EVM User's Guide: DAC8N-DGK-EVM

DAC8N-DGK-EVM

Description

The DAC8N-DGK-EVM is an easy-to-use platform to evaluate the functionality and performance of the DAC8N family of devices. The DAC8N-DGK-EVM supports devices with the DGK package. The DAC8N-DGK-EVM has optional circuits and jumpers to configure the device for different applications. The EVM comes with an FT4232 installed to facilitate easy SPI and I^2C communication between the EVM and the GUI. The DAC8N041 comes installed on the EVM.

Get Started

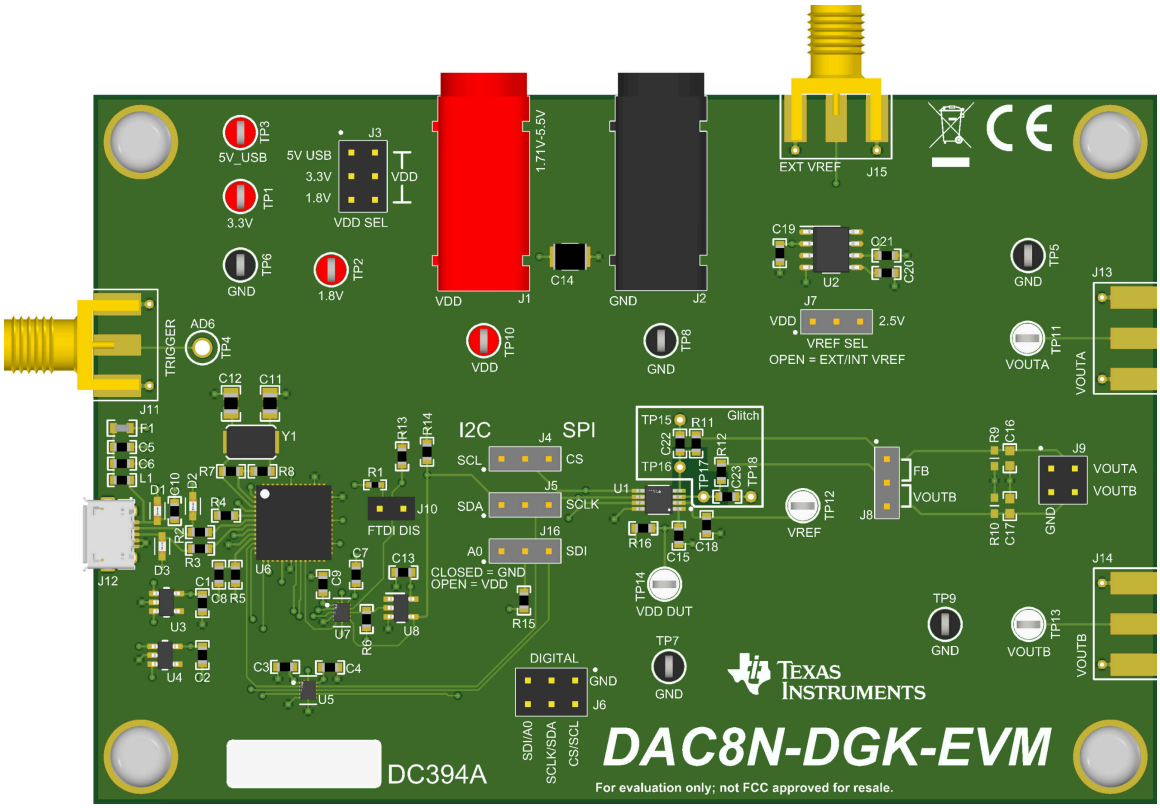
1. Order the EVM.
2. Configure EVM jumpers.
3. Install the DAC8N GUI from the resources folder.
4. Connect the USB and external power supplies.
5. Launch the DAC8N GUI.

Features

- Configurable circuit to evaluate the DAC8N devices with the DGK package
- Onboard VDD (5V, 3.3V, and 1.8V) support using USB
- Onboard 2.5V reference
- Onboard FT4232 used to easily write to DAC using the DAC8N GUI
- External SPI and I^2C connections available

Applications

- Process control
- Data acquisitions systems
- Closed-loop servo control
- PC peripherals
- Portable instrumentation



DAC8N-DGK-EVM Board

1 Evaluation Module Overview

1.1 Introduction

This user's guide describes the characteristics, operation, and recommended use cases of the DAC8N-DGK-EVM. This document provides examples and instructions on how to use the DAC8N-DGK-EVM board and included software. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the DAC8N-DGK-EVM. This document also includes a schematic, reference printed circuit board (PCB) layouts, and a complete bill of materials (BOM).

The DAC8N-DGK-EVM is connected to a personal computer (PC) using the USB cable that is supplied with the EVM. The evaluation board features connectors and test points for all communication lines, DAC outputs, and supplies. Figure 1-1 shows a block diagram of the DAC8N-DGK-EVM.

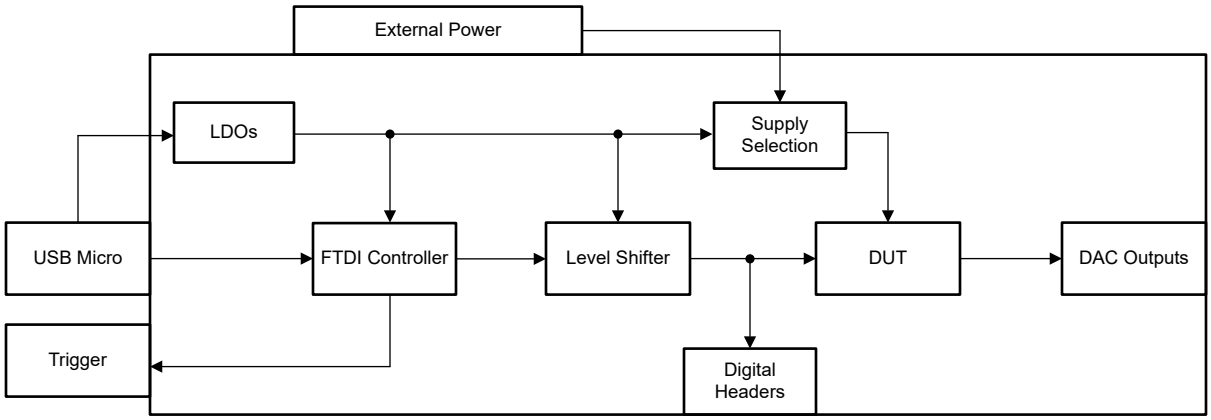


Figure 1-1. Theory of Operation Block Diagram

1.2 Kit Contents

Table 1-1 details the contents of the EVM kit. 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. DAC8N-DGK-EVM Kit Contents

Item	Quantity
DAC8N-DGK-EVM PCB evaluation board	1
USB-A to Micro-USB 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 designed for electromagnetic compatibility (EMC) testing. The EVM consists of a printed-circuit board (PCB), which has the DAC8N041 installed.

1.4 Device Information

The DAC8N is a software-compatible family of voltage-output digital-to-analog converters (DACs). The family of devices are available in single, dual, quad, and octal channels in 16-bit, 14-bit, 12-bit, 10-bit, and 8-bit resolutions. These devices support Hi-Z and finite-impedance power-down modes. These DACs offer ultra-low glitch and the lowest power consumption in the industry. These devices automatically detect I^2C and SPI.

The feature set combined with the tiny package and ultra-low power make these DACs an excellent choice for applications such as industrial automation and control, medical devices, and personal electronics.

The following devices are compatible with the DAC8N-DGK-EVM.

- DAC8N001
- DAC8N002
- DAC8N041
- DAC8N042
- DAC6N031
- DAC6N032

2 Hardware

2.1 Power Requirements

The DAC8N-DGK-EVM has one power rail, VDD. The USB connection provides the 5V supply to the EVM. Voltage regulators generate 3.3V and 1.8V from the USB 5V supply. These 3.3V and 1.8V supplies are used to power the FT4232 controller.

To use the onboard 5V, 3.3V, or 1.8V supply for the DAC8N-DGK-EVM VDD supply, short jumper J3. By default, VDD is connected to the onboard 5V supply. Alternatively, supply VDD externally through banana jack J1. Remove the jumper connector on J3 before connecting an external supply to VDD.

To connect the DAC8N-DGK-EVM VREF to the onboard 2.5V or VDD, short jumper J7. By default, VREF is connected to the VDD supply. Alternatively, supply VREF externally through SMA J15. Remove the jumper connector on J7 before connecting an external supply to VREF. If the DUT has an internal reference, remove the jumper and external voltage before enabling this reference.

2.2 Header Information

Table 2-1 defines the DAC8N-DGK-EVM output header J9.

Table 2-1. Output Header J9

Pin	Definition
2	VOUTA
4	VOUTB
1, 3	GND

Table 2-2 defines the DAC8N-DGK-EVM digital header J6.

Table 2-2. Digital Header J6

Pin	Definition
2	$\overline{CS}$/SCL
4	SCLK/SDA
6	SDI/A0
1, 3, 5	GND

Table 2-3 shows the connector definitions of the DAC8N-DGK-EVM.

Table 2-3. Connector Definitions

Designator	Definition
J1	DAC8N VDD supply (1.7V to 5.5V)
J2	DAC8N Ground
J11	SMA connector for FT4232 trigger output
J12	USB connector
J13	SMA connector for DAC8N VOUTA (unpopulated)
J14	SMA connector for DAC8N VOUTB (unpopulated)
J15	DAC8N external reference

2.3 Jumper Information

Table 2-4 shows the DAC8N-DGK-EVM jumper definitions. Figure 2-1 shows the default jumper connections on the board.

Table 2-4. Jumper Definitions

Designator	PCB Description	Positions
J3	VDD SEL	**SHORT 1-2**: VDD is connected to the 5V USB power (default) **SHORT 3-4**: VDD is connected to the 3.3V voltage regulator **SHORT 5-6**: VDD is connected to the 1.8V voltage regulator **OPEN**: VDD is not powered by on-board supplies.
J4	SCL – CS	**SHORT 1-2**: The EVM is configured for I^2C **SHORT 2-3**: The EVM is configured for SPI (default)
J5	SDA – SCLK	**SHORT 1-2**: The EVM is configured for I^2C **SHORT 2-3**: The EVM is configured for SPI (default)
J7	VREF SEL	**SHORT 1-2**: The DUT VREF is connected to the VDD (default) **SHORT 2-3**: The DUT VREF is connected to the onboard 2.5V **OPEN**: The DUT VREF is not connected to the onboard power supplies. An external reference can be used
J8	VOUTB – FB	**SHORT 1-2**: The third pin of the DUT is connected to VOUTA and acts as a feedback pin. **SHORT 2-3**: The third pin of the DUT is used as VOUTB.
J10	FTDI DIS	**SHORT**: Disconnects the DAC8N from the FTDI driver. **OPEN**: The FTDI driver is connected to the DAC8N (default).
J16	GND – SDI	**SHORT 1-2**: The EVM is configured for I^2C, where, A0 is connected to ground **SHORT 2-3**: The EVM is configured for SPI (default) **OPEN**: The EVM is configured for I^2C, where, A0 is connected to VDD. See Table 2-5 for I^2C address configurations

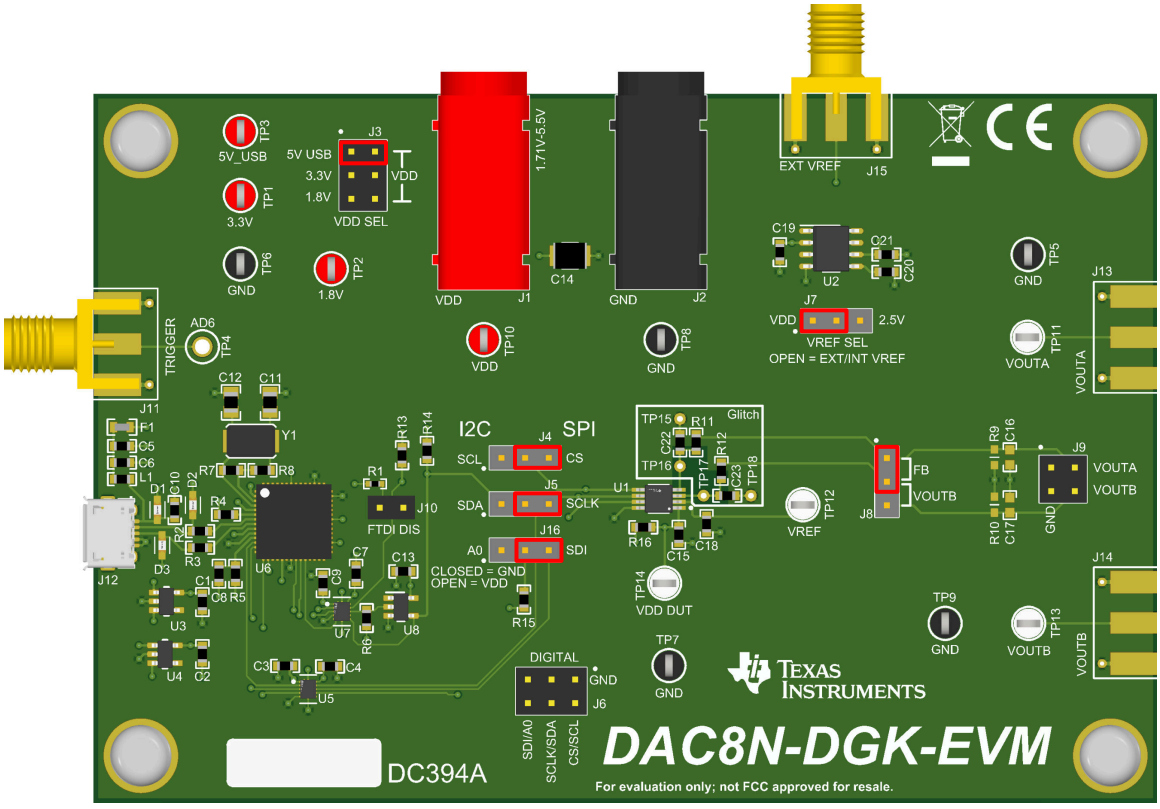


Figure 2-1. DAC8N-DGK-EVM Default Jumper Settings

2.4 Interfaces

The DAC8N-DGK-EVM uses the FT4232 controller to interface between the DAC8N and the EVM GUI. To connect the FT4232 digital controller on the EVM board to the computer, align and firmly connect the USB connector to the J12 connector. Verify the connection is snug; a loose connection potentially causes intermittent operation. A 100 mil header (J6) is available for external communication. Table 2-2 lists the J6 pin definitions. To use external communication, close jumper J10 to disable the connection to the FT4232 controller.

2.4.1 SPI Configuration

Figure 2-2 shows the DAC8N-DGK-EVM configured for SPI communication.

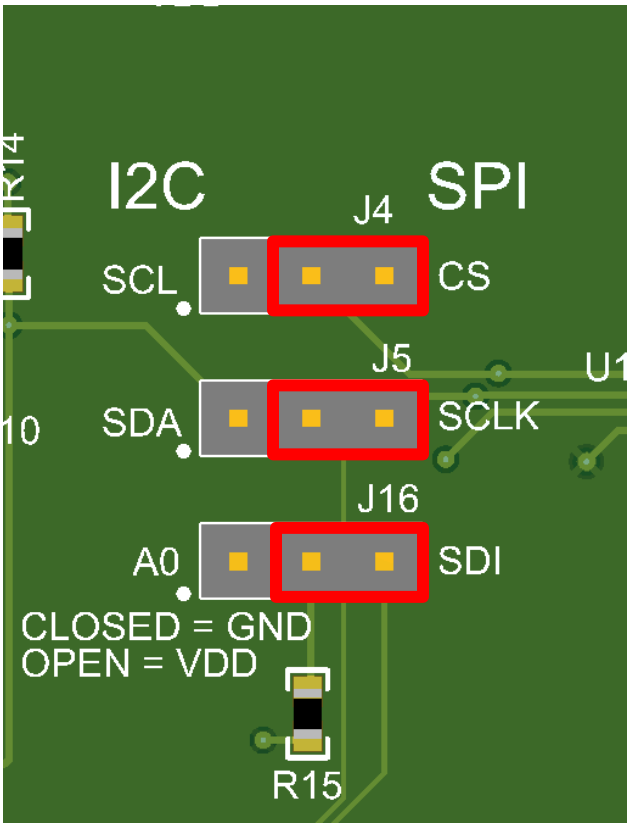


Figure 2-2. SPI Jumper Configuration

2.4.2 I²C Configuration

Figure 2-3 shows the DAC8N-DGK-EVM configured for I²C communication.

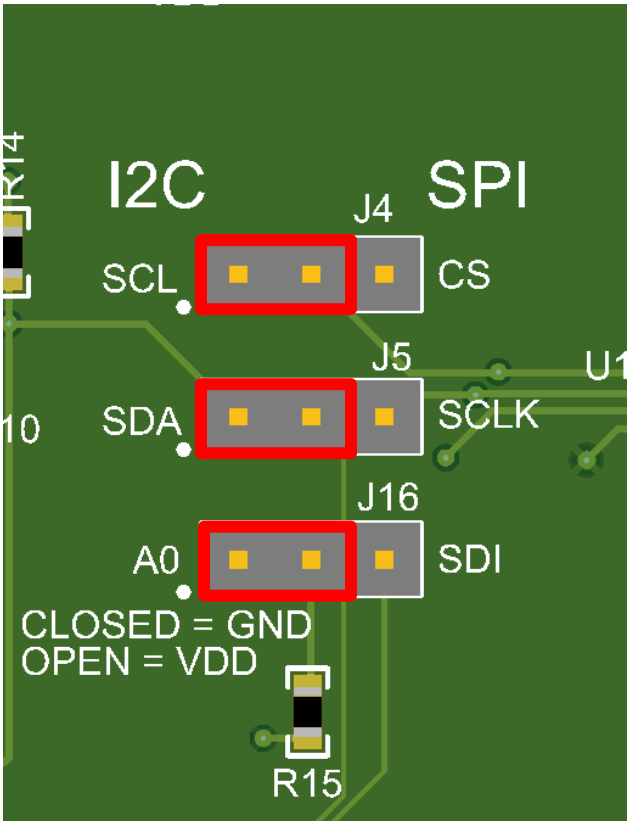


Figure 2-3. I²C Jumper Configuration

The jumper connection on J16 determines the device address. Table 2-5 shows the two possible jumper configurations and the respective device address.

Table 2-5. I²C Address Configuration

Jumper	A0	[A6:A0]
Jumper CLOSED	GND	100 1100
Jumper OPEN	VDD	100 1110

2.5 Test Points

Table 2-6 defines the DAC8N-DGK-EVM test points.

Table 2-6. Test Point Definitions

Designator	Net	Definition
TP1	3.3V	Onboard 3.3V supply
TP2	1.8V	Onboard 1.8V supply
TP3	USB_5V	USB 5V supply
TP4	FTDI_TRIGGER	Trigger from the FTDI (unpopulated)
TP5, TP6, TP7, TP8, TP9	GND	Ground test points
TP10	VDD	VDD
TP11	VOUTA	VOUTA
TP12	VREF	VREF
TP13	VOUTB	VOUTB
TP14	VDD DUT	Dedicated DUT VDD test point
TP15, TP16	VOUTA GLITCH	Isolated glitch test points for VOUTA. TP15 is ground, TP16 is VOUTA
TP17, TP18	VOUTB GLITCH	Isolated glitch test points for VOUTB. TP18 is ground, TP17 is VOUTB

2.6 Additional Functionality

2.6.1 Power Consumption Testing

Many of the DAC8N devices feature low power consumption. By default, the communication voltage level shifter and the onboard 2.5V reference run off the VDD voltage. The DAC8N-DGK-EVM has the functionality to isolate the DUT VDD for testing power consumption. To isolate the DUT, remove R16 and apply VDD power to TP14 and a ground test point. Apply board power through J3 or J1 as normal to power the rest of the board.

2.6.2 Glitch Testing

The DAC8N devices have extremely low glitch performance. The DAC8N-DGK-EVM has dedicated test points for testing glitch on the VOUTA and VOUTB outputs. Figure 2-4 shows the circuit.

To test glitch on VOUTA, remove R11 and populate C22 with a low-value capacitor. TP16 and the trace are fully isolated from the EVM power and ground planes.

To test glitch on VOUTB, remove R12 and populate C23 with a low value capacitor. TP17 and the trace are fully isolated from the EVM power and ground planes.

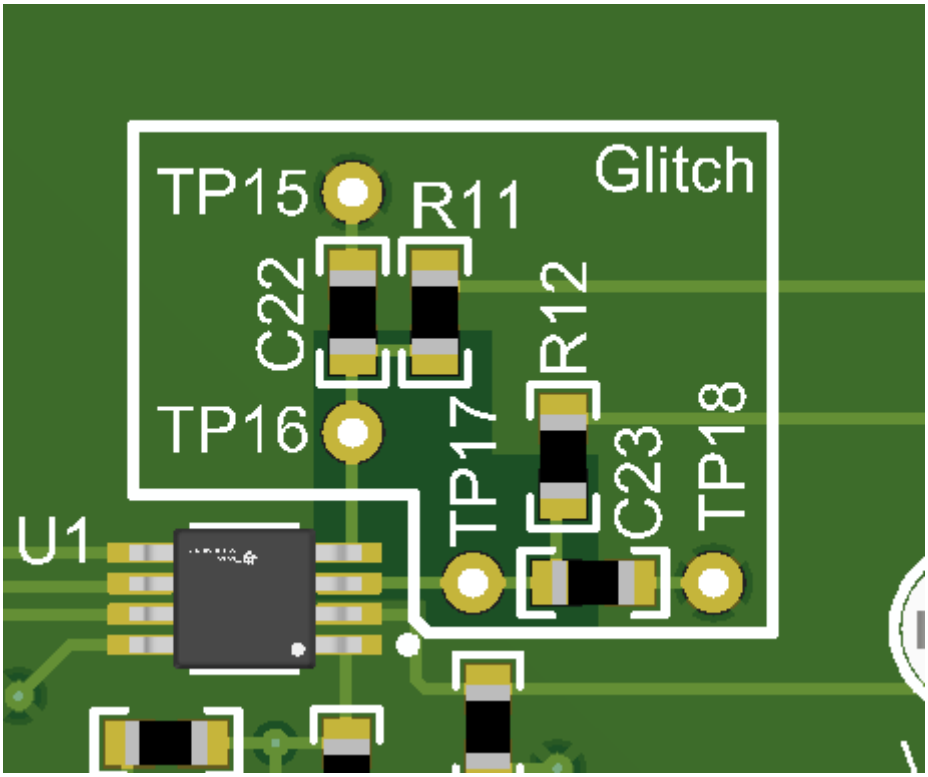


Figure 2-4. DAC8N GUI Glitch Circuit

3 Software

3.1 Software Installation

Download the latest version of the EVM GUI installer from the DAC8N-DGK-EVM tool page on TI.com. Run the installer to install the software, and copy the required LabVIEW™ software files and drivers to the PC.

When the installer launches, a dialog window appears to select an installation directory. If left unchanged, the location defaults to *C:\Program Files (x86)\Texas Instruments\DAC8N GUI*. Figure 3-1 shows the default path.

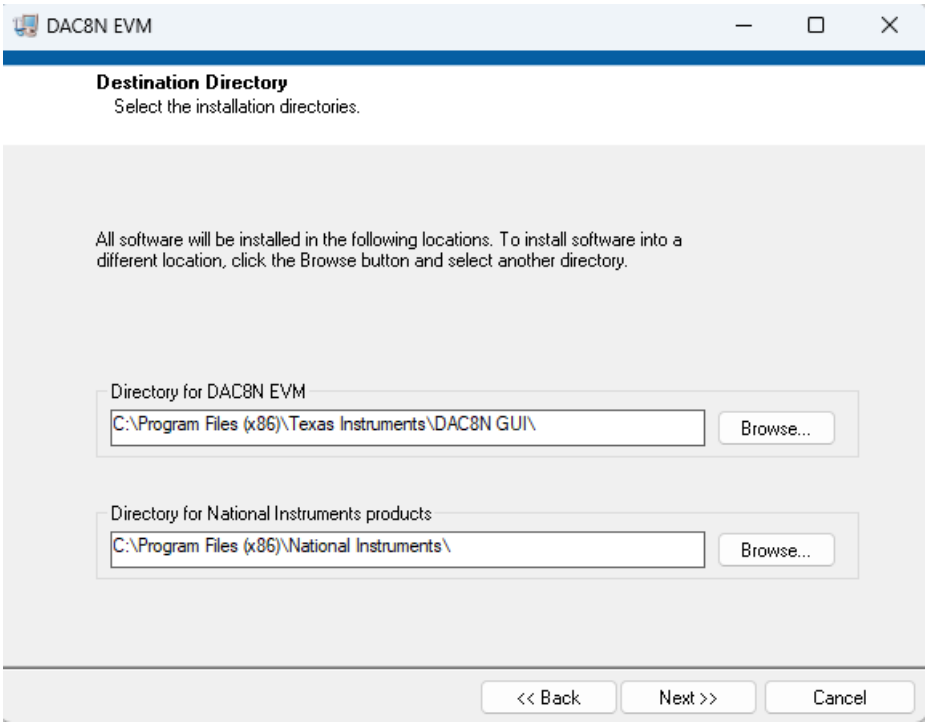


Figure 3-1. Software Installation Path

The EVM software also installs the Future Technology Devices International Limited (FTDI) USB drivers using a separate executable file. Figure 3-2 shows the FTDI USB drivers installation window that automatically launches after the DAC8N-DGK-EVM software installation is complete.

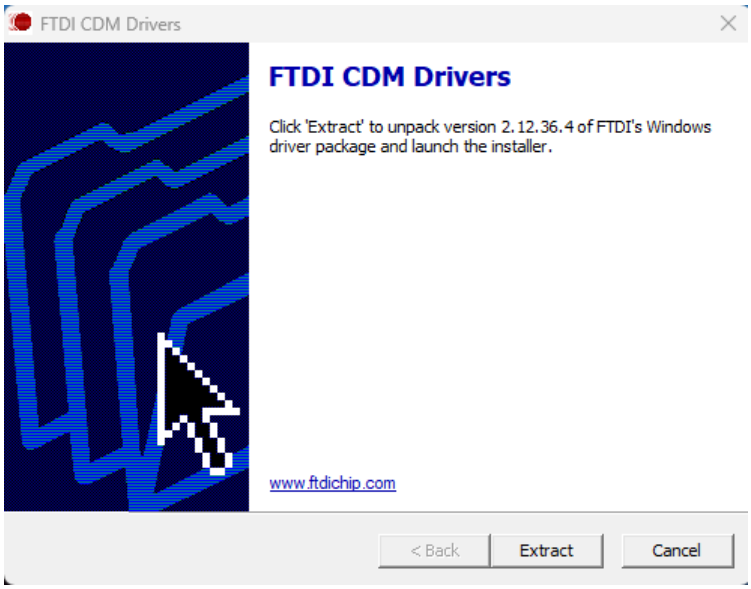


Figure 3-2. FTDI USB Drivers

3.2 Software Description

The DAC8N GUI enables easy I^{2}C or SPI communication to the device. While the entire register map is available to the user, some features have been abstracted into user controls in the *High-Level Configuration* page for easy operation.

3.2.1 Launching the Software

Launch the software by searching for DAC8N GUI in the Windows® *Start* menu.

When the GUI is launched, the *DAC8N Channel Selection* menu, shown in Figure 3-3, appears. The DAC8N-DGK-EVM supports one and two channel devices. Choose the number of output channels the device has and click *CONFIG*.

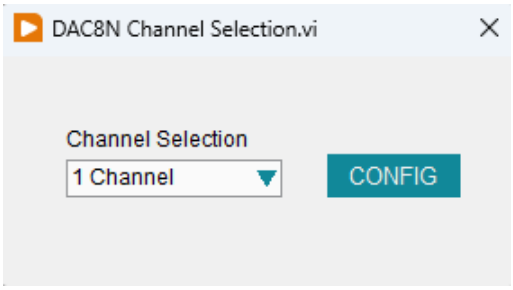


Figure 3-3. DAC8N Channel Selection

Figure 3-4 shows the GUI after launch. If the FTDI controller is not connected to the PC when the software is launched, the GUI defaults to *demo* mode. The bottom-left corner of the GUI shows the hardware connection status, DEMO MODE or CONNECTED, as shown in Figure 3-5. After the FTDI controller is properly connected to the PC, uncheck the *Demo Mode* box in the upper right to initialize the GUI.

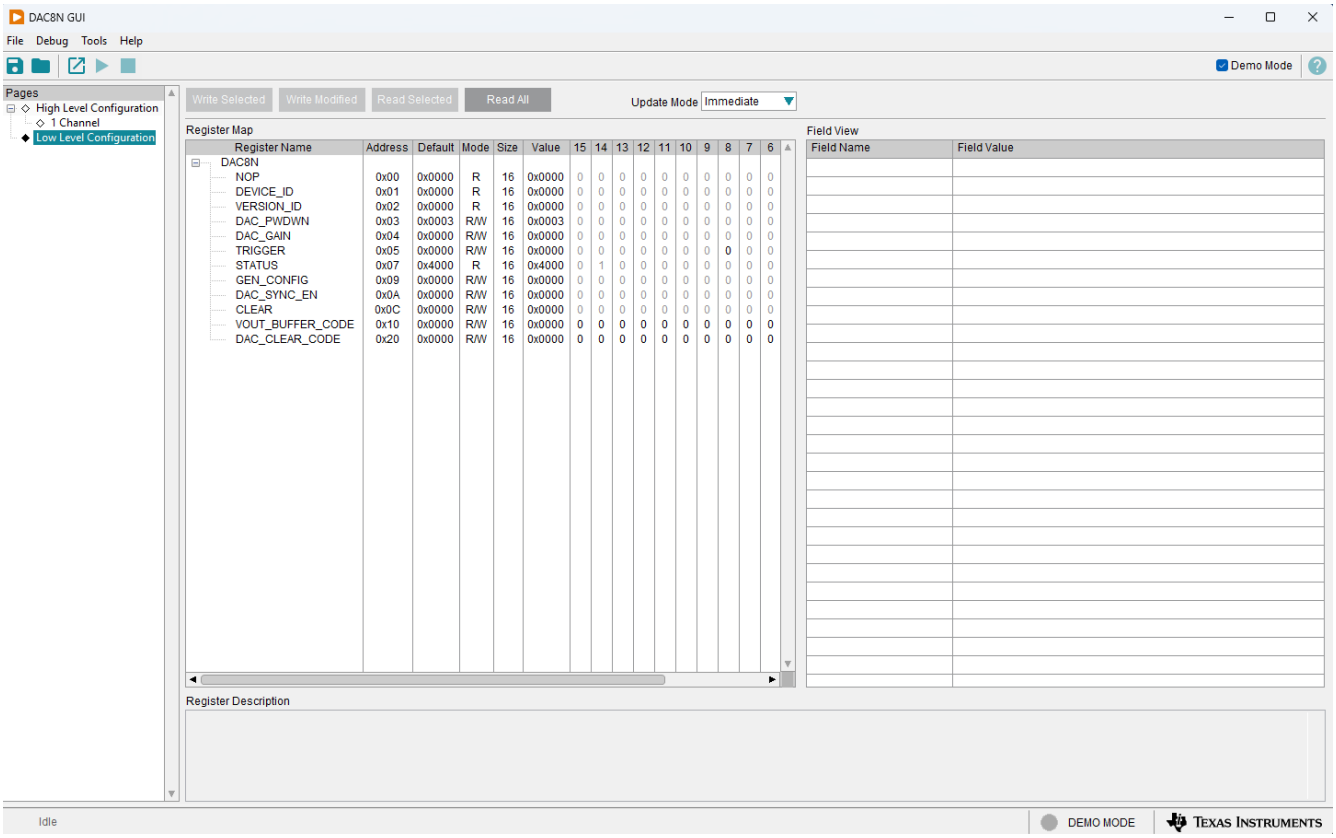


Figure 3-4. DAC8N GUI at Launch

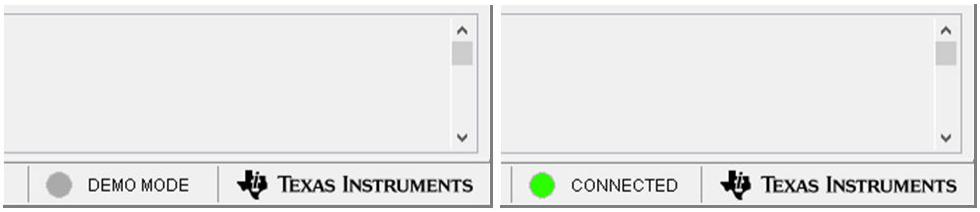


Figure 3-5. FTDI Digital Controller Connection Status

After you uncheck the *Demo Mode* box, the *Interface Configuration* menu pops up. Figure 3-6 shows the menu. The interface menus configure the SPI or I^2C speed and I^2C device address.

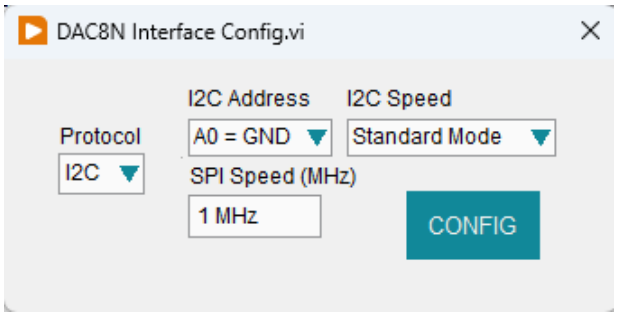


Figure 3-6. DAC8N Configuration Menu

3.2.2 Low Level Configuration Page

The DAC8N GUI register map is different depending on the number of channels selected at start-up. Figure 3-7 shows the *1 Channel Low Level Configuration* page of the GUI. Figure 3-8 shows the *2 Channel Low Level Configuration* page of the GUI. This page allows direct access to all registers on the device.

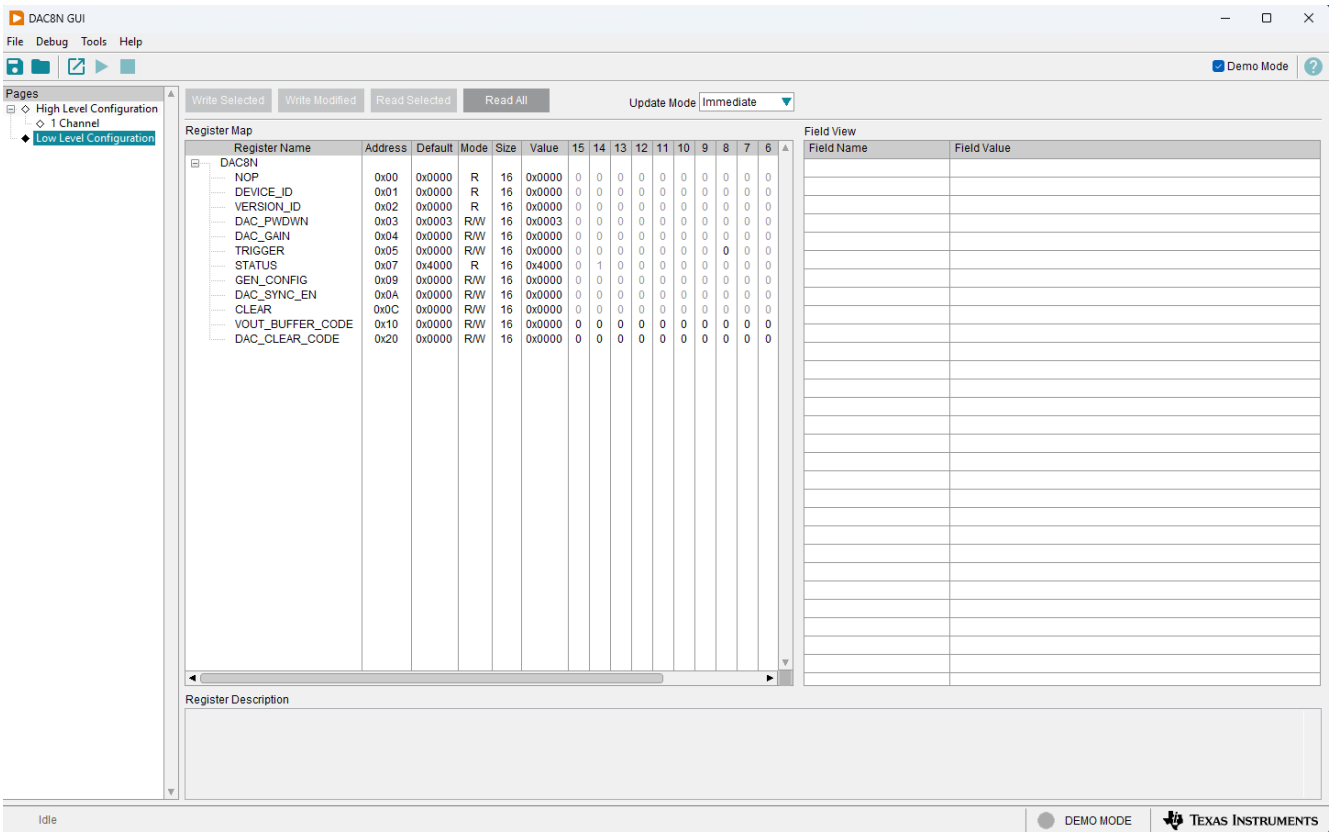


Figure 3-7. DAC8N GUI 1 Channel Low Level Configuration Page

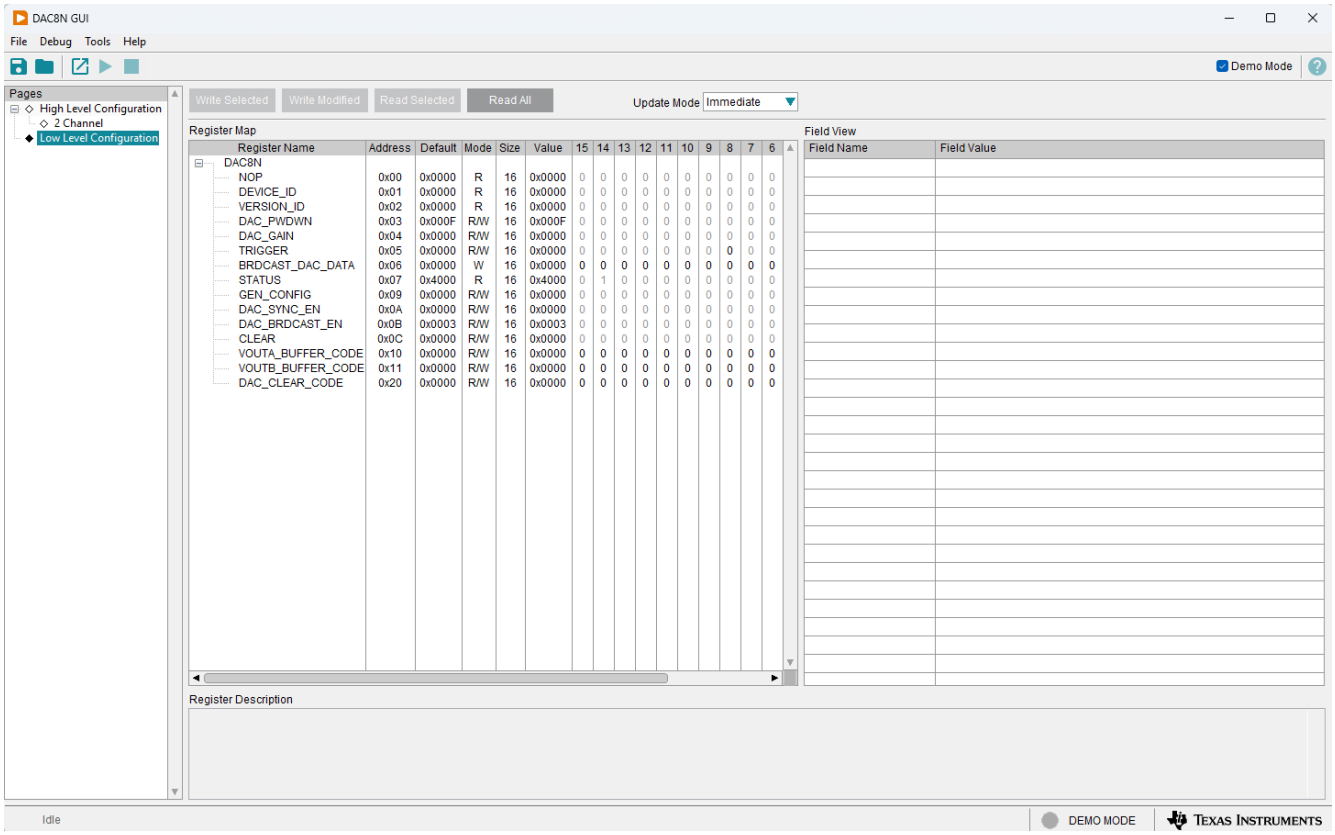


Figure 3-8. DAC8N GUI 2 Channel Low Level Configuration Page

The *Register Map* section in the center of the page lists all the registers in the device. Directly above the *Register Map* section are four buttons that allow read and write access to all registers.

The *Field View* section on the right side of the page shows the various fields in the currently selected register. Select a field to highlight the each field is described in the device data sheet. Data are written to the registers by entering a hex value into the *Value* column of the register map. To set individual bits to 1 and 0, click the bits.

3.2.3 High Level Configuration Page

The *High Level Configuration* page allows for easy writing to various device registers. The DAC8N GUI *High Level Configuration* page varies depending on the number of channels selected at startup. Figure 3-9 shows the *1 Channel High Level Configuration* page of the DAC8N GUI. Figure 3-10 shows the *2 Channel High Level Configuration* page of the DAC8N GUI.

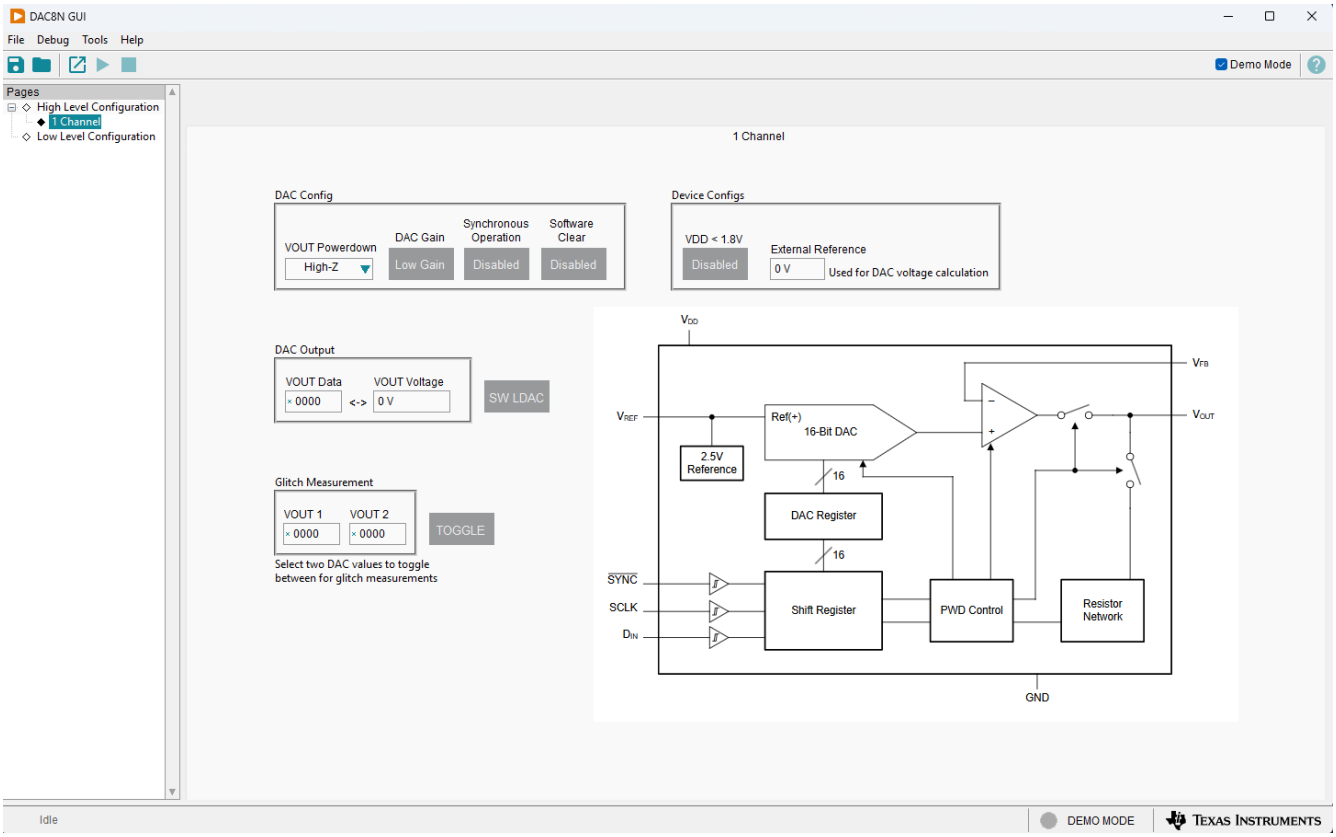


Figure 3-9. DAC8N GUI 1 Channel High Level Configuration Page

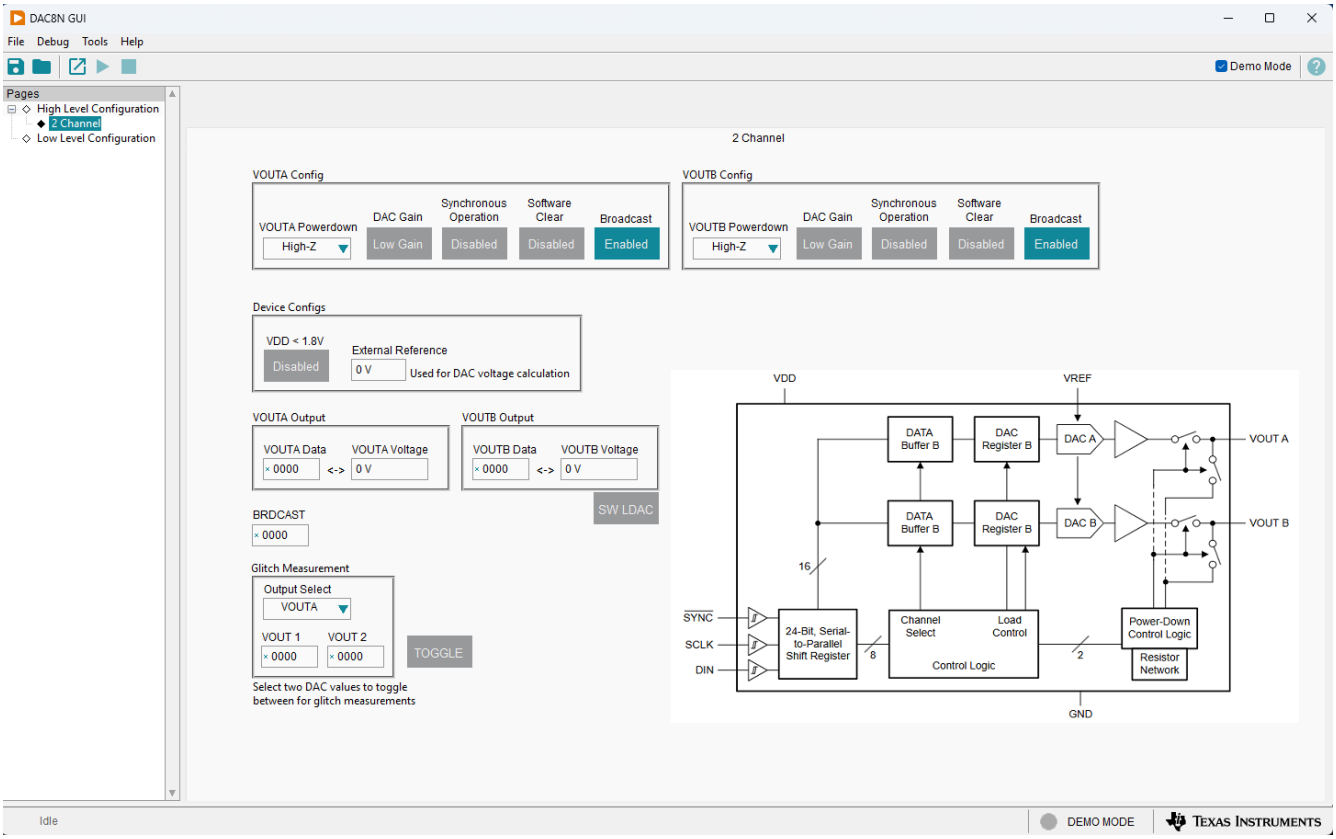


Figure 3-10. DAC8N GUI 2 Channel High Level Configuration Page

4 Hardware Design Files

4.1 Schematics

Figure 4-1 and Figure 4-2 show the DAC8N-DGK-EVM schematics.

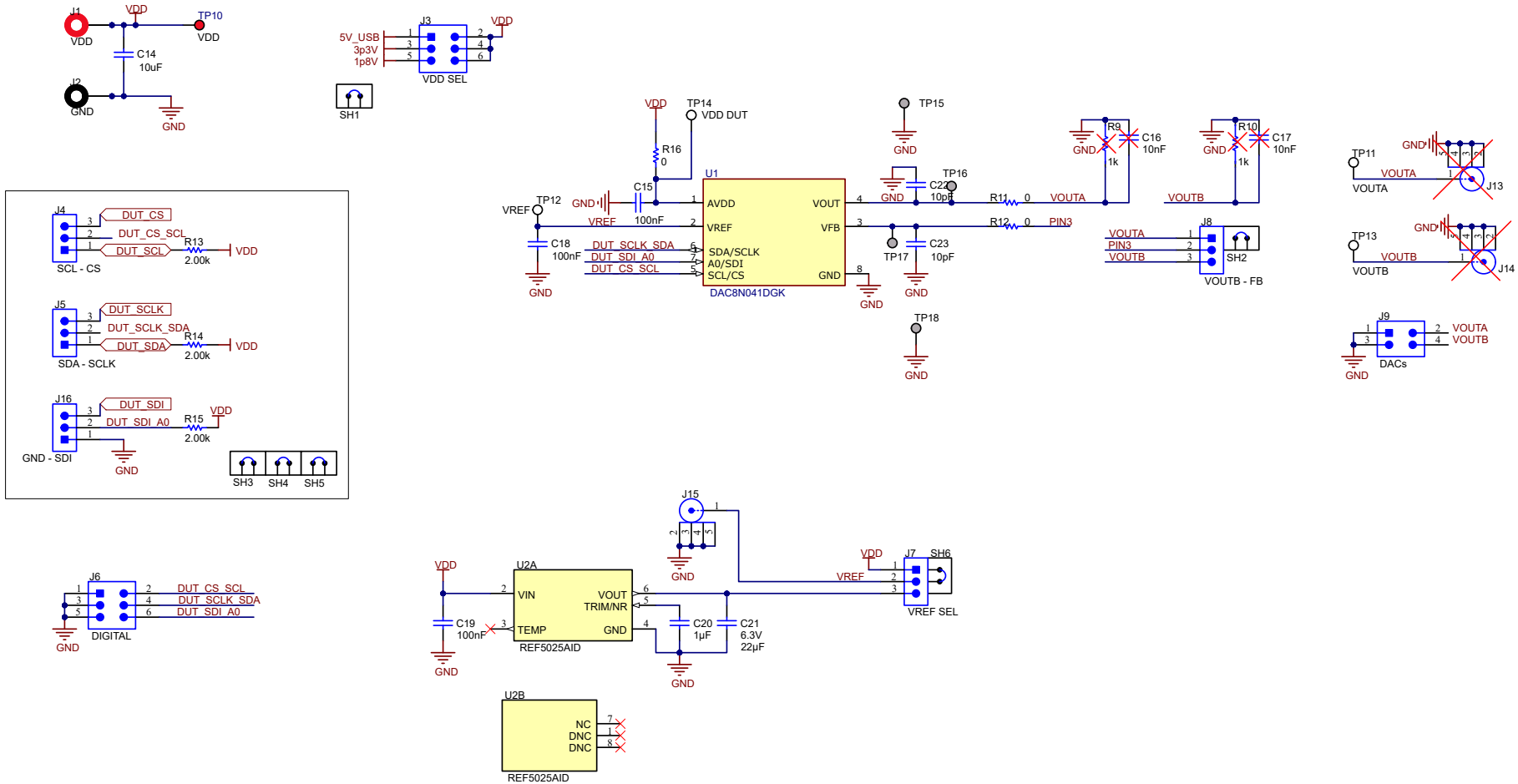


Figure 4-1. DAC8N-DGK-EVM DUT Schematic

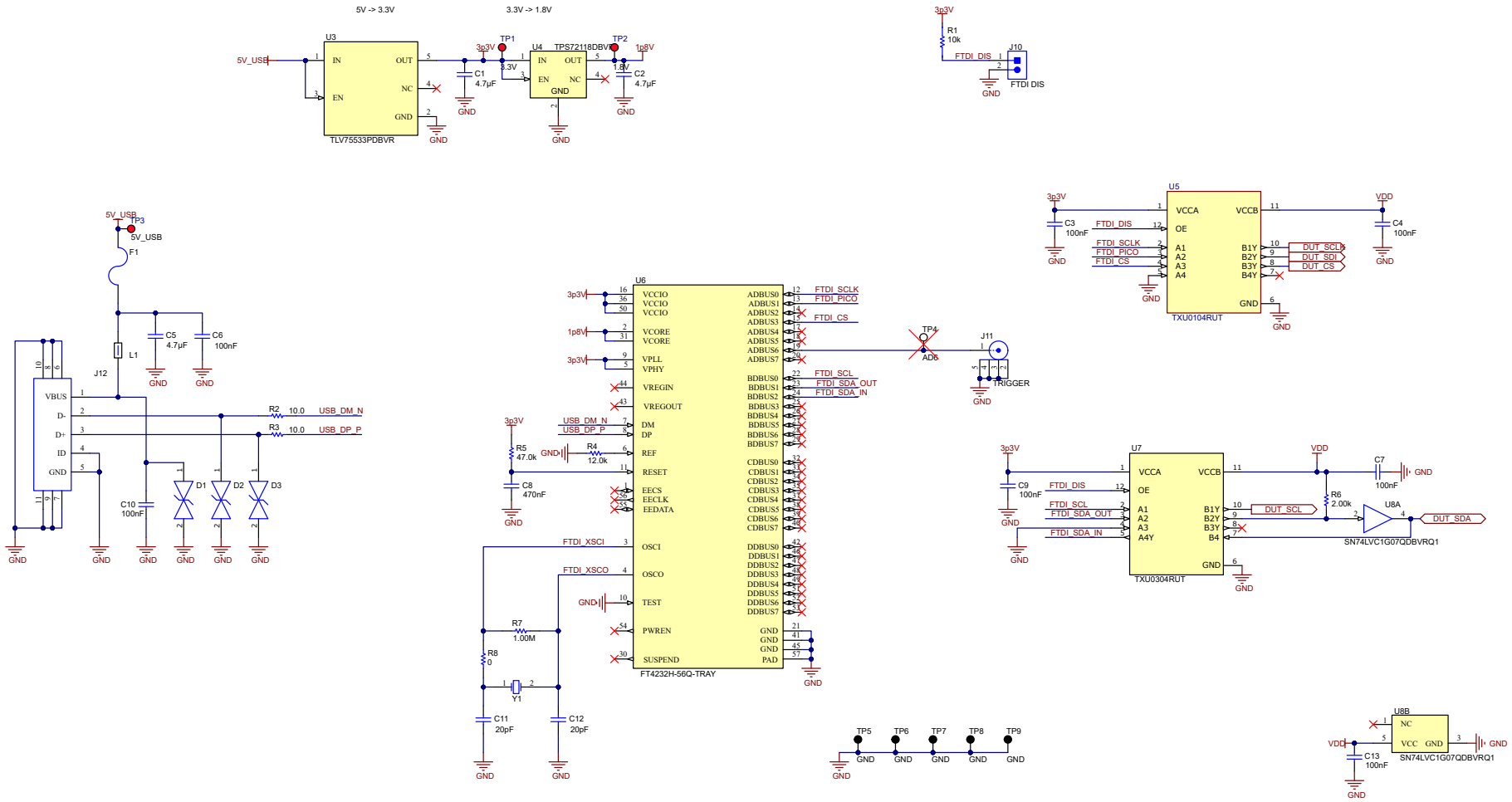


Figure 4-2. DAC8N-DGK-EVM FTDI Interface Schematic

4.2 PCB Layouts

Figure 4-3 through Figure 4-6 show the DAC8N-DGK-EVM board layout.

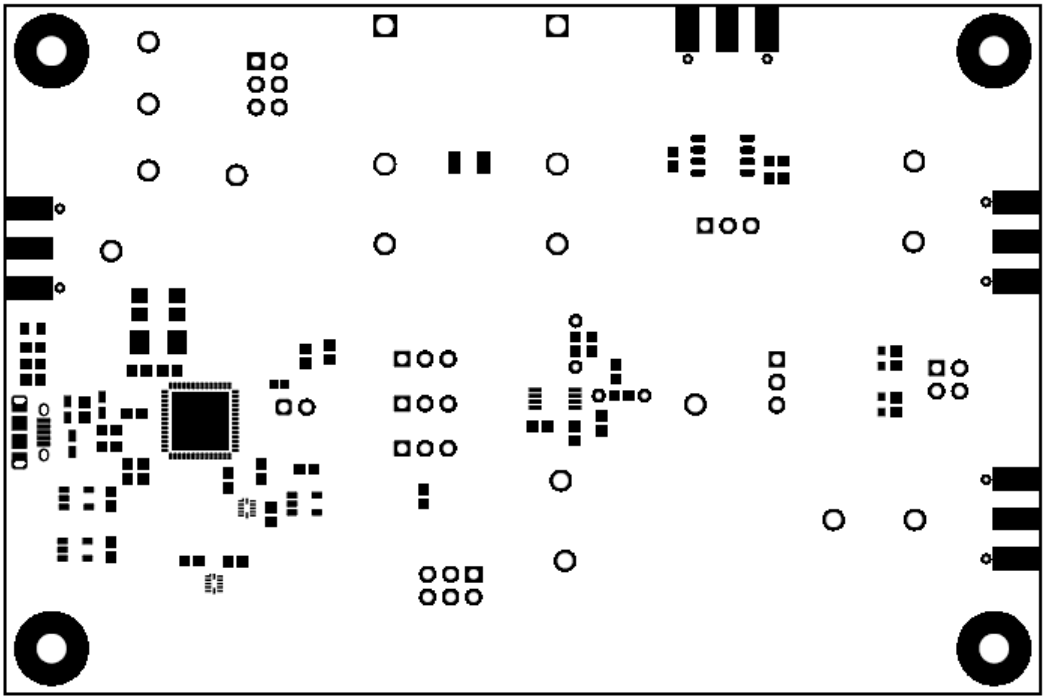


Figure 4-3. DAC8N-DGK-EVM PCB Top Layer Layout

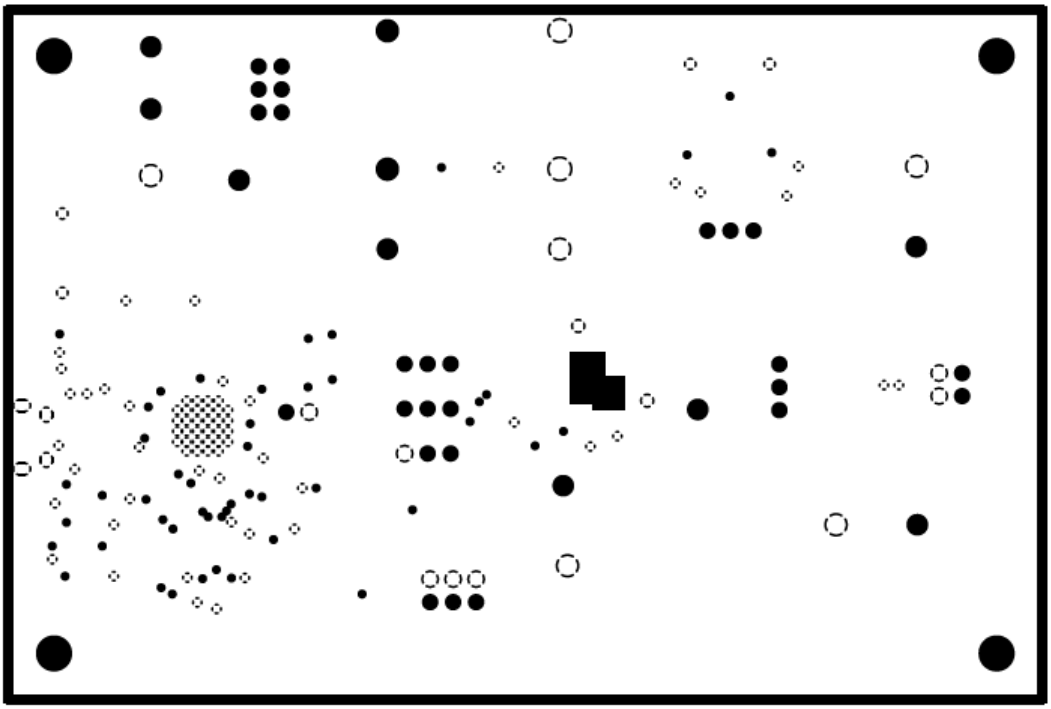


Figure 4-4. DAC8N-DGK-EVM PCB Mid Layer 1 Layout (Ground Plane)

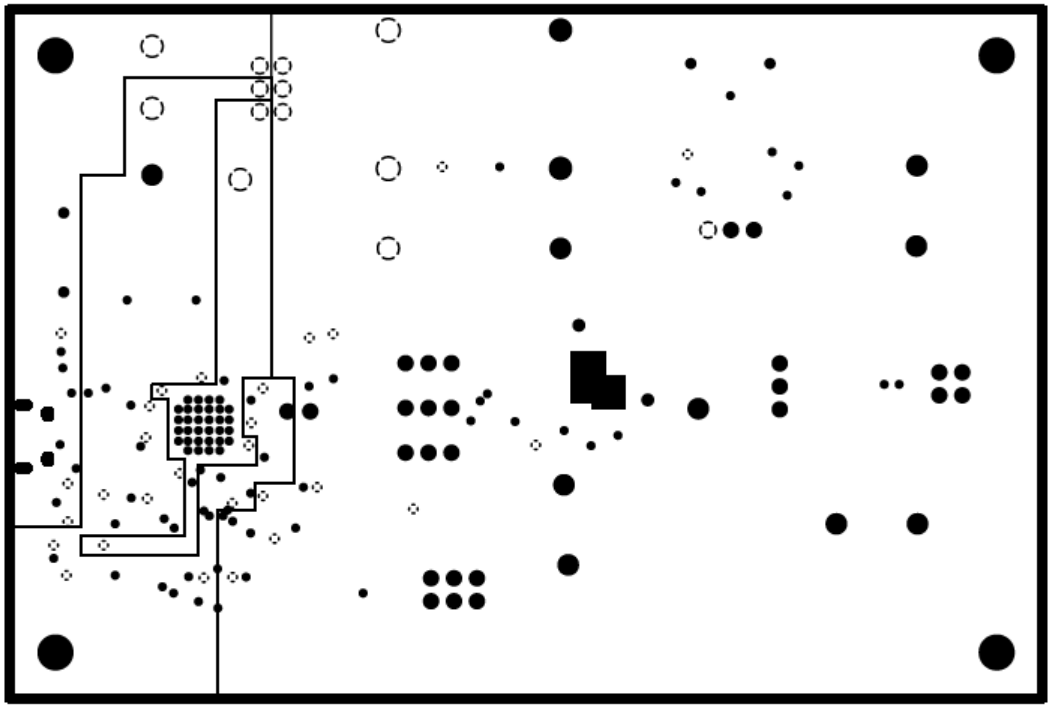


Figure 4-5. DAC8N-DGK-EVM PCB Mid Layer 2 Layout (Power Plane)

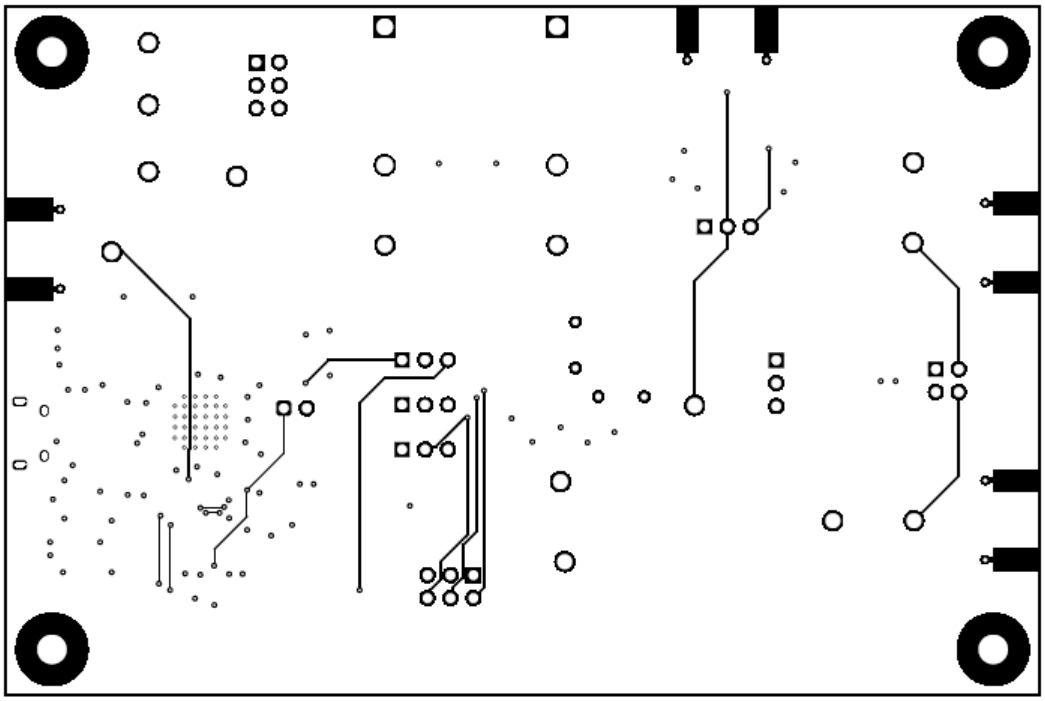


Figure 4-6. DAC8N-DGK-EVM PCB Bottom Layer Layout

4.3 Bill of Materials (BOM)

Table 4-1. BOM

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C1, C2, C5	3	4.7µF	CAP, CERM, 4.µF, 16V,+/- 10%, X7R, 0603	0603	GRM188Z71C475KE21D	MuRata
C3, C4, C6, C7, C9, C10, C13, C15, C18, C19	10	0.1µF	CAP, CERM, 0.1µF, 50V,+/- 10%, X7R, AEC-Q200 Grade 0, 0603	0603	06035C104K4Z4A	AVX
C8	1	0.47µF	CAP, CERM, 0.47µF, 25V, +/- 10%, X7R, 0603	0603	GRM188R71E474KA12D	MuRata
C11, C12	2	20pF	CAP, CERM, 20pF, 100V, +/- 5%, C0G/NP0, 0805	0805	08051A200JAT2A	AVX
C14	1	10µF	CAP, CERM, 10µF, 25V, +/- 10%, X7R, 1210	1210	C1210C106K3RACTU	Kemet
C20	1	1µF	CAP, CERM, 1µF, 25V,+/- 20%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E1X7R1E105M080AC	TDK
C21	1	22µF	CAP, CERM, 22µF, 6.3V,+/- 20%, X6S, 0603	0603	GRM188C80J226ME15D	MuRata
C22, C23	2	10pF	CAP, CERM, 10pF, 50V, +/- 5%, C0G/NP0, 0603	0603	C0603C100J5GACTU	Kemet
D1, D2, D3	3		150V (Typ) Clamp Ipp Tvs Diode Surface Mount 0603 (1608 Metric)	0603	PGB1010603MRHF	Littelfuse Inc
F1	1		Fuse, 0.5A, 50VDC, 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	1		Standard Banana Jack, insulated, 10A, red	571-0500	571-0500	DEM Manufacturing
J2	1		Standard Banana Jack, insulated, 10A, black	571-0100	571-0100	DEM Manufacturing
J3, J6	2		Header, 100mil, 3x2, Gold, TH	3x2 Header	TSW-103-07-G-D	Samtec
J4, J5, J7, J8, J16	5		Header, 100mil, 3x1, Gold, TH	Header, 100mil, 3x1, TH	HTSW-103-07-G-S	Samtec
J9	1		Header, 100mil, 2x2, Gold, TH	2x2 Header	TSW-102-07-G-D	Samtec
J10	1		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec
J11, J15	2		Connector, End launch SMA, 50 ohm, SMT	End Launch SMA	142-0701-801	Cinch Connectivity
J12	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

Table 4-1. BOM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
L1	1	600Ω	Ferrite Bead, 600Ω @ 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
R1	1	10.0kΩ	RES, 10Ωk, 0.1%, 0.0625W, 0402	0402	RT0402BRD0710KL	Yageo America
R2, R3	2	10Ω	RES, 10Ω, 1%, 0.1W, 0603	0603	RC0603FR-0710RL	Yageo
R4	1	12.0kΩ	RES, 12kΩ, 1%, 0.1W, 0603	0603	RC0603FR-0712KL	Yageo
R5	1	47.0kΩ	RES, 47kΩ, 1%, 0.1W, 0603	0603	RC0603FR-0747KL	Yageo
R6, R13, R14, R15	4	2.00kΩ	RES, 2.00kΩ, 0.1%, 0.1W, 0603	0603	RG1608P-202-B-T5	Susumu Co Ltd
R7	1	1.00MΩ	RES, 1MΩ, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	RMCF0603FG1M00	Stackpole Electronics Inc
R8, R11, R12, R16	4	0	RES, 0Ω, 5%, 0.1W, 0603	0603	RC0603JR-070RL	Yageo
SH1, SH2, SH3, SH4, SH5, SH6	6		Shunt, 100mil, Gold plated, Black	Shunt 2 pos. 100 mil	881545-2	TE Connectivity
TP1, TP2, TP3, TP10	4		Test Point, Compact, Red, TH	Red Compact Testpoint	5005	Keystone Electronics
TP5, TP6, TP7, TP8, TP9	5		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone Electronics
TP11, TP12, TP13, TP14	4		Test Point, Compact, White, TH	White Compact Testpoint	5007	Keystone Electronics
U1	1		DAC8N041DGK	VSSOP8	DAC8N041DGK	Texas Instruments
U2	1		Low Noise, Very Low Drift, Precision Voltage Reference, –40 to 125°C, 8-pin SOIC (D), Green (RoHS & no Sb/Br)	D0008A	REF5025AID	Texas Instruments
U3	1		500mA, Low IQ, Small Size, Low Dropout Regulator, DBV0005A (SOT-23-5)	DBV0005A	TLV75533PDBVR	Texas Instruments
U4	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°C, Green (RoHS & no Sb/Br)	DBV0005A	TPS72118DBVR	Texas Instruments

Table 4-1. BOM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
U5	1		4-Bit Fixed Direction Voltage-Level Translator with Schmitt Trigger Inputs, and Tri-State Outputs	UQFN12	TXU0104RUT	Texas Instruments
U6	1		Future Technology Devices International Ltd FT4232H Quad High Speed USB to Multipurpose UART/MPSSE IC, VQFN-56	VQFN-56	FT4232H-56Q-TRAY	FTDI
U7	1		Automotive 4-Bit Fixed Direction Voltage-Level Translator with Schmitt-Trigger Inputs, and Tri-State Outputs	UQFN12	TXU0304RUT	Texas Instruments
U8	1		Automotive Catalog Single Buffer/Driver With Open-Drain Output, DBV0005A (SOT-23-5)	DBV0005A	SN74LVC1G07QDBVRQ1	Texas Instruments
Y1	1		Crystal, 12MHz, 18pF, SMD	ABM3	ABM3-12.000MHZ-B2-T	Abracon Corporation

5 Additional Information

5.1 Trademarks

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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 semiconductors 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 DEGREDATION 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/lsds/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.

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2. 実験局の免許を取得後ご使用いただく。
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西新宿三井ビル

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

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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.

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.

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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.

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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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