	5011K-ND		3P3V
1	TP6	blkcon.100/vh/tm1sq/w.100/1	Digikey	5011K-ND		VA
1	U1		National Semiconductor	DAC121S101WGMPR		DAC121S101WG
1	U4	sm/sot23-5	Digikey	LMV710M5CT-ND		LMV710M5
1	U5	sog.050/8/wg.244/l.200				24C02
1	VR1	vres4	Digikey	3386F-103-ND		10K

APPENDIX

A1.0 Summary Tables of Test Points, Jumpers, and Connectors

Test Points on the DAC121S101WG Evaluation Board

TP1: AGND	Ground. Located at the top center of the board.
TP2: VOUT_DC	DC Coupled Analog Output test point. Located at the top center of the board.
TP3: AGND	Ground. Located at the top Right of the board.
TP4: 3P3V	3.3V test point. Located at the right edge of the board.
TP5: AGND	Ground. Located in the center of the board.
TP6: VA	V_A Test Point. Located in the center of the board.

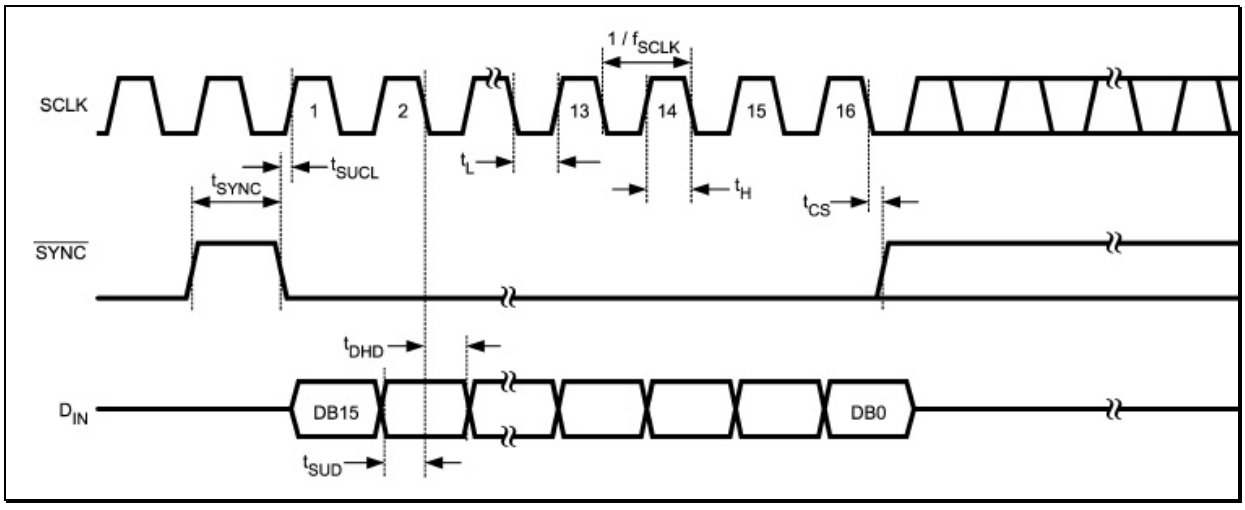
Connectors on the DAC121S101WG Evaluation Board

J1: BNC Connector	VOUT_AC. AC Coupled Analog Output.
J2: WV4S Header	Wave Vision 4 Serial connector (Future Use)
J3: Serial Interface Header	Serial Interface connector. Logic Input. (Refer to *Figure 3* for a pin-out diagram.)
J4: Terminal Block	VA_REMOTE. External power supply connector.

Selection Jumpers on the DAC121S101WG Evaluation Board (Refer to *Table 1* in Section 4.0 for configuration details)

JP1: VA SEL	Selects source of V_A.
JP2: Not Used	Not Used.
JP3: Output Load	Configures the output load.

A2.0 Enlarged Timing Diagram



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