AD5232 Non-Volatile Memory Digital Potentiometers Evaluation Board User Manual
Rev. G 10/7/02

7 STEPS TO SETUP THE EVALUATION BOARD

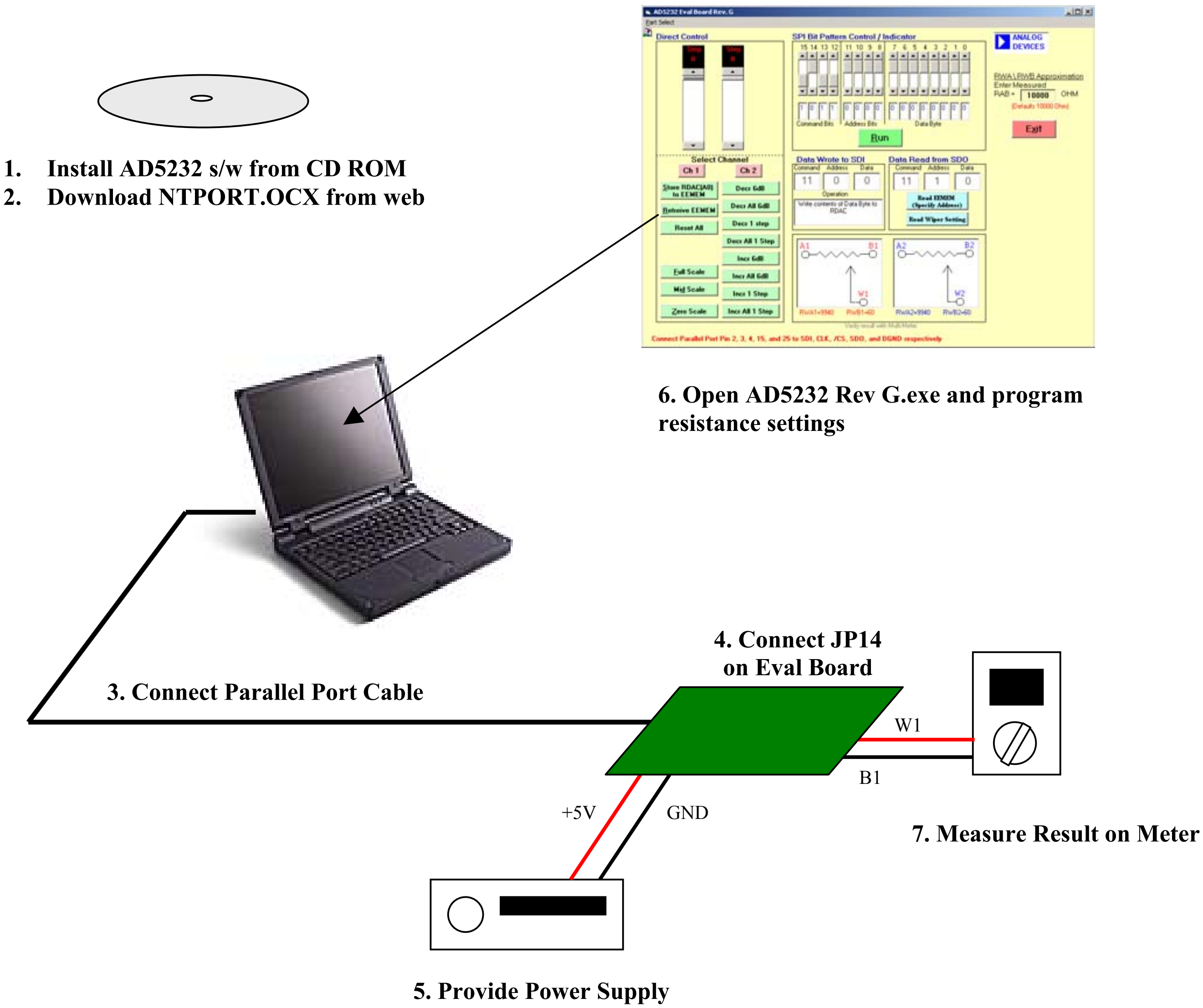


Figure 1. Evaluation Kit Setup

No Programming Skill or Programming Language Required!

ANALOG DEVICES

STEPS FOR OPERATING AD5232 EVALUATION KIT

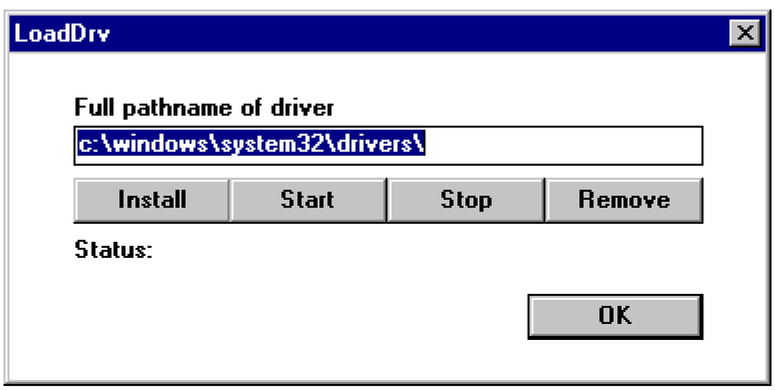
1. Installing AD5232 Rev G Evaluation Software

a. Run setup.exe under D:\AD5232 Evaluation Software Package
b. During the installation, hit ignore or yes to bypass error messages if they occur.
(Users may need to install the s/w few times to get successful installation)

2. Enabling PC Parallel Port Communications

(In addition to installing AD5232 Rev G, users need to install a 3rd party driver, NTPORT.OCX from UCT, to gain access of the PC parallel port. UCT offers a free trial of such driver)

a. Unzip ntport.zip from the CD Rom. If ntport.zip cannot be found, download it from http://www.uct.on.ca/. Click Download NTPORT.OCX, Click NTPORT free trial (user is obligated to pay a nominal license fee after 30 days free trial)
b. Save ntport.zip in default or specified directory
c. unzip and extract all to the specified directory
d. Run setup.exe
e. If it prompts file violations during installation, hit Ignore to bypass it.
f. **The following instructions are for users running Windows® 2000 and XP (For Win NT, skip and jump to step g)**
Users must ensure the file DLPORTIO.SYS is placed in Winnt\system32\drivers or Windows\system32\drivers directory.
1. Run **LOADDRV.EXE** under c:\program files\project1 or the specified directory. A dialog box will appear as



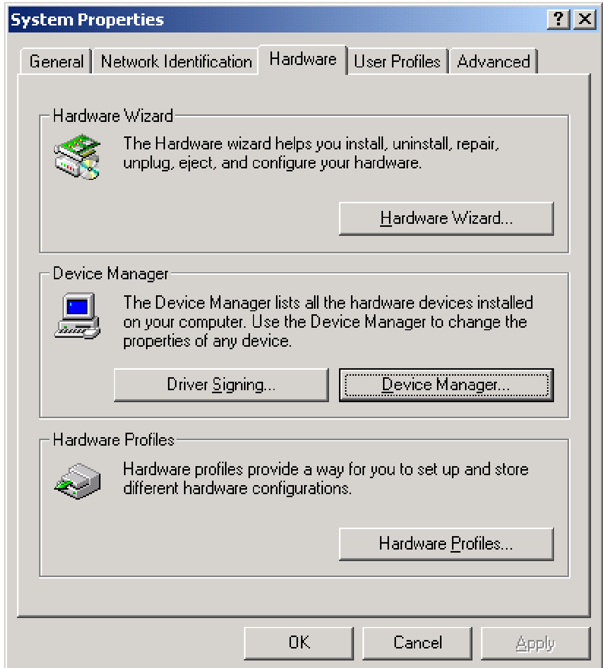
(Error Message: if windows prompts you some error messages such as 'Can't connect to service control manager', you need to contact the IS department to grant you an authority for further installation)

2. Change pathname to

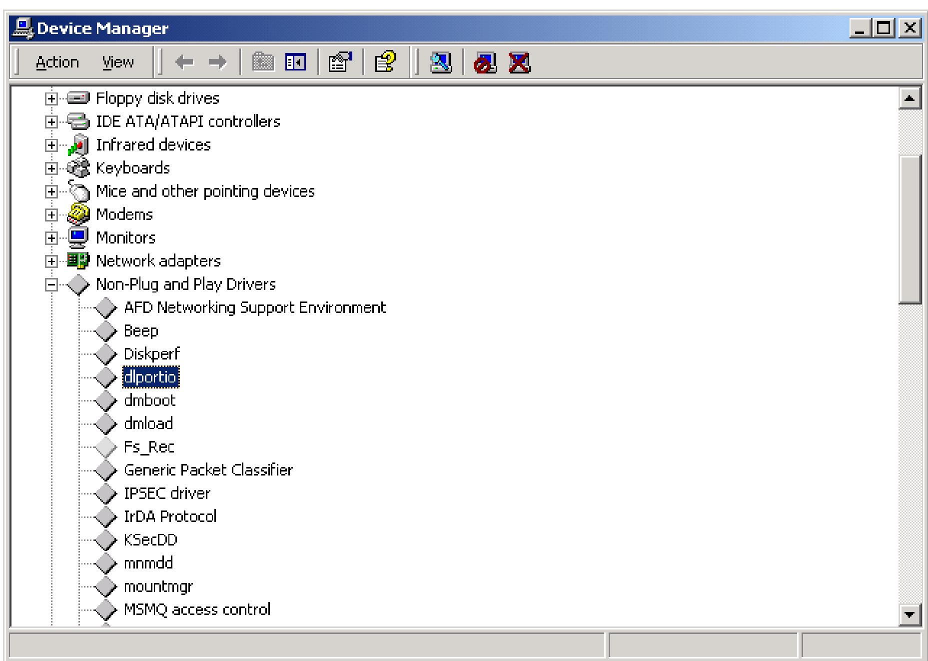
c:\winnt\system32\drivers\dlportio.sys (For Windows 2000)
c:\windows\system32\drivers\dlportio.sys (For Windows XP)

3. Hit **Install** button, then **Start** button. If the status message states successful, the driver is installed and operating. Click **OK** button.

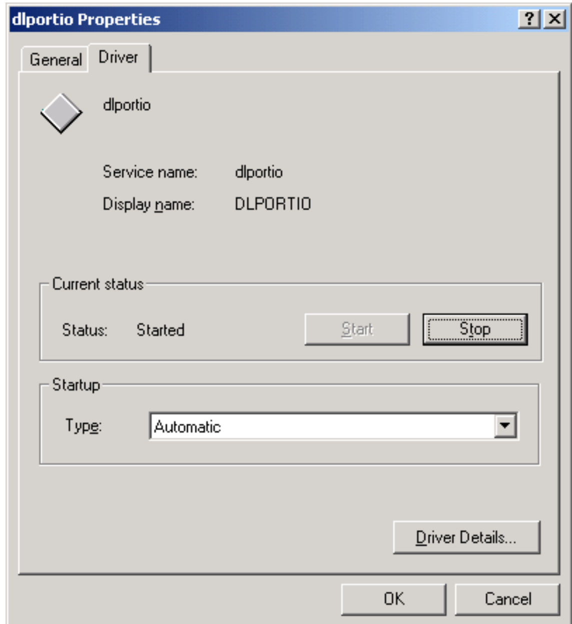
4. Go to Device Manager
(For Win 2000, go to Control Panel – Systems – Hardware – Device Manager,
For Win XP, go to System Properties – Hardware – Device Manager)



5. The "**Non-Plug and Play Divers**" entry may not be visible at first. If not, click on the **View** menu item in Device Manager and click on **View Hidden Devices** to make sure that hidden driver files are listed. Then it should be visible.
(Note: If you do not see dlportio, reboot windows or redo LOADDRV.EXE and then reboot windows.)



6. From the non-plug and play drivers list in Device Manager locate the dlportio device and double-click.



7. The dlportio properties page for the driver will be shown. At Driver tab, select Current Status as **Start** and Startup Type as **AUTOMATIC**.

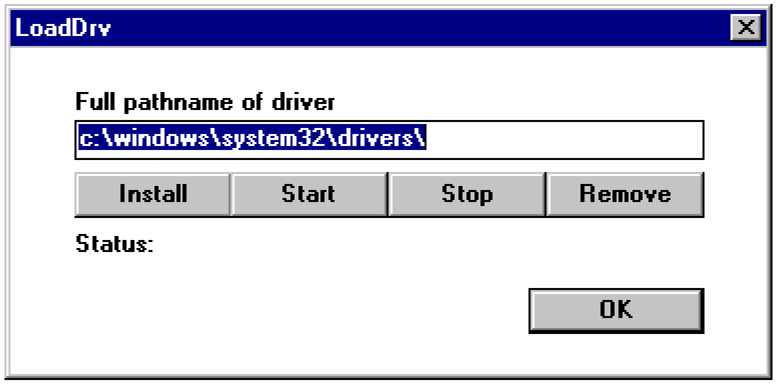
(Note: If Startup is not active and you cannot change Type, your computer may be administered by your IS department. You may need to consult them to change your PC administrative setting)

g. **The following instructions are for users running Windows NT only**

Users must ensure that the file: DLPORTIO.SYS is placed in the **Winnt\system32\drivers** directory. In order to load the **DLPORTIO.SYS** driver; use the driver loader program **LOADDVR.EXE**

1. Open c:\program files\project1\loaddrv.exe

A dialog box will be appear as



(Error Message: if windows prompts you some error messages such as 'Can't connect to service control manager', you need to contact the IS department to grant you an authority for further installation)

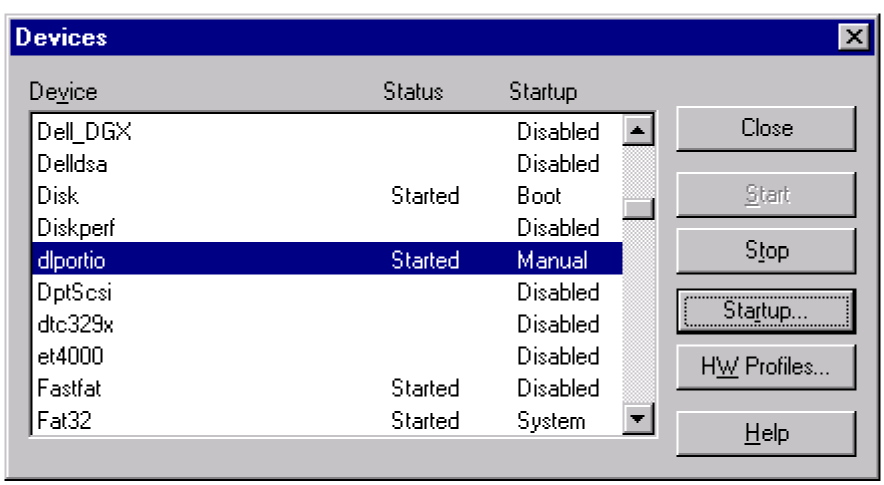
2. The pathname for DLPORTIO.SYS must be changed accordingly to the following operating systems:

c:\winnt\system32\drivers\dlportio.sys

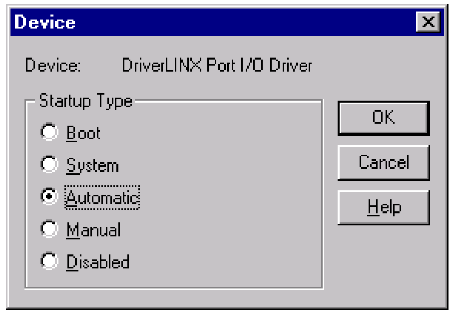
3. Hit **Install** button, then **Start** button. If the status message states successful, the driver is installed and operating. Click **OK** button.

4. Automatic Driver Loading Under Windows NT

Once the DLPORTIO.SYS driver has been installed and run on an NT system it can be made to start automatically every time NT is started. To place the driver into this mode select the **DEVICES** icon from the Windows NT **Control Panel.** From "Devices" dialog box that will appear select **dlportio** and click on the **Startup**... button



5. The device **Startup Type** dialog box will be shown as illustrated below. From the option buttons select **Automatic.** The driver will now automatically start each time that Windows NT is restarted.



Note

Due to the large variations in computer platforms and configurations, Analog Devices, Inc. cannot guarantee this software to work on all systems. Should you encounter problem, you may consult www.analogdigitalpotentiometers@analog.com or call 1-408-382-3082 for application support.

Uninstall

To uninstall AD5232 and NTPORT, use Add/Remove Programs in Control Panel

3. Connect Parallel Port Cable to LPT1

4. Evaluation Board Configuration

1. For single supply, connect JP14 and JP13 to ground Vss of U1 and U3, apply 5V to pin +5V
   (Some boards do not come with jumper caps. Users should get suitable caps or simply short the jumpers for proper operations)
2. For dual supplies, connect JP15 and JP12 to provide –2.5V to Vss of U1 and U3, apply +2.5V to pin +5V and –2.5V to pin –5V
3. The states of $\overline{PR}$, $\overline{WP}$, and RDY can be selected from the DIP switches provided.
4. SDO can be monitored TPSDO. 1k to 10kohm pull-up resistors are needed for both SDO and RDY pins.

5. Apply Power Supply according Step 4.1 and 4.2.

6. How to Use The Evaluation Board

1. Open AD5232 Rev G.exe from Windows Start - Programs - AD5232 Rev G, the program is shown in Figure 2.
2. Users can use Direct Control such as moving the scroll bars or pressing the buttons to control the devices. Users can also adjust the Bit Pattern and then hit Run to program the device. Their operations are self-explanatory.
3. User can also approximate R_{WA} and R_{WB} by first entering the measured R_{AB} after power is applied.

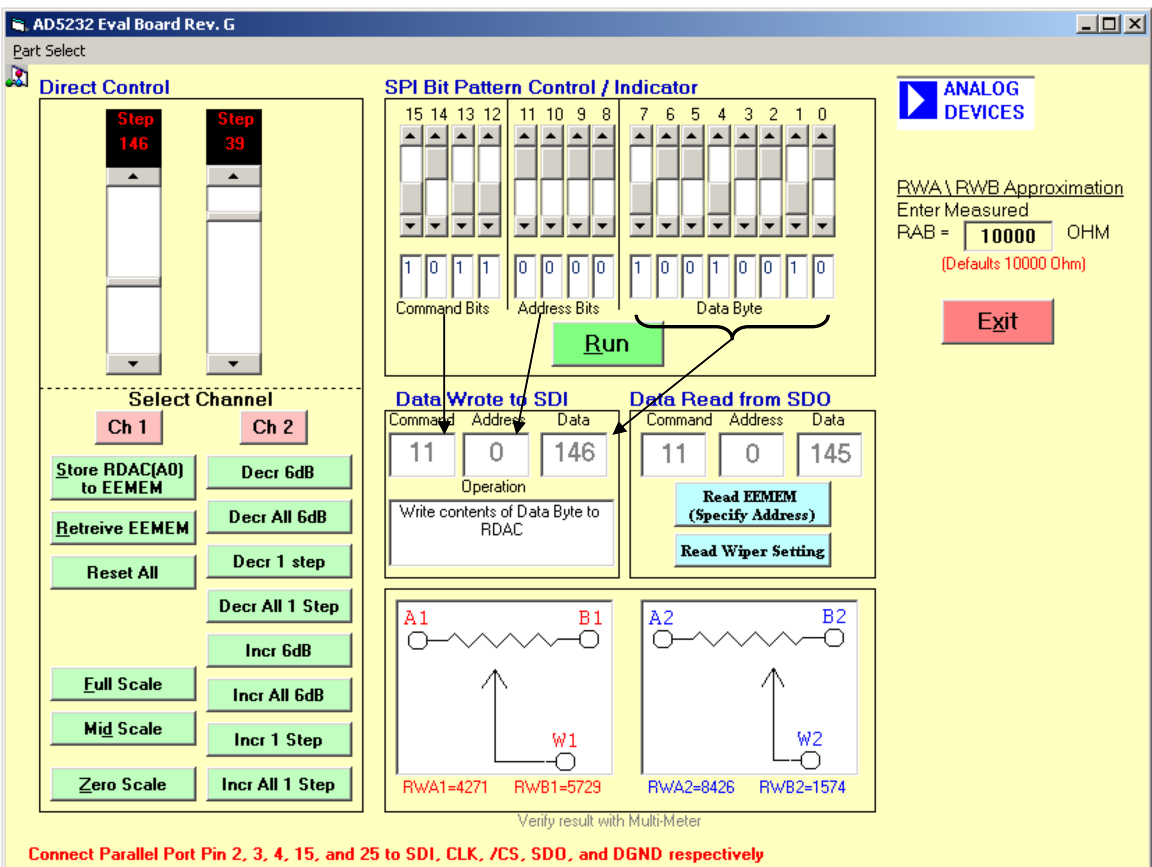


Figure 2. AD5232 Software Graphical Interface

7. Measure Result

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Evaluation Board Schematic

General purpose opamp AD820, U3A can be configured as various building block circuits in conjunction with AD5235 for various circuit evaluations, see appendix. Other opamps in P-DIP can replace AD820.
For single supply, 2.5V Voltage reference AD1582 can be used to offset opamp bias point for AC operation.

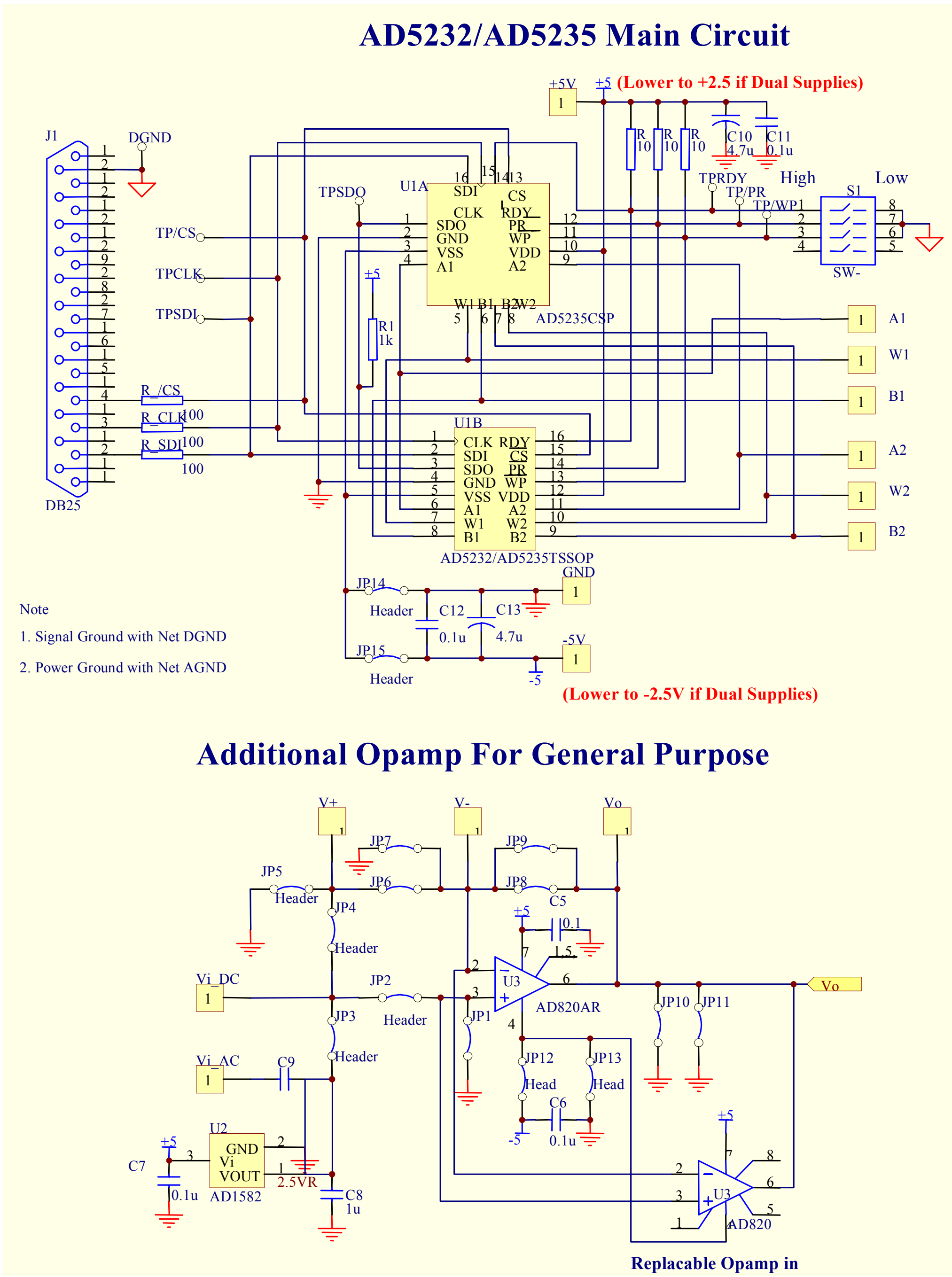

Figure 3. Evaluation Board Schematic

Note

Should you encounter problem, you may consult www.analogdigitalpotentiometers@analog.com or call 1-408-382-3082 for application support. If you are interested of the source code, you may contact alan.li@analog.com for further information.

Table 1. AD5232 16-bit Serial Data Word

MSB															LSB
C3	C2	C1	C0	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0

Command bits are identified as Cx, address bits are Ax, and data bits are Dx. Command instruction codes are defined in table 2.

Table 2. AD5232 Dual 8-bit Instruction/Operation Truth Table

Inst No.	Instruction Byte 1 B15 ••••••••••••••• B8 C3 C2 C1 C0 A3 A2 A1 A0	Data Byte 0 B7 ••••••••••••••••••• B0 D7 D6 D5 D4 D3 D3 D2 D1 D0	Operation
0	0 0 0 0 X X X X	X X X X X X X X X	NOP: Do nothing
1	0 0 0 1 << ADDR >>	X X X X X X X X X	Write contents of EEMEM to RDAC Register
2	0 0 1 0 << ADDR >>	X X X X X X X X X	SAVE WIPER SETTING: Write contents of RDAC to EEMEM
3	0 0 1 1 << ADDR >>	D7 D6 D5 D4 D3 D3 D2 D1 D0	Write contents of Serial Register Data Byte 0 to EEMEM
4	0 1 0 0 << ADDR >>	X X X X X X X X X	DEC 6dB: Right Shift contents of RDAC, LSB rolls over to MSB position
5	0 1 0 1 X X X X	X X X X X X X X X	DEC All 6dB: Right Shift contents of all RDAC Registers, LSB rolls over to MSB position
6	0 1 1 0 << ADDR >>	X X X X X X X X X	Decrement contents of RDAC by One, does not rollover at zero-scale
7	0 1 1 1 X X X X	X X X X X X X X X	Decrement contents of all RDAC Registers by One, does not rollover at zero-scale
8	1 0 0 0 0 0 0 0	X X X X X X X X X	RESET: Load all RDACs with their corresponding EEMEM previously-saved values
9	1 0 0 1 << ADDR >>	X X X X X X X X X	Write contents of EEMEM to Serial Register Data Byte 0. SDO activated
10	1 0 1 0 << ADDR >>	X X X X X X X X X	Write contents of RDAC to Serial Register Data Byte 0. SDO activated
11	1 0 1 1 << ADDR >>	D7 D6 D5 D4 D3 D3 D2 D1 D0	Write contents of Serial Register Data Byte 0 to RDAC
12	1 1 0 0 << ADDR >>	X X X X X X X X X	INC 6dB: Left Shift contents of RDAC, stops at all ones
13	1 1 0 1 X X X X	X X X X X X X X X	INC All 6dB: Left Shift contents of all RDAC Registers, stops at all ones
14	1 1 1 0 << ADDR >>	X X X X X X X X X	Increment contents of RDAC by One, does not rollover at full-scale
15	1 1 1 1 X X X X	X X X X X X X X X	Increment contents of all RDAC Registers by One, does not rollover at full-scale

NOTES:

1. The SDO output shifts-out the last 16-bits of data clocked into the serial register for daisy chain operation. Exception, following Instruction #9 or #10 the selected internal register data will be present in data byte 0 & 1. Instructions following #9 & #10 must be a full 24-bit data word to completely clock out the contents of the serial register.
2. The RDAC register is a volatile scratch pad register that is refreshed at power ON from the corresponding non-volatile EEMEM register.
3. The increment, decrement and shift commands ignore the contents of the shift register Data Byte 0.
4. Execution of the Operation column noted in the table takes place when the $\overline{CS}$ strobe returns to logic high.

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APPLICATION PROGRAMMING EXAMPLES

The following command sequence examples have been developed to illustrate a typical sequence of events for the various features of the AD5232 nonvolatile digital potentiometer. [PCB = Printed Circuit Board containing the AD523X part]. Instruction numbers (Commands), addresses and data appearing at SDI and SDO pins are listed in hexadecimal.

SDI	SDO	Action
$B140_H$	$XXXX_H$	Loads 40_H data into RDAC2 register, Wiper W2 moves to 1/4 full-scale position
$B080_H$	$B140_H$	Loads 80_H data into RDAC1 register, Wiper W1 moves to 1/2 full-scale position

Table 3. Set two digital POTs to independent data values

SDI	SDO	Action
$B040_H$	$XXXX_H$	Loads 40_H data into RDAC1 register, Wiper W1 moves to 1/4 full-scale position
$E0XX_H$	$B040_H$	Increments RDAC1 register by one to 41_H, Wiper W1 moves one resistor segment away from terminal B.
$E0XX_H$	$E0XX_H$	Increments RDAC1 register by one to 42_H, Wiper W1 moves one more resistor segment away from terminal B.
Continue until desired wiper position reached		
$20XX_H$	$E0XX_H$	Saves RDAC1 register data into corresponding nonvolatile EEMEM1 memory ADDR=0_H

Table 4. Active trimming of one POT followed by a save to nonvolatile memory (PCB calibrate)

PCB setting: Tie WP to GND [prevents changes in PCB wiper set position] Power V_{DD} & V_{SS} with respect to GND Optional: Strobe PR pin [insures full power ON preset of wiper register with EEMEM contents in unpredictable supply sequencing environments]

Table 5 Equipment customer startup sequence for a PCB calibrated unit with protected settings

SDI	SDO	Action
$C1XX_H$	$XXXX_H$	Moves wiper W2 to double the present data value contained in RDAC2 register, in the direction of the A terminal
$C1XX_H$	$XXXX_H$	Moves wiper W2 to double the present data value contained in RDAC2 register, in the direction of the A terminal

Table 6. Using Left shift by one to change circuit gain in 6dB steps

SDI	SDO	Action
3280_H	$XXXX_H$	Stores 80_H data into spare EEMEM location USER1
3340_H	$XXXX_H$	Stores 40_H data into spare EEMEM location USER2

Table 7. Storing additional data in nonvolatile memory

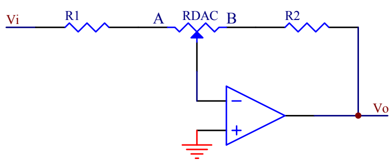
SDI	SDO	Action
$94XX_H$	$XXXX_H$	Prepares data read from USER3 location. Assumption USER3 previously loaded with 80_H
$00XX_H$	$XX80_H$	NOP instruction #0 sends 16-bit word out of SDO where the last 8 bits contain the contents of USER3 location. NOP command insures device returns to idle power dissipation state.

Table 8. Reading back data from various memory locations

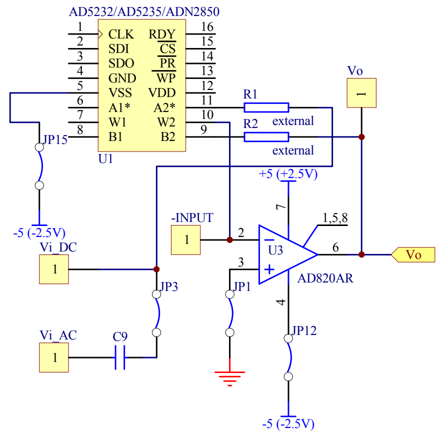
APPENDIX

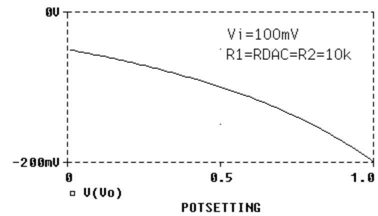
APPLICATIONS

Inverting Gain & Attentuator

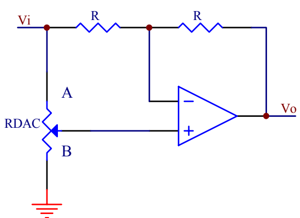


- R2/(R1+RAB)*Vi < Vo < -(R2+RAB)/R1*Vi

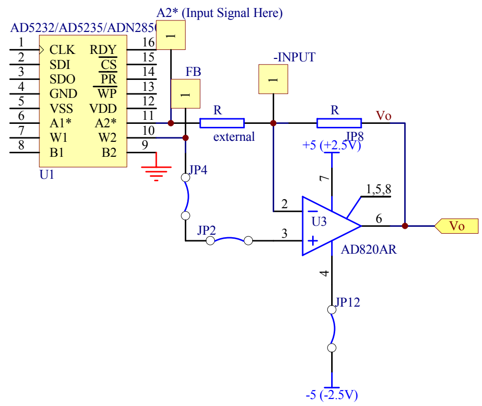


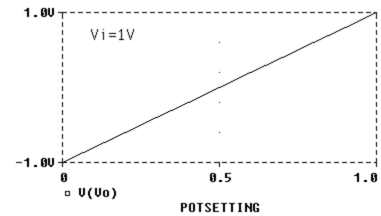


Bipolar Unity Gain Amplifier

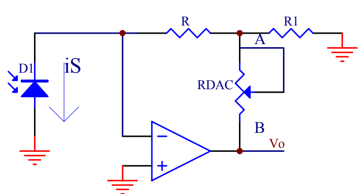


-1 < Vo/Vi < 1



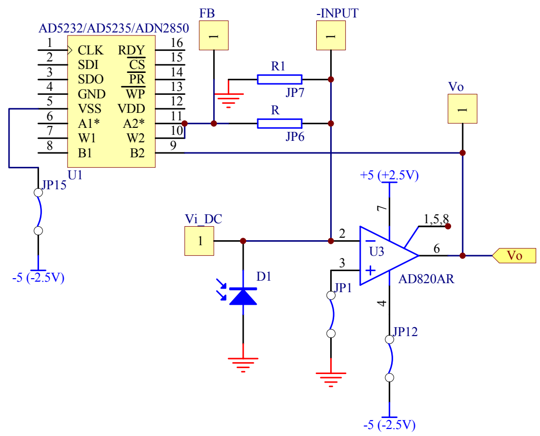


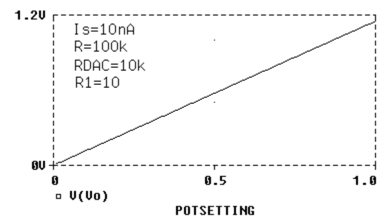
High Sensitivity I-V Converter



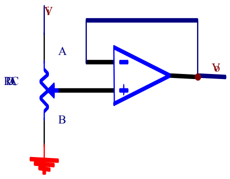
Vo = -k*R*iS

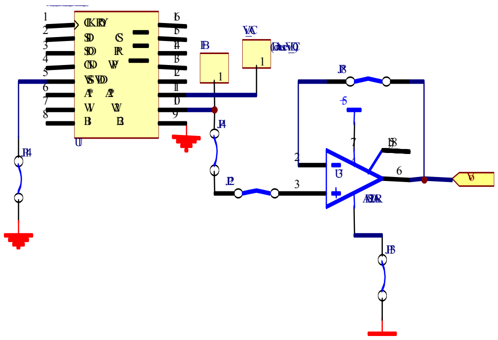
k = 1 + RWB/R1 + RWB/R

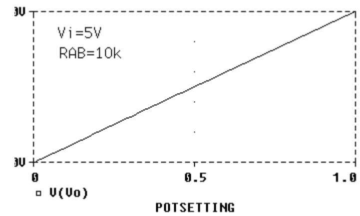




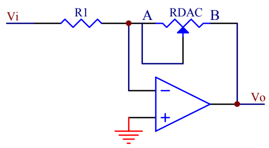
Buffered Voltage Output

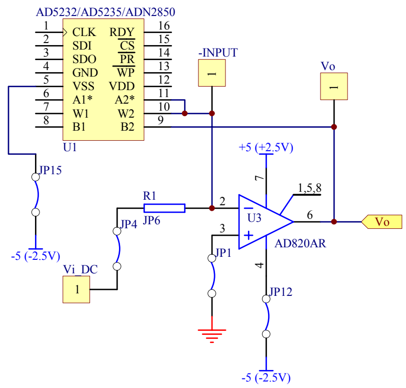


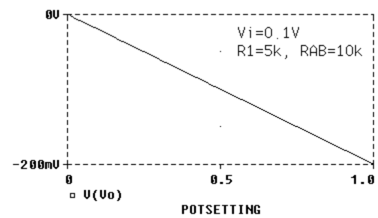




Inverting Linear Gain & Attentuator



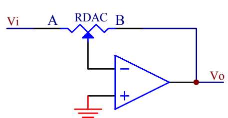


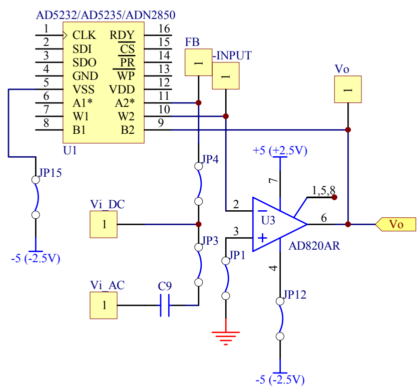


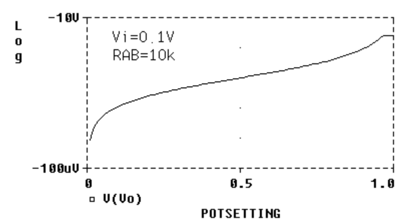
G = - RWB/R1

Vo=-Vi*(D*RAB)/(2^n*R1)

Inverting Quasi Log Gain & Attentuator



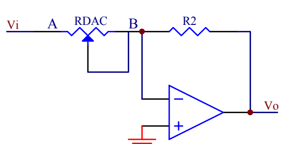


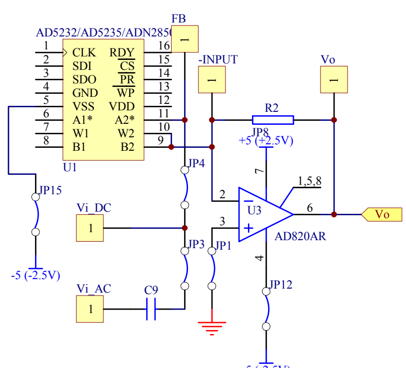


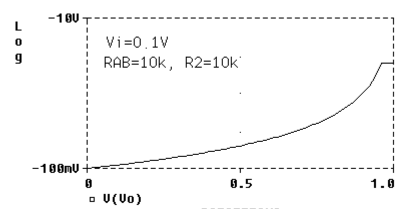
G = - RWB/RWA

Vo=-Vi*(D/2^n-1)

Inverting Exponential Gain & Attentuator



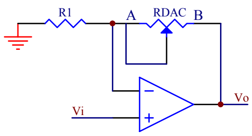


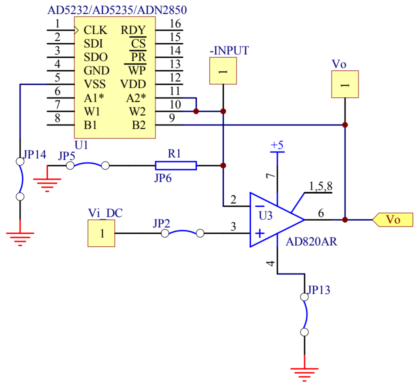


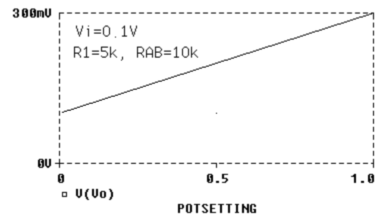
G = - R2/RWA

Vo=-Vi*(2^n*R2)/((2^n-D)*RAB)

Non-Inverting Linear Gain



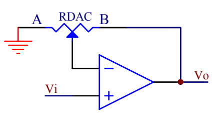


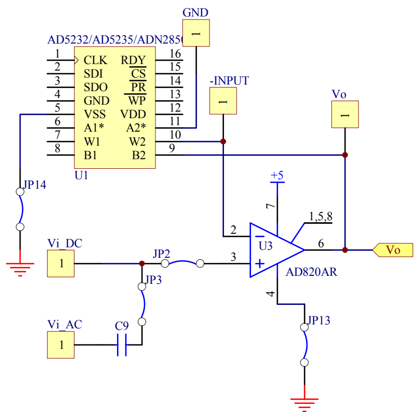


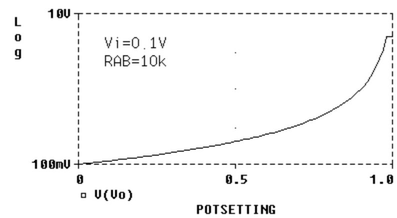
G = 1 + RWB/R1

Vo=Vi*(1+D*RAB/(2^nR1))

Non-Inverting Quasi Log Gain



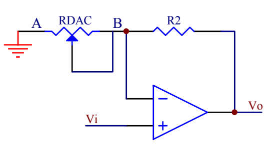


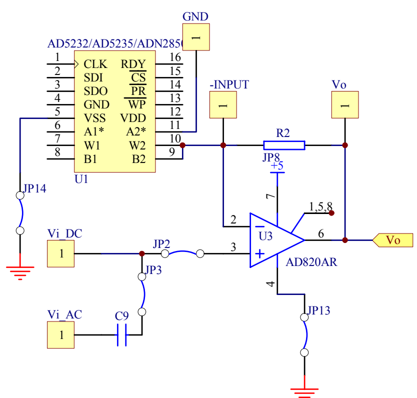


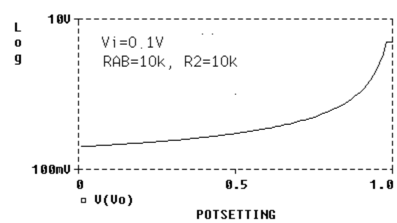
G = 1 + RWB/RWA

Vo=Vi*(1+D/(2^n-D))

Non-Inverting Exponential Gain



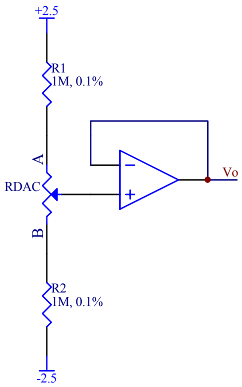


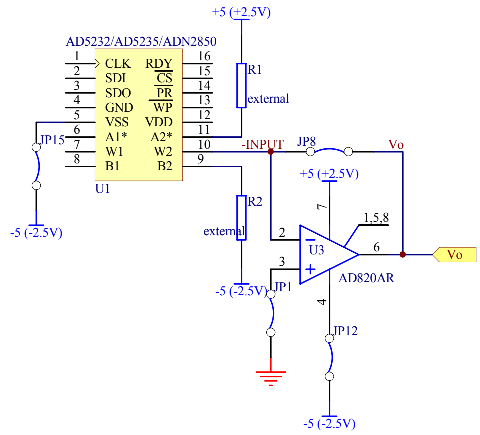


G = 1 + R2/RWA

Vo=Vi*(1+2^nR2/((2^n-D)RAB))

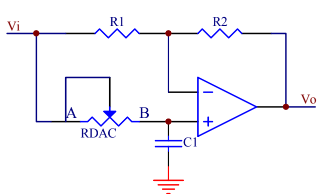
Ultra Fine Adjustment

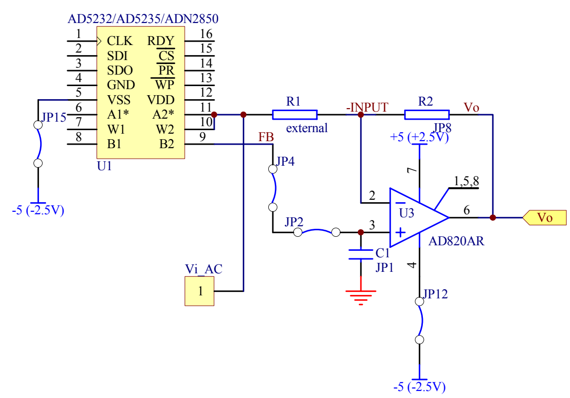


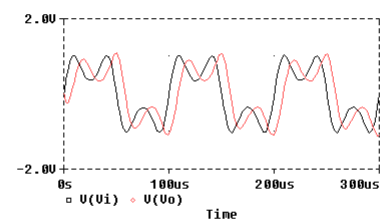


VW = V+*(RWB/(R2+RAB) -V-*(RWA/(R1+RAB))

Phase Shifter

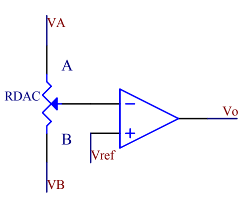


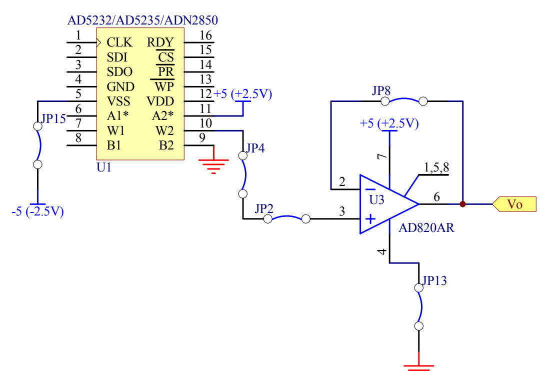


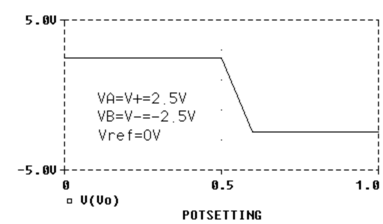


G = 180 - 2tan^-1wRC

Level Detector







PCB LAYOUT

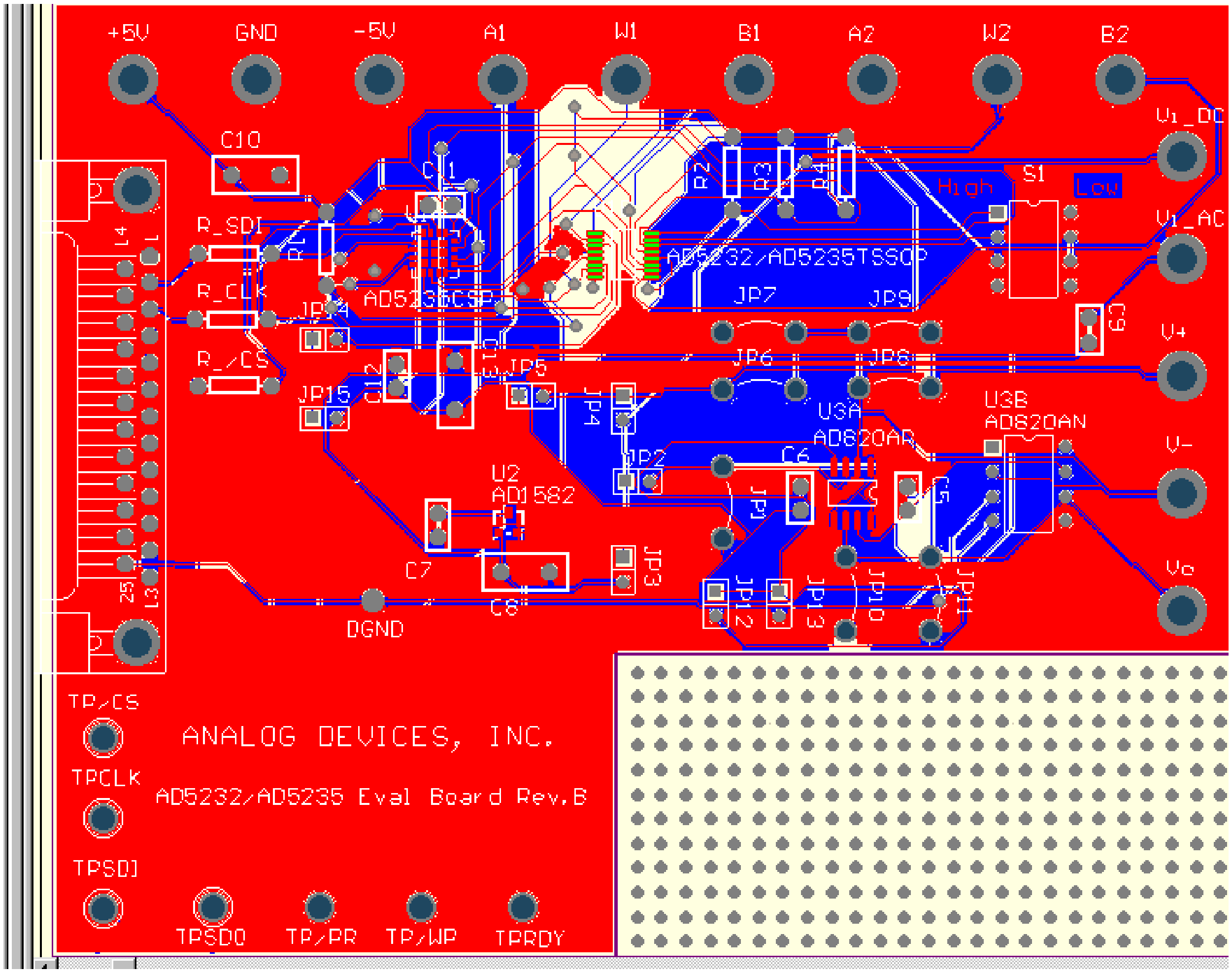
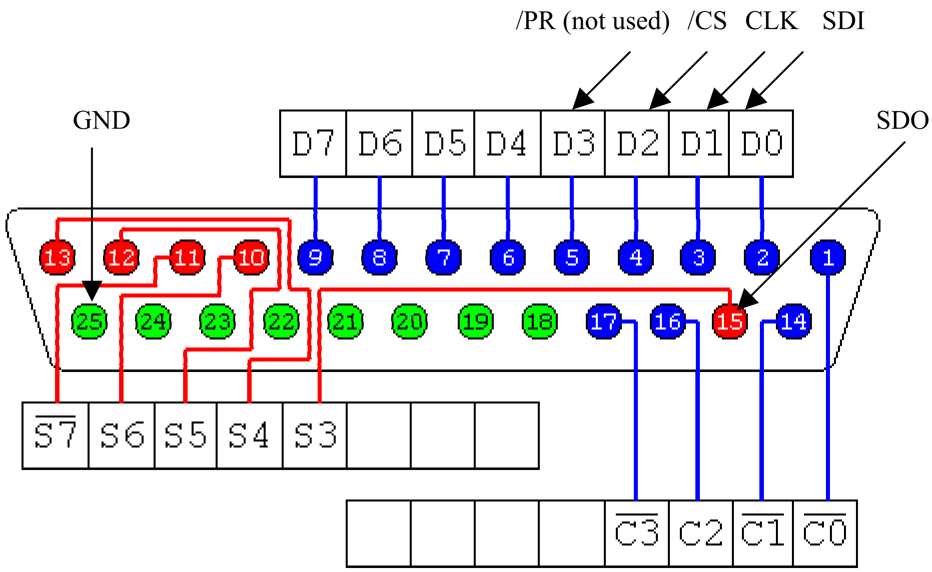


Figure 4. Evaluation Board Layout

PCB LAYOUT CONSIDERATION

To stabilize voltage supplies, bypassed +5V and –5V with a 4.7u or 10uF capacitor with proper polarities. Add 0.1uF decoupling capacitors, very close to the supply pins of active component, can minimize high frequency noise as well.

AD5232 Parallel Port Connection (For Visual Basic Program Developer Only. Users Can Ignore)



http://www.doc.ic.ac.uk/~ih/doc/par/

8 output pins accessed via the **DATA Port** (NTPORT1.Address = 888)
5 input pins (one inverted) accessed via the **STATUS Port** 4 (NTPORT1.Address = 889)
output pins (three inverted) accessed via the **CONTROL Port** (NTPORT1.Address = 890)
The remaining 8 pins are grounded

TIMING DEFINATION IN VISUAL BASIC SOURCE CODE cmdRUN

(For Visual Basic Program Developer Only. Users Can Ignore)