

## **DAC8560 Evaluation Module**

This user's guide describes the characteristics, operation, and the use of the DAC8560 evaluation module (EVM). It covers all pertinent areas to properly use this EVM board along with the devices that it supports. The physical PCB layout, schematic diagram, and circuit descriptions are included.

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## 1 EVM Overview

This section gives a general overview of the DAC8560 evaluation module (EVM), and describes some of the factors to consider when using this module.

### 1.1 Features

This EVM features the DAC8560 digital-to-analog converter (DAC). The DAC8560EVM is a simple evaluation module designed to quickly and easily evaluate the functionality and performance of the 16-bit high-resolution, single-channel, and serial input DAC with a built-in 2.5-V internal reference that is enabled by default. This EVM features a serial interface to communicate with any host microprocessor or TI DSP base system.

Although the DAC was designed for single-supply operation, a bipolar output range is also possible by configuring the output operational amplifier circuit properly. This is discussed in detail in section 3.2.3. In addition, the external operational amplifier is also installed as an option to provide output signal conditioning or boost capacitive load drive and for other output mode requirements desired.

A +5-V precision voltage reference is provided via U3 as well as a 4.096-V precision reference via U4. These references are optional voltage reference provided externally in case the user needs to evaluate the DAC8560 with external reference circuits. The external +5-V and +4-V reference source can be selected via W8 and W4 jumper configuration.

There is also a provision for possibly experimenting with different circuit loads on the reference of the DAC8560. These are available through R16, C6, and a small 4x4 through-hole grid.

### 1.2 Power Requirements

The following sections describe the power requirements of this EVM.

#### 1.2.1 Supply Voltage

The dc power supply requirement for this DAC8560EVM (VDD) is selectable between +3.3 V and +5 V via the W1 jumper header. The +3.3 V comes from J6-8 and the +5 V comes from J6-3 terminal. These power-supply voltages are referenced to ground through the J6-6 terminal. The VSS and VCC are only used by the U2 operational amplifier and the U3 voltage reference, which ranges from -15 V to +15 V maximum and connects through J6-1 and J6-2 terminals, respectively. All the analog power supplies are referenced to analog ground through J6-6 terminal.

#### CAUTION

To avoid potential damage to the EVM board, ensure that the correct cables are connected to their respective terminals as labeled on the EVM board.

Stresses greater than the maximum listed voltage ratings may cause permanent damage to the device.

The negative rail of the output operational amplifier, U2, can be selected between  $V_{SS}$  and AGND via the W5 jumper. The external operational amplifier is installed as an option to provide output signal conditioning or for other desired output mode requirements.

#### CAUTION

To avoid potential damage to the EVM board, ensure that the correct cables are connected to their respective terminals as labeled on the EVM board.

Stresses greater than the maximum listed voltage ratings may cause permanent damage to the device.

### 1.2.2 Reference Voltage

The DAC8560 comes with a +2.5-V internal reference that is enabled by default. The +2.5-V internal reference can be measured from its  $V_{REF}$  pin, which can be used to source other devices that requires +2.5-V reference. Because the DAC8560's internal reference is enabled by default, care should be taken to ensure that the W4 and W8 jumper headers are open. Otherwise, inaccurate performance or damage to the part can result. However, the DAC8560 should not be damaged, providing that the external voltage that is applied to the  $V_{REF}$  pin does not exceed the applied voltage in the  $V_{DD}$  pin, and it does not exceed 100 mA of sourcing current. It is not recommended to leave the external voltage applied on the  $V_{REF}$  pin if the internal reference is not disabled. The external reference source should be disconnected immediately, and the EVM power must be recycled to ensure correct performance of the device.

The +5-V and +4-V precision voltage references are provided as an optional reference source to supply the external voltage reference for the DAC through REF02 (U3) and REF3240 (U4). These reference voltages are selectable via the jumper W8. When shorting pins 1 and 2, the +5-V reference is selected whereas shorting pins 2 and 3 selects +4-V reference. The jumper W4 must be shorted between pins 1 and 2 in order for these reference sources to propagate through the DAC.

The +5-V reference voltage goes through an adjustable 100-k $\Omega$  potentiometer, R11, in series with 20-k $\Omega$  R10, to allow the user to adjust the reference voltage to its desired settings. The voltage reference then is buffered through U5 as seen by the device under test. The REF02 precision reference is powered by  $V_{CC}$  (+15 V) through J6-1 terminal.

The REF3240 precision reference is powered by +5 VA through J6-3 terminal.

The test point TP1 also is provided, as well as J4-20, to allow the user to connect other external reference source if the onboard reference circuit is not desired. The external voltage reference should not exceed the applied power supply,  $V_{DD}$ , of the DAC under test.

#### CAUTION

When applying an external voltage reference through TP1 or J4-20, ensure that it does not exceed the applied  $V_{DD}$ . Otherwise, this can permanently damage the DAC8560, U1, device under test.

### 1.3 EVM Basic Functions

This EVM is designed primarily as a functional evaluation platform to test certain functional characteristics of the DAC8560 digital-to-analog converter (DAC). Functional evaluation of the installed DAC device can be accomplished with the use of any microprocessor, TI DSP, or some sort of a signal/waveform generator.

The headers J2 (top side) and P2 (bottom side) are pass-through connectors provided to allow the control signals and data required to interface a host processor or waveform generator to the DAC8560EVM using a custom-built cable.

The DAC output can be monitored through the selected pins of J4 header connector. The output can be switched through its respective jumper W2 whereas the sense pin  $V_{FB}$  also can be switched through its respective jumper W7 for the reason of stacking. The  $V_{FB}$  pin is discussed further in section 3 of this user's guide manual. Stacking allows a total of two (DAC8560) DAC channels to be used provided the frame synchronization signal,  $\overline{SYNC}$ , is unique for each EVM board stacked.

In addition, the option of selecting the DAC output to be fed to the noninverting side of the output operational amplifier, U2, is also possible by using a jumper across the selected pins of J4. The output operational amplifier, U2, must be first configured correctly for the desired waveform characteristic (see [Section 3](#) of this document).



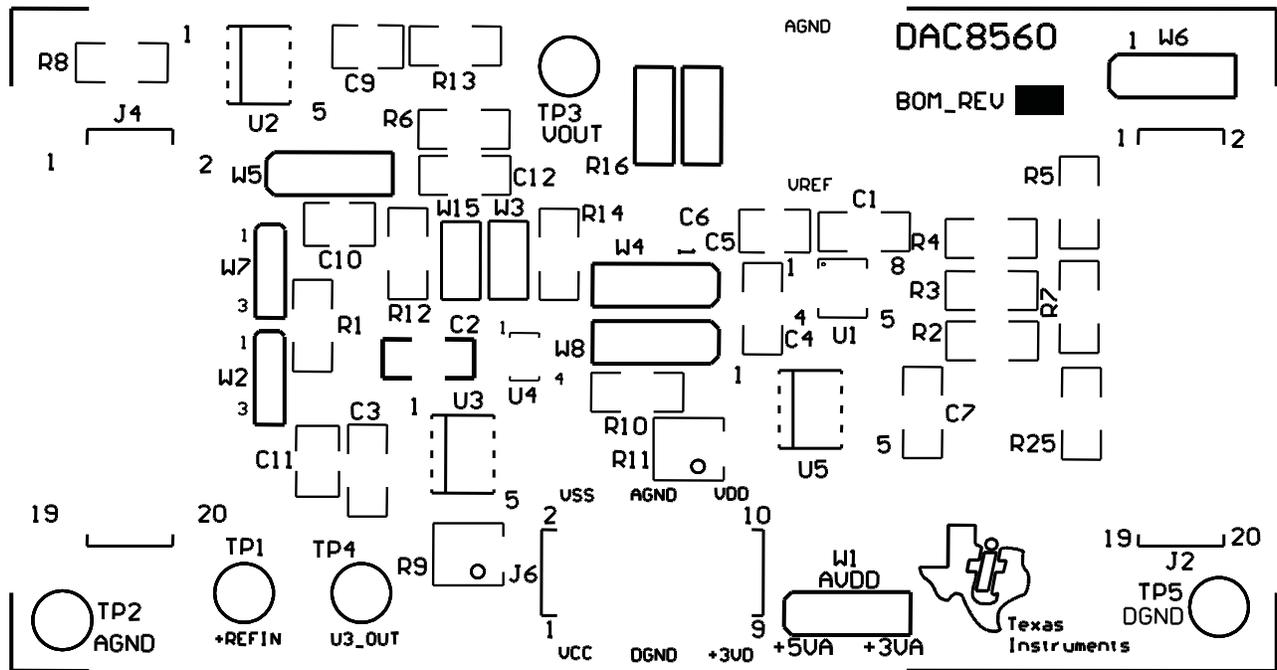


Figure 2. Top Silkscreen

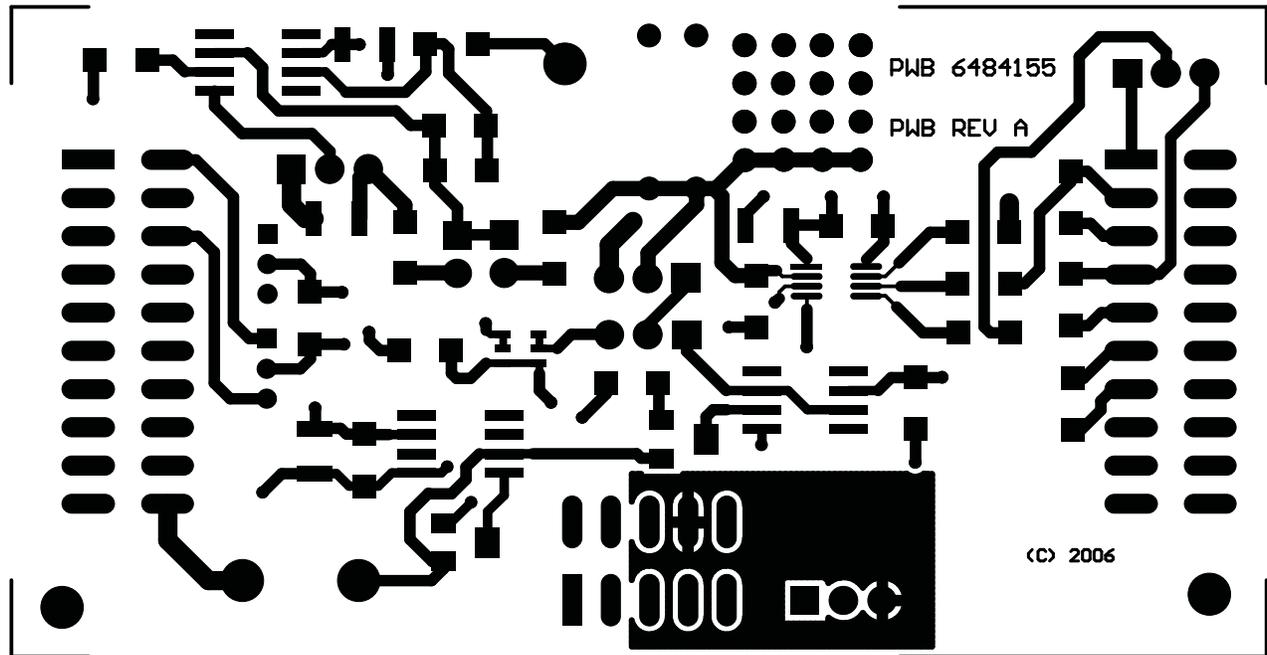


Figure 3. Layer 1 (Top Signal Plane)

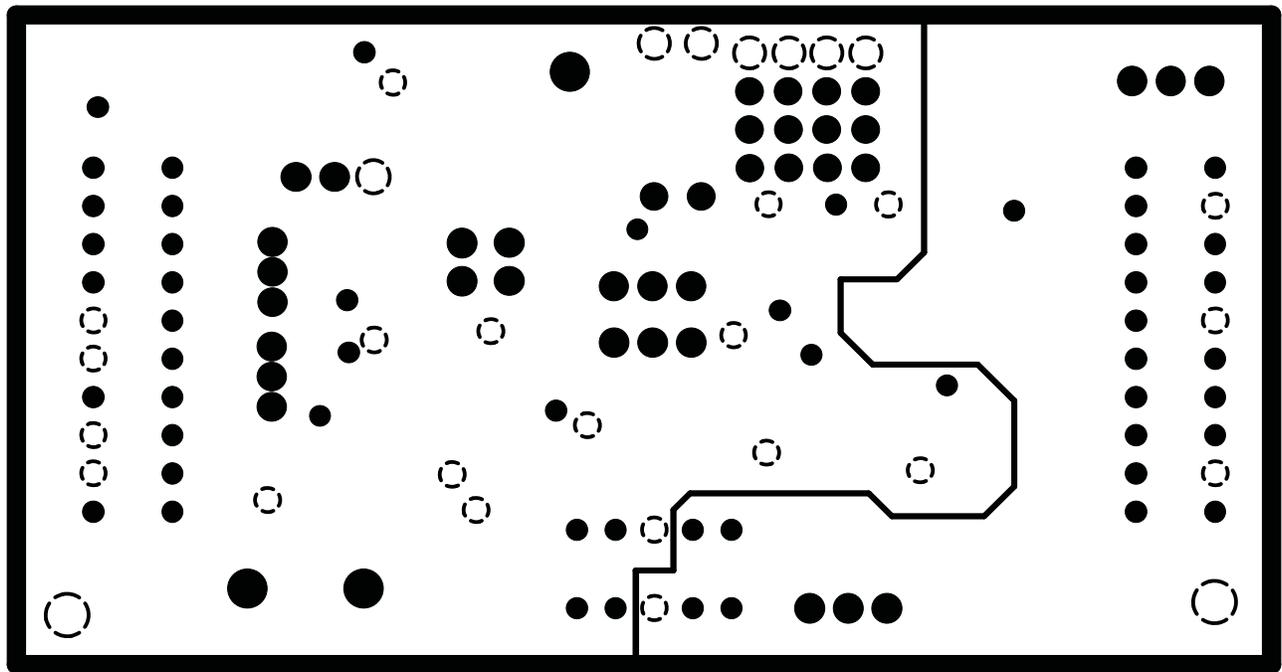


Figure 4. Layer 2 (Ground Plane)

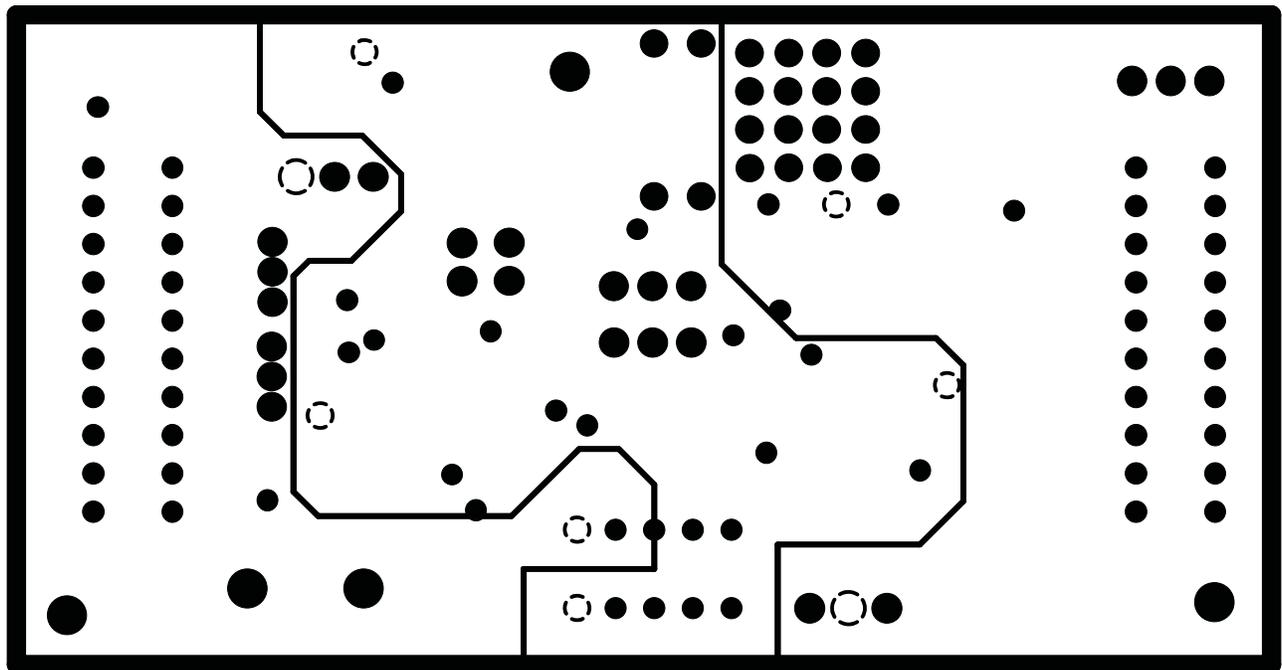


Figure 5. Layer 3 (Power Plane)

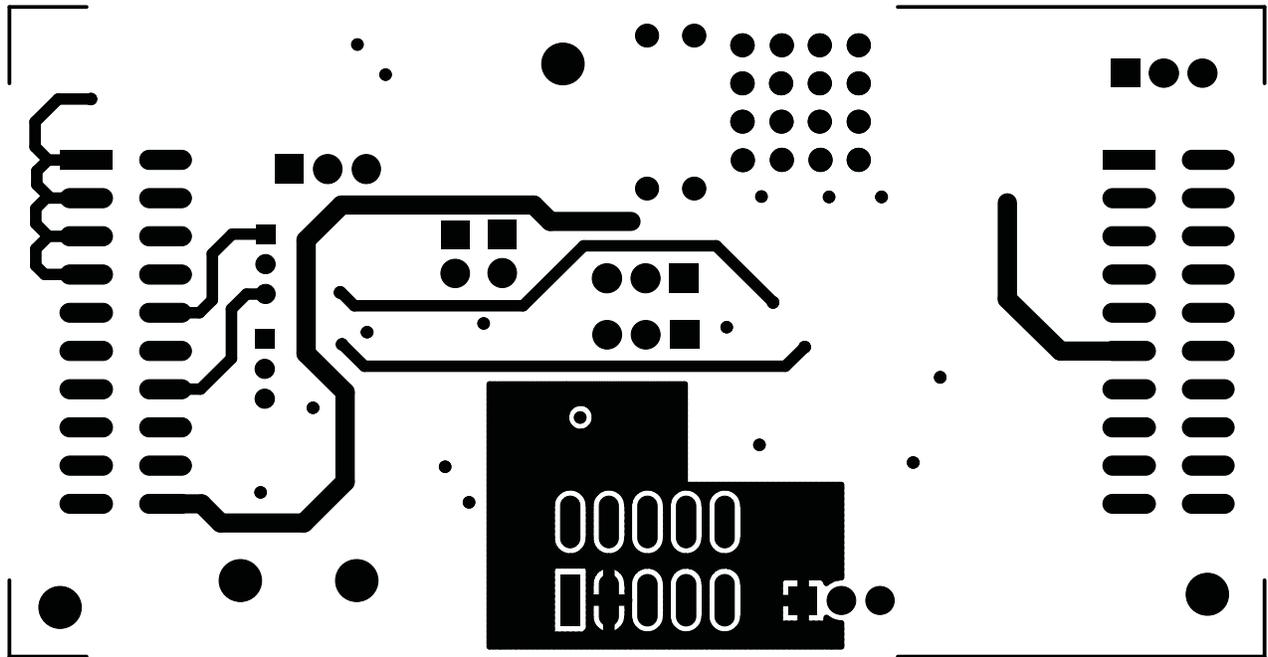


Figure 6. Layer 4 (Bottom Signal Plane)

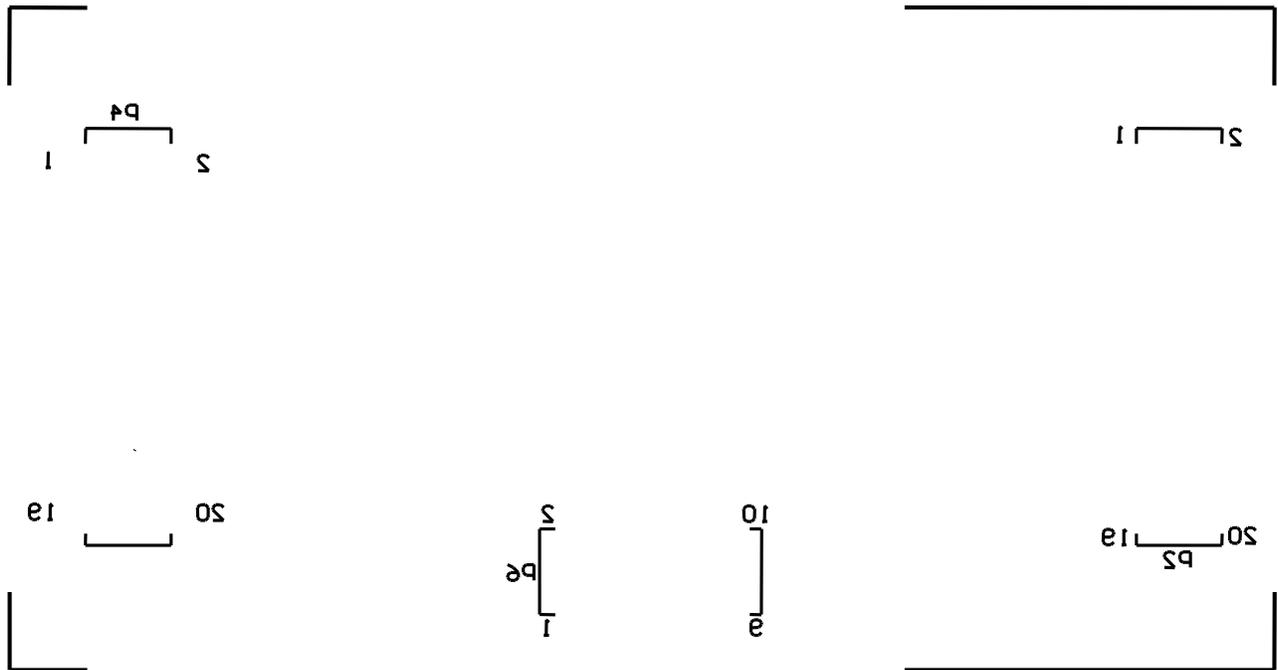


Figure 7. Bottom Silkscreen

## 2.2 EVM Performance

The EVM performance test is performed using a high-density DAC bench test board, an Agilent 3458A digital multimeter, and a PC running the LabVIEW® software. The EVM board is tested for all codes of 65535 and the device under test (DUT) is allowed to settle for 1 ms before the meter is read. This process is repeated for all codes to generate the measurements for INL and DNL.

Figure 8 shows the characteristic INL and DNL plots.

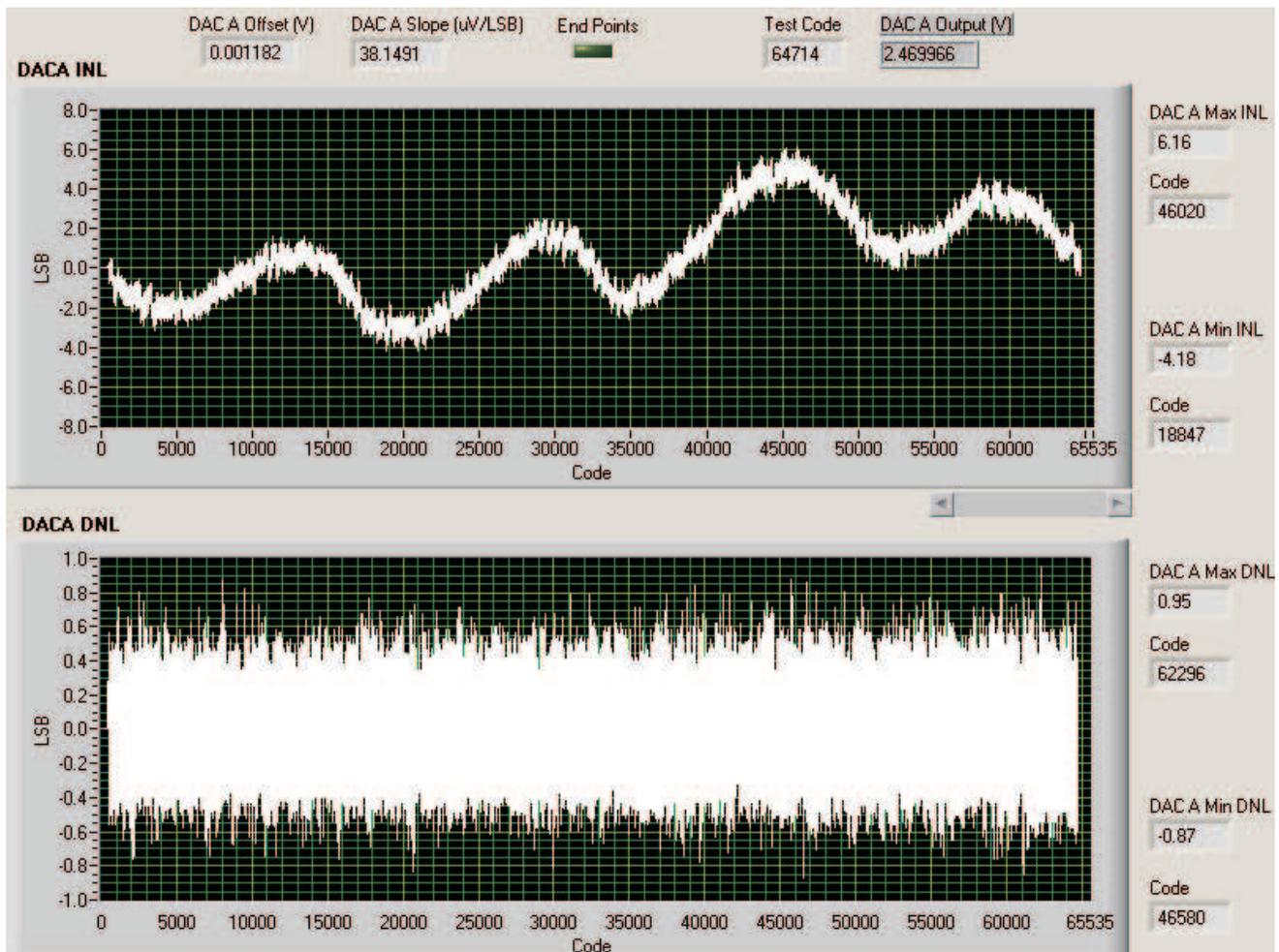


Figure 8. INL and DNL Characteristic Plot

## 3 EVM Operation

This section covers in detail the operation of the EVM to provide guidance to the user in evaluating the onboard DAC and how to interface the EVM to a specific host processor.

See the DAC8560 data sheet, [SLAS264](#), for information about its serial interface and other related topics.

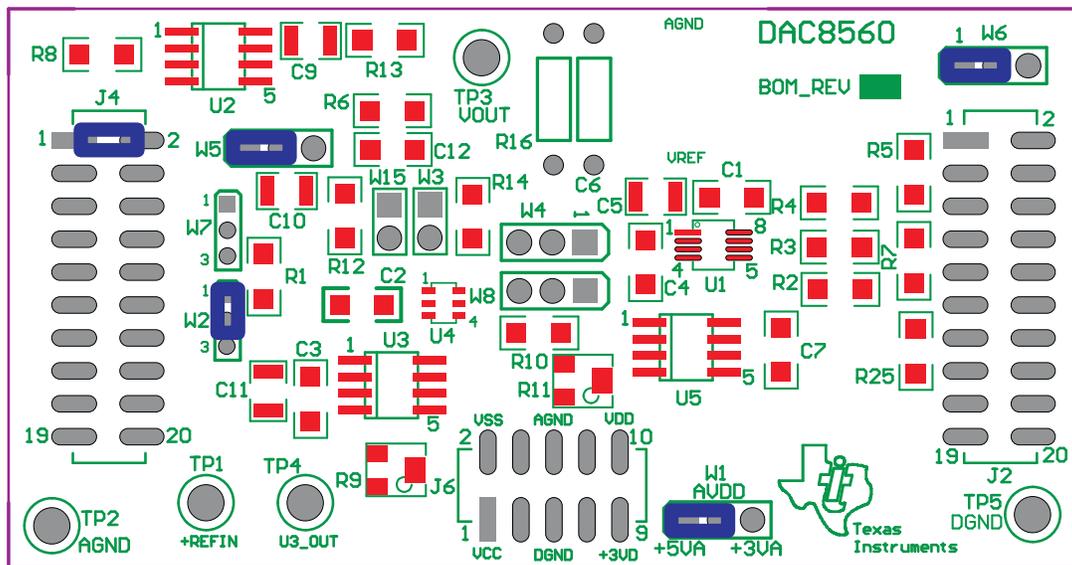
The EVM board is factory tested and configured to operate in the unipolar output mode.

### 3.1 Factory Default Settings

The EVM board is set to its default configuration from factory as described in Table 1 to operate in unipolar +2.5-V mode of operation. Figure 9 shows the default jumper configuration as described in the table for the DAC8560.

**Table 1. Factory Default Jumper Settings**

Reference	Jumper Position	Function
W1	1-2	Analog supply for the DAC8560 is +5 VA.
W2	1-2	DAC output ( $V_{OUT}$ ) is routed to J4-2.
W3	OPEN	$V_{REF}$ is not routed to the inverting input of the operational amplifier for voltage offset (for bipolar mode of operation).
W4	OPEN	Onboard external buffered reference U3 or U4 is not routed to $V_{REF}$ .
W5	1-2	Negative supply rail of U2 operational amplifier is supplied with $V_{SS}$ .
W6	1-2	$\overline{CS}$ signal from J2 is used for frame synchronization, $\overline{SYNC}$ , signal.
W7	OPEN	For DAC8560EVM, the $V_{FB}$ is not routed out unless there is a need to minimize the output error. If using W7, remove R1 and short W7, then connect $V_{FB}$ and $V_{OUT}$ as close as possible to the load.
W8	OPEN	Onboard external buffered reference U3 or U4 are not selected. Default is the +2.5-V internal reference of the DAC8560.
W15	OPEN	Output operational amplifier, U2, is configured as voltage follower.
J4	1-2	DAC output ( $V_{OUT}$ ) is connected to the noninverting input of the output operational amplifier, U2.



**Figure 9. DAC8560EVM Default Jumper Configuration**

### 3.2 Host Processor Interface

The host processor basically drives the DAC; so, the DAC's proper operation depends on the successful configuration between the host processor and the EVM board. In addition, a properly written code also is required to operate the DAC.

A custom cable can be made specific to the host interface platform. The EVM allows interface to the host processor through J2 header connector for the serial control signals and the serial data input. The output can be monitored through the J4 header connector.

An interface adapter board also is available for a specific TI DSP starter kit as well as an MSP430-based microprocessor as previously mentioned. Using the interface board alleviates the tedious task of building customized cables and allows easy configuration of a simple evaluation system.

The DAC8560 interfaces with any host processor capable of handling SPI protocols or the popular TI DSP. For more information regarding the DAC8560 data interface, see the DAC8560 data sheet ([SLAS464](#)).

### 3.3 EVM Stacking

The stacking of EVMs is possible if the user needs to evaluate two DAC8560 devices to yield a total of up to two (DAC8560) channel outputs. A maximum of two EVMs are allowed because the output terminal, J4, dictates the number of DAC channels that can be connected without output bus contention. [Table 2](#) shows how the DAC output channels are mapped into the output terminal, J4, with respect to the jumper position of W2 and W7.

**Table 2. DAC Output Channel Mapping**

Reference	Jumper Position	Function
W2	1-2	DAC output ( $V_{OUT}$ ) is routed to J4-2.
	2-3	DAC output ( $V_{OUT}$ ) is routed to J4-6.
W7	1-2	DAC sense pin ( $V_{FB}$ ) is routed to J4-10, if R1 jumper resistor is disconnected.
	2-3	DAC sense pin ( $V_{FB}$ ) is routed to J4-14, if R1 jumper resistor is disconnected.

In order to allow exclusive control of each EVM that is stacked together, the DAC8560 must have a separate  $\overline{\text{SYNC}}$  signal. This is accomplished in hardware by routing the  $\overline{\text{SYNC}}$  signal of the first EVM through  $\overline{\text{CS}}$  (P2/J2 pin 1) by shorting pins 1-2 of jumper W6. The second EVM should use the  $\overline{\text{FSX}}$  signal (P2/J2 pin 7) to drive the  $\overline{\text{SYNC}}$  signal by shorting pins 2-3 of the jumper W6. The output can be mapped as described in [Table 2](#) for each of the EVM stacked.

### 3.4 The Output Operational Amplifier

The EVM includes an optional signal-conditioning circuit for the DAC output through an external operational amplifier, U2. During stacking of the EVMs, only one DAC output channel can be monitored at any given time for evaluation because the odd-numbered pins (J4-1 to J4-7) are tied together. If both outputs are needed to be buffered and monitored at the same time, the traces in the back of the EVM board are exposed for ease of cutting. When cutting a trace, make sure to cut through the trace adjacent to the appropriate J4 header pin and not at the curvy line. If the trace is cut through the curving line, the signal may not propagate through to the operational amplifier. See [Figure 6](#) and the schematic included in this manual.

The output operational amplifier is set to unity gain configuration by default but can be modified by simple jumper settings. Nevertheless, the raw output of the DAC can be probed through the specified pins of the J4 output terminal, which also provides mechanical stability when stacking or plugging into any interface board. In addition, it provides easy access for monitoring up to two (DAC8560) DAC channels when stacking two EVMs together (see section 3.3).

The following sections describe the different configurations of the output amplifier, U2.

### 3.4.1 Unity Gain Output

The buffered output configuration can be used to prevent loading the DAC8560, although it may present some slight distortion because of the feedback resistor and capacitor. The user can tailor the feedback circuit to closely match the desired wave shape by simply desoldering R6 and C12 and replacing them with components of the desired values. Additionally, C12 can be eliminated and R6 can be replaced with a 0Ω resistor to simplify the feedback circuit.

Table 3 shows the jumper setting for the unity gain configuration of the DAC external output buffer in unipolar or bipolar mode.

**Table 3. Unity Gain Output Jumper Settings**

Reference	Jumper Setting		Function
	Unipolar	Bipolar	
W3	Open	Open	Disconnect $V_{REF}$ from the inverting input of the operational amplifier.
W5	2-3	1-2	Supplies $V_{SS}$ to the negative rail of operational amplifier or ties it to AGND.
W15	Open	Open	Disconnect the negative input of the operational amplifier from the gain resistor, R12.

### 3.4.2 Output Gain of Two or Bipolar Operation

Two types of configurations yield a gain of two output, depending on the setup of the jumpers W3 and W15. These configurations allow the user to choose a DAC output having  $V_{REF}$  as an offset or not.

Table 4 shows the proper jumper settings of the EVM for the 2x gain output of the DAC.

**Table 4. Gain of Two Output Jumper Settings**

Reference	Jumper Setting		Function
	Unipolar	Bipolar	
W3	Close	Close	Inverting input of the output operational amplifier, U2, is connected to $V_{REF}$ for use as its offset voltage for bipolar operation. W15 jumper must be open.
	Open	Open	$V_{REF}$ is disconnected from the inverting input of the output operational amplifier, U2. W15 jumper must be close to achieve gain of 2 output.
W5	2-3	1-2	Supplies power, $V_{SS}$ , to the negative rail of operational amplifier, U2, for bipolar mode, or ties it to AGND for unipolar mode.
W15	Close	Close	Configures operational amplifier, U2, for a gain of 2 output without a voltage offset. W3 jumper must be open.
	Open	Open	Inverting input of the operational amplifier, U2, is disconnected from the gain resistor, R12. W3 jumper must be close.

### 3.4.3 Capacitive Load Drive

Another output configuration option is to drive a wide range of capacitive load requirement. However, all operational amplifiers under certain conditions may become unstable depending on the operational amplifier configuration, gain, and load value. These are just few factors that can affect operational amplifiers stability performance and should be considered when implementing.

In unity gain, the OPA627 operational amplifier, U2, performs well with large capacitive loads. Increasing the gain enhances the amplifier's ability to drive even more capacitance, and by adding a load resistor even improves the capacitive load drive capability.

Table 5 shows the jumper setting configuration for a capacitive load drive.

**Table 5. Capacitive Load Drive Output Jumper Settings**

Reference	Jumper Setting		Function
	Unipolar	Bipolar	
W3	Open	Open	$V_{REF}$ is disconnected from the inverting input of the output operational amplifier, U2.
W5	2-3	1-2	Supplies power, $V_{SS}$ , to the negative rail of operational amplifier, U2, for bipolar mode, or ties it to AGND for unipolar mode.
W15	Open	Open	Capacitive load drive output of DAC is routed to pin 1 of W15 jumper and can be used as the output terminal.

### 3.5 Jumper Settings

Table 6 shows the function of each specific jumper setting of the EVM.

**Table 6. Jumper Setting Functions**

Reference	Jumper Position	Function
W1		+5-V analog supply is selected for $AV_{DD}$ .
		+3.3-V analog supply is selected for $AV_{DD}$ .
W2		Routes $V_{OUT}$ to J4-2.
		Routes $V_{OUT}$ to J4-6.
W3		Disconnects $V_{REF}$ to the inverting input of the output operational amplifier, U2
		Connects $V_{REF}$ to the inverting input of the output operational amplifier, U2
W4		Routes the adjustable, onboard +5-V reference or the fixed +4-V reference to the $V_{REF}$ input of the DAC8560.
		This is the default jumper position for DAC8560EVM because the +2.5-V internal reference is enabled by default.
		Routes the user-supplied reference from TP1 or J4-20 to the $V_{REF}$ input of the DAC8560.
W5		Negative supply rail of the output operational amplifier, U2, is powered by $V_{SS}$ for bipolar operation.
		Negative supply rail of the output operational amplifier, U2, is tied to AGND for unipolar operation.
W6		$\overline{CS}$ signal from J2-1 is routed to drive the $\overline{SYNC}$ signal of the DAC8560.
		$\overline{FSX}$ signal from J2-7 is routed to drive the $\overline{SYNC}$ signal of the DAC8560.

**Table 6. Jumper Setting Functions (continued)**

Reference	Jumper Position	Function
W7		For DAC8560EVM, the $V_{FB}$ is routed out to minimize the output error. Remove R1 and short W7 as shown; then connect $V_{FB}$ and $V_{OUT}$ as close as possible to the load. The $V_{FB}$ signal will be routed to J4-10.
		This is the default jumper position for DAC8560EVM when R1 is installed.
		For DAC8560EVM, the $V_{FB}$ is routed out to minimize the output error. Remove R1 and short W7 as shown then connect $V_{FB}$ and $V_{OUT}$ as close as possible to the load. The $V_{FB}$ signal will be routed to J4-14.
W8		This jumper position selects the adjustable +5-V reference to route to the $V_{REF}$ input of the DAC8560.
		This is the default jumper position for DAC8560EVM because the +2.5-V internal reference is enabled by default.
		This jumper position selects the +4-V reference to route to the $V_{REF}$ input of the DAC8560.
W15		Disconnects the inverting input of the output operational amplifier, U2, from the gain resistor, R12.
		Connects the inverting input of the output operational amplifier, U2, to the gain resistor, R12, for gain of 2 configuration.

Legend:  Indicates the corresponding pins that are shorted or closed.

3.6 Schematic

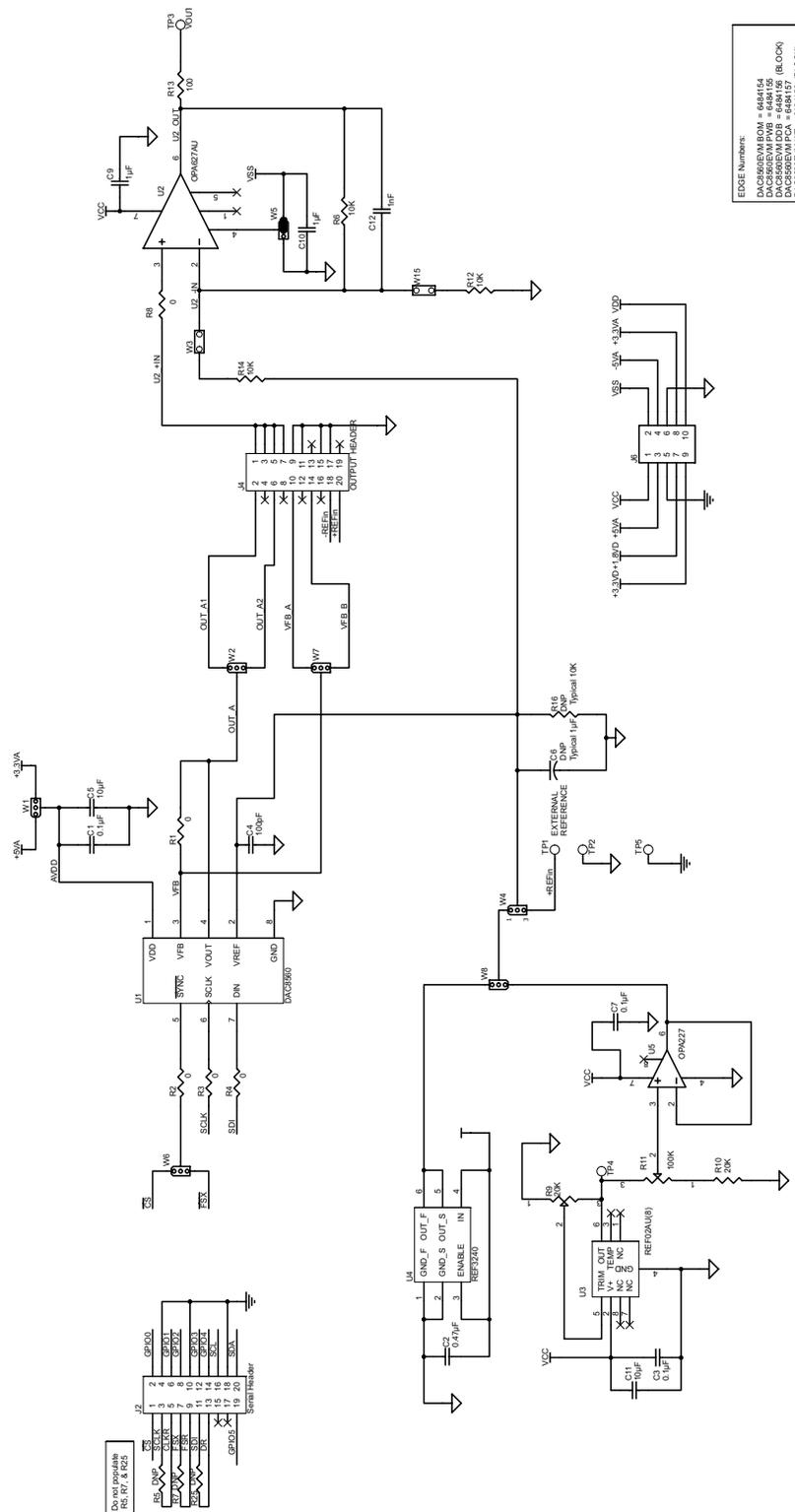


Figure 10. DAC8560EVM Schematic

## 4 Related Documentation from Texas Instruments

To obtain a copy of any of the following TI documents, call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center (PIC) at (972) 644-5580. When ordering, identify this manual by its title and literature number. Updated documents also can be obtained through the TI Web site at [www.ti.com](http://www.ti.com).

### Related Documentation

Data Sheet	Literature Number
DAC8560	<a href="#">SBAS254</a>
REF02	<a href="#">SBVS003</a>
REF3240	<a href="#">SBVS058</a>
OPA627	<a href="#">SBOS165</a>
OPA227	<a href="#">SBOS110</a>

## 5 Using the DAC8560 EVM with DXP

The DAC8560EVM is compatible with the [DAC eXerciser Program \(DXP\)](#) from Texas Instruments. DXP is a tool that can generate the necessary control signals required to output various signals and waveforms from the device installed on the DAC8560EVM. The DAC8560EVM-PDK kit combines the DAC8560EVM board with the DSP-based MMB0 modular motherboard. The kit includes the DXP software for evaluation using any available USB port on a Microsoft® Windows® XP-based computer.

DXP is a program that controls the digital input signals such as the clock,  $\overline{CS}$ , and SDI. Wave tables are built into the DSP software to allow sine, ramp, triangle, and square wave signals to be generated by the DAC8560. Straight dc outputs can also be obtained.

The DAC8560EVM-PDK uses the DSP-based MMB0 to control the DAC8560EVM using the DXP software. For complete information about installing and configuring DXP, see the [DXP User's Guide](#), available for download from [the TI web site](#). This section covers the specific operation of the DAC8560EVM-PDK.

### 5.1 Hardware

The hardware consists of two primary components: the DAC8560EVM itself and a modular motherboard called the MMB0. The MMB0 board houses a TMS320VC5507 DSP that controls the serial interface to the device loaded on the EVM board.

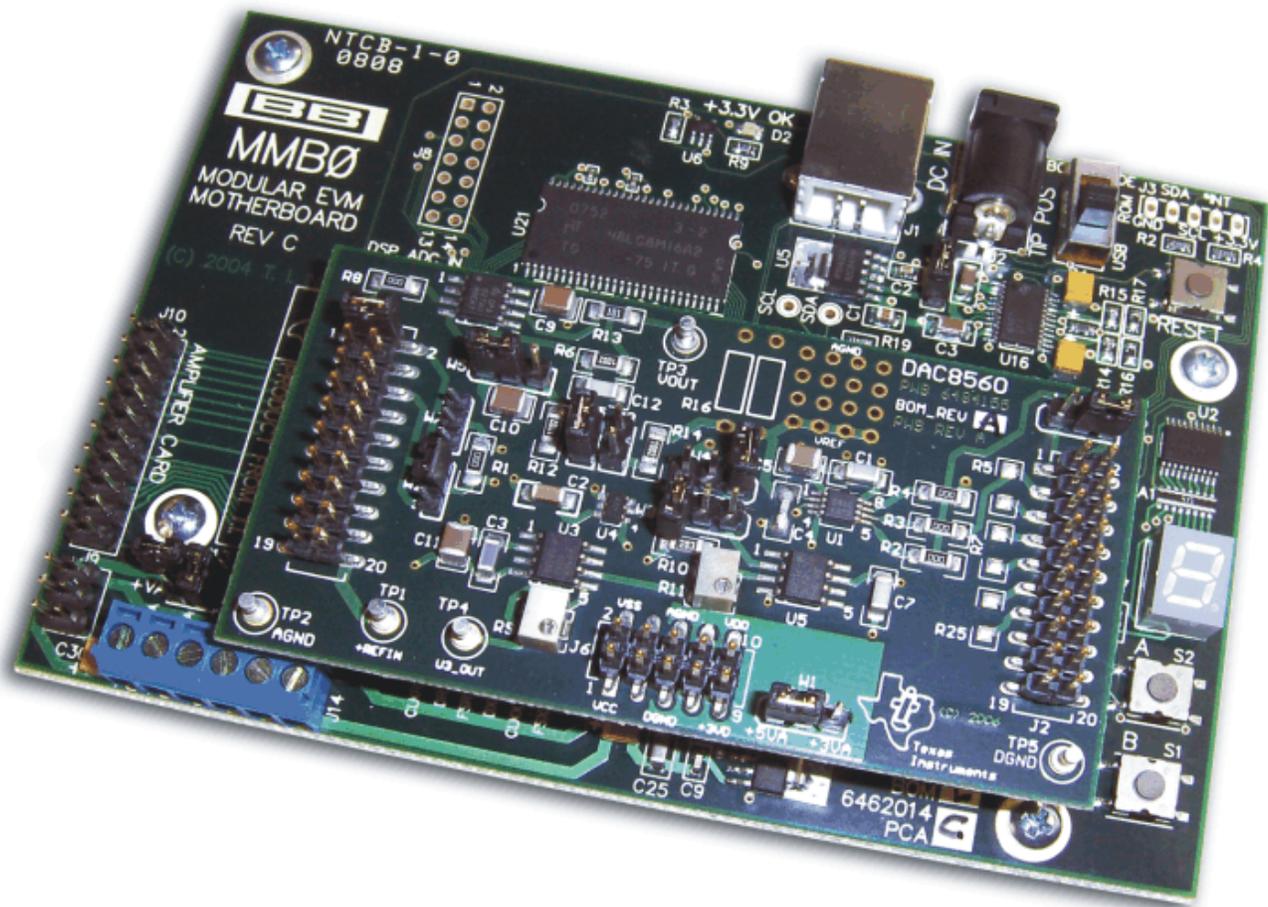
The hardware must be configured such that the DAC8560EVM is plugged onto the MMB0, aligning female connectors J4, J2, and J6 (on the bottom side of the DAC8560EVM) with male connectors J7, J4, and J5 on the MMB0. The assembled hardware is shown in [Figure 11](#).

#### CAUTION

Be sure to exercise caution when assembling the boards. It is possible to misalign the connectors and damage both the EVM and the motherboard.

#### CAUTION

**DO NOT** connect the MMB0 to your PC before installing the DXP software as described in the DXP User's Guide. Installing the software first ensures that the necessary drivers are properly loaded to run the hardware.



**Figure 11. MMB0 with DAC8560EVM Installed**

## 5.2 MMB0 Power Supplies

Several power connections are required for the hardware to work properly. For the MMB0, the supplied 6-V ac/dc converter is all that is necessary. Be sure that J12 on the MMB0 board is closed before connecting the ac/dc adapter to the *DC In* connector of the MMB0. This supply provides all power to the digital portion of the DAC8560EVM as well as all necessary power for the DSP. Clean, well-regulated analog power for the DAC8560EVM should be supplied externally via J14, a six-position screw terminal mounted in the lower left corner of the MMB0 board.

### CAUTION

When using external power supplies applied to J14 on the MMB0, please ensure all shorting blocks from J13 are completely removed. Permanent damage to the MMB0 may occur otherwise

From left to right, the J14 screw terminal connections are  $-VA$ ,  $+VA$ ,  $+5VA$ ,  $-5VA$ ,  $+5VD$ , and GND. The 5V from the ac/dc adapter can be connected to the  $+VA$  or the  $+5VA$  by installing a jumper across JP13A or JP13B. If the jumpers are not installed, the analog  $V_{SS}$ ,  $V_{CC}$ ,  $+5VA$ , and  $-5VA$  may be applied directly to the  $-VA$ ,  $+VA$ ,  $+5VA$ , and  $-5VA$  screw terminals at J14 on the MMB0 (referenced to the GND terminal). The DAC8581 board power requirements are described in [Section 1.2.1](#) of this manual.

### 5.3 Software: Running DXP

Install DXP on a laptop or personal computer running Windows XP according to the detailed instruction in the DXP Users Guide (TI document [SBAU146](#)). Run the DXP program by clicking on the DXP icon on your desktop, or by browsing to your installation directory.

Before you can generate signals with DXP, a DAC EVM configuration file must be loaded. To load a configuration file, select the desired DAC from the configuration list under the *DAC* menu, as [Figure 12](#) illustrates. Choose the DAC configuration file for the device installed on the EVM.

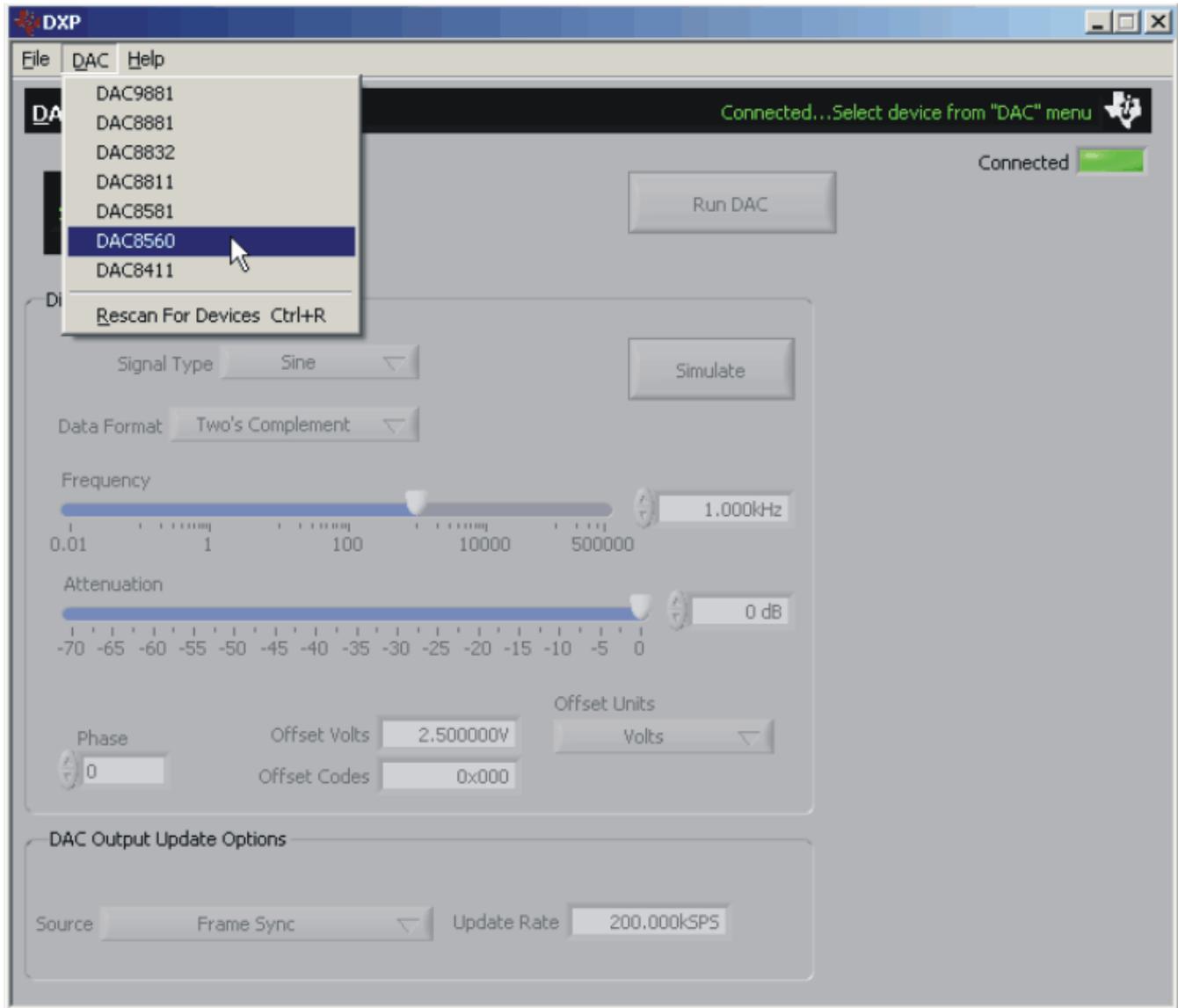
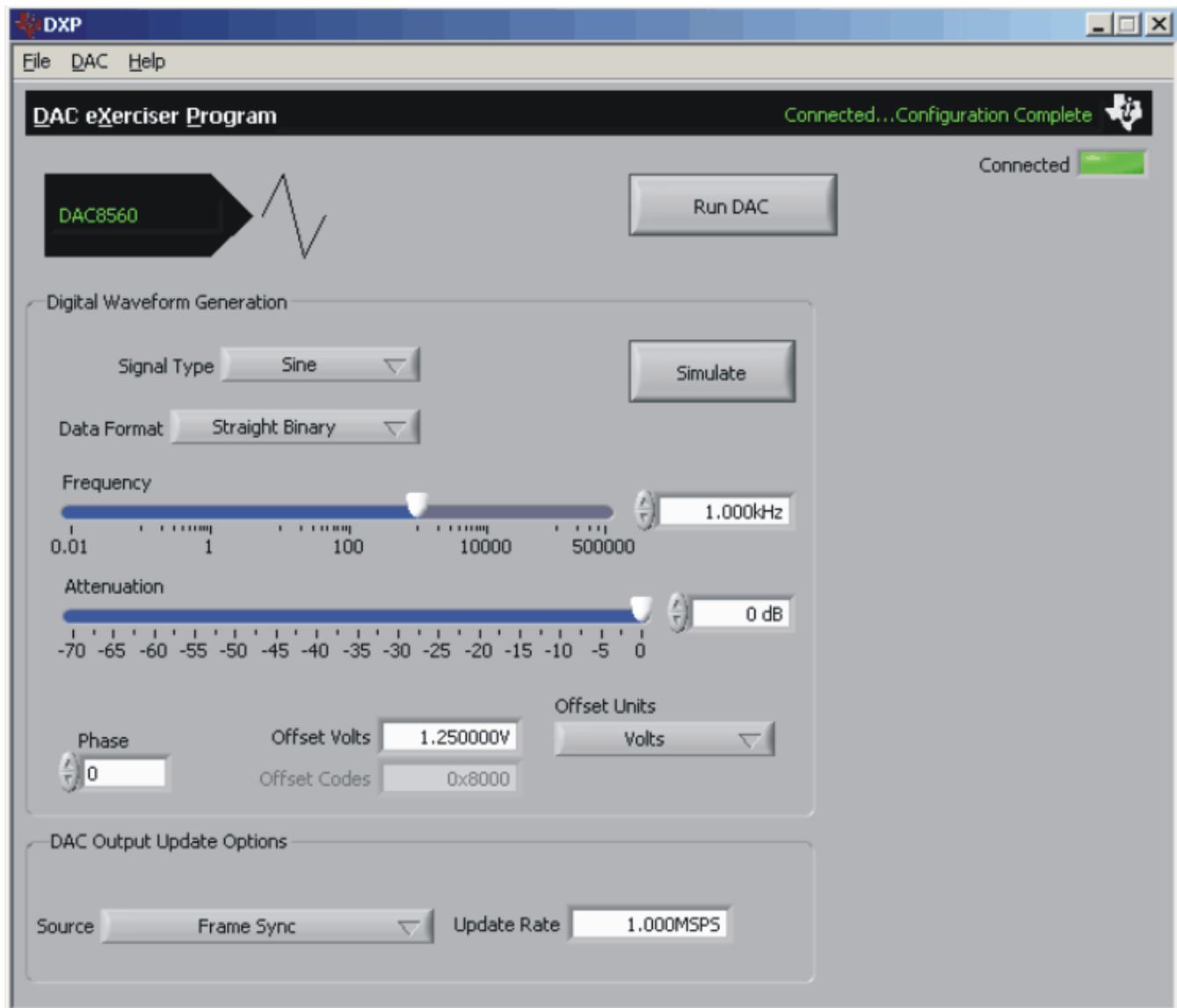


Figure 12. Loading a DAC8560EVM Configuration

The DXP software defaults to output a 1-kHz sine wave from the DAC. Other waveform options include square, sawtooth, triangle, and dc output options, as described in the [DXP User's Guide](#). The frequency and amplitude of the output waveform are controlled by sliders on the DXP software interface. The DAC update rate can also be modified, as shown in [Figure 13](#).



**Figure 13. DAC8560EVM: Frequency/Amplitude and Update Rate Adjustments**

## 5.4 DAC Output Update Options

The DXP software also allows the user to choose several DAC output update options, as [Figure 14](#) shows.



**Figure 14. DAC Output Update Options**

[Table 7](#) lists the details on these options.

**Table 7. Output Update Features**

Options	Detailed Description
Frame Sync	The DXP software defaults to Frame Sync. The Frame Sync output of the MMB0 connects to the SYNC input of the DAC8560. The DAC output changes to the corresponding level when the DAC latch is updated via SDI. Ensure the shunt jumper on W6 is covering pins 2-3 (default is 1-2) to use this feature.
Latch with DSP Timer	N/A
Latch with External Timer	N/A
Update Rate	User Input - enter the desired DAC update rate, 1MSPS is the default

## 6 Bill of Materials

**Table 8. DAC8560EVM Parts List**

Item	Qty	Value	Designators	Description	Vendor	Vendor Part No.
1	3	10kΩ	R6 R12 R14	1/8W 1206 Thick Film Chip Resistor, ±1% Tol	Panasonic	ERJ-8ENF1002V
2	1	20kΩ Trim Pot	R9	5T Potentiometer, 4mm SMD, Cermet	Bourns	3214W-1-203E
3	5	0 Ω	R1–R4 R8	1/4 W 1206 Thick Film Chip Resistor, ±5% Tol	Panasonic	ERJ-8GEY0R00V
4	1	100 Ω	R13	1/4W 1206 Thick Film Chip Resistor, ±5% Tol	Panasonic	ERJ-8GEYJ101V
5	1	20kΩ	R10	1/4W 1206 Thick Film Chip Resistor, ±5% Tol	Panasonic	ERJ-8GEYJ203V
6	1	100kΩ Trim Pot	R11	Potentiometer, 4mm SMD, Cermet	Bourns	3214W-1-104E
7	3	0.1μF	C1 C3 C7	Multilayer Ceramic Chip Capacitor, 1206 SMD, 25V, ±15% TC, ±10% Tol	TDK	C3216X7R1E104KT
8	2	1μF	C9 C10	Multilayer Ceramic Chip Capacitor, 1210 SMD, 25V, ±15% TC, ±10% Tol	TDK	C3225X7R1E105KT
9	1	1nF	C12	Multilayer Ceramic Chip Capacitor, 1206 SMD, 25V, ±15% TC, ±10% Tol	TDK	C3216X7R1H102KT
10	1	0.47μF	C2	Multilayer Ceramic Chip Capacitor, 1206 SMD, 50V, ±15% TC, ±10% Tol	TDK	C3216X7R1H474KT
11	2	10μF	C5 C11	Multilayer Ceramic Chip Capacitor, 1210 SMD, 25V, ±15% TC, ±10% Tol	TDK	C3225X7R1E106KT
12	1	100pF	C4	Multilayer Ceramic Chip Capacitor, 0603 SMD, 50V, 30ppm/°C, ±5% Tol	TDK	C1608COG1H101J
13	1	Bipolar Op-Amp	U5	8-SOP(D) High Precision Low Noise Op-Amp	Texas Instruments	OPA227UA
14	1	16-Bit String DAC	U1	MSOP-8(DGK), 1-CH, SPI, Low Glitch, Voltage Output DAC with Internal reference	Texas Instruments	DAC8560IDDGK
15	1	4.096V Reference	U4	4ppm/°C, 100μA, SOT23-6 VOLTAGE REFERENCE	Texas Instruments	REF3240AIDBV
16	1	5V Reference	U3	15ppm/°C, ±0.2% Tol Output, SOIC-8, Voltage Reference	Texas Instruments	REF02AU

**Table 8. DAC8560EVM Parts List (continued)**

Item	Qty	Value	Designators	Description	Vendor	Vendor Part No.
17	1	Difet Op-Amp	U2	8-SOP(D) Precision High-Speed, Difet Op-Amp	Texas Instruments	OPA627AU
18	2	10 x 2 x 0.1 SMT	J2 J4	20-PIN Terminal Strip	Samtec	TSM-110-01-S-DV-M
19	1	5 x 2 x 0.1 SMT	J6	10-PIN Terminal Strip	Samtec	TSM-105-01-T-DV
20	2	10 x 2 x 0.1 SMT	P2 P4	20-PIN Socket Strip <sup>(1)</sup>	Samtec	SSW-110-22-S-D-VS-P
21	1	5 x 2 x 0.1 SMT		P6 10-PIN Socket Strip <sup>(1)</sup>	Samtec	SSW-105-22-F-D-VS-K
22	5	1 x 1 x 0.061D TH	TP1–TP5	Turret Terminal Pin	Mill-Max	2348-2-00-01-00-00-07-0
23	2	3 x 1 x 0.7874 TH	W2 W7	3-PIN Terminal Strip	Samtec	TMM-103-01-T-S
24	2	2 x 1 x 0.1 TH	W3 W15	Modified 0.025" Square Post Header	Samtec	MTSW-102-08-T-S-295
25	5	3 x 1 x 0.1 TH	W1 W4–W6 W8	Modified 0.025" Square Post Header	Samtec	MTSW-103-08-T-S-295
26	0	N/A	N/A	Schematic Diagram	Texas Instruments	6484156
27	1	N/A	N/A	Printed Wiring Board	Texas Instruments	6484155
28	0	N/A	N/A	Printed Circuit Assembly	Texas Instruments	6484157
29	0	N/A	N/A	29 0 N/A N/A Kit Assembly	Texas Instruments	6484158
30	5	Do Not Populate	C6 R5 R7 R16 R25	Do not install these components <sup>(1)</sup>		
31	1	2mm Shunt	N/A	Shorting Block for W2	Samtec	2SN-BK-G
32	6	0.100 Shorting Blocks	N/A	Shorting Blocks	Samtec	SNT-100-BK-G-H

<sup>(1)</sup> P2, P4, and P6 parts are not shown in the schematic diagram. All the P-designated parts are installed in the bottom side of the PC board opposite the J-designated counterpart. Example, J2 is installed on the topside whereas P2 is installed in the bottom side opposite of J2. **Do NOT** install the following: C6, R5, R7, R16, and R25.

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It is important to operate this EVM within the input voltage range of +2.7 V to +5 V and the output voltage range of -5 V to +5 V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

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During normal operation, some circuit components may have case temperatures greater than +30° C. The EVM is designed to operate properly with certain components above +85° C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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