

EVM User's Guide: DAC121S101SEPEVM

DAC121S101-SEP Evaluation Module



Description

The [DAC121S101SEPEVM](#) is an easy-to-use platform to evaluate the functionality and performance of the [DAC121S101-SEP](#) device. The DAC121S101SEPEVM has optional circuits and jumpers to configure the device for different applications.

The DAC121S101-SEP device is a full-featured, general-purpose, 12-bit voltage-output digital-to-analog converter (DAC) that can operate from a single 2.7V to 5.5V supply and consumes just 177µA of current at 3.6V.

Get Started

1. Order the [DAC121S101SEPEVM](#).
2. Configure EVM jumpers.
3. Install the DAC121S101SEPEVM GUI from the [DAC121S101SEPEVM tool folder](#).

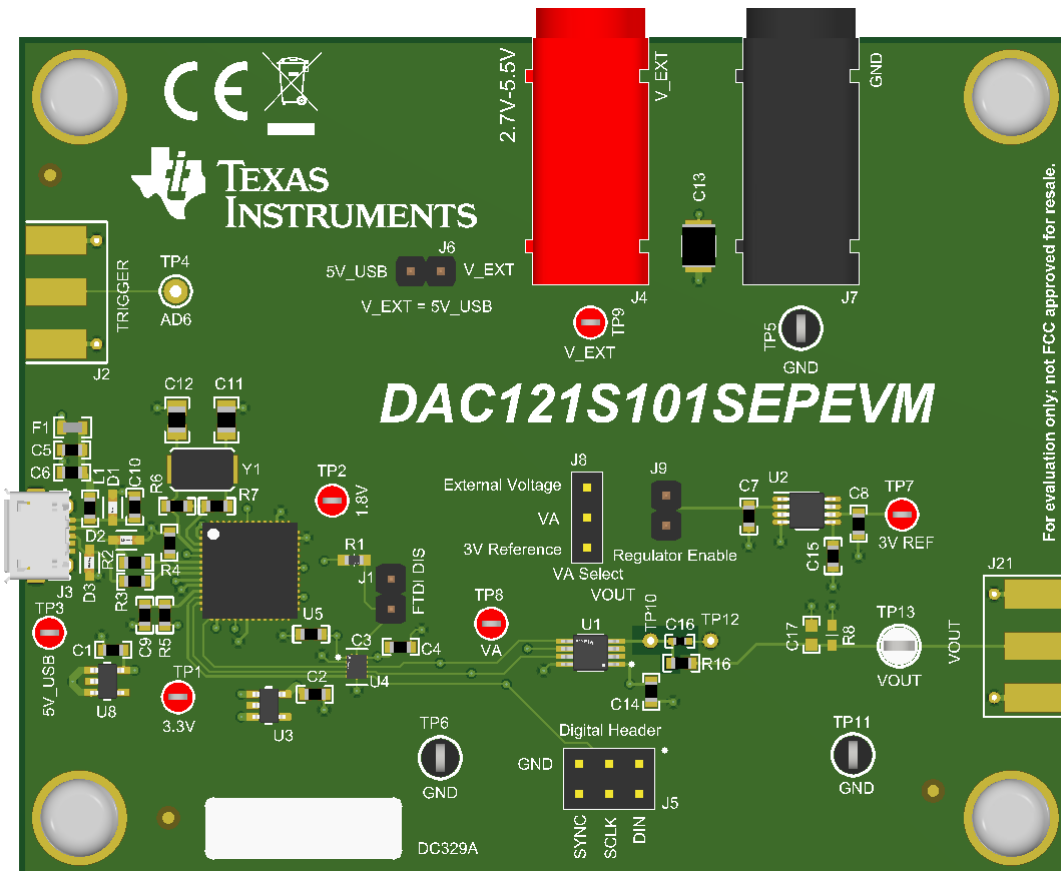
4. Download the latest libraries.
5. Connect USB and external power supplies.
6. Launch the DAC121S101SEPEVM GUI.

Features

- Configurable circuit to evaluate the DAC121S101-SEP
- Onboard VDD (5V) support via USB
- Onboard precision 3V voltage regulator
- FT4232 easily writes to the DAC using the DAC121S101SEPEVM GUI
- External SPI connections available

Applications

- [Satellites](#)
 - [Altitude and orbit control](#)
 - [Precision sensors](#)
 - [Motor control](#)



1 Evaluation Module Overview

1.1 Introduction

This user's guide describes the characteristics, operation, and recommended use cases of the DAC121S101SEPEVM. This document provides examples and instructions on how to use the DAC121S101SEPEVM board and included software. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the DAC121S101SEPEVM. This document also includes schematics, the reference printed circuit board (PCB) layouts, and a complete bill of materials (BOM).

1.2 Kit Contents

The contents of the EVM kit are shown in [Table 1-1](#). Contact the TI Product Information Center at (972) 644-5580 if any component is missing. Download the latest versions of the related software on the TI website, www.ti.com.

Table 1-1. DAC121S101SEPEVM Kit Contents

Item	Quantity
DAC121S101SEPEVM board	1
USB micro-B plug to USB-A plug cable	1

1.3 Specification

The EVM is intended to provide basic functional evaluation of the device. The layout is not intended to be a model for the target circuit, nor laid out for electromagnetic compatibility (EMC) testing. The EVM consists of a printed-circuit board (PCB), which has the DAC121S101-SEP installed.

1.4 Device Information

The DAC121S101 device is a full-featured, general-purpose, 12-bit voltage-output digital-to-analog (DAC) that can operate from a single 2.7V to 5.5V supply and consumes just 177 μ A of current. The on-chip output amplifier allows rail-to-rail output swing and the three wire serial interface operates at clock rates up to 30MHz over the specified supply voltage range and is compatible with standard SPI, QSPI, MICROWIRE and DSP interfaces. Competitive devices are limited to 20MHz clock rates at supply voltages in the 2.7V to 3.6V range.

The supply voltage for the DAC121S101 serves as the voltage reference, providing the widest possible output dynamic range. A power-on reset circuit verifies that the DAC output powers up to zero volts and remains there until there is a valid write to the device. A power-down feature reduces power consumption to less than a microWatt.

The low power consumption and small packages of the DAC121S101 makes the device an excellent choice for use in battery operated equipment.

2 Hardware

2.1 Hardware Setup

This section describes the overall system setup for the EVM. A personal computer (PC) runs software that communicates with the onboard FTDI controller using SPI protocol.

2.1.1 Hardware Theory of Operation

The DAC121S101SEPEVM is connected to the computer through the onboard FTDI digital controller using the USB cable that is supplied with the EVM. The evaluation board features connectors and test points for all communication lines, supplies, and the DAC output. A block diagram of the DAC121S101SEPEVM is shown in Figure 2-1.

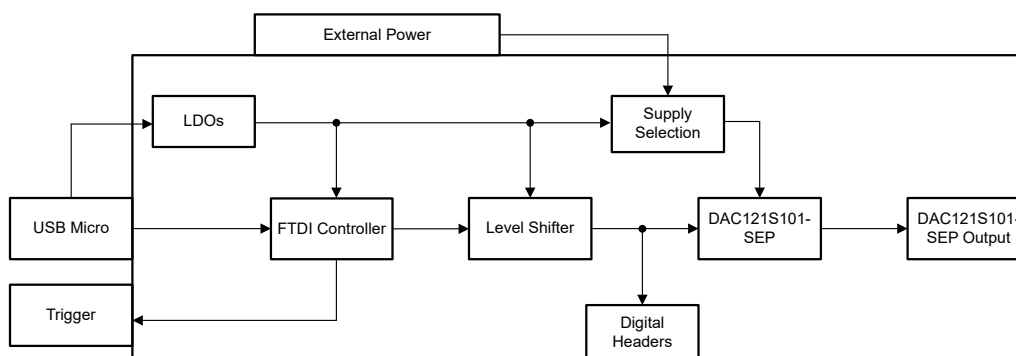


Figure 2-1. Theory of Operation Block Diagram

The USB connection provides the 5V supply to the EVM. Voltage regulators generate 3.3V and 1.8V from the USB 5V supply. These 1.8V and 3.3V supplies are used to power the FTDI controller.

The DAC121S101-SEP VA has multiple supply options. By default, VA is connected to the USB-5V supply through jumpers J6 and J8. VA can be supplied by an external power supply through banana jack J4 by removing the shunt on J6 and connecting pins 1 and 2 on J8. In addition, the EVM comes with a precision 3V voltage regulator. The regulator can be enabled by shorting J9 to and connecting pins 2 and 3 on jumper J8.

There are multiple unpopulated components on the EVM that can be populated to change the configuration of the EVM:

- C17 and R8 are 0603 footprints for capacitor or resistor loads on the VOUT output.
- J2 and J21 are an optional SMA outputs. For more information, see Table 2-3.

2.1.2 Jumper Definitions

The jumper definitions of the DAC121S101SEPEVM are shown in Table 2-1.

Table 2-1. Jumper Definitions

Designator	Name	Positions
J1	FTDI DIS	SHORT 1-2 - Disconnects the DAC121S101-SEP from the FTDI driver. OPEN - The FTDI driver is connected to the DAC121S101-SEP (default).
J6	V_EXT = 5V_USB	SHORT 1-2 - The external voltage is connected to the 5V USB voltage (default). OPEN - The external voltage is not connected to the 5V USB voltage.
J8	VA Select	SHORT 1-2 - VA is powered by the external voltage (default). SHORT 2-3 - VA is powered by the on-board 3V regulator.
J9	Regulator Enable	SHORT 1-2 - The power supply of the on-board 3V regulator is connected to the external voltage. This enables the regulator. OPEN - The on-board 3V regulator is disabled (default).

2.1.3 Connector Definitions

The power connector definitions of the DAC121S101SEPEVM is shown in [Table 2-2](#).

Table 2-2. Power Connector Definitions

Designator	Definition
J3	USB connector
J4	DAC121S101-SEP external supply (2.7V to 5.5V). Connects to VA through jumper J8.
J7	DAC121S101-SEP Ground

The optional connector definitions of the DAC121S101SEPEVM are shown in [Table 2-3](#).

Table 2-3. Optional Connector Definitions

Designator	Definition
J2	FTDI Trigger output SMA (unpopulated)
J21	DAC121S101-SEP VOUT SMA (unpopulated)

2.1.4 Test Points

The DAC121S101SEPEVM has a variety of test points available for measuring and debugging purposes. The purpose of each test point is explained in [Table 2-4](#).

Table 2-4. DAC121S101SEPEVM Test Points

Test Point	Net	Description
TP1	3p3V	3.3V regulator output
TP2	1p8V	1.8V regulator output
TP3	5V_USB	5V USB voltage
TP4	AD6	Trigger test point (unpopulated)
TP5	GND	Ground test point
TP6	GND	Ground test point
TP7	3V_REF	3V regulator output
TP8	VA	DAC121S101-SEP VA supply
TP9	V_EXT	External voltage supply
TP10	VOUT	Dedicated VOUT test point for glitch measurement
TP11	GND	Ground test point
TP12	GND	Dedicated GND test point for glitch measurements
TP13	VOUT	DAC121S101-SEP VOUT

2.2 Hardware Overview

This section details how to configure the EVM for and voltage outputs using SPI. The following subsections provide detailed information on the EVM hardware for SPI. (see also [Section 2.1.2](#)).

2.2.1 Electrostatic Discharge Caution

CAUTION

Many of the components on the DAC121S101SEPEVM are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap at an approved ESD workstation.

2.2.2 Connecting the FTDI Digital Controller

To connect the FTDI digital controller on the EVM board to the PC, align and firmly connect the USB connector to the J3 connector. Verify the connection is snug; a loose connection can cause intermittent operation. A 100 mil header (J5) is available for external communication. The J5 pin definitions are listed in [Table 2-5](#). To use external communication, place a shunt on J1 to disconnect the FTDI controller from the DAC121S101-SEP.

Table 2-5. Digital Header J5 Definitions

Pin	Definition
2	DIN
4	SCLK
6	SYNC
1, 3, 5	GND

2.2.3 Glitch Testing

The DAC121S101SEPEVM has dedicated test points for measuring glitch on the VOUT pin. Test point TP10 and capacitor C16 are isolated from the ground and power plane on the EVM. To best measure glitch, remove R16 to isolate the VOUT pin from the rest of the EVM circuitry and populate C16 with the desired capacitive load. A probe can be placed across TP10 and TP12. The glitch measurement taken with the DAC121S101SEPEVM is shown in [Figure 2-2](#). In this example, C12 was populated with a 3.3pF capacitor and the glitch was captured on the rising edge between codes 0x07FF to 0x0800.

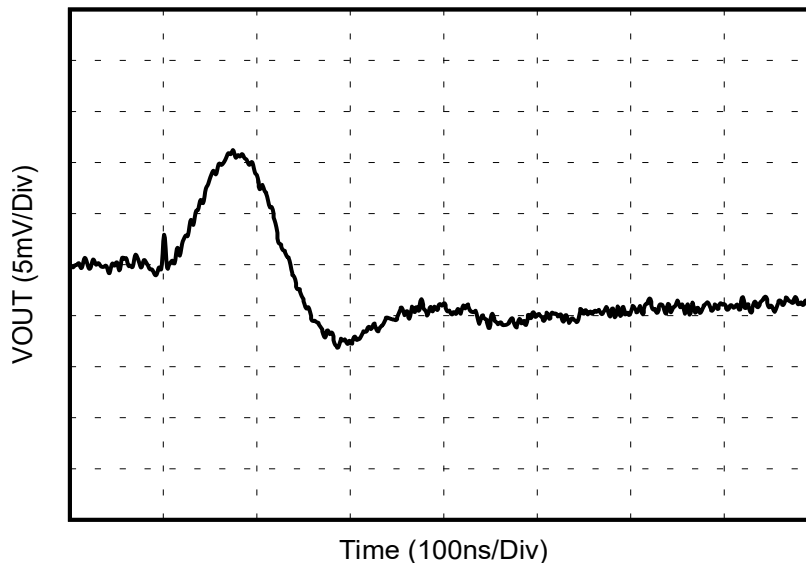


Figure 2-2. Glitch Testing

3 Software

3.1 Software Setup

This section provides the procedure for EVM software installation.

3.1.1 Software Installation

Note

Do not connect the EVM to the PC when the software is installing.

Download the latest version of the EVM graphical user interface (GUI) installer from the *Order and start development* subsection of the [DAC121S101SEPEVM tool folder](#) on TI.com. Run the GUI installer to install the DAC121S101SEPEVM GUI software on your PC. The software installation automatically copies the required LabVIEW™ software files and drivers to the PC.

When the DAC121S101SEPEVM GUI is launched, an installation dialog window opens and prompts the user to select an installation directory. If left unchanged, then the software location defaults to *C:\Program Files (x86)\Texas Instruments\DAC121S101SEPEVM GUI*, as shown in [Figure 3-1](#).

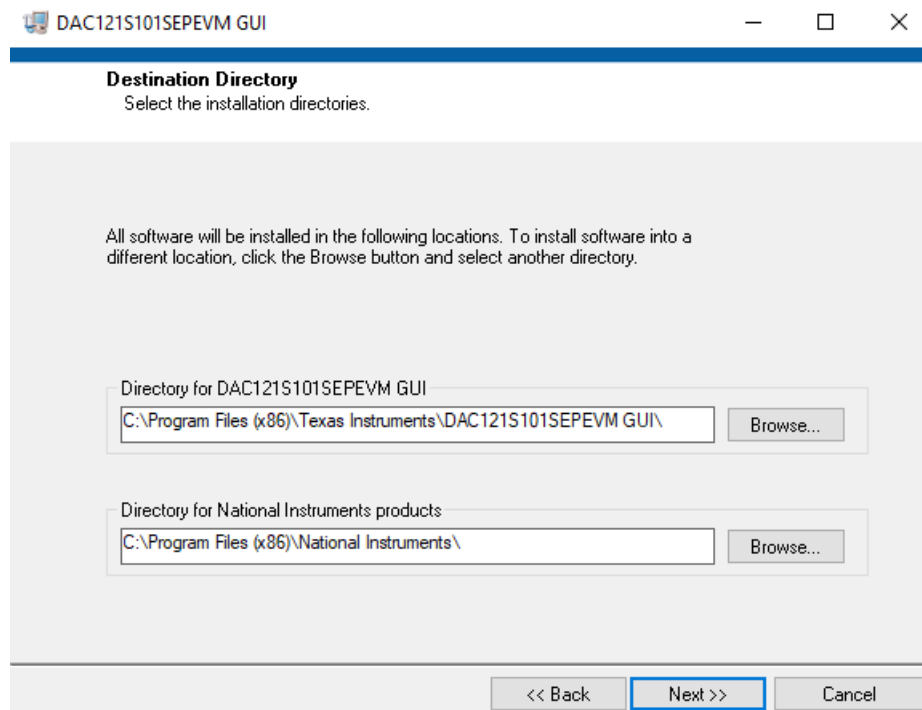


Figure 3-1. Software Installation Path

The EVM software also installs the Future Technology Devices International Limited (FTDI) USB drivers using a separate executable file. The FTDI USB drivers installation window that is automatically launched after the DAC121S101SEPEVM software installation is complete, as shown in [Figure 3-2](#).

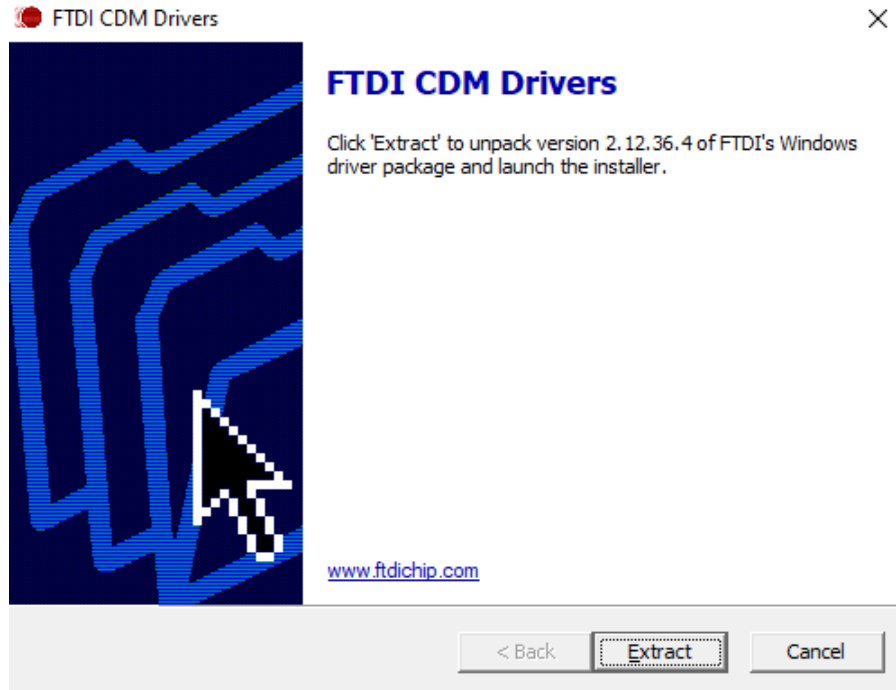


Figure 3-2. FTDI USB Drivers

3.2 Software Overview

This section discusses how to use the DAC121S101SEPEVM software.

3.2.1 Launching the Software

If installed in the default directory, then launch the DAC121S101SEPEVM software by searching for *DAC121S101SEPEVM* in the Windows® *Start* menu.

The GUI after launch is shown in [Figure 3-3](#).

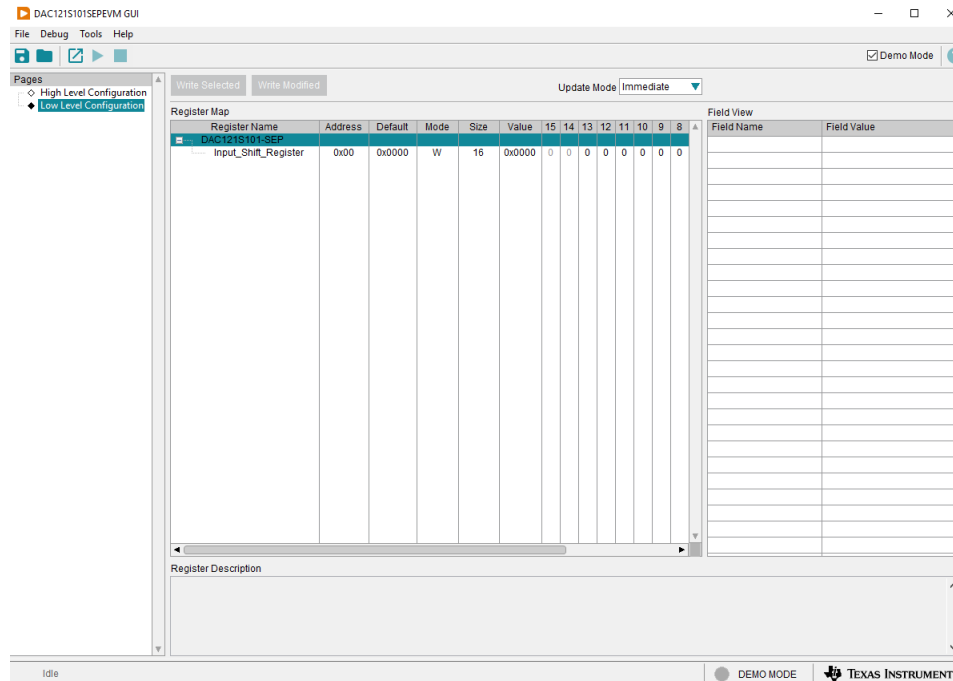


Figure 3-3. DAC121S101SEPEVM GUI at Launch

If the FTDI controller is not connected to the PC when the software is launched, then the GUI defaults to *demo* mode. The bottom-left corner of the GUI that shows the hardware connection status: DEMO MODE or CONNECTED, as shown in [Figure 3-4](#). After the FTDI controller is properly connected to the PC, restart the DAC121S101SEPEVM software to detect the device.

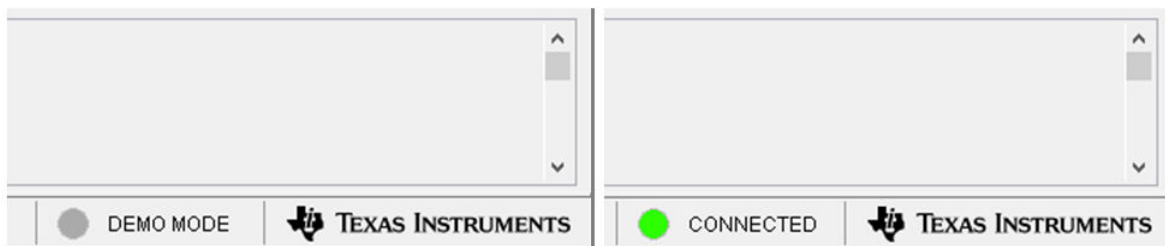


Figure 3-4. FTDI Digital Controller Connection Status

3.2.2 Software Features

The DAC121S101SEPEVM GUI allows for SPI communication to the DAC121S101-SEP. Although the entire register map is available for use, some features have been abstracted into user controls in the *High-Level Configuration* page for easy operation.

3.2.2.1 Low Level Configuration Page

The DAC121S101SEPEVM *Low Level Configuration* page of the DAC121S101SEPEVM GUI is shown in [Figure 3-5](#). This page allows direct access to the DAC register in the DAC121S101-SEP. The GUI handles page address management, allowing seamless access to the register. Directly above the *Register Map* section are two buttons that allow for write access to the register.

Select the register on the Register Map list to show a description of the values in that register, as well as information on the register address, default value, size, and current value. Data is written to the register by entering a value in the value column of the GUI.

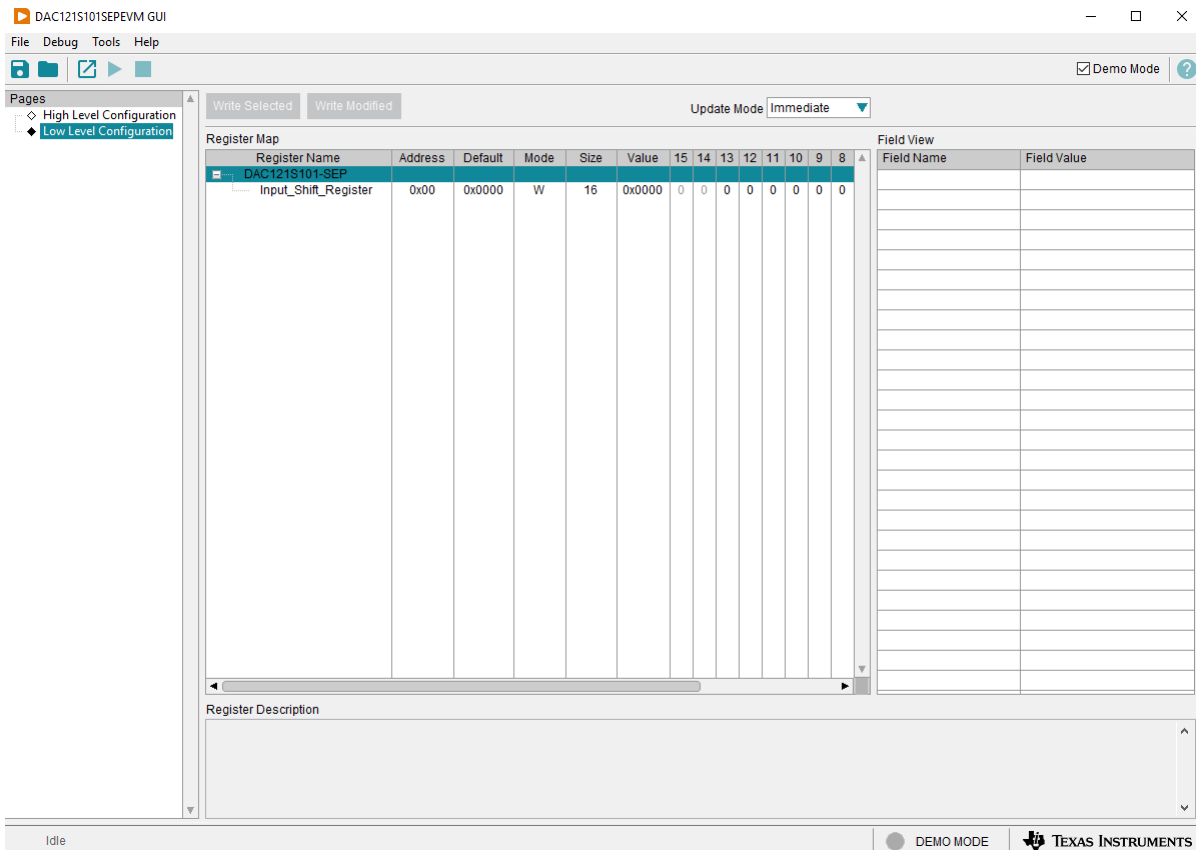


Figure 3-5. Low Level Configuration Page

3.2.2.2 High Level Configuration Page

The *High Level Configuration* page is used to set the configuration of the DAC121S101SEPEVM GUI. This page acts as a shortcut to configure the DAC121S101-SEP for basic functionality and testing.

The *High Level Configuration* page is shown in [Figure 3-6](#). This page is used to set the operation of the device and the output of the DAC.

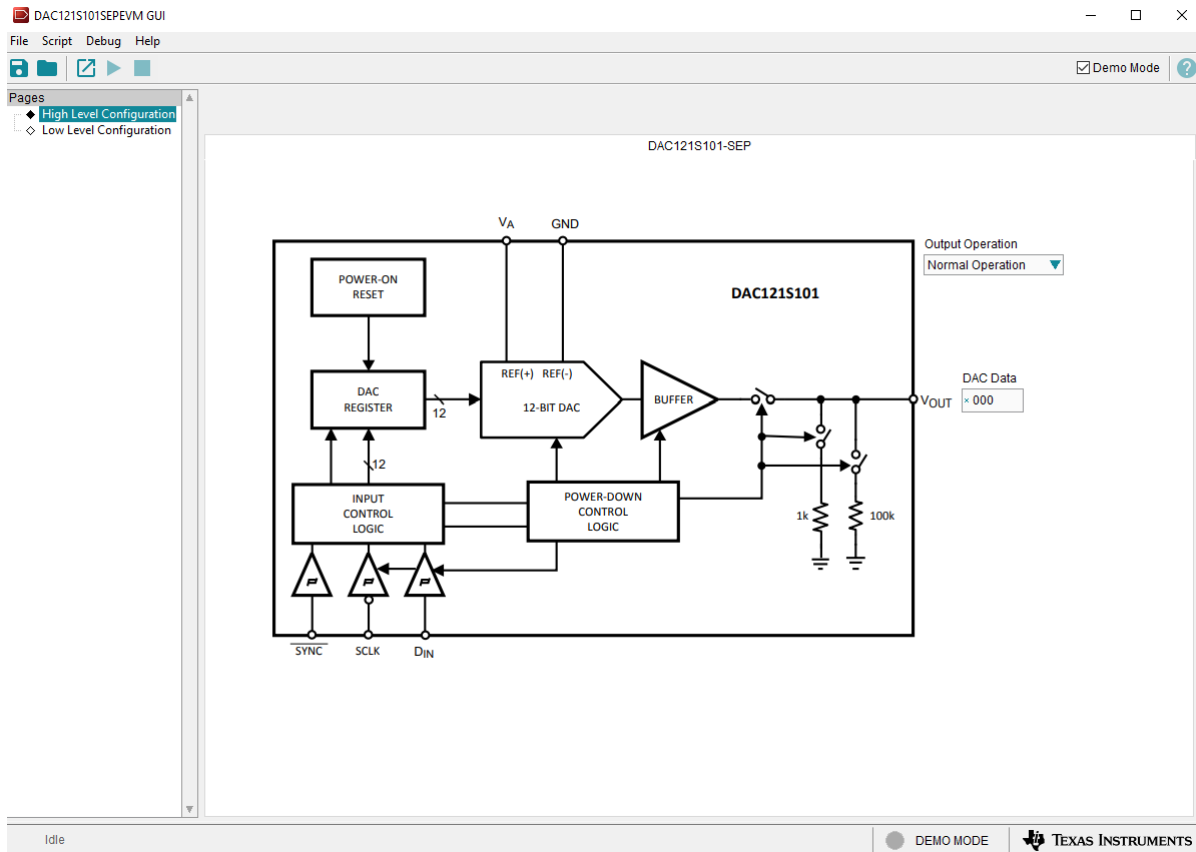


Figure 3-6. High Level Configuration Page

4 Hardware Design Files

4.1 Schematics

The DAC121S101SEPEVM schematics are shown in Figure 4-1 and Figure 4-2.

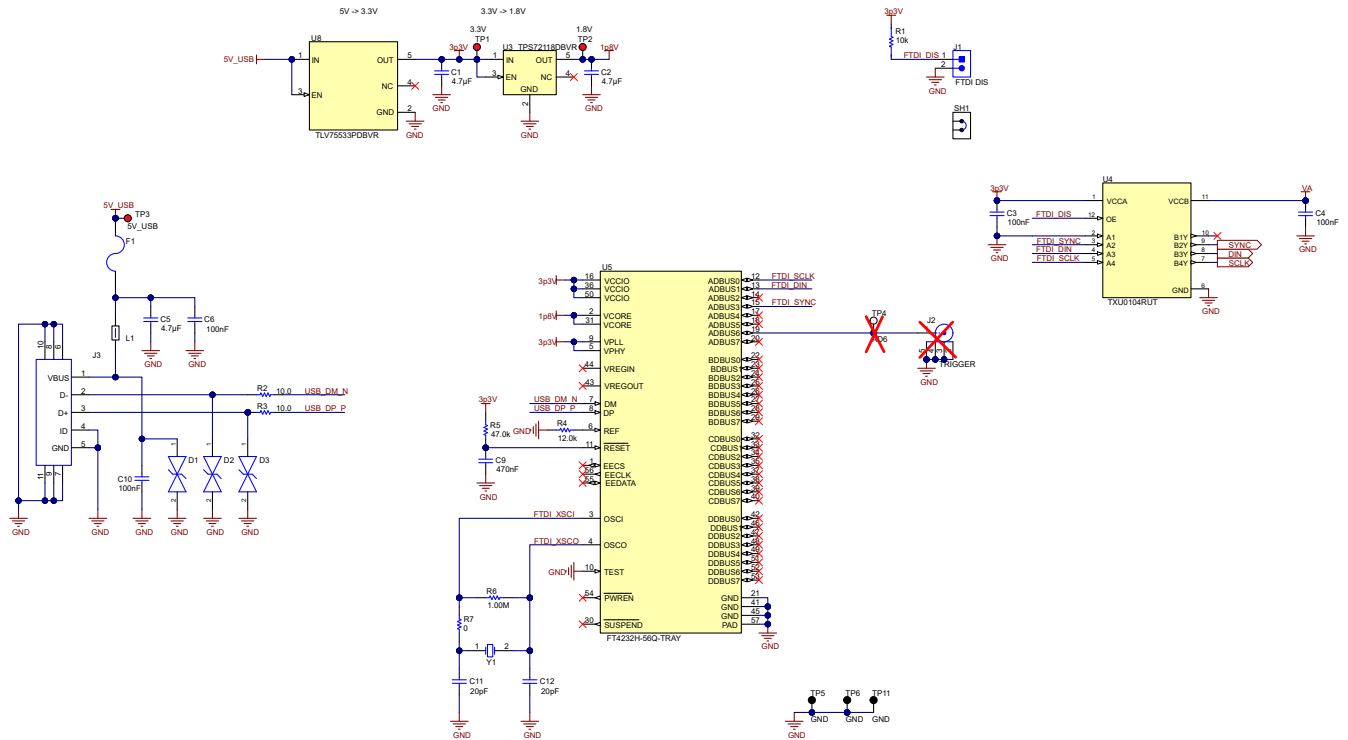


Figure 4-1. DAC121S101SEPEVM FTDI Schematic

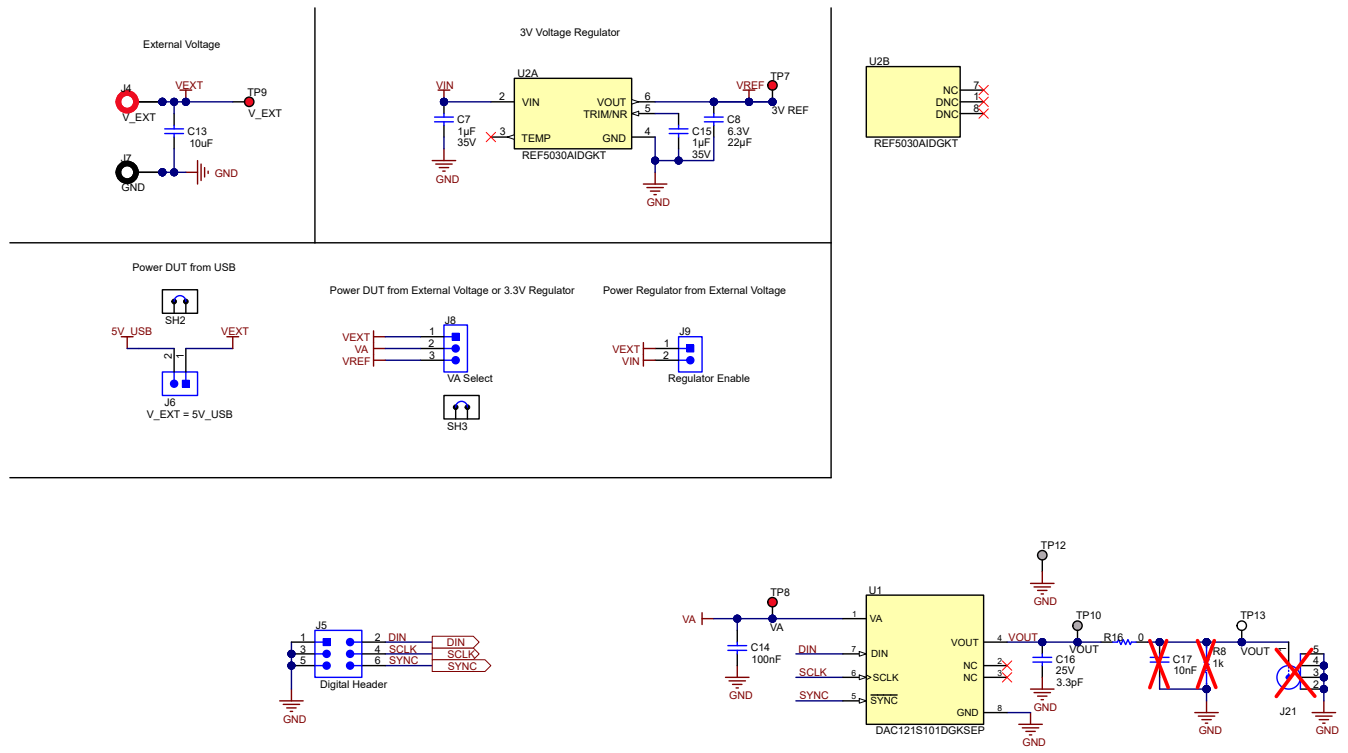


Figure 4-2. DAC121S101SEPEVM DUT Schematic

4.2 PCB Layout

The board layout for the DAC121S101SEPEVM is shown in [Figure 4-3](#) through [Figure 4-6](#).

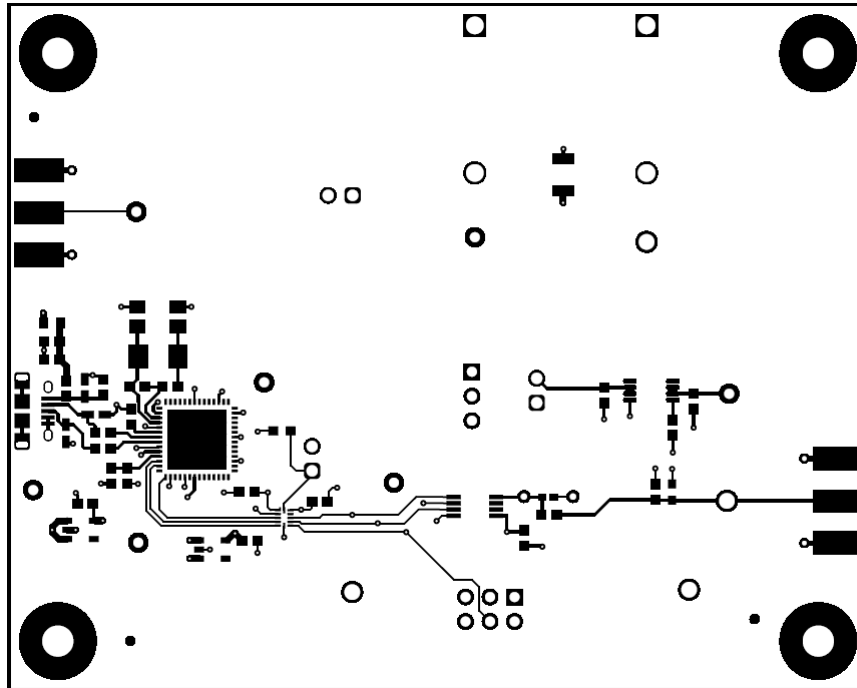


Figure 4-3. DAC121S101SEPEVM PCB Top Layer Layout

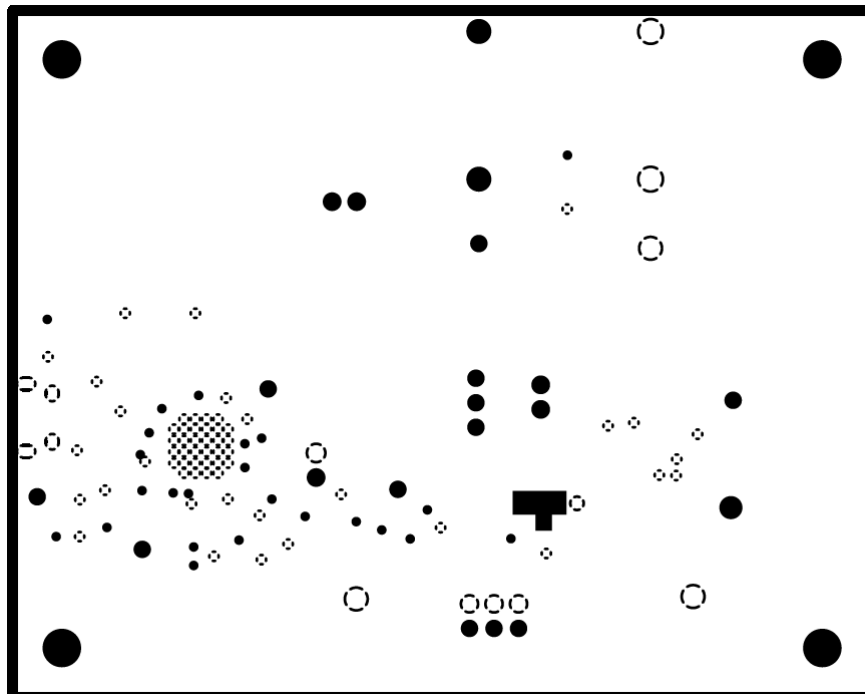


Figure 4-4. DAC121S101SEPEVM PCB Mid Layer 1 Layout (Ground Plane)

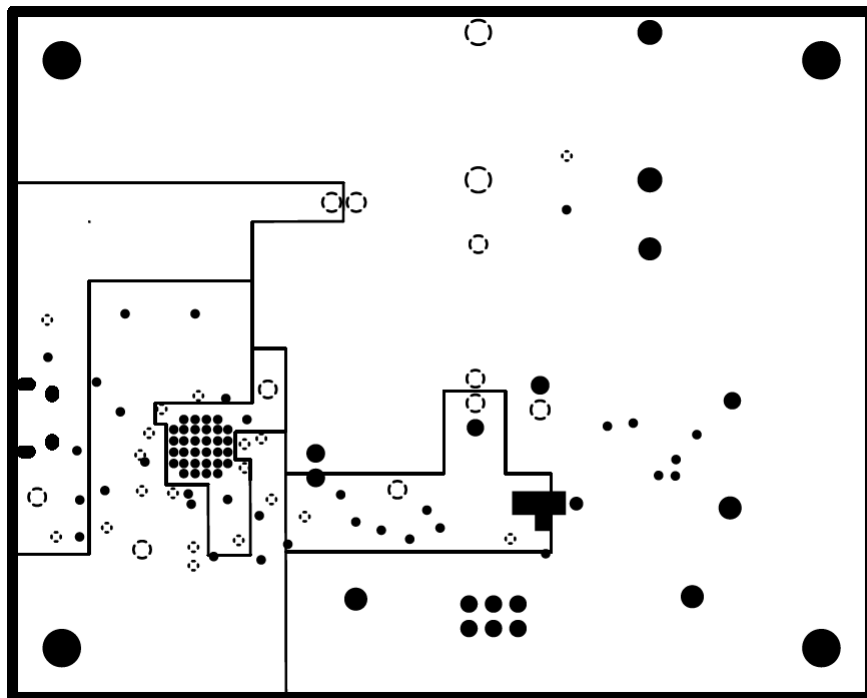


Figure 4-5. DAC121S101SEPEVM PCB Mid Layer 2 Layout (Power Plane)

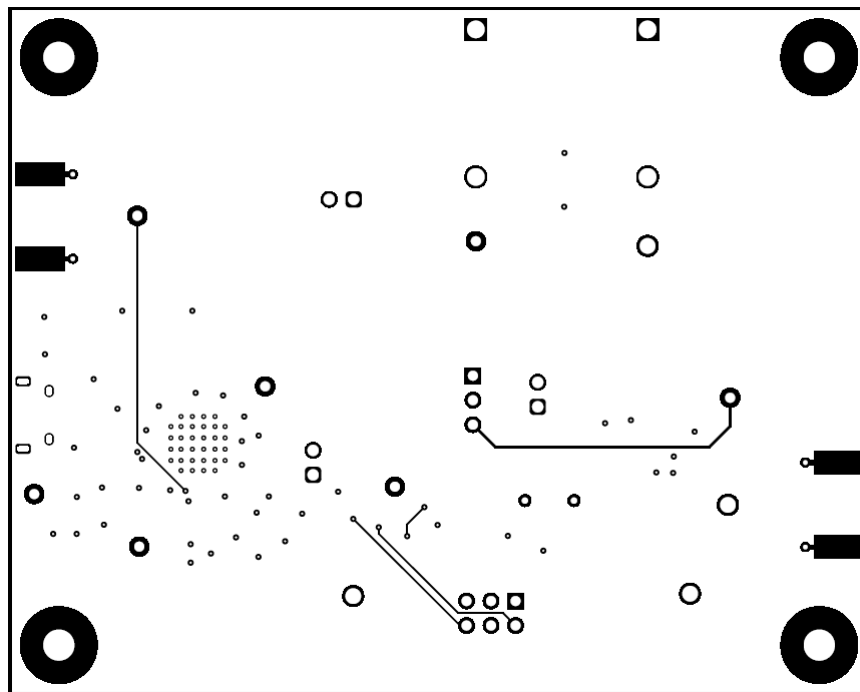


Figure 4-6. DAC121S101SEPEVM PCB Bottom Layer Layout

4.3 Bill of Materials

The DAC121S101SEPEVM bill of materials (BOM) is listed in [Table 4-1](#).

Table 4-1. Bill of Materials for the DAC121S101SEPEVM

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C1, C2, C5	3	4.7 μ F	CAP, CERM, 4.7 μ F, 16V,+/- 10%, X7R, 0603	0603	GRM188Z71C475KE21D	MuRata
C3, C4, C6, C10, C14	5	0.1 μ F	CAP, CERM, 0.1 μ F, 50V,+/- 10%, X7R, AEC-Q200 Grade 0, 0603	0603	06035C104K4Z4A	AVX
C7, C15	2	1 μ F	CAP, CERM, 1 μ F, 35V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E1X7R1V105K080AE	TDK
C8	1	22 μ F	CAP, CERM, 22 μ F, 6.3V,+/- 20%, X6S, 0603	0603	GRM188C80J226ME15D	MuRata
C9	1	0.47 μ F	CAP, CERM, 0.47 μ F, 25V, +/- 10%, X7R, 0603	0603	GRM188R71E474KA12D	MuRata
C11, C12	2	20pF	CAP, CERM, 20pF, 100V, +/- 5%, C0G/NP0, 0805	0805	08051A200JAT2A	AVX
C13	1	10 μ F	CAP, CERM, 10 μ F, 25V, +/- 10%, X7R, 1210	1210	C1210C106K3RACTU	Kemet
C16	1	3.3pF	CAP, CERM, 3.3pF, 25V, +/- 5%, C0G/NP0, 0402	0402	GRM1555C1E3R3CA01D	MuRata
D1, D2, D3	3		150V (Typ) Clamp Ipp Tvs Diode Surface Mount 0603 (1608 Metric)	0603	PGB1010603MRHF	Littelfuse Inc
F1	1		Fuse, 0.5A, 50 VDC, SMD	0603	SF-0603F050-2	Bourns
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J6, J9	3		Header, 2.54mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	61300211121	Wurth Elektronik
J3	1		Receptacle, USB 2.0, Micro-USB Type B, R/A, SMT	USB-micro B USB 2.0, 0.65mm, 5 Pos, R/A, SMT	10118194-0001LF	FCI
J4	1		Standard Banana Jack, insulated, 10A, red	571-0500	571-0500	DEM Manufacturing
J5	1		Header, 100mil, 3x2, Gold, TH	3x2 Header	TSW-103-07-G-D	Samtec
J7	1		Standard Banana Jack, insulated, 10A, black	571-0100	571-0100	DEM Manufacturing
J8	1		Header, 100mil, 3x1, Gold, TH	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions
L1	1	600 Ω	Ferrite Bead, 600 Ω at 100MHz, 1A, 0603	0603	782633601	Wurth Elektronik
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady

Table 4-1. Bill of Materials for the DAC121S101SEPEVM (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
R1	1	10kΩ	10kΩ ±0.1% 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Current Sense Thin Film	0603	CRT0603-BY-1002ELF	Bourns Inc.
R2, R3	2	10Ω	RES, 10Ω, 1%, 0.1 W, 0603	0603	RC0603FR-0710RL	Yageo
R4	1	12.0kΩ	RES, 12kΩ, 1%, 0.1 W, 0603	0603	RC0603FR-0712KL	Yageo
R5	1	47.0kΩ	RES, 47kΩ, 1%, 0.1 W, 0603	0603	RC0603FR-0747KL	Yageo
R6	1	1MΩ	RES, 1MΩ, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603FG1M00	Stackpole Electronics Inc
R7, R16	2	0Ω	RES, 0Ω, 5%, 0.1 W, 0603	0603	RC0603JR-070RL	Yageo
SH1, SH2	2		Shunt, 100mil, Gold plated, Black	Shunt 2 pos. 100 mil	881545-2	TE Connectivity
TP1, TP2, TP3, TP7, TP8, TP9	6		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone, Keystone Electronics
TP5, TP6, TP11	3		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone Electronics
TP13	1		Test Point, Compact, White, TH	White Compact Testpoint	5007	Keystone Electronics
U1	1		12-Bit Micro Power, RRO Digital-to-Analog Converter, VSSOP8	VSSOP8	DAC121S101DGKSEP	Texas Instruments
U2	1		Low Noise, Very Low Drift, Precision Series Voltage Reference, DGK0008A (VSSOP-8)	DGK0008A	REF5030AIDGKT	Texas Instruments
U3	1		Single Output Low Input Voltage Requirement LDO, 150mA, Fixed 1.8V Output, 1.8 to 5.5V Input, with Low IQ, 5-pin SOT-23 (DBV), -40 to 125 degC, Green (RoHS & no Sb/Br)	DBV0005A	TPS72118DBVR	Texas Instruments
U4	1		4-Bit Fixed Direction Voltage-Level Translator with SchmittTrigger Inputs, and Tri-State Outputs	UQFN12	TXU0104RUT	Texas Instruments
U5	1		Future Technology Devices International Ltd FT4232H Quad High Speed USB to Multipurpose UART/MPSSE IC, VQFN-56	VQFN-56	FT4232H-56Q-TRAY	FTDI
U8	1		500mA, Low IQ, Small Size, Low Dropout Regulator, DBV0005A (SOT-23-5)	DBV0005A	TLV75533PDBVR	Texas Instruments
Y1	1		Crystal, 12MHz, 18pF, SMD	ABM3	ABM3-12.000MHZ-B2-T	Abracon Corporation

5 Additional Information

5.1 Trademarks

LabVIEW™ is a trademark of National Instruments Corporation.
Windows® is a registered trademark of Microsoft Corporation.
All trademarks are the property of their respective owners.

6 Related Documentation

The documents in [Table 6-1](#) provide information regarding Texas Instruments integrated circuits used in the assembly of the DAC121S101SEPEVM. This user's guide is available from the TI web site under literature number SLAU934. Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions are available from the TI web site at www.ti.com, or call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number.

Table 6-1. Related Device Documentation

Document	Literature Number
DAC121S101-SEP product data sheet	SLASFK2

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductor products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。日本テキサス・イ

ンスツルメンツ株式会社

東京都新宿区西新宿 6 丁目 2 4 番 1 号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。 <https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html>

3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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4. *EVM Use Restrictions and Warnings:*
 - 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
 - 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
 - 4.3 *Safety-Related Warnings and Restrictions:*
 - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
 - 4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
 - 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.
 5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.
 6. *Disclaimers:*
 - 6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
 - 6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.
 7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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