Evaluation Board for AD7877 Touch Screen Controller

EVAL-AD7877*

AD7877 FEATURES
4-Wire Touch Screen Interface
LCD Noise Reduction Feature (STOPACQ Pin)
On-Chip Temperature Sensor: –40°C to +85°C
On-Chip 2.5 V Reference
On-Chip 8-Bit DAC
Three Auxiliary Analog Inputs
One Dedicated and Three Optional GPIOs
Two Direct Battery Measurement Channels
 (0.5 V to 5 V)
Three Interrupt Outputs
Automatic Conversion Sequencer and Timer
Touch-Pressure Measurement
Wake Up on Touch Function
Specified Throughput Rate of 125 kSPS
Single Supply, V_{CC} of 2.7 V to 5.25 V
ESD Protection on All Analog Pins
Shutdown Mode: 1 μA Max

APPLICATIONS
Personal Digital Assistants
Smart Hand-Held Devices
Touch-Screen Monitors
Point-of-Sales Terminals
Pagers

GENERAL DESCRIPTION
The AD7877 is a 12-bit successive approximation ADC with a synchronous serial interface and low on resistance switches for driving touch screens. The AD7877 operates from a single 2.7 V to 5.25 V power supply (functional operation to 2.2 V) and features throughput rates of 125 kSPS.

The AD7877 features direct battery measurement on two inputs, temperature measurement, and touch-pressure measurement. The AD7877 also has an on-board reference of 2.5 V. When not in use, it can be shutdown to conserve power. An external reference can also be applied and can be varied from 1 V to $+V_{CC}$, while the analog input range is from 0 V to V_{REF}. The device includes a shutdown mode that reduces the current consumption to less than 1 μA.

To reduce the effects of noise from LCDs, the acquisition phase of the on-board ADC may be controlled via the STOPACQ pin. There is also an on-board DAC for LCD backlight or contrast control. The AD7877 can run in either a slave or master mode, using a conversion sequencer and timer. It is ideal for battery-powered systems, such as personal digital assistants with resistive touch screens and other portable equipment. The part is available in a 32-lead LFCSP.

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EVALUATION SYSTEM PACKAGE CONTENTS
The evaluation system contains the following items:

- The EVAL-AD7877 Evaluation Board
- USB Cable
- Evaluation Software
- MicroTouch™ Touch Screen
- Stylus

EVALUATION BOARD DESCRIPTION
The user can use this evaluation board to fully investigate all features of the AD7877 touch screen controller.

The AD7877 evaluation board plugs directly into the USB port on a standard PC. An on-board USB controller IC interfaces directly to the AD7877 and gives the evaluation software full control of the AD7877 registers. A MicroTouch touch screen is included in this evaluation kit and can be plugged directly into the AD7877 evaluation board.

This evaluation board contains the following main components that can be identified from the block diagram in Figure 1. The printed circuit board (PCB) schematic and silk screen are shown in Figures 12 through 14.

- AD7877 IC
- USB Microcontroller IC CY7C68013
- LED indicators for power, $\overline{PENIRQ}$, $\overline{ALERT}$, and $\overline{THERM}$
- EEPROM for USB initialization information
- Connector for USB interface
- Connector for touch screen
- Sub-BNC connectors for the following signals: BAT1, BAT2, AUX1/GPIO1, AUX2/GPIO2, AUX3/GPIO3, STOPACQ, GPIO4, and A_{OUT}
- Screw-top connectors for the following signals: V_{CC}, GND, X+, Y+, X–, Y–, V_{REF}, and V_{DRIVE}
- Test points for the following signals: DOUT, DIN, DCLK, $\overline{CS}$, $\overline{DAV}$, $\overline{PENIRQ}$, and A_{OUT}
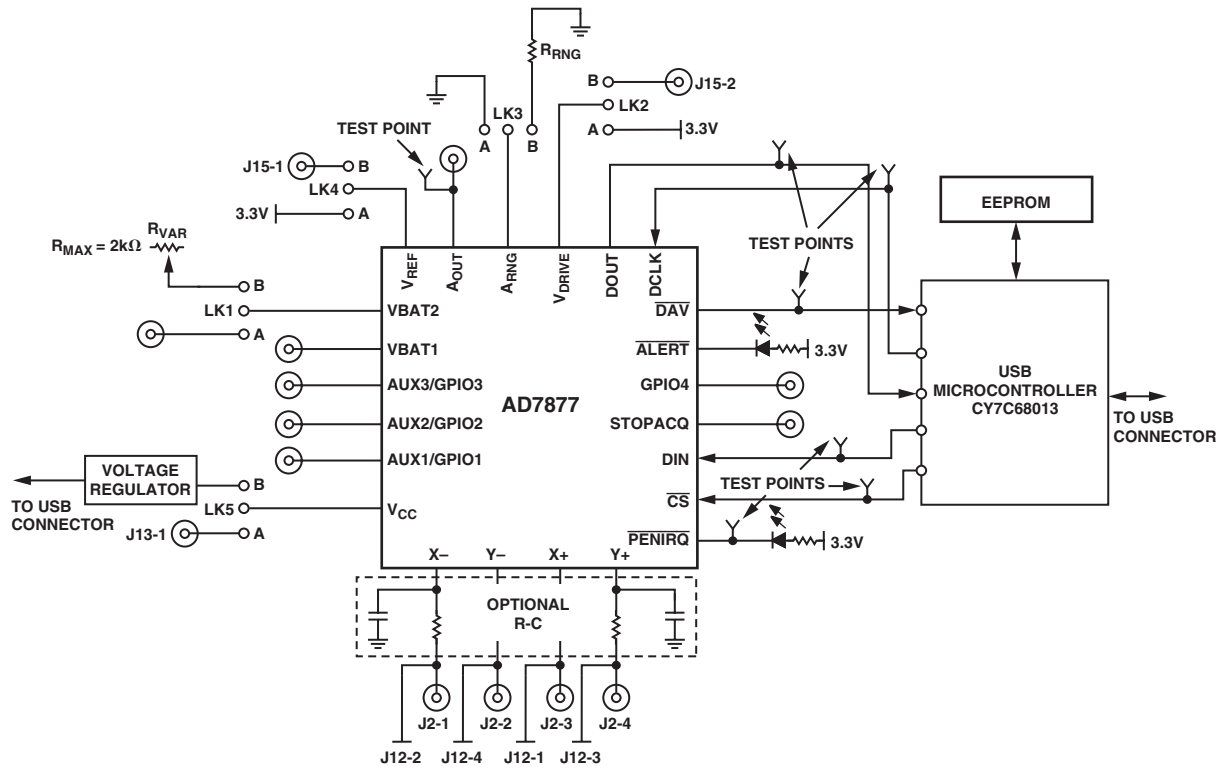
Figure 1. AD7877 Evaluation Board Block Diagram

CONNECTOR FUNCTION DESCRIPTIONS

Number	Name	Description
J15	V_{REF} and V_{DRIVE}	These screw-top connectors can be used to supply V_{REF} and V_{DRIVE} to the AD7877. To supply an external V_{REF}, Link 4 should be in the B position, and the signal applied to J15-1. To supply an external V_{DRIVE}, Link 2 should be in the B position, and the signal applied to J15-2.
J14	USB Interface	The USB cable should be plugged directly from the PC into this connector. It is a type B USB socket.
J13	Power	Power can be supplied to the board either via the USB cable or via the power connector J13. If Link 5 is in Position B, power is supplied via the USB cable. If Link 5 is in Position A, power is supplied from the J13 connector.
J12	Touch Screen	The MicroTouch touch screen included with the demonstration kit can be connected directly into the AD7877 demonstration board using this connector. Connections are as follows: X+ to J12-1, X– to J12-2, Y+ to J12-3, and Y– to J12-4.
J11	A_{OUT}	This subminiature BNC socket can be used to access the A_{OUT} output signal from the AD7877.
J10	USB IC Interface	The USB controller IC has an I^2C interface that can be accessed using this connector. SDA is available on J10-1, SCL is available on J10-2, GND is available on J10-3, and 3.3 V is available on J10-4.
J9	STOPACQ	This subminiature BNC socket can be used to apply a signal to the STOPACQ input on the AD7877. If Link 6 is in Position B, the signal applied to J9 goes directly to the STOPACQ pin. If Link 6 is in Position A, STOPACQ is tied to GND.
J8	GPIO4	This subminiature BNC socket can be used to apply a signal to the GPIO4 input on the AD7877.
J7	AUX1/GPIO1	This subminiature BNC socket can be used to apply a signal to the AUX1/GPIO1 input on the AD7877.
J6	AUX2/GPIO2	This subminiature BNC socket can be used to apply a signal to the AUX2/GPIO2 input on the AD7877.

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Number	Name	Description
J5	AUX3/GPIO3	This subminiature BNC socket can be used to apply a signal to the AUX3/GPIO3 input on the AD7877.
J4	BAT1	This subminiature BNC socket can be used to apply a signal to the BAT1 input on the AD7877.
J3	BAT2	This subminiature BNC socket can be used to apply a signal to the BAT2 input on the AD7877. Link 1 must be in the A position for this connector to be linked to the AD7877.
J2	Touch Screen	This connector can be used to connect a touch screen to the AD7877 and should be connected as follows: J2-1 to X–, J2-2 to Y–, J2-3 to X+, and J2-4 to Y+.

LINK FUNCTION DESCRIPTIONS

Number	Name	Description
LK1	BAT2 Input	This jumper selects the input signal to the BAT2 input of the AD7877. If the jumper is in Position A, BAT2 is connected to Connector J3. An input voltage signal can then be applied to J3. If the link is in Position B, BAT2 is connected to a variable resistor, R1. The user can vary R1 to change the input voltage on BAT2. The maximum resistance of R1 is 2 kΩ.
LK2	V_{DRIVE} Input	This jumper selects the input signal to the V_{DRIVE} input of the AD7877. If the jumper is in Position A, 3.3 V is connected to V_{DRIVE}. If the jumper is in Position B, Connector J15-2 is connected to V_{DRIVE}.
LK3	A_{RNG}	If this jumper is in Position A, A_{RNG} on the AD7877 is connected to GND. When the DAC on the AD7877 is in voltage mode, the link should be in this position.
		If the jumper is in Position B, A_{RNG} is connected through Resistor R9 to GND. When the DAC on the AD7877 is in current mode, the link should be in this position. Resistor R9 sets the output range for the DAC in current mode.
LK4	V_{REF} Input	This jumper selects the input signal to the V_{REF} input of the AD7877. If the jumper is in Position A, 3.3 V is connected to V_{REF}. If the jumper is in Position B, Connector J15-1 is connected to V_{REF}. If the internal reference is used, the jumper must be either left open or in Position B with J15-1 left floating.
LK5	Input Power	This jumper selects the input power for the evaluation board. If the jumper is in Position A, power for the board must be supplied through Connector J13. If the link is in Position B, the USB connection supplies the power for the board.
LK6	STOPACQ Input	This jumper selects the input signal to the STOPACQ pin. If the jumper is in Position A, the pin is tied to GND. If the link is in Position B, it is connected to J9. STOPACQ should not be left floating at any time; either a signal should be applied to J9 or the pin tied.

INDICATOR LED FUNCTION DESCRIPTIONS

Number	Name	Description
D1	$\overline{PENIRQ}$ Green	This LED indicates when lit that the $\overline{PENIRQ}$ interrupt on the AD7877 is active.
D2	$\overline{DAV}$ Green	This LED indicates when lit that the $\overline{DAV}$ interrupt on the AD7877 is active.
D3	Power Green	This LED indicates when lit that the evaluation board is powered.

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AD7877 DEMONSTRATION BOARD HARDWARE SETUP

The USB cable should be connected from the user's PC to the board via the Connector J14. The links should be in the following positions.

Link Number	Position
LK1	B
LK2	A
LK3	A
LK4	B
LK5	B
LK6	A

AD7877 EVALUATION SOFTWARE

The software allows the AD7877's functions to be controlled from the PC via an easy-to-use interface operating under the Windows® environment. The contents of the device's internal registers can be read easily or altered through a user-friendly graphics interface, all measured signals can be graphed on-screen, and the touch screen coordinates can be plotted on a dedicated screen.

INSTALLING THE SOFTWARE

To install the software, insert the CD-ROM with the program software into CD-ROM drive. The CD-ROM should auto-run and start installing the software. If this does not happen, click on the Start icon, then on the Run icon, and then type D:setup.exe as the file name. If the CD-ROM drive is not drive D, then type X instead of D, where X is the drive letter of the CD-ROM drive. To finish installing the software, follow the on screen instructions.

RUNNING THE SOFTWARE

When using the software, first ensure the evaluation board is connected to the PC via the USB cable. To run the software, select Start/Programs/Analog Devices/AD7877 Eval Software. When the program is started, the About screen, shown in Figure 2, is displayed.

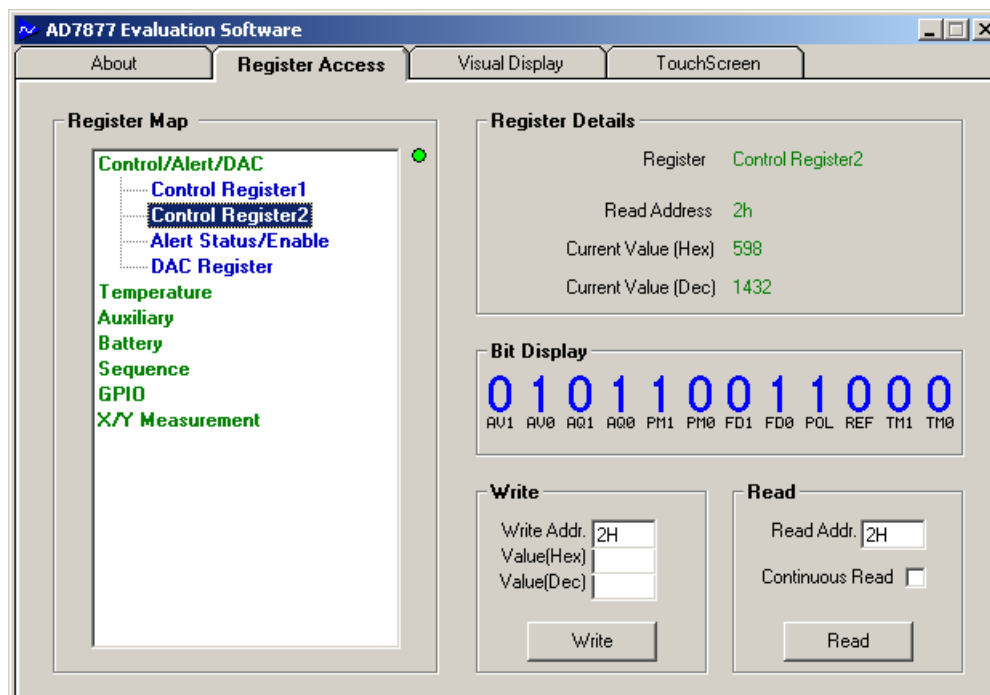

Figure 2. Evaluation Software about Screen

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Figure 3. AD7877 Register Access Screen

REGISTER ACCESS SCREEN
To read and write to the AD7877 registers, click on the Register Access tab. The screen in Figure 3 is displayed. If the dot is green to the right of the register map, this signifies that the USB connection between the PC and the board is active. If this dot is red, the connection is not functional. In this situation, the user should check that the USB port on their PC is configured correctly and that the evaluation board is connected via the USB connector to the PC.

Reading and Writing to the Registers
The register access screen gives access to all the registers on the AD7877. A map of the AD7877's registers is given on the left-hand side of the screen. Details of the current selected register appear on the right-hand side of the screen. The user can read or write to the registers by supplying values in either hex or decimal and then clicking on the Read or Write buttons. The user may also write to the register by clicking on a bit in the Bit Display section. Clicking on a bit will invert that bit's value in the relevant AD7877 register.

Selecting a Register
By double-clicking on any heading in the register map section, a full list of registers relevant to that heading are displayed. Under the Control/Alert/DAC heading, the following registers may be accessed: Control Register1, Control Register2, Alert/Status Enable, and the DAC register.

Under the Temperature heading, the following registers may be accessed: Temp1 (single ended), Temp2 (differential), Temp1 High Limit, and Temp1 Low Limit. The result of clicking on the Temperature heading is shown in Figure 4. The TEMP2 register is selected in this example. The Temp1 reading is calibrated automatically by the evaluation software, using the Temp2 reading.

Under the Auxiliary heading, the following registers may be accessed: AUX1, AUX2, AUX3, AUX1 High Limit, and AUX1 Low Limit.

Under the Battery heading, the following registers may be accessed: BAT1, BAT2, BAT1 High Limit, BAT1 Low Limit, BAT2 High Limit, and BAT2 Low Limit.

Under the Sequence heading, the two sequencer registers, Sequencer Register 1 and Sequencer Register 2, can be accessed.

The GPIO registers can be found under the GPIO heading; GPIO Control Register 1, GPIO Control Register 1, and GPIO Data Register.

The touch screen inputs can be accessed under the X/Y Measurement heading. The X+, Y+, Y− (Z2) and X+ (Z1) registers are found here. Figure 5 shows how to access the Y+ register.
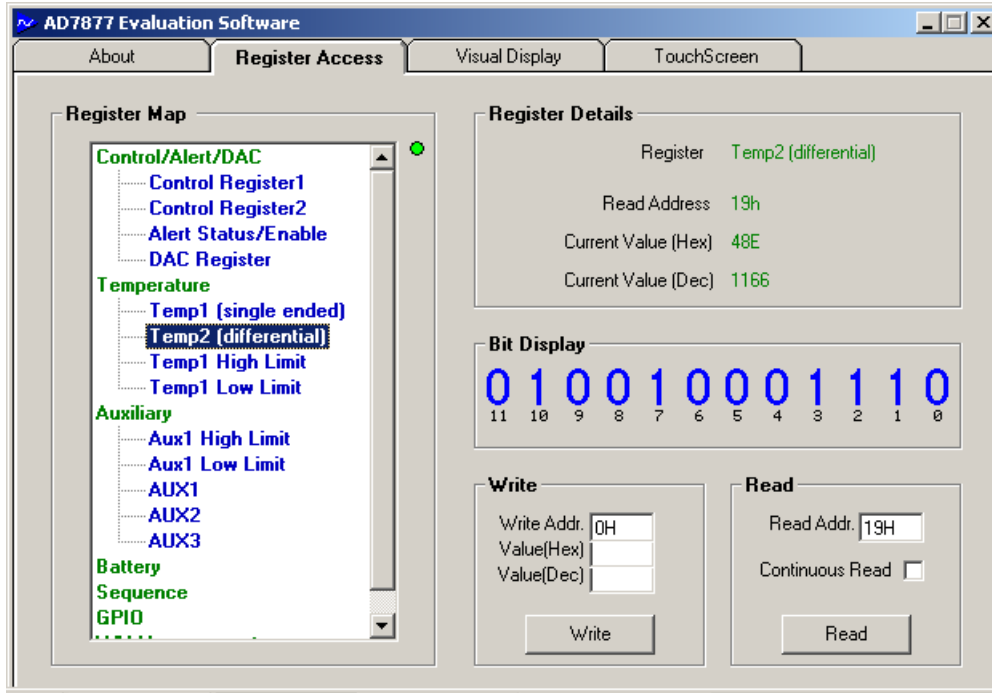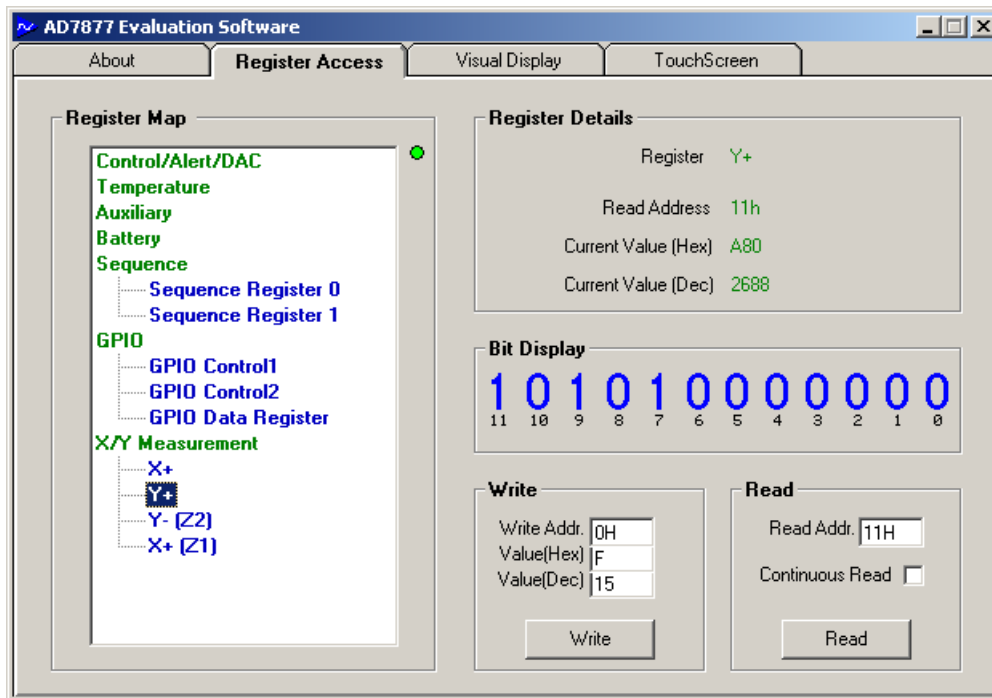
Figure 4. Accessing the TEMP2 Register

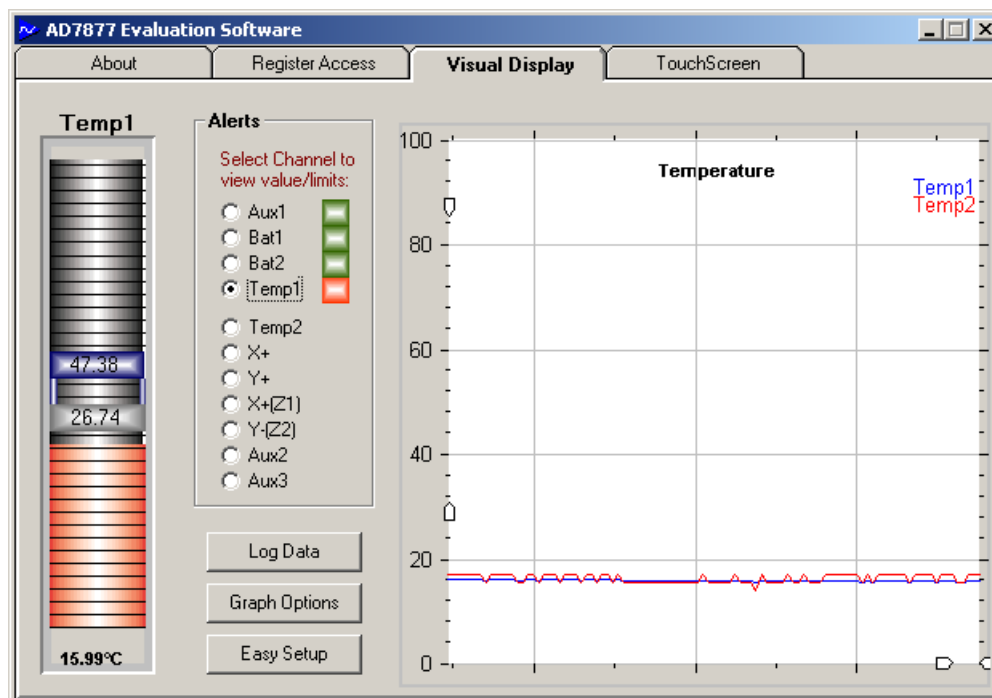Figure 5. Accessing the Y+ Register

Figure 6. Visual Display Screen

VISUAL DISPLAY SCREEN

Clicking on the Visual Display tab will bring the user to the screen shown in Figure 6. Values measured by the AD7877 can be graphed on this screen.

Selecting a Channel Measurement to Display

To select the measurement to be graphed, select one of the channels from the list. The selected channel value will be displayed on the left of the screen, along with the channel high and low limits, if there are any. The limits may be changed by dragging the limit bars up or down. The new limits are automatically written to the relevant AD7877 registers by the evaluation software.

The AUX1, BAT1, BAT2, and Temp1 channels all have upper and lower limits. Also displayed next to these channels in the list is an ALERT button. If the button is green, the channel's measured value is within its limits. If the button is red, the channel's measured value is outside its limits and is causing the $\overline{\text{ALERT}}$ interrupt to assert.

In Figure 6, the Temp1 measurement is selected. The bar graph shows the value in the Temp1 register. The upper limit in Figure 6 is set to 47.38°C, while the lower limit is set to 26.74°C. These limits can be changed by clicking and dragging on the limit bars. In Figure 6, the temperature breaches the lower temperature limit and so an $\overline{\text{ALERT}}$ interrupt is triggered. The $\overline{\text{ALERT}}$ interrupt indicator button long side Temp1 has changed from green to red to reflect this.

Graphing a Measurement

On the right of the Visual Display screen is a graphing area. What is graphed here depends on which channel is selected. If any of the following is the selected channel, then all are graphed in the graphing area: AUX1, AUX2, AUX3, BAT1, and BAT2. If any of the touch screen measurement channels (X+, Y+, Y−, or Z1) are selected, then all four channels are graphed. If either of the temperature measurement channels is selected, then both channels are displayed in the graphing area. Graphing more than one channel at a time makes it easy for the user to compare and contrast channel measurements.

In Figure 7, the Y+ measurement is selected. In the graphing window, the four touch screen measurements are graphed.
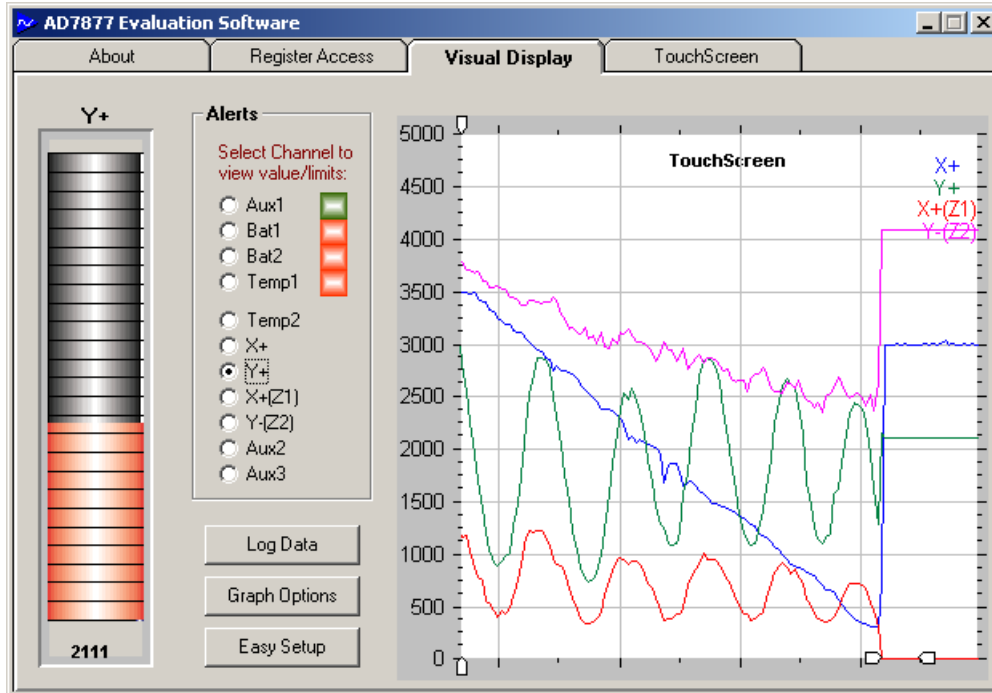
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Figure 7. Visual Display Screen: Touch Screen Coordinates

Log Data

Clicking on the Log Data button opens the window in Figure 8. The user can choose the data to be logged to an Excel file by clicking the relevant boxes. The voltage measurements, the touch screen inputs, and the temperature results can all be logged to a file. The interval at which data is logged can also be chosen. On pressing the OK button, the user can open an Excel file, where the data is logged.
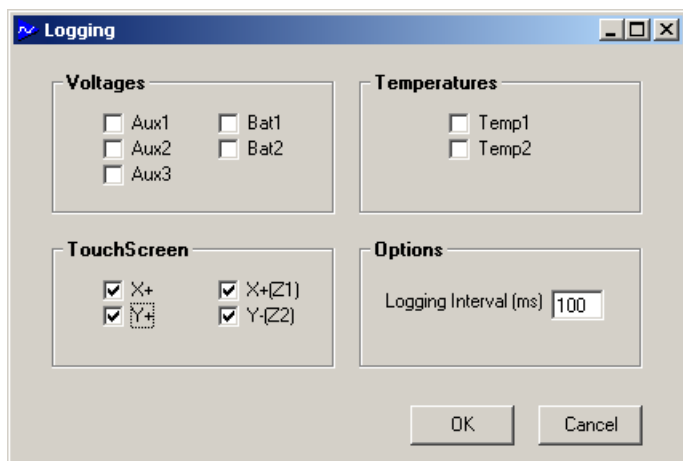

Figure 8. Log Data Screen

Easy Setup

Clicking on the Easy Setup button at the bottom of the Visual Display screen sets the AD7877 up and running.

The evaluation software writes to the AD7877 to set up the registers. The software then programs the device to perform a measurement on each channel. The software reads back the result of each measurement before going on to the next and then this cycle is repeated. The Temp1 measurement is also calibrated on Easy Setup, using the Temp2 measurement result.

All alerts are enabled by the easy setup, and the DAC is powered down. The ADC and the reference are in continuous power mode. All GPIOs are disabled by default.

Easy Setup sets the conversion mode to differential. Averaging is set to 8, the Acquisition Time is set to 8 μs, and the First Conversion Delay is set to 1.024 ms. The STOPACQ polarity bit, POL, is set to 1, active high. Any of these settings can be changed by the user by writing to the relevant control register.

Limits are written to the limit registers for all relevant channels. The AUX1 limits are set to 1.2 (lower limit) and 2 (upper limit). The BAT1 and BAT2 channel limits are set to 2.4 (lower limit) and 4.7 (upper limit). Limits for Temp1 are also programmed into the limit registers. Any of these limits may be changed by the user by clicking and dragging on the limit bars in the visual display screen or by writing to the relevant registers.

More information on programming the registers, and information on the register contents, may be found in the AD7877 data sheet.

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Graph Options

By clicking on the Graph Options button on the Visual Display screen, the window displayed in Figure 9 opens. This window gives the user a range of options to control the Visual Display window and the AD7877.

By selecting the relevant options, the main graphing display can be enabled/disabled, the bargraph can be enabled/disabled, the Limit Monitor can be enabled/disabled, and the $\overline{\text{ALERT}}$ interrupt can be set to clear on read.

Enable Monitoring: If Monitoring is enabled, then the user can choose the interval at which the measurement channels are monitored. In Figure 9, the monitoring interval is set to 30 ms. Every channel is monitored, with the monitoring cycle beginning every 30 ms. The user can change this to any value, with the minimum value being 5 ms. This is the default value. If monitoring is disabled, then the evaluation software stops reading data from the AD7877.

Enable graphing: This controls whether the selected measurement is graphed on the graphing window.

Enable bargraph: This controls whether the selected measurement is graphed on the bargraph. If this is disabled, the limit registers can still be changed by clicking and dragging on the limit bars.

Enable Limit Monitor: If the Limit Monitor is enabled, a measured value exceeding the limit register values will cause an $\overline{\text{ALERT}}$. If the Limit Monitor is disabled, then a measured value exceeding the limit register values will not cause an $\overline{\text{ALERT}}$.

Clear Alerts on read: If this is enabled, then an $\overline{\text{ALERT}}$ is cleared when the measured value falls within its limit values. If this is disabled, then once an $\overline{\text{ALERT}}$ is set, it cannot be cleared, and it will remain active.
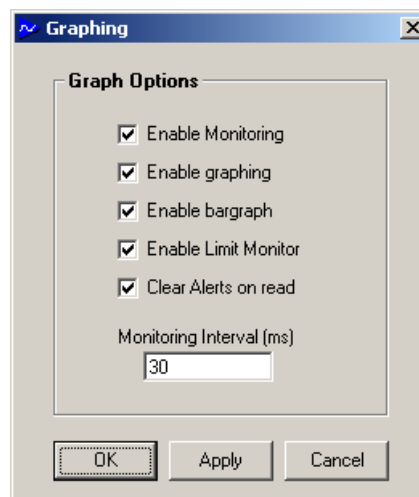

Figure 9. Graphing Options Window

TOUCH SCREEN WINDOW

Clicking on the Touch Screen tab will display the Touch Screen window, as shown in Figure 10. The X and Y coordinates from the touch screen are displayed here.

This window approximates a real touch screen application. If a touch screen is connected to the AD7877 evaluation board, then any touch on the screen will be plotted in this window.

The user can select the DrawWidth, which modifies the size of the point plotted by the display in respect of each coordinate received from the touch screen. Both the background color and trace color can be changed by selecting one of the color buttons. The Clear button will clear any points plotted on-screen, leaving it blank. The screen may also be cleared by clicking on the display section.
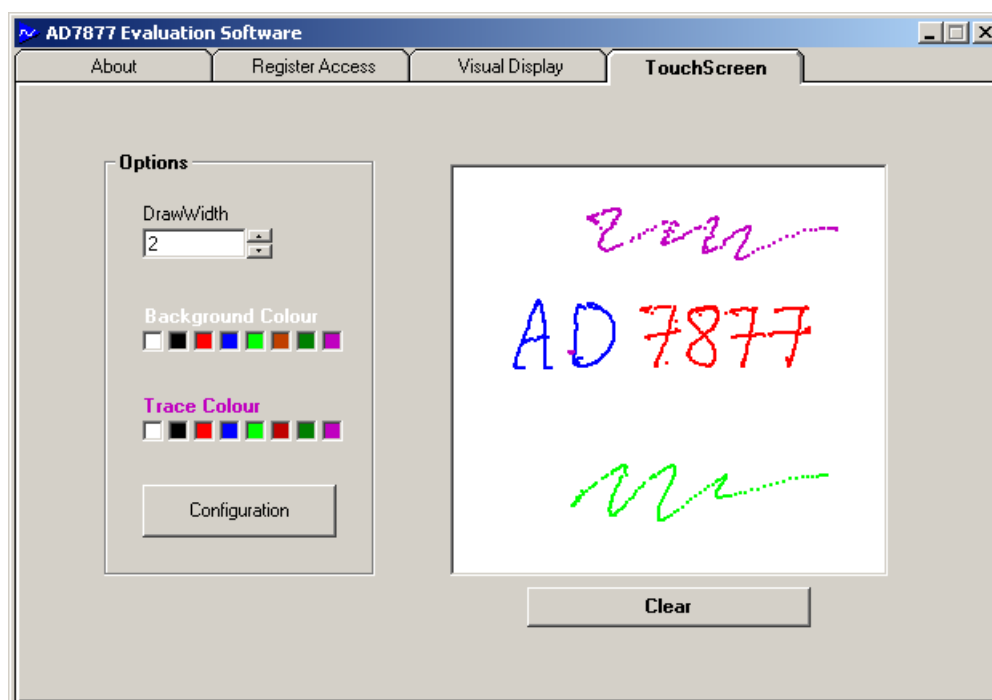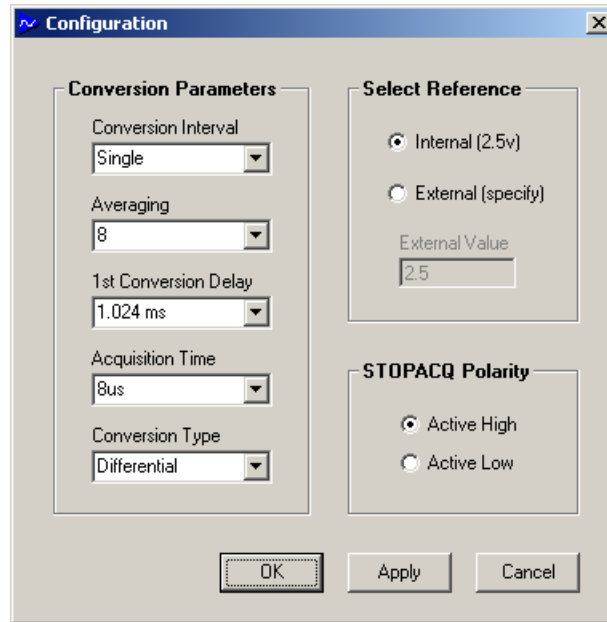

Figure 10. TouchScreen Window

Figure 11. Configuration Window

Configuration

The Configuration button in the Touch Screen window opens the window displayed in Figure 11. Various parameters can be changed to alter the configuration of the AD7877. For any touch screen, a particular set of parameters will yield the best result for touch screen measurements. The user should experiment with the various parameters to get the best results. The easy setup configuration is particularly suited to the touch screen that is included with the evaluation kit.

Conversion Parameters

The Conversion Interval, Acquisition Time, 1st Conversion Type, and Averaging parameters of the AD7877 can all be accessed and modified here.

The Conversion Interval sets the timer interval on the AD7877. The user can set this interval to be 8.19 ms, 1.024 ms, and 512 μs, or it can set the AD7877 to convert once (single interval).

The user can turn the AD7877's averaging function off, or it can set the device to perform 4, 8, or 16 averages on each measurement.

The 1st Conversion Delay, which is necessary to allow the touch screen to settle, can be chosen by the user. The options for the 1st Conversion Delay are 500 ns, 128 μs, 1.024 ms, or 8.19 ms.

The Acquisition Time for each conversion can be chosen to be 2 μs, 4 μs, 8 μs, or 16 μs.

There are two choices for Conversion Type: single or differential.

For more information on choosing the conversion parameters, see the AD7877 data sheet.

Reference Selection

The reference voltage for the AD7877 can be either internal or external. If the user supplies the part with an external reference voltage, it is of utmost importance that the external reference value is specified. If the external reference is not specified, all measurements read by the software may be in error.

If the internal reference is being used, no other reference may be tied to the V_{REF} pin on the AD7877. Tying an external reference to V_{REF}, while using the internal reference, may cause all measurements read by the software to be in error.

STOPACQ Polarity

The STOPACQ input signal polarity can be selected by the user. It is very important that the user selects the correct polarity for the signal applied to the STOPACQ input of the evaluation board. If the wrong polarity is selected, the ADC on the AD7877 will stop acquiring data and no new measurements will be made.
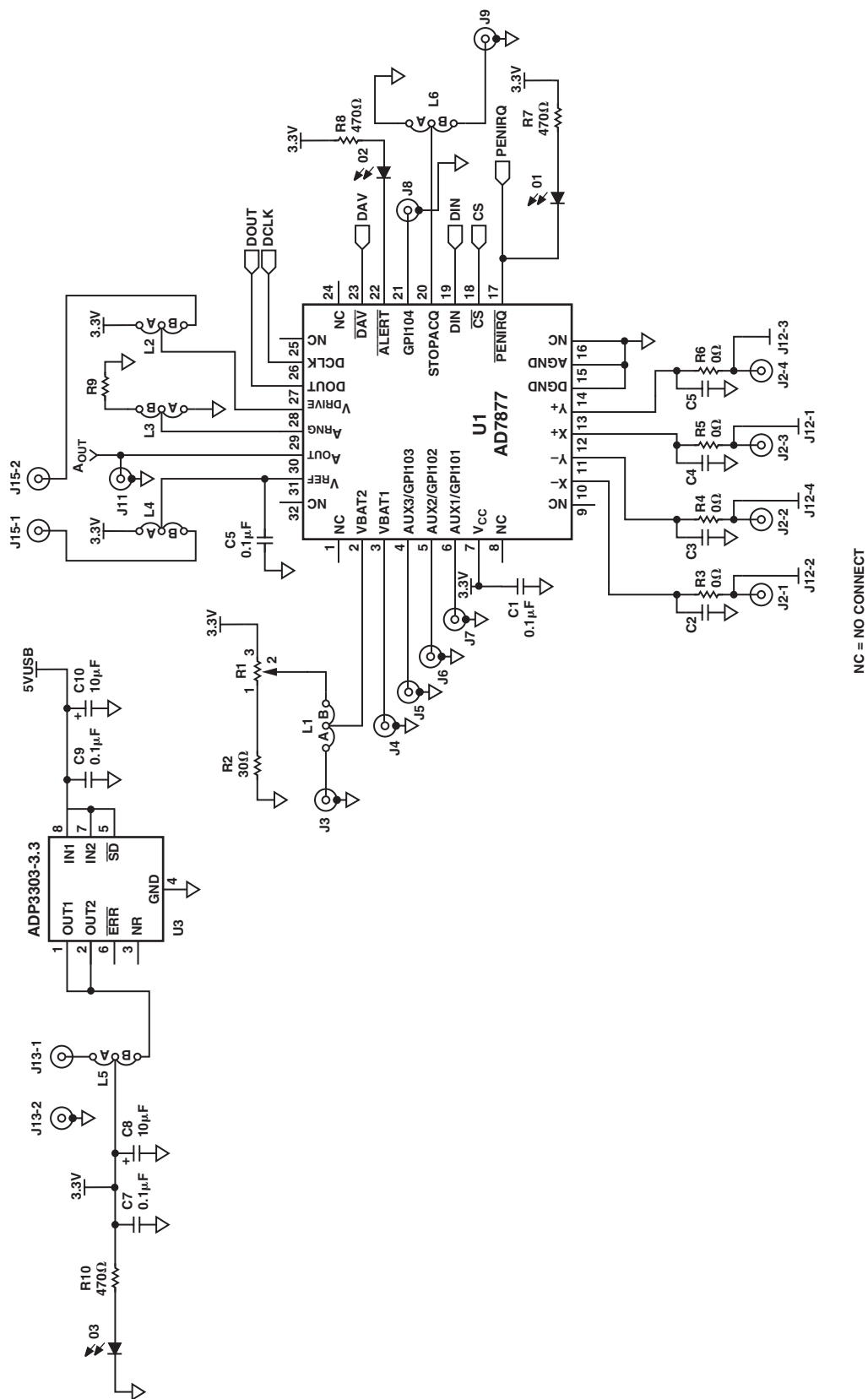
The easy setup function sets STOPACQ active high.

Figure 12. AD7877 Evaluation Board Schematic AD7877 Section
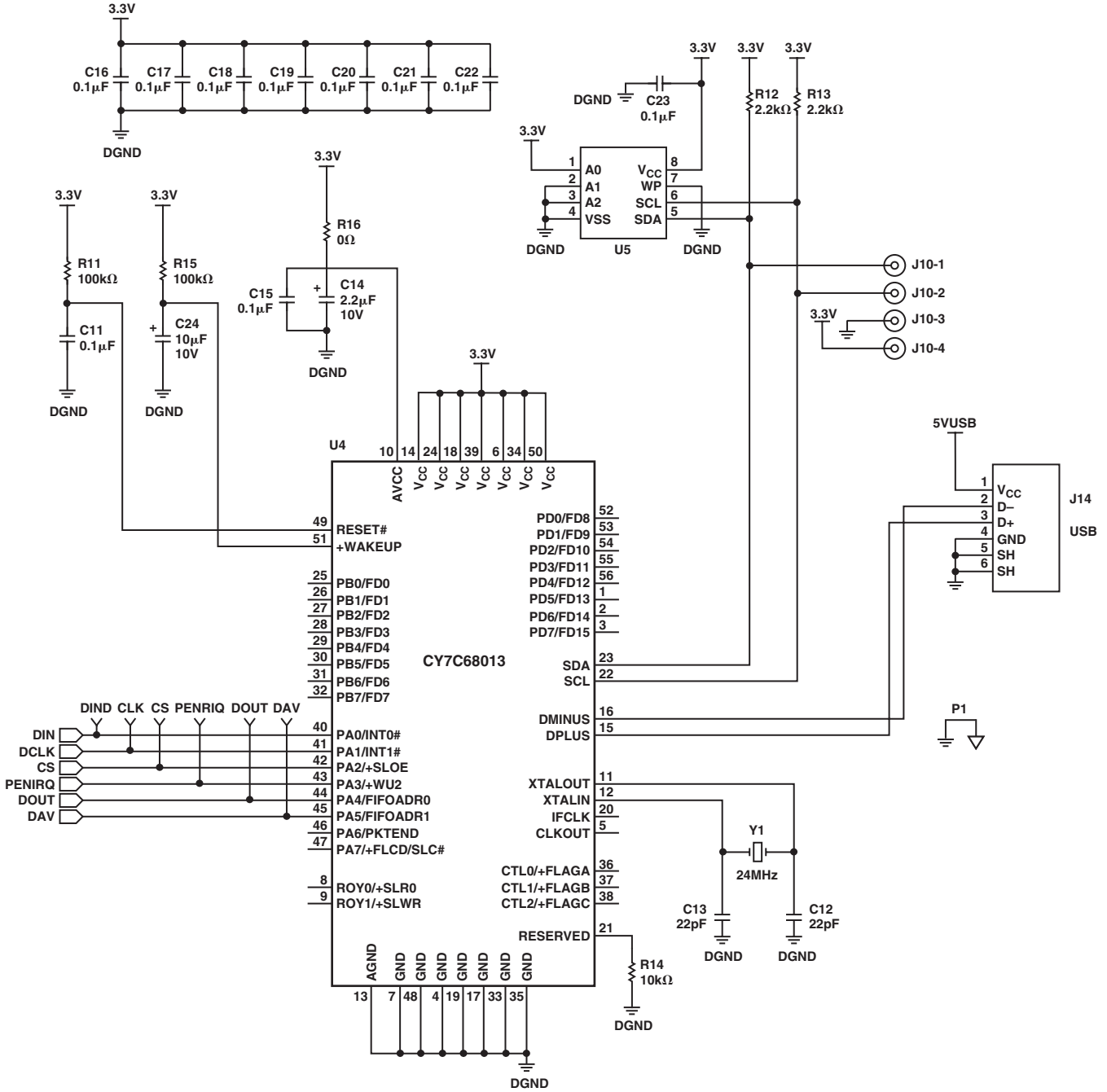
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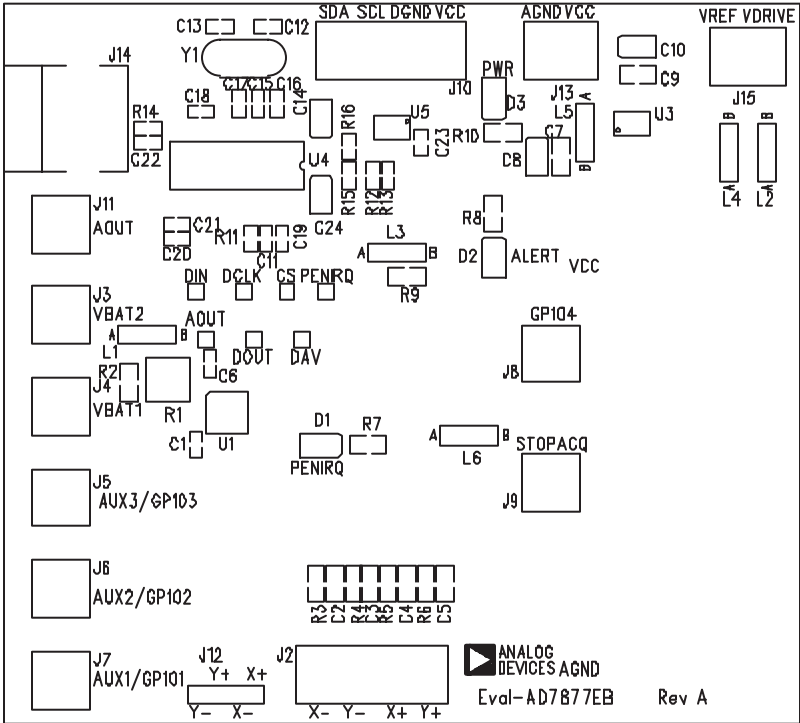*Figure 13. AD7877 Evaluation Board Schematic USB Section*

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Figure 14. AD7877 Evaluation Board Silkscreen
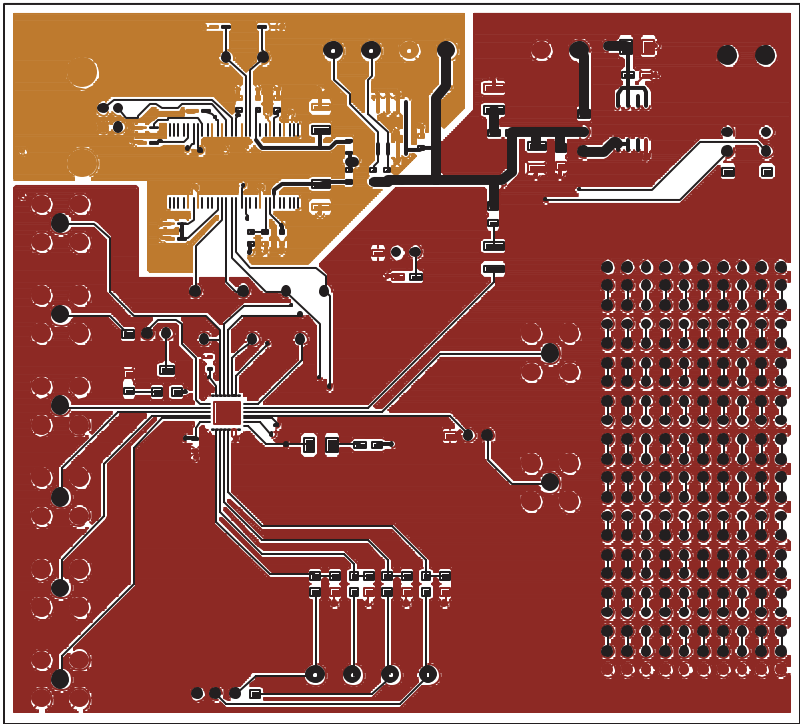

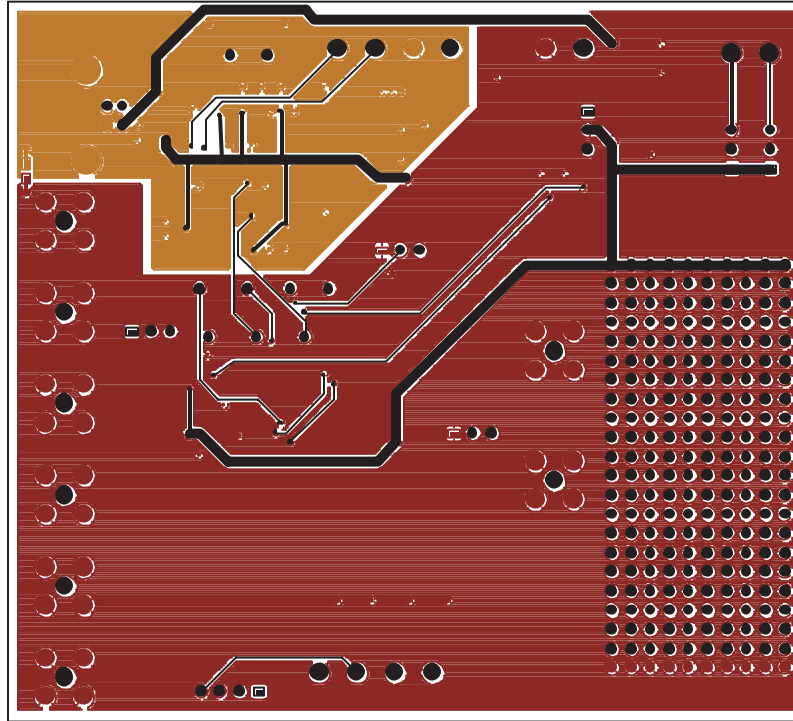Figure 15. AD7877 Evaluation Board Component Side Artwork

Figure 16. AD7877 Evaluation Board Solder Side Artwork

Table I. Bill of Materials

Name	Type	Value	Description
C1, C6	CAP	0.1 μF	0.1 μF Multilayer Ceramic (603)
C2 to C5, C7, C9	CAP	0.1 μF	0.1 μF Multilayer Ceramic (805)
C8, C10	CAP+	10 μF	10 μF 16 V Electrolytic (SMD B Size)
C11, C15 to C23	CAP	0.1 μF	0.1 μF Multilayer Ceramic (603)
C12, C13	CAP	0.1 μF	22 pF Multilayer Ceramic (603)
C14	CAP+	2.2 μF	2.2 μF 16 V Electrolytic (SMD B Size)
C24	CAP+	10 μF	10 μF 16 V Electrolytic (SMD B Size)
D1, D2, D3	LED		Green LED
J2, J10, J13, J15	CON/POWER		4-Way Terminal Block
J3 to J9, J11	SMB		Subminiature BNC Connector
J12	CON-SIP-4P_SMD		Right-Angle Pin Connector
J14	USB		USB_RECPTACLE_B
L1 to L6	JUMPER2\SIP3		3-Pin Sil Header
R1	VRES	2 kΩ	2 kΩ Variable Resistor
R2, R9	RES	30 Ω	30 Ω Resistor (805)
R3 to R6	RES	0 Ω	0 Ω Resistor (805)
R7, R8, R10	RES	470 Ω	470 Ω ±5% Resistor (805)
R11, R15	RES	100 kΩ	100 kΩ ±1% Resistor (603)
R12, R13	RES	2.2 kΩ	2.2 kΩ ±1% Resistor (603)
R16	RES	0 Ω	0 Ω Resistor (603)
U1	AD7877		AD7877
U3	ADP3303-3.3		ADP3303 3.3 V Regulator
U4	CY7C68013		Cypress Semiconductor USB Processor
U5	24LC64		8 Kbyte EEPROM
Y1	XTAL1	24 MHz	24 MHz Crystal

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