BUF22821EVM Evaluation Board and Software Tutorial

This user's guide describes the characteristics, operation, and use of the BUF22821EVM evaluation board. It discusses how to set up and configure the software and hardware, and reviews various aspects of the program operation. Throughout this document, the terms *evaluation board*, *evaluation module*, and *EVM* are synonymous with the BUF22821EVM. This user's guide also includes information regarding operating procedures and input/output connections, an electrical schematic, PCB layout drawings, and a parts list for the EVM. Project collateral discussed in this application report can be downloaded from the following URL: http://www.ti.com/lit/zip/SBOU053.

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1 Overview

The BUF2281 is a programmable gamma-voltage generator and V_{COM} calibrator with integrated two-bank memory. This device offers 22 programmable gamma channels, two programmable V_{COM} channels, and two static gamma channels, making it ideal for 10-bit source TFT-LCD reference drivers. The BUF22821EVM is a platform for evaluating the performance of the BUF22821 under various signal, reference, and supply conditions.

This document gives a general overview of the BUF22821EVM, and provides a general description of the features and functions to be considered while using this evaluation module.

2 Unpacking the EVM

Upon opening the BUF22821EVM kit, please check to make sure that the following items are included:

- One BUF22821EVM printed circuit board (PCB);
- One serial connection cable with RS-232/RJ-45 plug connector;
- One CD containing the BUF22821EVM software, and electronic copies of the BUF22821 product data sheet and this user's guide;

If any of these items are missing, please contact the Texas Instruments Product Information Center nearest you to inquire about a replacement.

3 BUF22821EVM Software

3.1 Hardware Requirements

The minimum hardware requirements for the BUF22821EVM sofware are:

- IBM PC-compatible computer running Microsoft Windows® 98/ME/NT/2000/XP operating system
- Pentium® or equivalent processor
- 64MB of RAM
- Hard disk drive with at least 100MB free space
- Available COM port
- Mouse
- VGA adapter card and monitor

3.2 Installation

The BUF22821EVM software is included on the CD that is shipped with the EVM. It is also available through the BUF22821EVM product folder on the TI web site. To download the software to your system, insert the disc into an an available CD-ROM drive. Navigate to the drive contents and open the BUF22821EVM software folder. Locate the compressed file (*BUF22821EVM.zip*) and open it. Using WinZIP®, unzip the BUF22821EVM files into a specific BUF22821 folder on your hard drive.

Once the files are unzipped, navigate to the BUF22821 folder that you created on your hard drive. Locate the *setup.exe* file; click the file to start the installation process, as shown in Figure 1.

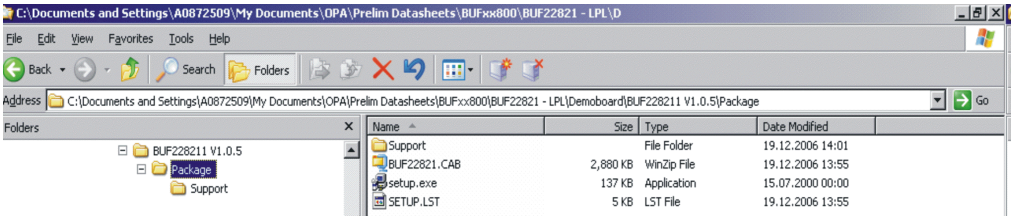


Figure 1. BUF22821EVM Software Installation

Follow all on-screen commands to finish installing the software.

3.3 Software Description and Set-Up

The EVM software is controlled through a graphical user interface (GUI). The software communicates with the EVM through an available COM or other serial port on the PC. Pressing the *COM Setting* button brings up a panel that allows you to change the serial port number through which the PC communicates with the BUF22821EVM, as shown in Figure 2. COM1 is an appropriate choice for most PCs. You can also set the appropriate baud rate through the same dialog box.

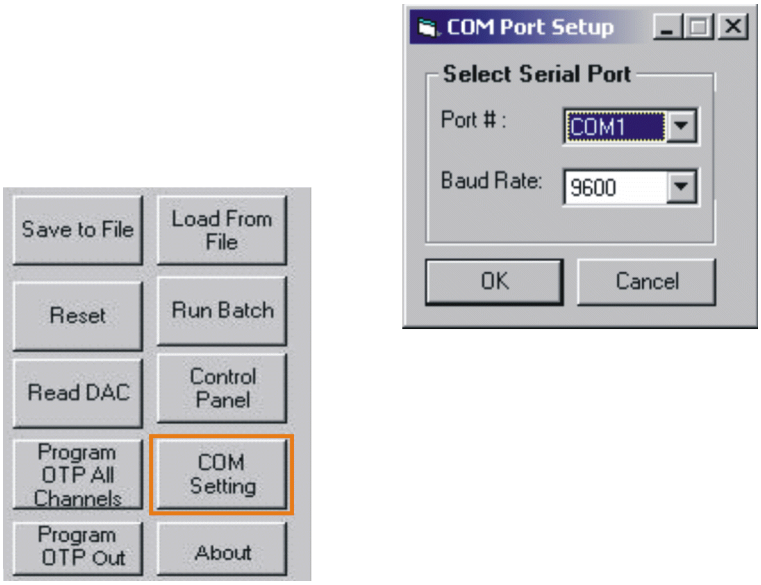


Figure 2. COM Port Selection and Dialog Window

The BUF22821EVM software allows the user to read and write to all registers in the BUF22821 gamma correction buffer. Furthermore, it allows programming of the OTP register on the BUF22821. The software also permits the user to select either I^2C™ address.

Press the *About* button as shown in Figure 3 to verify that you have the latest version of the software.

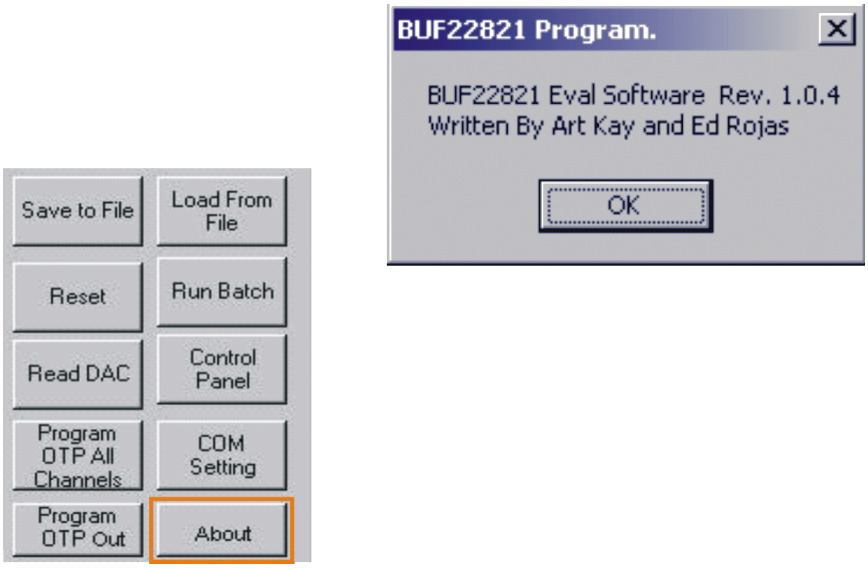


Figure 3. BUF22821EVM Software *About* Button

4 EVM Operation

Figure 4 shows the BUF22821EVM with the test point, switch, and jumper locations noted.

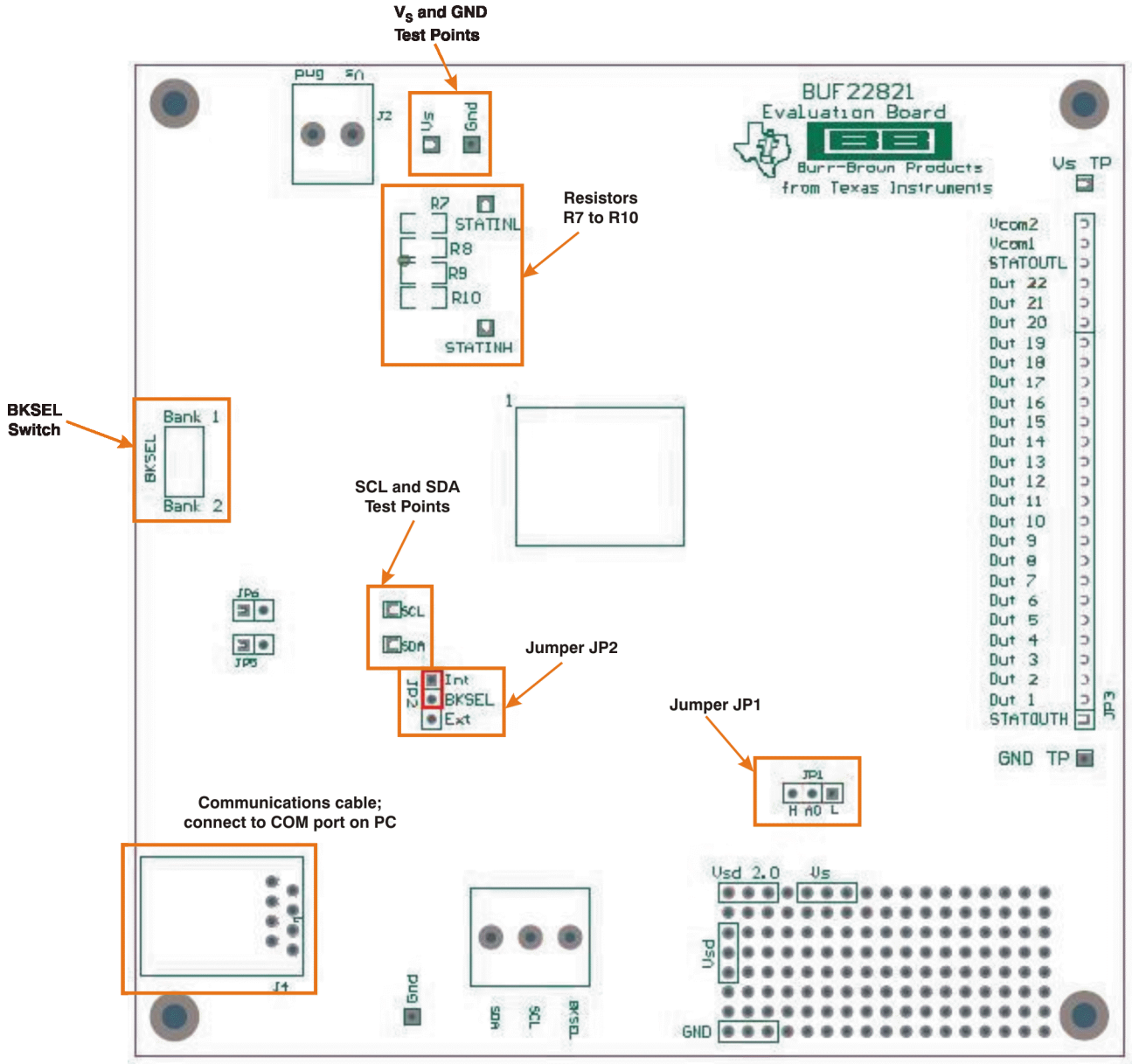


Figure 4. BUF22821EVM Switch and Jumper Locations

4.1 BKSEL

The BKSEL switch (illustrated in Figure 5) selects the memory bank to be used when operating the EVM. *Bank 1* selects the gamma curve that is stored in Bank_0 of the BUF22821. *Bank 2* selects the gamma curve that is stored in Bank_1 of the BUF22821.

The SCL and SDA jumpers must be installed on the EVM in order to allow communication between the board and the BUF22821. The communications cable must be connected to COM1 or another COM port on your PC.

Figure 5. BKSEL Switch

4.2 JP1

Jumper JP1 is used to set the I^2C address pin of the BUF22821 to logic high or logic low. When J1 is in the position shown in Figure 6, A0 on the BUF22821 is connected to DV_{DD} (logic '1'). Note that the software *Change Address* button must be as shown in Figure 6 for A0 = '1'.

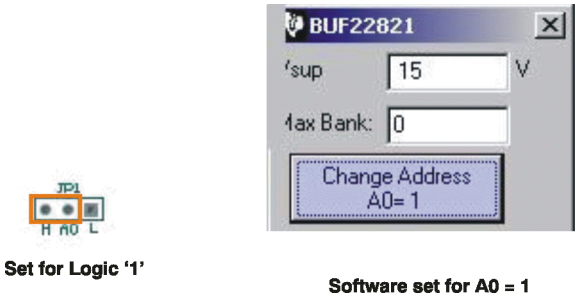


Figure 6. BUF22821EVM Jumper JP1 Set for Logic '1'

When JP1 is in the position shown in Figure 7, A0 on the BUF22821 is connected to GND (logic '0'). Note that the software must be as shown in Figure 7 for an address of A0 = '0'.

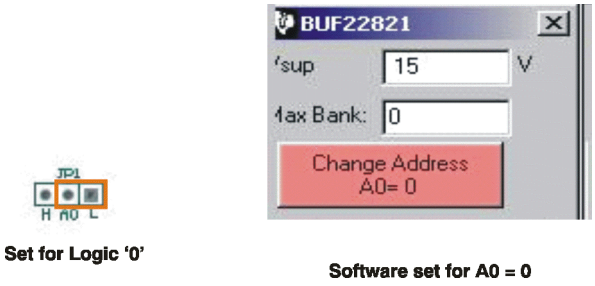


Figure 7. BUF22821EVM Jumper JP1 Set for Logic '0'

4.3 JP2

Jumper JP2 selects either the BKSEL switch on the EVM or an external signal to switch between the two nonvolatile memory banks of the BUF22821. When JP2 is in the position shown in Figure 8, the BKSEL switch is used to switch between the memory banks

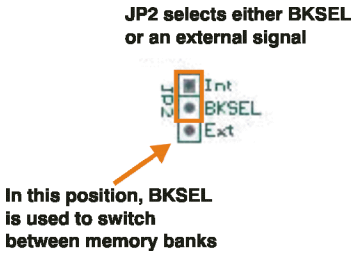


Figure 8. BUF22821EVM Jumper JP2 Set for BKSEL Switching

When JP2 is in the position shown in Figure 9, the memory banks are switched according to the external signal applied via the connector.

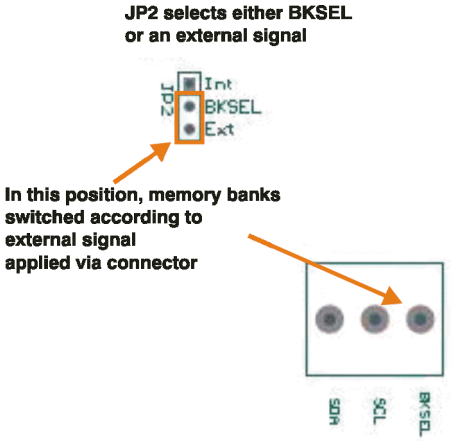
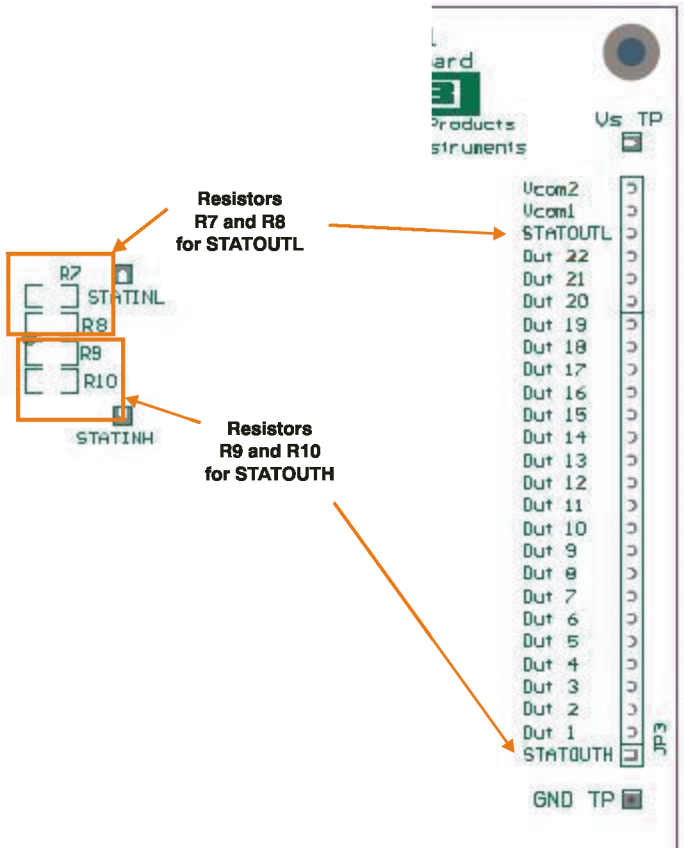


Figure 9. BUF22821EVM Jumper JP2 Set for External Signal Switching

4.4 STATOUTH

The output of STATOUTH is preset with resistors R9 and R10, as shown in Figure 10. These resistors form a voltage divider from V_S to GND. STATOUTL is preset with resistors R7 and R8.

All four resistors are installed on the EVM at the factory.



Note: Resistors R7 through R10 are installed at the factory.

Figure 10. STATOUTH Settings

5 Using the BUF22821EVM Software

Figure 11 shows the EVM software interface.

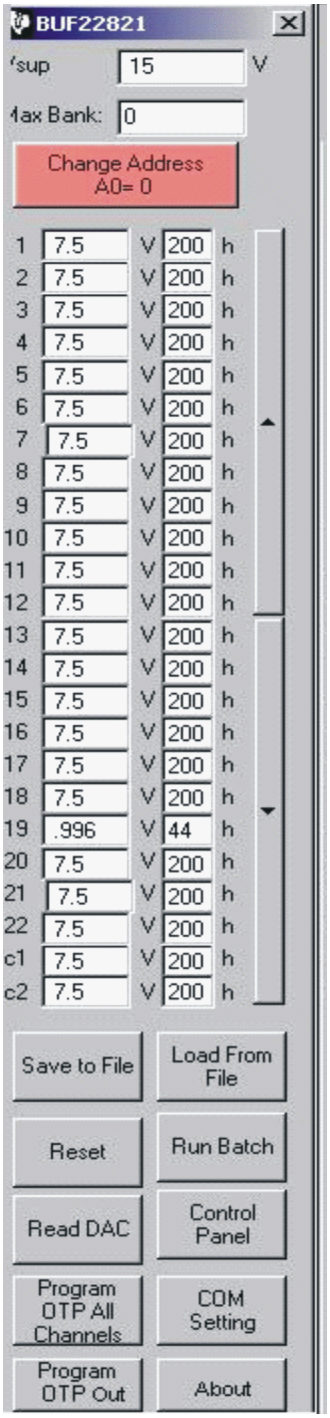


Figure 11. BUF22821EVM Software GUI

5.1 Change Address Button

Pressing the *Change Address* button (located near the top of the interface) changes the I^2C address that the software writes to. In Figure 11, the address is A0 = '0'. Pressing the button changes it to A0 = '1'. Note that the Change Address button is color-coded to help you quickly identify the current address. Red indicates that the address is A0 = '0'.

The interface also displays the last power-supply value used for the new address. This feature is helpful when changing back to an address that was previously used.

Whenever the address is changed, a Read DAC command is automatically performed so that all the DAC output displays are updated.

5.2 Measuring the Power Supply

You must measure the power supply (V_S) value against GND, and then enter it in the *Vsup* field of the software interface, as shown in Figure 12. The voltage out of each DAC is calculated according to the V_S value entered.

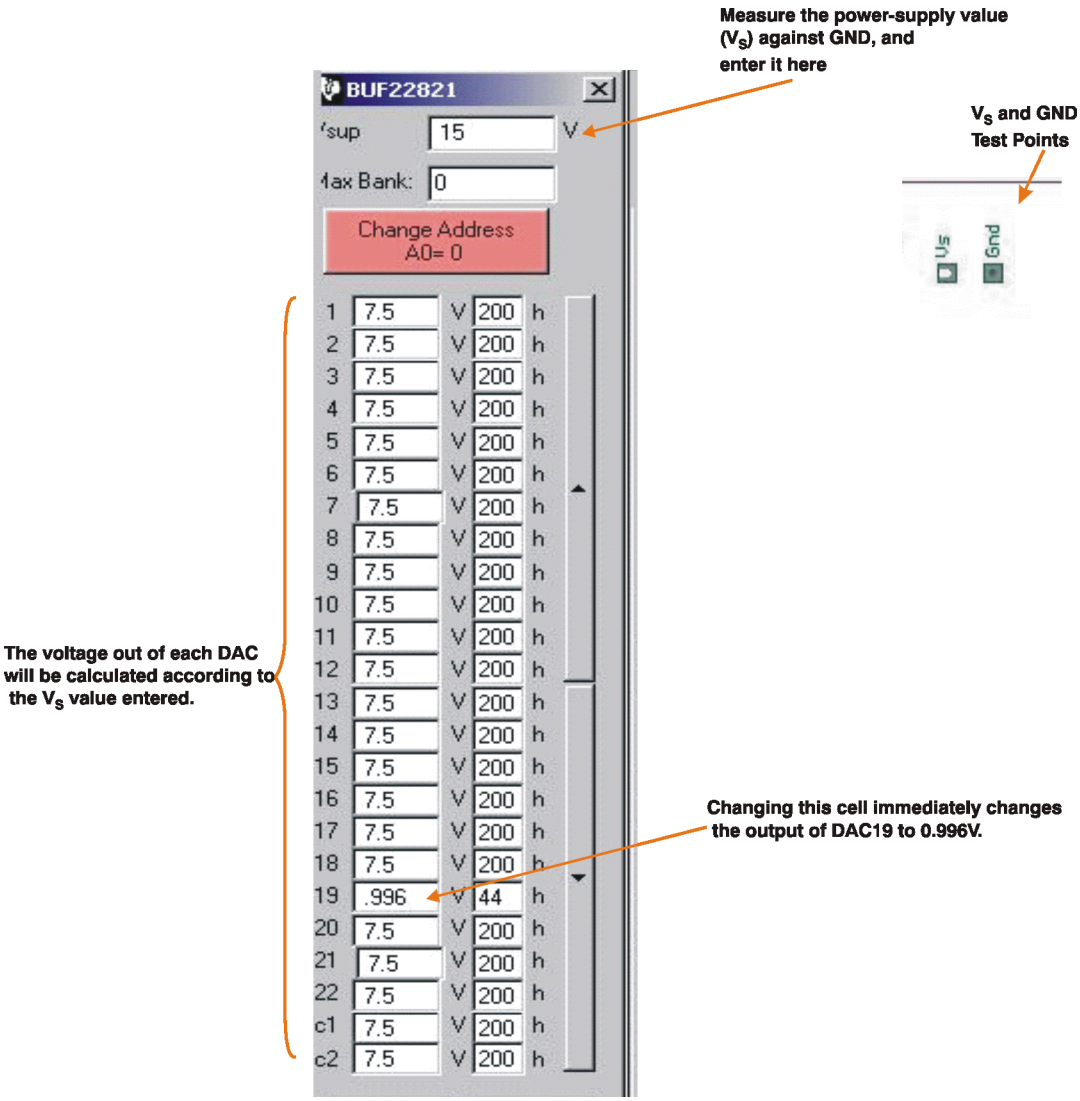


Figure 12. Power Supply Measurement and Recording

Measure V_S at the location indicated in Figure 4.

For example, changing the value in the DAC 19 cell immediately changes the output of DAC19 to 0.996V. The calculation is performed according to Equation 1.

$$\frac{V_{DAC_CHANNEL} = V_S \xi Code_in_decimal}{1024} \quad (1)$$

For example:

DAC 19: Code 44 (hexadecimal) = 68 (decimal)

$V_{DAC_CHANNEL} = 15V \xi 68 / 1024 = 0.996V$

5.3 Reset and Read DAC Buttons

Push the *ReadDAC* button to read the binary value in the DAC output registers of the BUF22821. Pushing the *Reset* button forces an I^2C general call reset and causes all registers in the BUF22821 to reset to the respective default values (mid-code or $V_S/2$). Figure 13 illustrates the Reset and Read DAC buttons.

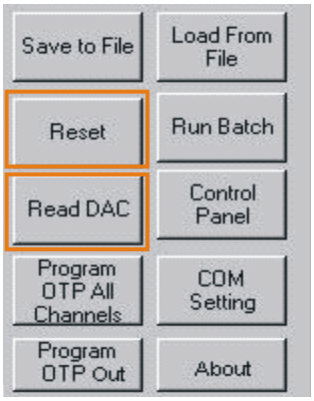


Figure 13. Reset and Read DAC Buttons

5.4 Save to File

The register configurations of the BUF22821 DACs are displayed in both analog voltage and in hexadecimal (see Figure 12). The DAC codes (that is, gamma voltages) can be saved into a text file using the *Save to File* button.

Pressing the Save to File button opens a file-save dialog box similar to that shown in Figure 14. Pressing the folder icon creates a new folder on your PC. It is a good idea to create a directory exclusively for BUF22821 DAC code (gamma voltage) files. Enter a unique file name in the *File name* field to store your BUF22821 register information. Press the *Open* button to save the file.

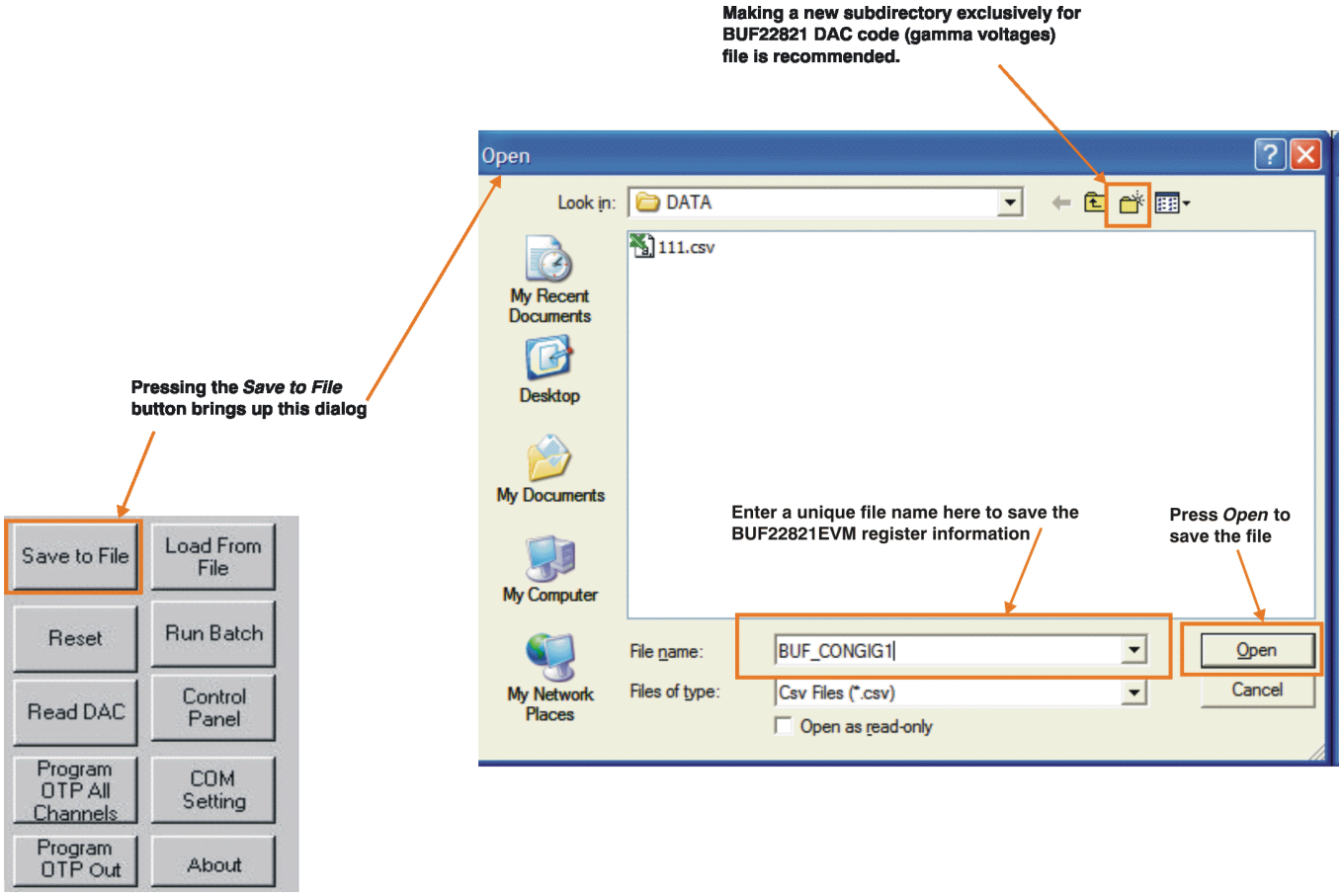


Figure 14. Save to File Dialog Box

Saving the BUF22821 DAC codes (gamma voltages) creates a text file that can be opened in a spreadsheet program or text editor, as illustrated in Figure 15.

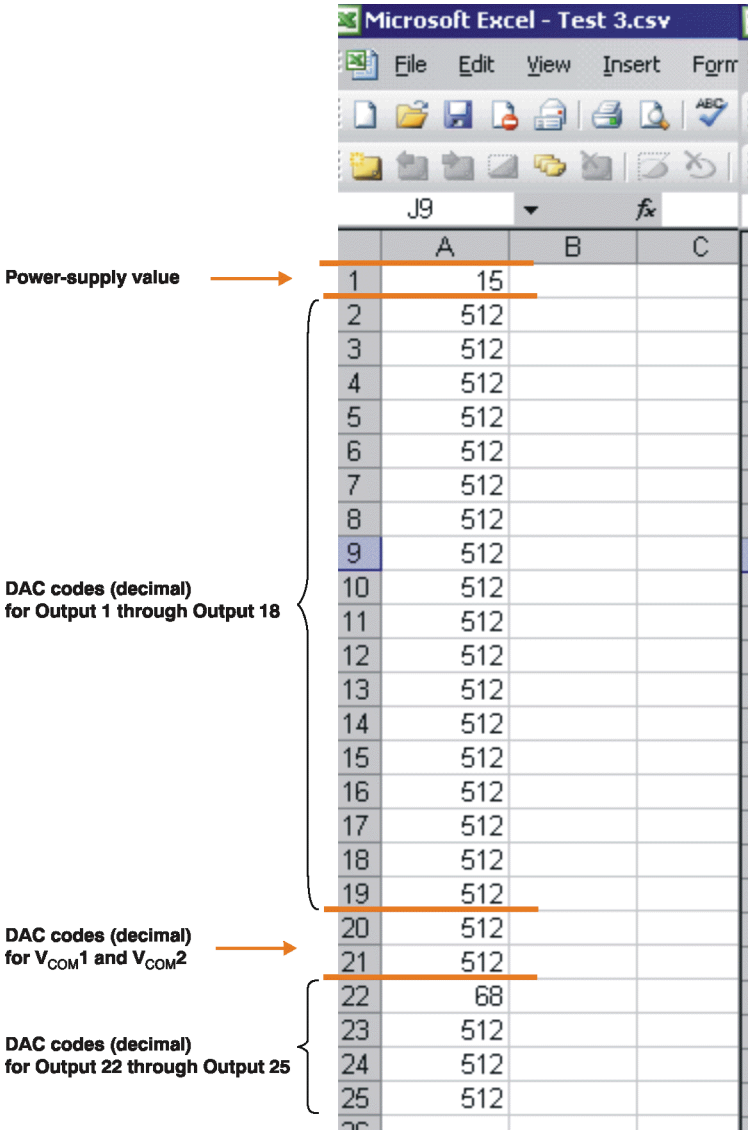


Figure 15. Working with a Saved BUF22821 Data File

The first entry in the file is the power-supply value. Fields 2 through 19 contain the DAC codes (decimal) for Outputs 1 through 18. Fields 20 and 21 contain the DAC codes (decimal) for $V_{COM}1$ and $V_{COM}2$. Fields 22 through 25 contain the DAC codes (decimal) for Outputs 19 through 22.

5.5 Loading a Saved Data File

The BUF22821EVM software is also able to load data saved from previous evaluations. A saved register configuration can be loaded into the BUF22821 using the *Load From File* button, shown in Figure 16. The program remembers where you saved the last register configuration. Simply select the desired configuration and press *Open*.

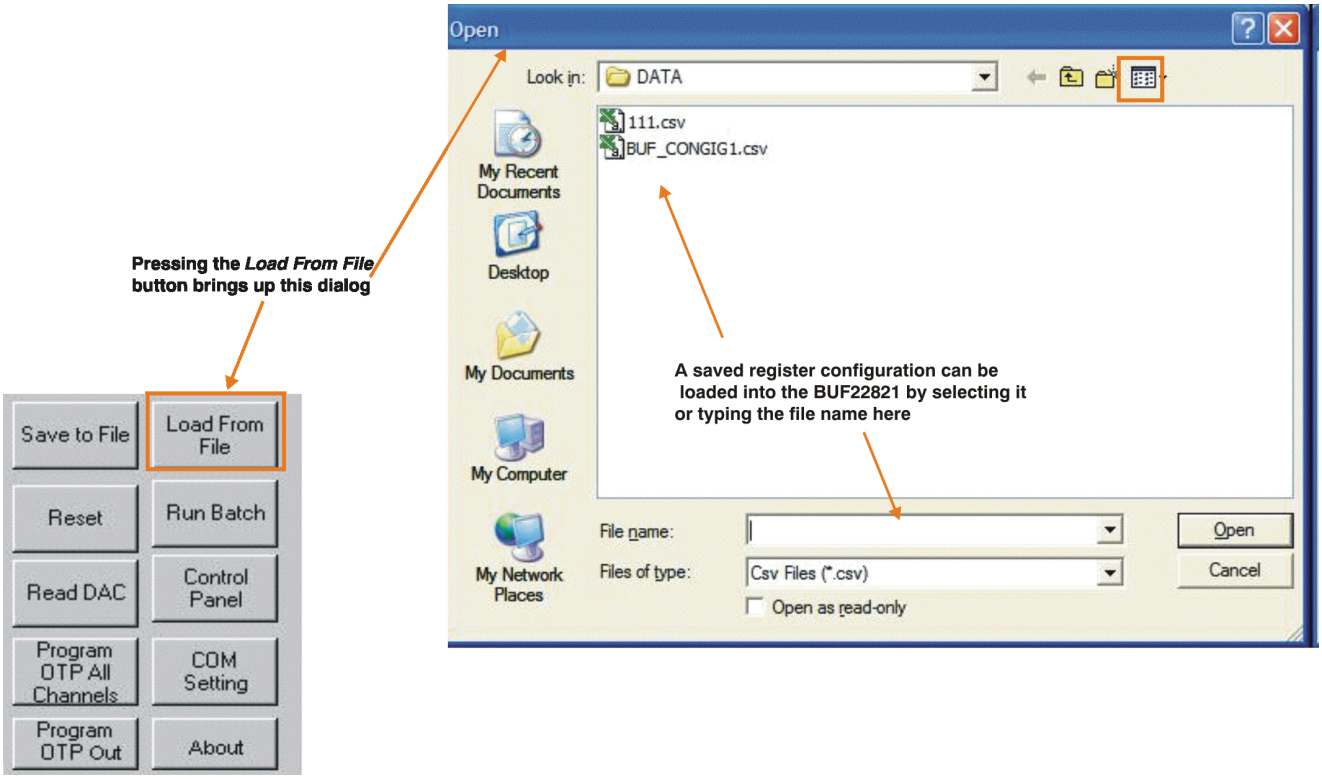


Figure 16. Load From File Button

5.6 Changing the DAC Analog Voltage

The analog voltage of any DAC can be directly edited, as Figure 17 shows.

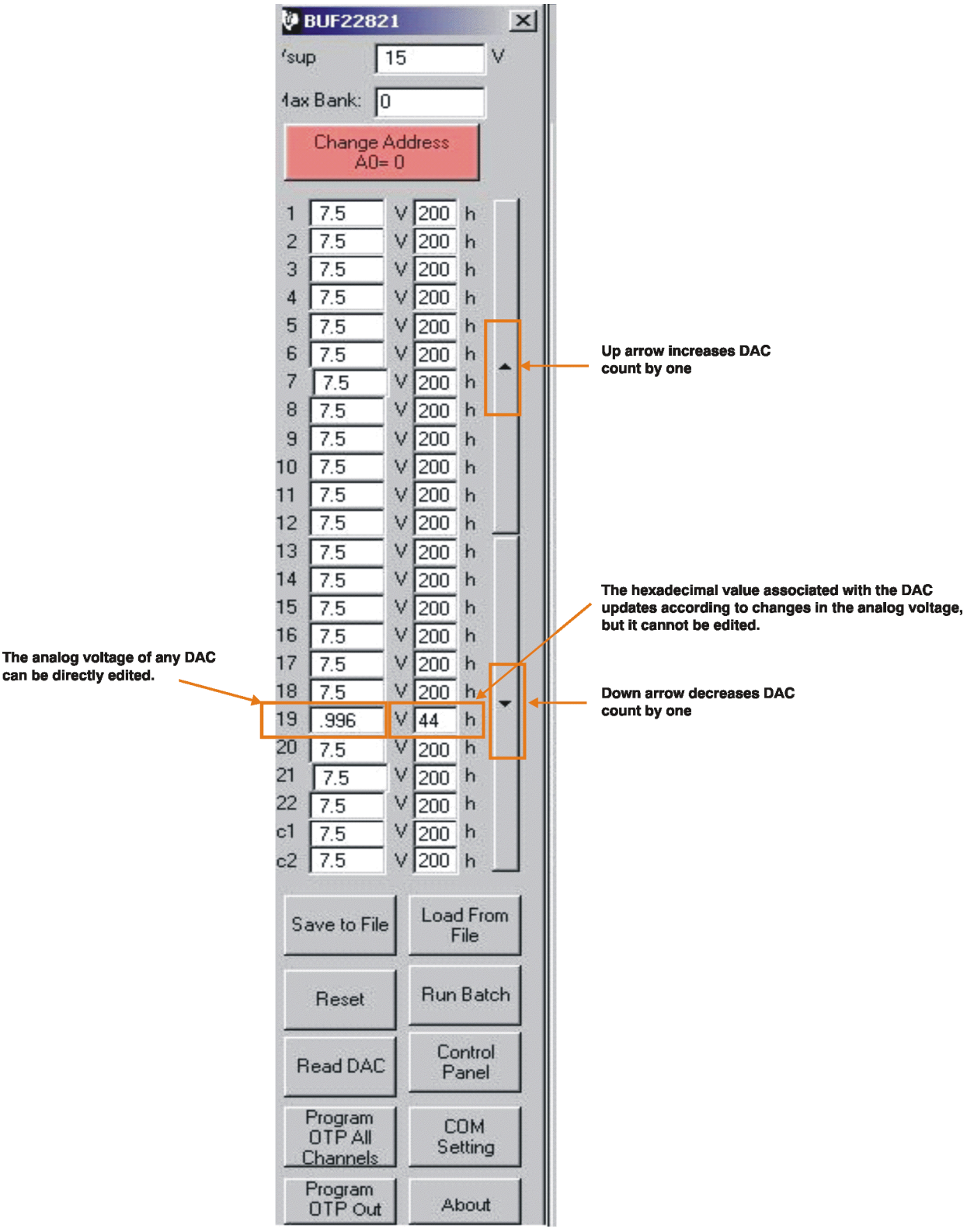


Figure 17. Changing the DAC Analog Voltage

Note, however, that the hexadecimal value associated with the DAC updates according to changes in the analog voltage, but it cannot be directly edited.

If you select a DAC and click on the up arrow control, the DAC register increases by one count. Conversely, clicking on the down arrow control decreases the DAC register by one count.

5.7 Run Batch Button

The *Run Batch* button (as noted in Figure 18) enables the user to configure the BUF22821 to cycle through different register configurations in a continuous loop. When connected to the end application, this feature can be used to cycle through different gamma settings to determine what the optimal settings must be for a given application.

When the Run Batch button is pressed, a new dialog box displays, as shown in Figure 18. The delay time is the amount of time in between loading new configurations into the BUF22821.

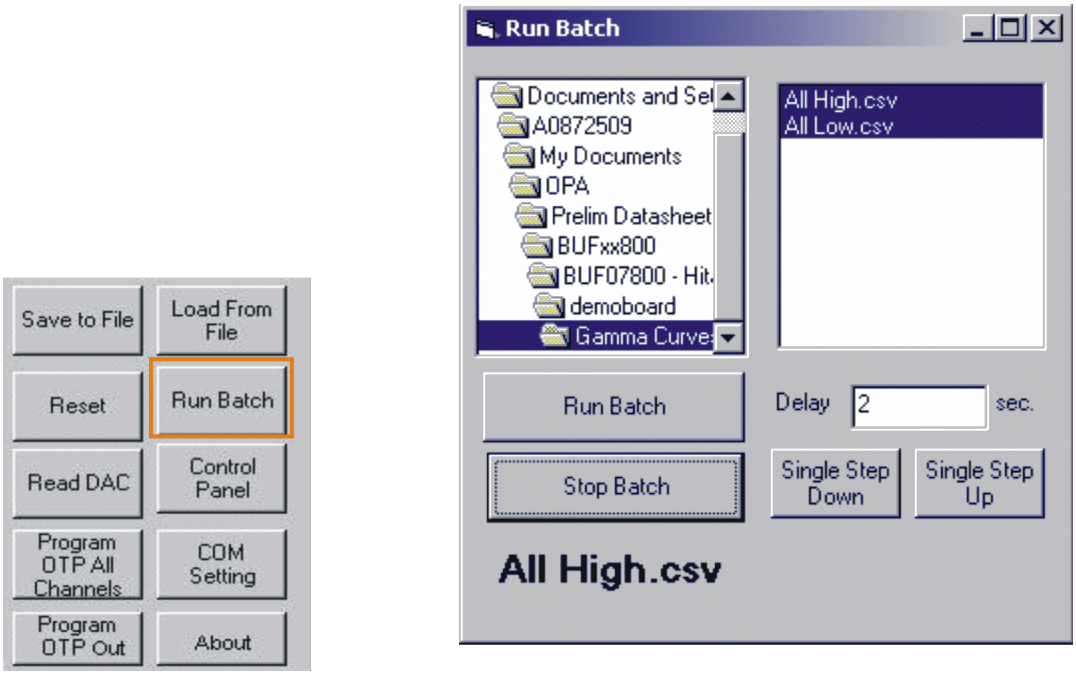


Figure 18. Run Batch Dialog Box

Use the *Single Step Up* and *Single Step Down* buttons to step through the selected files manually. The currently-selected file name is displayed in the lower left corner area of the dialog box. Press the <*Shift*> key and click on the files you want to select. In Figure 18, two configuration files are selected.

5.8 Control Panel

Pressing the *Control Panel* button brings up a display panel that allows you to adjust each channel using a set of graphical sliders, as shown in Figure 19. Simply drag the slider to adjust the desired channel output. The DAC output value changes automatically.

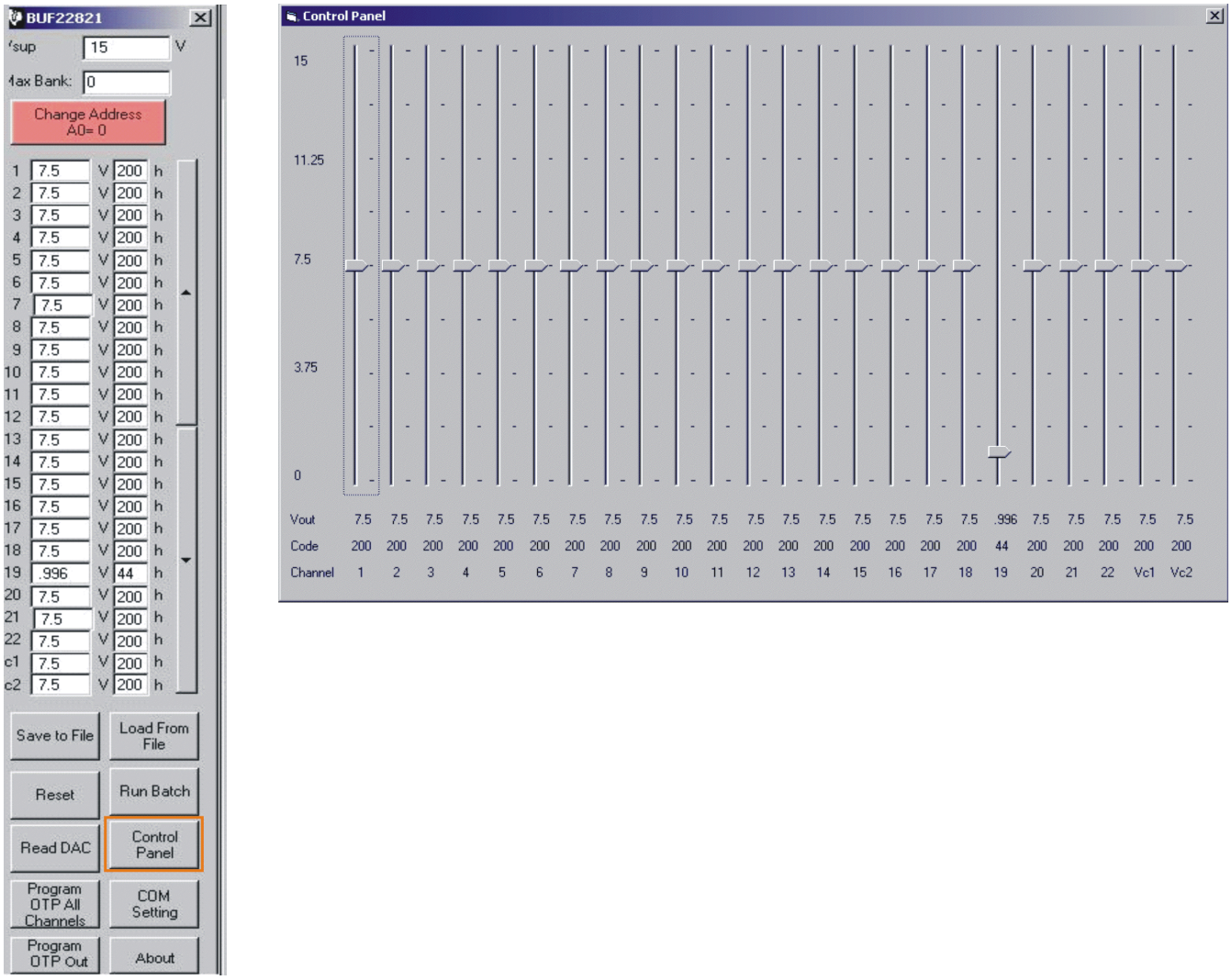


Figure 19. Control Panel Button and Graphical Sliders

5.9 Program OTP All Channels Button

As Figure 20 shows, pressing the *Program OTP All Channels* button allows you to program a gamma curve into the nonvolatile memory in the BUF22821. All 22 channels (including the V_{COM} channels) are then programmed simultaneously. The values are stored in the memory bank that is selected via the BKSEL switch (see Section 4.1). Note that *Bank 1* corresponds to Bank_0 inside the BUF22821, while *Bank 2* corresponds to Bank_1.

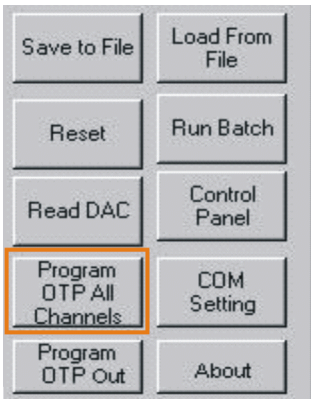


Figure 20. Program OTP All Channels Button

5.10 Program OTP Out Button

Pressing the *Program OTP Out* button (illustrated in Figure 21) allows you to store the value of a specific channel into the nonvolatile memory in the BUF22821. This feature is useful when the V_{COM} channels must be programmed at different times. The values are stored in the memory bank that is selected via the BKSEL switch. The *Write OTP Reg* dialog box appears.

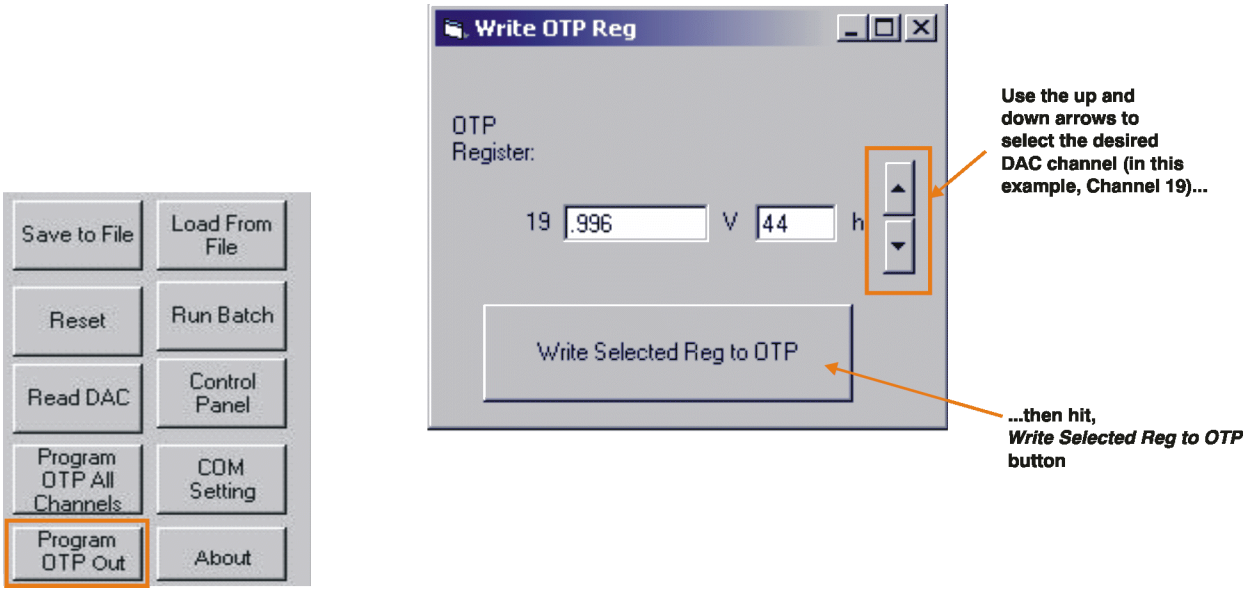


Figure 21. Program OTP Out Button and Write OTP Reg Dialog

In the example shown in Figure 21, to program 0.996V into the nonvolatile memory of channel 19, use the up and down arrows to select channel 19. Then press the *Write Selected Reg to OTP* button.

5.11 Max Bank Field

The *Max Bank* field at the top of the software interface (see Figure 22) shows how many times the memory of the most-programmed channel of the selected memory bank has been previously written.

- None: Max bank shows **0**.
- Once: Max Bank shows **0**.
- Twice: Max bank shows **1**.
- Three times: Max bank shows **2**.
- 16 times: Max bank shows **15**.

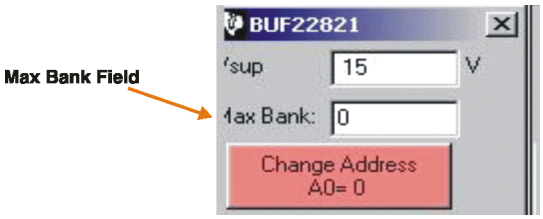


Figure 22. Max Bank Field

6 Hardware and Schematic

This section contains the complete bill of materials, schematic diagram, and PCB layouts for the BUF22821EVM.

Note: Board layouts are not to scale. These are intended to show how the board is laid out; they are not intended to be used for manufacturing BUF22821EVM PCBs.

6.1 Schematic

Figure 23 shows the schematic for the BUF22821EVM.

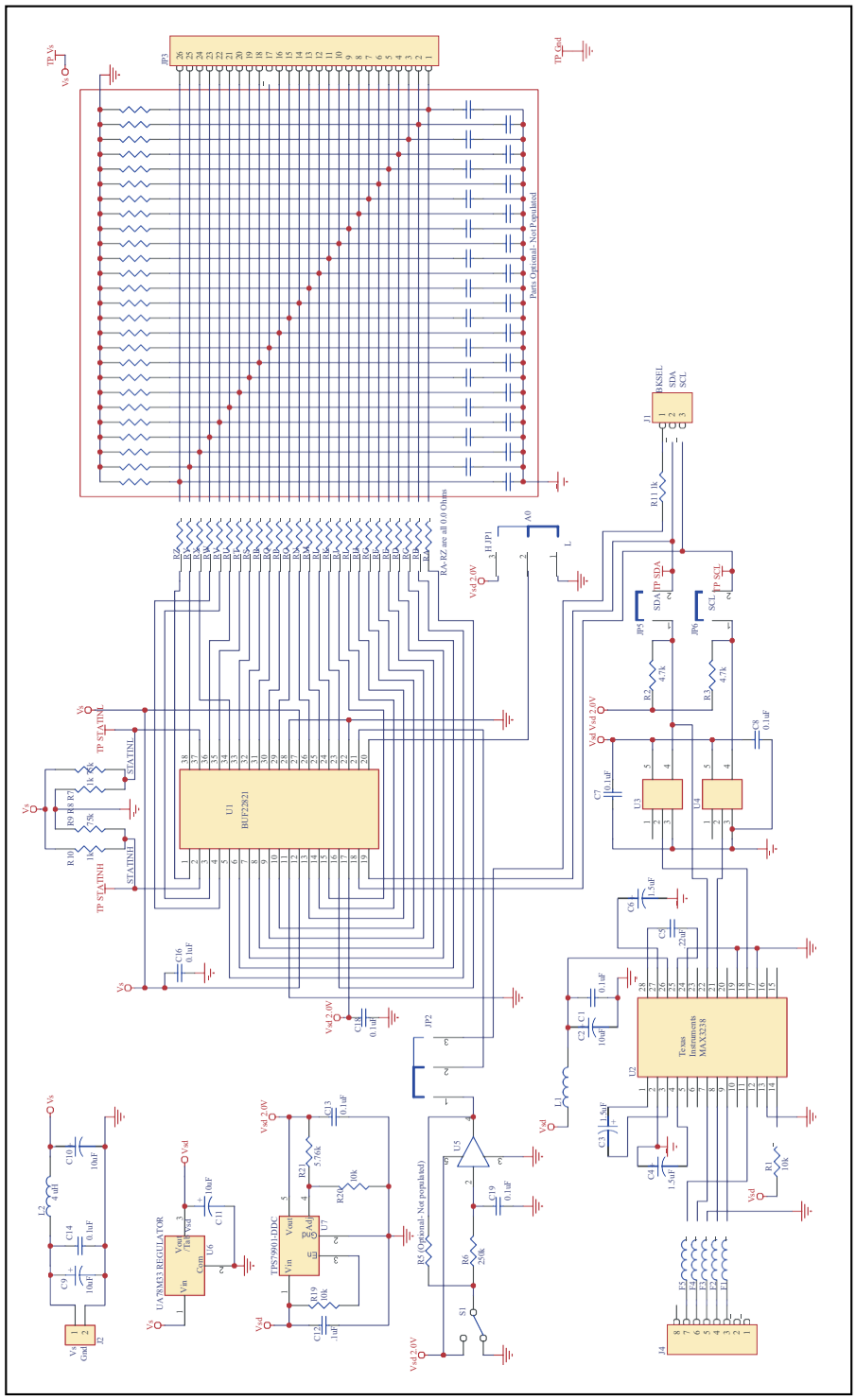


Figure 23. BUF22821EVM Schematic

6.2 PCB Layouts

Figure 24 and Figure 25 show the PCB layout of the BUF22821EVM.

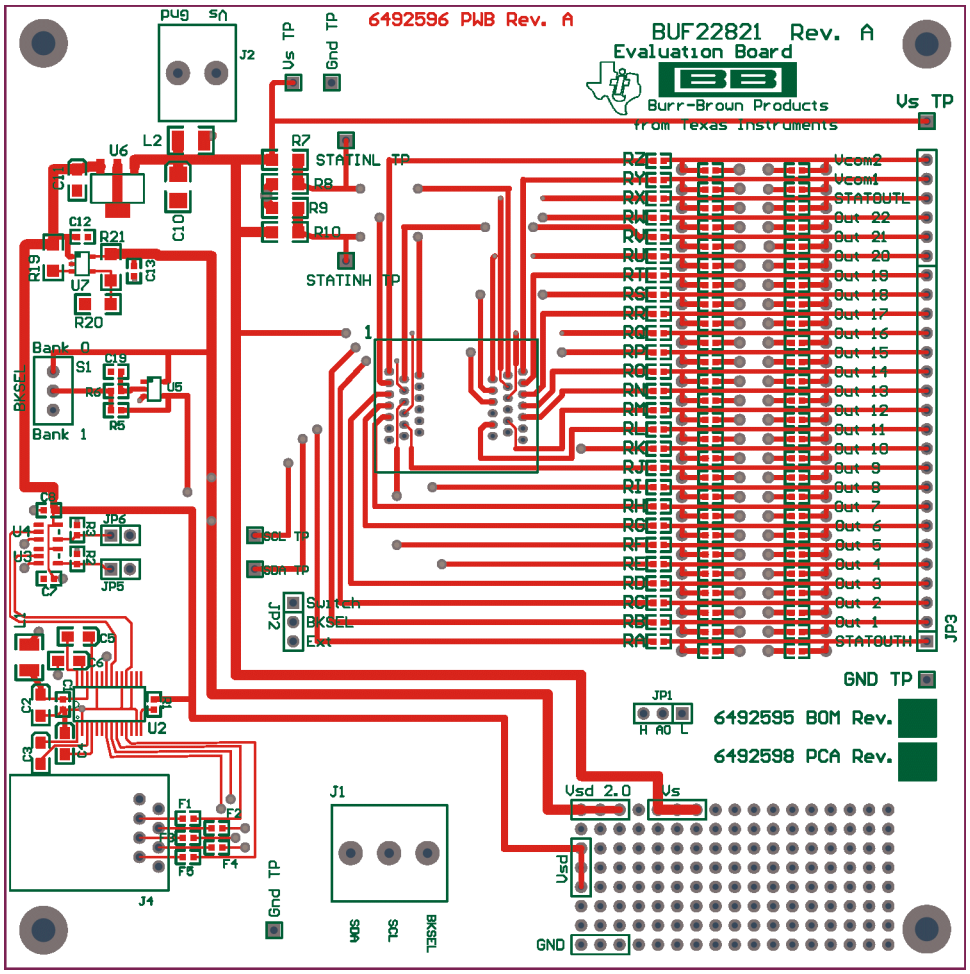


Figure 24. BUF22821EVM PCB Top Layer (Component Side)

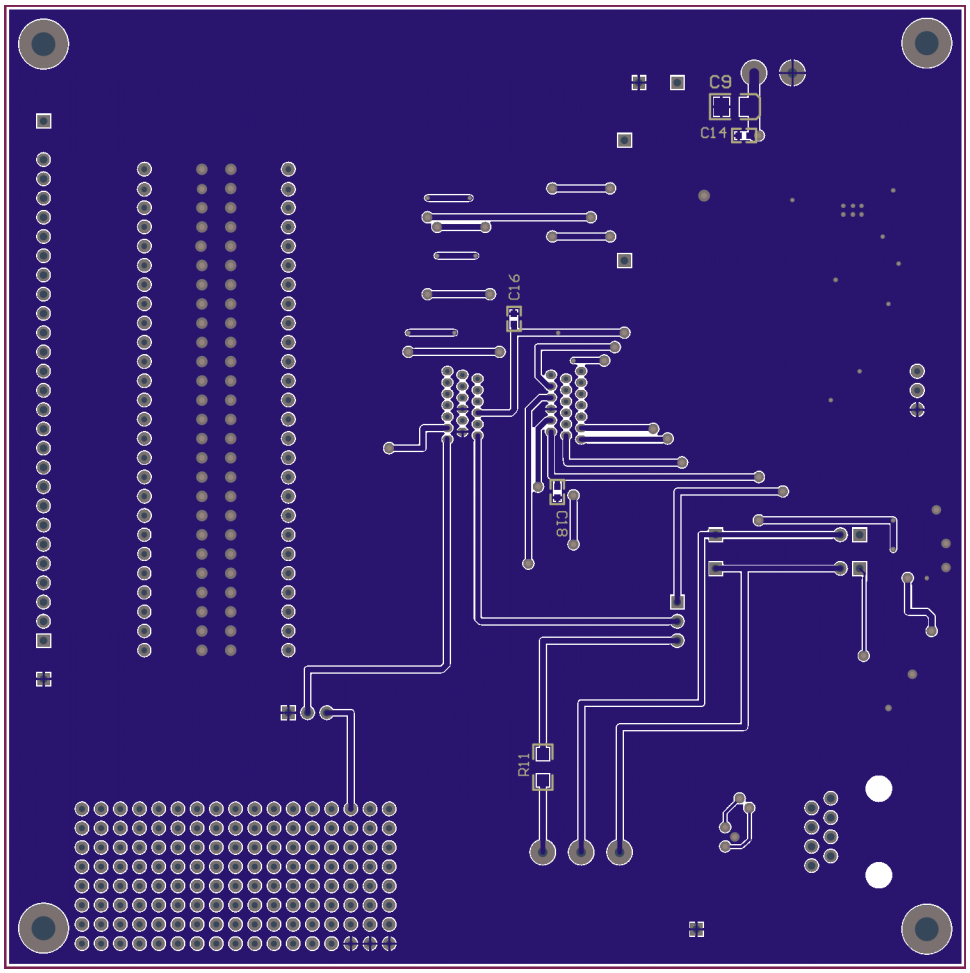


Figure 25. BUF22821EVM PCB Bottom Layer (Solder Side)

6.3 Bill of Materials

Table 1 lists the bill of materials for this EVM.

Table 1. Bill of Materials

Count	RefDes	Description	Part Number	MFR
9	C1, C7–C8, C12–C14, C16, C18–C19	Capacitor, Ceramic, 0.1µF, 603 size	C1608X7R1E104K	TDK
2	C2, C11	Capacitor, Tantalum, 10µF, 10V, SMT 3216 "A"	T491A106K010AT	Kemet
3	C3, C4, C6	Capacitor, Tantalum, 1.5µF, 16V, SMT 3216 "A"	T491A155K016AT	Kemet
1	C5	Capacitor, Ceramic, 0.22µF, 1206	C1608X7R1C224K	TDK
2	C9, C10	Capacitor, Tantalum, 10µF, 20V, SMT 3528 "B"	B45196H4106M209	Kemet
5	F1–F6	Ferrite Bead, 600Ω at 100MHz, SM 0603	HZ0603C601R-10	Steward
1	J1	Terminal Strip, 3-Position, Cage Clamp, 45°, Dove-tailed	ED300/3	On-Shore Technology Inc
1	J2	Terminal Strip, 2-Position, Cage Clamp, 45°, Dove-tailed	ED300/2	On-Shore Technology Inc
1	J4	Connector, Modular Receptacle, RJ-45, Side Entry, 8 position/ 8 contact	5520426-4	AMP Tyco Electronics
1	L1	Inductor, 150µH, 1210 SMD 10%	ELJ-FA151KF	Panasonic
1	L2	Inductor, 3.9µH, 1210 SMD 10%	ELJ-FA3R9KF	Panasonic
1	R1	Resistor, 10kΩ, 603 size	CRCW060310K0FKEA	Vishay/Dale
2	R19, R20	Resistor, 10kΩ, 1206 size	CRCW120610K0FKEA	Vishay/Dale
2	R2, R3	Resistor, 4.7kΩ, 603 size	CRCW06034K70FKEA	Vishay/Dale
1	R21	Resistor, 6.81kΩ, 1206 size	CRCW12066K81FKEA	Vishay/Dale
0	R5	Resistor, 603 size. OPTIONAL; NOT NORMALLY INSTALLED.		
1	R6	Resistor, 249kΩ, 603 size	CRCW0603249KFKEA	Vishay/Dale
2	R7, R9	Resistor, 75kΩ, 1206 size	CRCW120675K0FKEA	Vishay/Dale
3	R8, R10, R11	Resistor, 1kΩ, 1206 size	CRCW12061K00FKEA	Vishay/Dale
26	RA–RZ	Resistor, 0.0Ω, 603 size	CRCW06030000Z0EA	Vishay/Dale
1	S1	Switch, Toggle, SPDT, .4VA, PC Mount	200AWMSP1T1A1M2RE	E-Switch
1	JP3	Terminal Strip, 26 position, .100 centers, .025 square pins	TSW-126-07-G-S	Samtec
2	JP1, JP2	Terminal Strip, 3 position, .100 centers, .025 square pins	TSW-103-07-G-S	Samtec
2	JP5, JP6	Terminal Strip, 2 position, .100 centers, .025 square pins	TSW-102-07-G-S	Samtec
9	XXXXX TP (All)	Terminal Strip, 1 position, .100 centers, .025 square pins	TSW-101-07-G-S	Samtec
1	U1	Socket, TSSOP 38-Pin ZIF	OTS-38(44)-0.5-01	ENPLAS
1	U2	IC, 3V to 5.5V MultiChannel RS-232 Line Driver/Receiver, TSSOP-28	MAX3238CPWR	Texas Instruments
2	U3, U4	IC, Single Buffer/Driver w/Open Drain Out, SOT23-5	SN74LVC1G07DB	Texas Instruments
1	U5	IC, Single Buffer, Schmitt Trigger, SOT23-5	SN74LVC1G17DB	Texas Instruments
1	U6	IC, Voltage Regulator, 3.3V, SOT223-4	UA78M33CDCYR	Texas Instruments
1	U7	IC, Voltage Regulator, Adjustable, TSOT23-5	TPS79901DDC	Texas Instruments
4		Standoff, Hex 4-40 Aluminum. 0.500in	2203	Keystone Electronics
4		Screw, Machine, Phillips, 4-40X1/4 SS	PMSSS 440 0025 PH	Building Fasteners
4		Shunt, w/ handle, 2 pos, 0.100in	881545-2	AMP Tyco Electronics

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 9V (min) to 20V (max) and the output voltage range of 9V (min) to 20V (max).

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.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's 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, some circuit components may have case temperatures greater than +25°C. The EVM is designed to operate properly with certain components above +25°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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