EVM User's Guide: BQF0008EVM
Single-Wire FRAM Evaluation Module

TEXAS INSTRUMENTS

Description

The BQF0008EVM allows users to evaluate the performance of BQF0008 Single-Wire FRAM memory devices. The EVM comes in a USB stick form factor for interfacing with the host PC. The microcontroller is preloaded with the required firmware to communicate between the device under test and the host PC. The provided BQ2026-BQF-EVM-GUI software (referred to as *GUI*) is an all-in-one suite capable of managing registers, modifying memory pages, and reporting device status.

Get Started

1. Order the BQF0008EVM.
2. Download the latest version BQ2026-BQF-EVM-GUI software.
3. Follow this EVM user's guide.

Features

- Direct USB connection to PC for power and data transfer
- Control SDQ pull-up voltage control to 5V and 3.3V by jumpers
- Multiple test points for relevant signal probing
- Onboard MSP430F5509 MCU with hardware Single-Wire support
- Optional firmware reprogramming over USB
- BQF0008DRS device included onboard
- Header available for external device interfacing
- Plug-and-play operation for use with BQ2026-BQF-EVM-GUI software
- Support for standard (15.4Kbps) and overdrive (90Kbps) Single-Wire data transfer speeds
- Read and write to FRAM memory, modify status registers, and read device identifiers

Applications

- Medical disposables
- Cable identification
- Asset tracker
- Energy infrastructure
- Connected peripherals and printers
- Counterfeit hardware detection
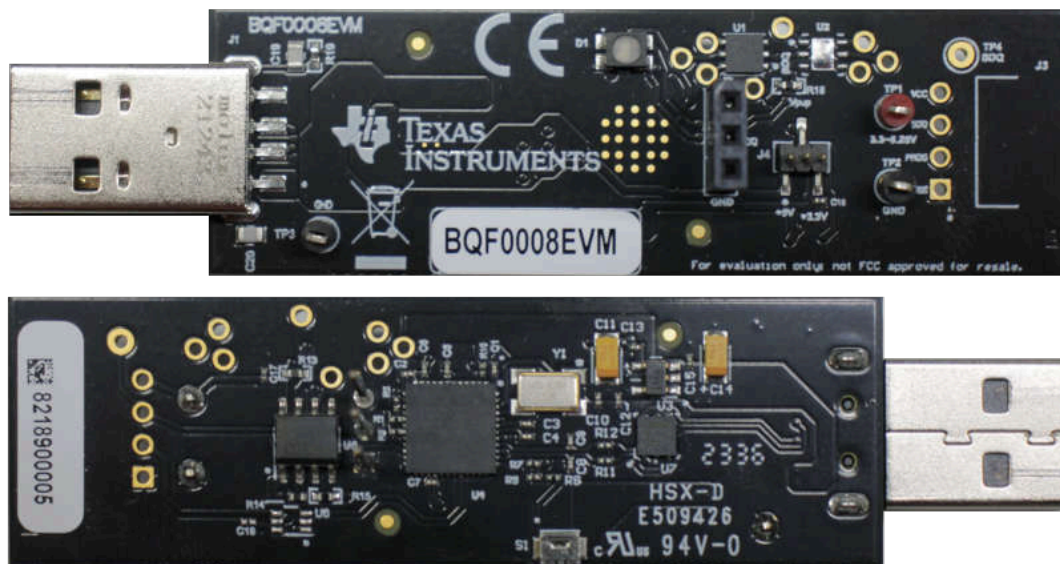
BQF0008EVM (Top and Bottom View)

1 Evaluation Module Overview

1.1 Introduction

The BQF evaluation module demonstrates the performance, behavior, and function of TI's family of FRAM memories utilizing the Single-Wire communication protocol. This user's guide details the required hardware and software setup process, schematic, and PCB layout. References within this document to *evaluation board, evaluation module*, and *EVM* refers to the BQF0008EVM.

1.2 Kit Contents

Table 1-1 summarizes the contents of the BQF EVM kit. Contact the nearest Texas Instruments Product Information Center if any component is missing. TI recommends checking the product folder on ti.com for the latest versions of released software.

Table 1-1. BQF EVM Kit Contents

Item	Quantity
BQF0008EVM Evaluation Board	1

1.3 Specifications

Supported features in this version:

*   Manage up to 6 BQF memories simultaneously
*   Access to status registers, ID, and memory space
*   Read and write to memory pages
*   View stored memory at a glance
*   Manage communication speed between standard and overdrive
*   Error console for quick troubleshooting and logging
*   Optional firmware upgrades over USB

1.4 Device Information

The BQF0008 stores data in FRAM non-volatile memory and facilitates data transfer over the **SDQ**™ Single-Wire interface. The device supports 15.4kbps (standard) and 90kbps (overdrive) maximum speeds. Each device contains a unique factory-programmed 64-bit identification number used for addressing and identification. Data communication and power are facilitated via the SDQ line and GND. The memory is structured as 30 memory pages, each storing 32 bytes. Data is written to a 32-byte scratchpad for verification before copying to memory. Each adjacent set of 4 pages constitutes a single memory block, which can be configured for write-protect, or emulated EPROM modes.

EVM	Device	Description
BQF0008EVM	BQF0008	8Kb Serial FRAM with SDQ Interface

2 BQF EVM Hardware Overview

The BQF0008EVM is a USB-stick form factor board designed for evaluating BQF0008 Single-Wire memory devices. The connected PC runs the graphical user interface (GUI) software for communication with the device. The MSP430F5509 MCU on the EVM receives USB commands from the PC and communicates with the device over SDQ. The EVM requires a PC running x64 Windows® 10 or later, equipped with a USB 2.0 Type-A port. The EVM firmware is preloaded for out-of-the-box operation.
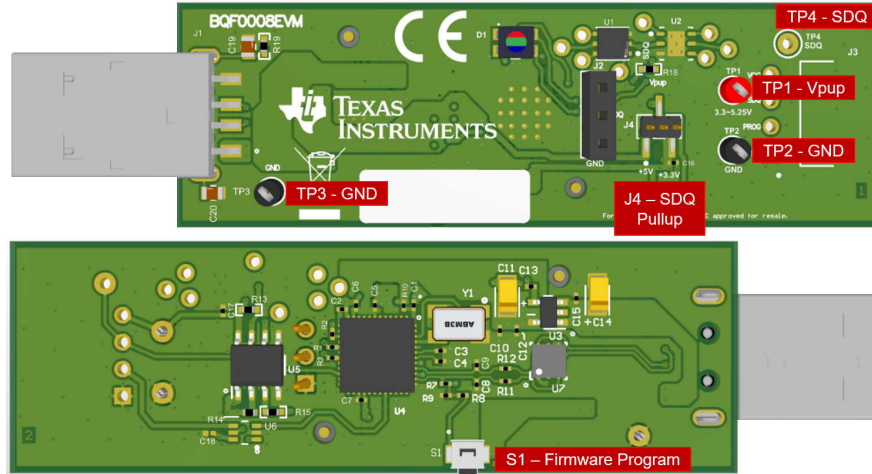

Figure 2-1. BQF0008EVM Test Points and Switches

2.1 SDQ Pullup Selection Jumper

Figure 2-1 shows jumper J4, responsible for control of the SDQ pullup voltage. Table 2-1 shows the configuration options of the jumper.

Table 2-1. SDQ Jumper to Voltages

J4 Jumper Connection	SDQ Voltage
1 - 2	+5V
Not installed	User-supplied voltage at TP1 (V_{PUP})
2 - 3	+3.3V

2.2 Test Points

Table 2-2 lists the EVM test points for probing device voltages and signals

Table 2-2. BQF0008EVM Test Points

Test Point	Signal
TP1	V_{PUP}
TP2	GND
TP3	GND
TP4	SDQ

2.3 Flash Mode

The BQF EVM can be forced into flash mode for programming firmware over USB of the MSP430. Press S1 while inserting into a PC to enable the flash state. S1 is located on the back of the EVM (see Figure 2-1). If pressed on insert with no intent to flash, then reinsert to revert to standard operation.

3 BQ2026-BQF-EVM-GUI Software

The BQ2026-BQF-EVM-GUI Software (referred to as *GUI*) is a unified platform for evaluating TI's Single-Wire memory devices. This section describes the installation and operation of the GUI software. The GUI allows the user to adjust the communication speed, modify stored memory, and access status registers.

3.1 Hardware Requirements

The BQF EVM software has been tested on 64-bit versions of Windows 10 or Windows 11. Proper software function requires a PC with at minimum a dual-core 64-bit processor, 2GB of available memory, 2GB of available storage, and 1 available USB2.0 port.

3.2 Software Installation

The EVM GUI software is available at BQ2026-BQF-EVM-GUI. Download and install the GUI and follow the prompts as shown in Figure 3-1.
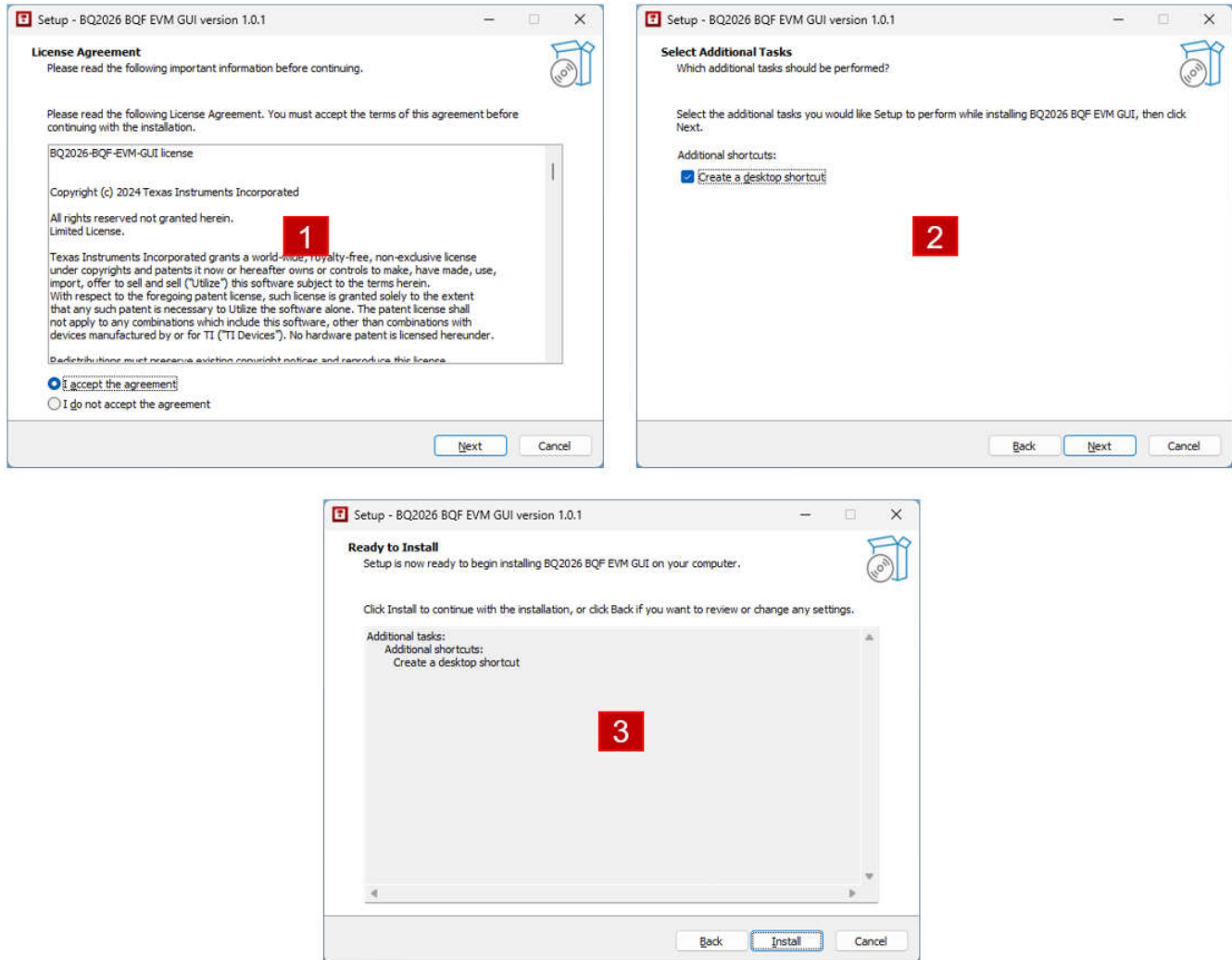

Figure 3-1. EVM GUI Software Install (EULA, Options, Install)

3.3 GUI Software Operation

This section discusses how to operate the BQ2026 BQF EVM GUI software.

3.3.1 Launching GUI

With the EVM properly connected and software installed, launch the BQ2026 BQF EVM GUI application. The software launches with a screen similar to that shown in Figure 3-2.

Figure 3-2. BQF0008 EVM GUI Splash Screen

The GUI has two main sections: *Memory Table*, which enables manipulation of the main memory space on the device, and *Status Registers*, used to modify memory settings. *Controls* is always available, and is for controlling device communication.
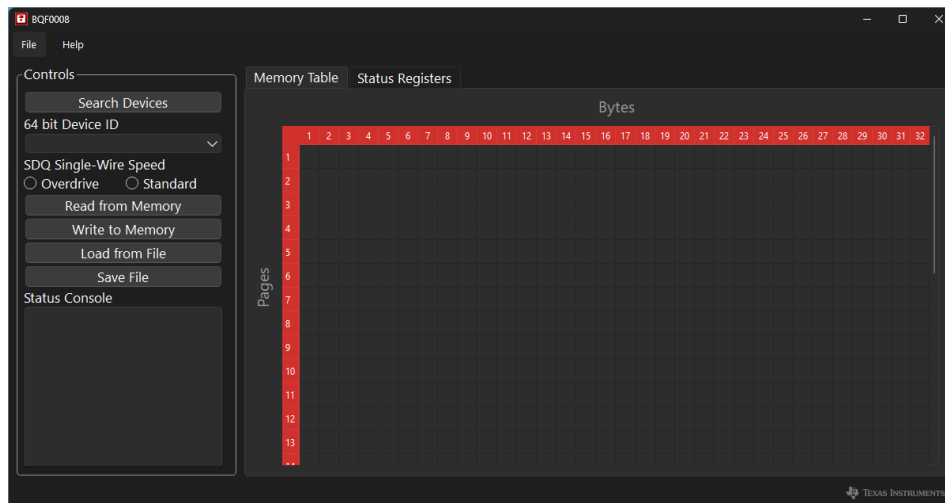
Figure 3-3. EVM GUI Main Screen

The message shown in Figure 3-4 appears when the GUI is launched and the EVM was not detected. Check the USB connection and that the board appears in Device Manager.
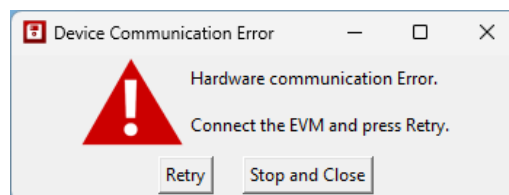

Figure 3-4. Device Communication Error

3.3.2 Menu Bar

The menu bar at the top contains *File* and *Help* options, shown in Figure 3-5. The program can be closed by *File -> Exit*. The *Help* tab contains the *About* and *Product Safety Warnings* for the device and EVM GUI.

3.3.3 Main Controls

The Main Controls are always available for changes and appear in the left side of the application window. The Status Console, located at the bottom left, relays back error messages while the application is running. Any fatal errors appear in a pop-up window. Please note that if the software is used in a multiple monitor setup, then pop-up messages appear on the main screen, regardless of the screen that the GUI is on.
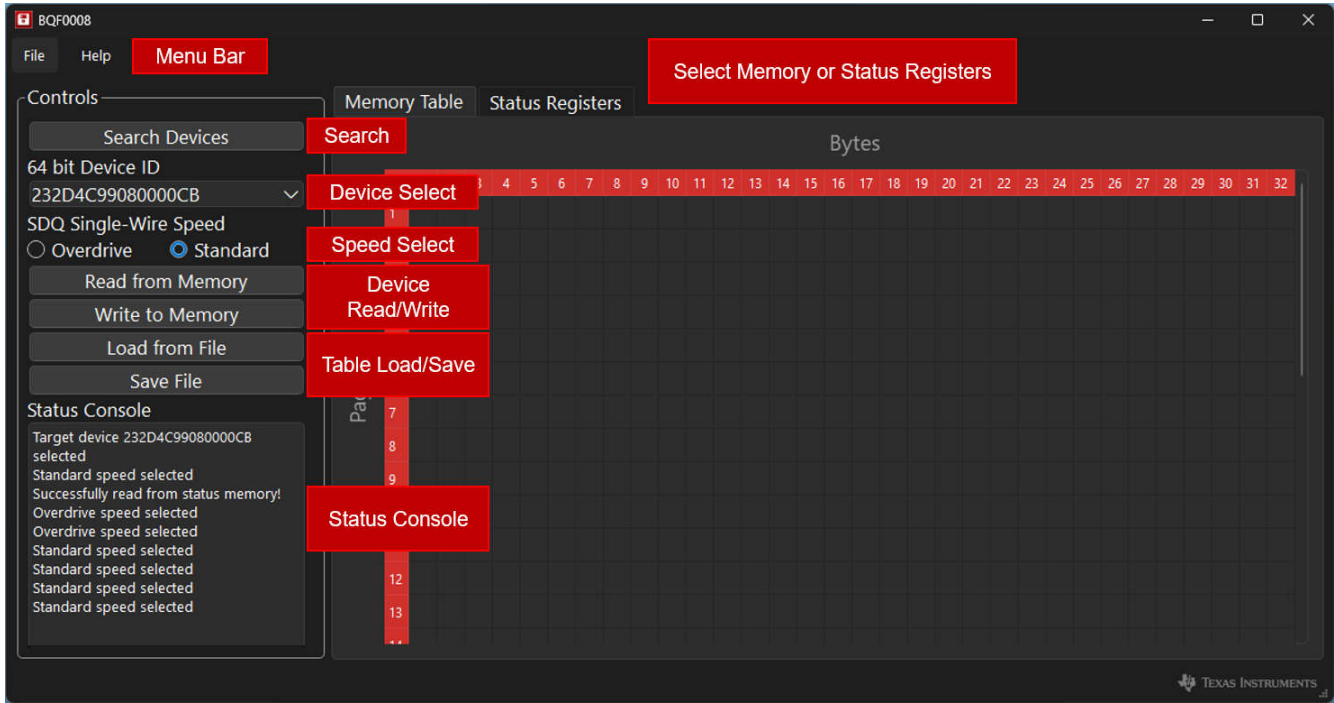

Figure 3-5. Main Controls

3.3.3.1 Search Devices

The *Search Devices* button is located at the top left of the controls area in the program. This function is used to collect information on the Single-Wire devices present on the bus. Shown in Figure 3-6, clicking *Search Devices* populates the device list with all Single-Wire sub-devices in the *Select 64 bit Device ID* drop-down menu. This also clears the *Memory Table* and *Status Registers*. If any devices are detected, then the first device is automatically selected and set to the standard speed.
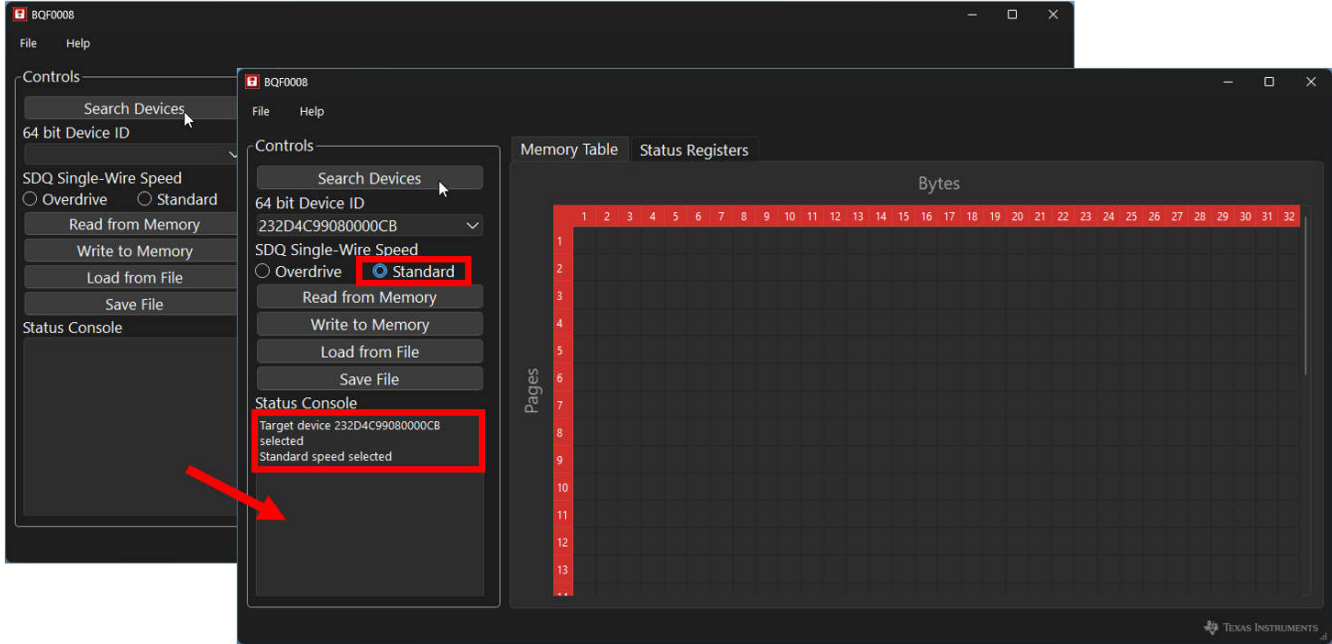

Figure 3-6. Search Devices

Table 3-1. Search Device Error Messages

Error	Explanation
There are more than 6 devices on the bus	Limit total number of connected SDQ devices to 6 or fewer.
CRC Fail	The CRC-8 value given by the device doesn't match the calculated CRC-8 value derived from the received data.
No devices connected	No presence pulse was detected on the SDQ line. Verify Single-Wire devices are connected to SDQ and Jumper J4 is installed in Figure 2-1.

3.3.3.2 Select 64 bit Device ID

The *64 bit Device ID* drop-down list is for selecting a Single-Wire device on the bus, which is below *Search Devices* as shown in Figure 3-5. The ID selected from this list is what the rest of the controls applies to. The *Search Devices* button must be clicked before the IDs are populated into the menu. A device selection is only required if more than one device is on the bus.

Table 3-2. Select Device Error Messages

Error	Explanation
Your device has NOT been selected. A device has been added or removed from the bus. Please search for devices again or reconnect your device	Removing or adding a device to the bus without searching for devices again causes this. Search for devices again.
Target device is not present. Search again or select another device	The target device is not present on the bus. Check the physical connection of the memory device.
Unknown error occurred	This is usually due to a connection issue. Check the hardware connections and try reinstalling the GUI. Make sure the device appears in Device Manager.

3.3.3.3 Speed Selection

The BQF0008 device has two speeds for communication, *Standard Speed* (15.4kbps) and *Overdrive Speed* (90kbps). Shown in Figure 3-5, these options are available in the Controls sidebar. Standard Speed is automatically selected following a device selection. Overdrive speed can only be accessed for BQF devices operating at 5V V_{PUP}.

Table 3-3. Speed Selection Error Messages

Error	Explanation
No **One-Wire** devices detected	There are no devices on the bus. Make sure jumper J4 in Figure 2-1 is installed in a proper position.
Please select a device	No device has been selected from the "Select 64 bit Device ID" drop down menu.
Unknown error occurred	Check the hardware connections and try reinstalling the GUI.
Target device is not present. Search again or select another device	The target device is not present on the bus. Check the physical connection of the memory device.

3.3.4 Memory Table

In the center of the GUI window, users see the *Memory Table* that displays the data stored in the memory. Each row represents individual memory *pages* on the device, while columns represent bytes in each page. Scrolling is necessary to view the entire table.

Table 3-4. Memory Table Error Messages

Error	Explanation
Invalid character at row X and column Y	A cell in the table is edited to contain no value or an invalid byte. Cell is automatically filled with 0xFF values.
The data at row X and column Y has been padded.	A cell contains a valid byte, but is only 1 character. The upper nibble is padded with 0x0 (Figure 3-8).
Data in table is not valid hexadecimal	Select *Read from Memory* again.

3.3.4.1 Memory Table Auto Corrections

When inputting values into the data table, the data must be hexadecimal bytes. Lowercase entries are automatically capitalized. If only a single character is entered, then the table pads the upper nibble with 0x0. If more than 2 characters are entered, then the leftmost 2 are kept. If the data cannot be interpreted as a hexadecimal byte value, then the table is overwritten with a 0xFF value. To make changes to bytes, click on the cell and type in a 2-character representation of the byte. For example, to write 0x36 to a cell, enter *36*.
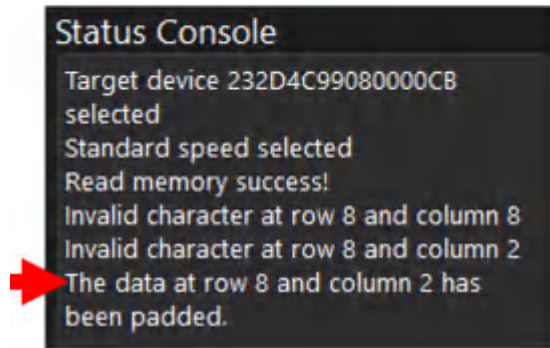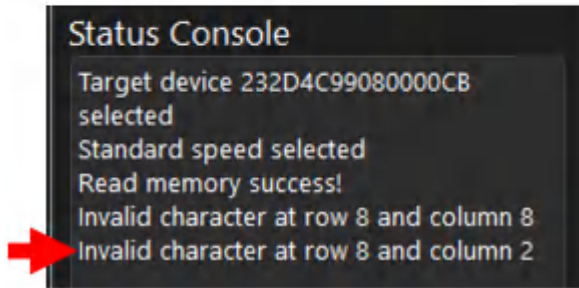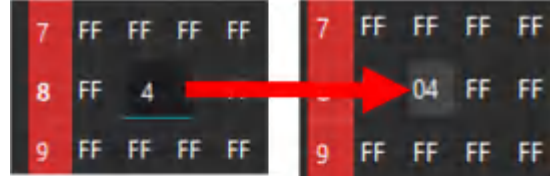
Figure 3-7. Invalid Byte Entered and Capitalization

Figure 3-8. Padded Byte

Figure 3-9. Truncated Input

3.3.4.2 Memory Table Controls

The Memory Table Controls allow access to manipulate the device's stored information. These controls are only available when accessing the Main Memory table.

Figure 3-10. Memory Table Controls

3.3.4.2.1 Read from Memory

Selecting *Read from Memory* automatically populates that main device memory into the table. Allow a few moments for the read to occur. A *Read memory success!* message appears in the Status Console on a good read (for example, see Figure 3-11).

Figure 3-11. Read Memory Steps

Table 3-5. Memory Read Error Messages

Error	Explanation
Please select a device	Device was not selected. Press *Search Devices* again and select a new device.
No Single-Wire devices detected	No Single-Wire devices were detected on the bus. Check the USB connection and the presence of the board in device manager. Make sure jumper J4 is installed in a position that powers the SDQ bus (Figure 2-1).
Target device is not present. Search again or select another device	The target device is not present on the bus. Check the physical connection of the memory device.

Please note that in a situation where there are multiple devices on the bus and the user removes the target device from the bus, a *Read Memory* command populates the data table with values of *FF* and still receives a success message. This is because a presence pulse is pulled low from another device, but no device on the bus responds to the match ROM or subsequent read memory command. Due to the communication behavior as open-drain of Single-Wire, no response is interpreted as a *1* on the bus.

3.3.4.2.2 Write to Memory

The *Write to Memory* button, shown in Figure 3-12, is used to write the values in the *Memory Table* to the target device. Please be patient as the memory is being written to. TI recommends to read from the memory to verify a successful write.
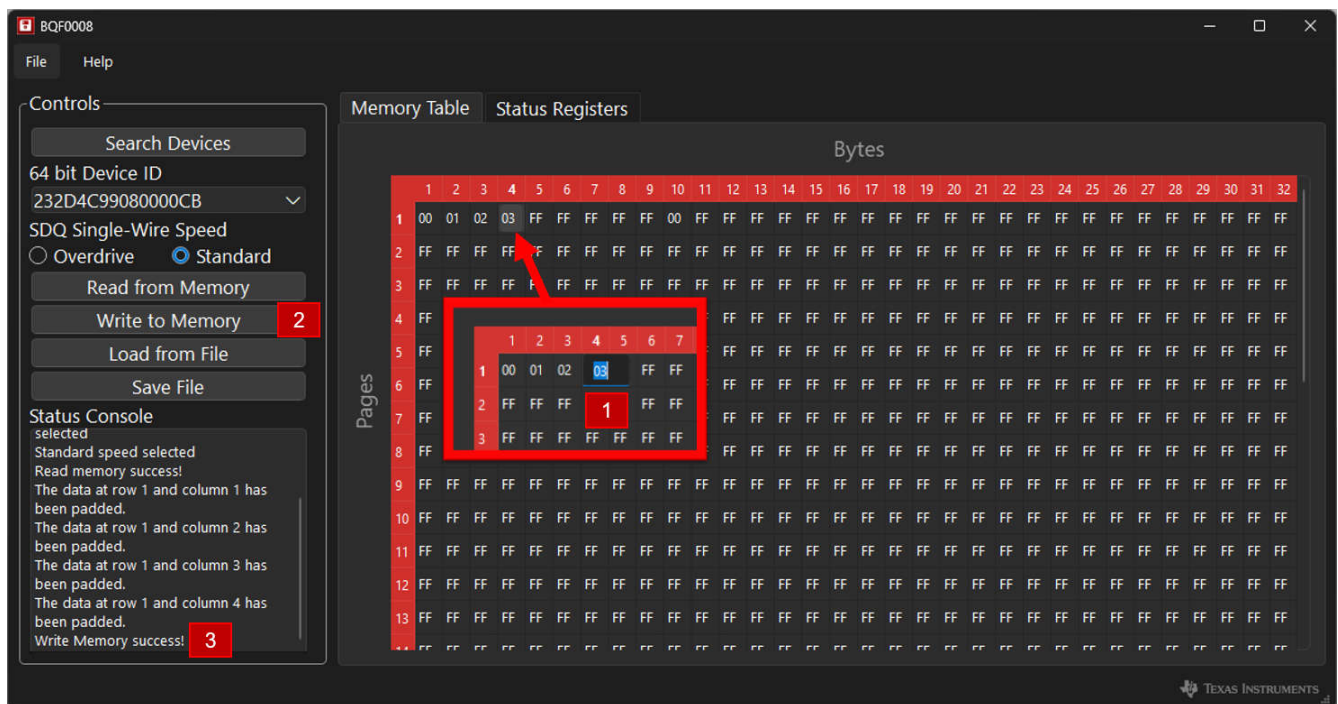

Figure 3-12. Write to Memory

Table 3-6. Memory Write Error Messages

Error	Explanation
Please load from file or read from memory.	The user has not read from memory or loaded data in from a file. Click the *Read from Memory* button to read in the values on the memory device or click the *Load from file* to load values to be written into the memory table.
Please make sure entire table has data. Error found at row X and column Y.	There are blank cells in the table. Go to the error cell at the X and Y values given and add a hex value.
Data must be in byte format. Error found at row X and column Y	A cell contains more than 2 characters. Go to the error cell and enter new values.
Invalid character at row X and column Y	A cell contains a special character. Go to the error cell and enter new values.
Copy Scratchpad failure	A communication error has occurred when sending the command to copy the device scratchpad data into memory. Try writing again.
No Single-Wire devices detected	No devices are connected to the bus. Check the USB connection and that the board appears in the device manager.
Read Scratchpad memory failure Read Scratchpad command fail	The values in the scratchpad were read back and were an unexpected value. There was likely a communication error when sending data to the device. Try writing again.
Write scratchpad command fail	There is a write scratchpad command failure. There was most likely a communication error. Check setup connections.
Target device is not present. Search again or select another device	Device selected to send data to was disconnected from the bus between Search and Write commands. Make sure SDQ line is powered and check device connections.
Invalid CRC	There is a mismatch with the calculated CRC and the returned CRC from the device. This indicates a data transmission error or device malfunction.
Unknown error occurred	This is a catch-all for any error not listed. Retry sending the command. If the error persists, check the hardware connections and try reinstalling the GUI.

3.3.4.2.3 Load from File

The *Load from File* button, shown in Figure 3-13, is used to load in a .csv file into the table. This can only be accessed once a device has been selected. Once the file dialog is opened, the user can select a .CSV file to load into the *Memory Table*.
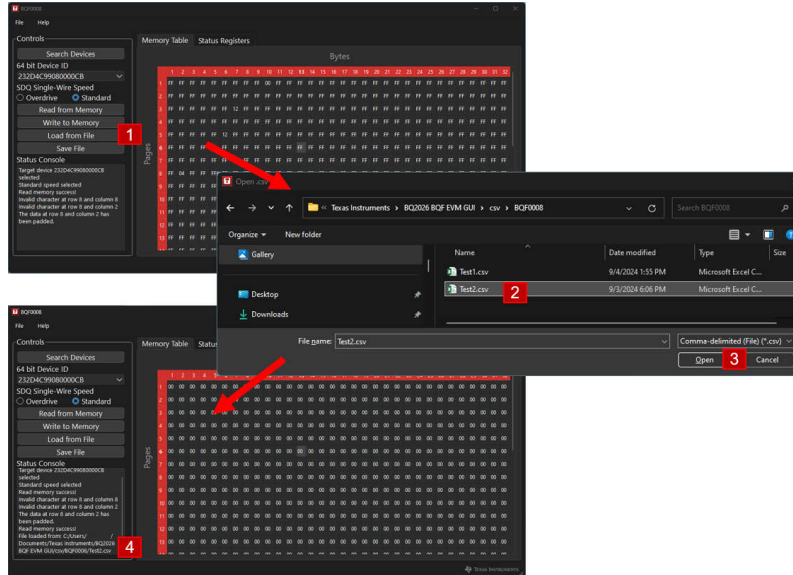

Figure 3-13. File Load Process

Figure 3-14. Example .CSV file loaded in spreadsheet software

Error	Explanation
Please select a device before loading from file	Device must be selected before populating table. Press *Search Devices* and then load from file.
Loaded csv file does not match memory map dimensions [col]/[row]	The loaded file contains a special character in a data cell, or the table loaded did not match the dimensions of the memory space of the device. Edit the CSV in a spreadsheet application and reload after fixing. Make sure CSV loaded was for the right type of memory. BQ2026 files does not load for a BQF0008, for example.

3.3.4.2.3.1 Load from File Auto Corrections

If the user loads in a file containing more than two characters per cell, then this truncates the data in any of the relevant cells and only loads the last two characters into the cell. If a loaded file contains only one character per cell, then this pads the upper nibble with 0x0.

3.3.4.2.3.2 Tips for Creating a .CSV File

The recommended way to create the .csv files is by opening an Excel® sheet and use the following formulas to fill the table with values. When ready, save as a .csv comma-delimited file.

Table 3-7. Excel Cell Formulas

Fill cell with random byte value	=BIN2HEX(TEXT(DEC2BIN(RANDBETWEEN(0,255)),"00000000"),2)
Fill cell with 0x00	=BIN2HEX(TEXT(DEC2BIN(0),"00000000"),2)
Fill cell with 0x00	=BIN2HEX(TEXT(DEC2BIN(RANDBETWEEN(0,0)),"00000000"),2)

3.3.4.2.4 Save File

The *Save File* button, shown in Figure 3-15, saves a .csv file to a location with the data displayed in the *Memory Table*. Writing to memory is not required before saving to file. The table must be populated to save.
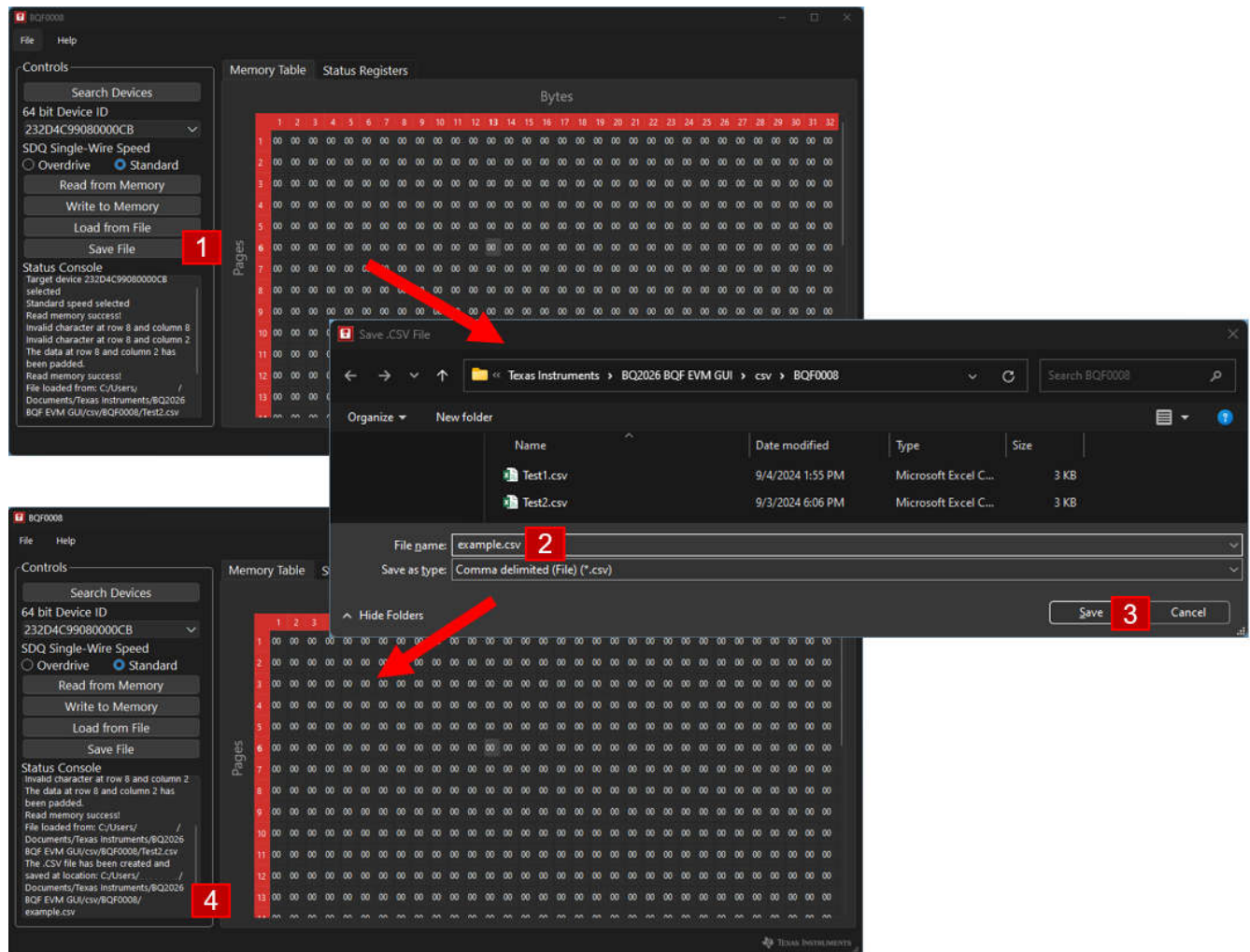

Figure 3-15. File Save Process

Table 3-8. Save File Errors

Error	Explanation
Please load from file or read from memory	The table has not been populated. *Search Devices* again and select device.
Please make sure entire table has data. Error found at row X and column Y	There are blank cells in the *Memory Table*. Go to the error cell and enter a valid byte.
Data must be in byte format. Error found at row X column Y	There are cells with more than two characters. Go to the error cell and enter a valid byte.
Invalid character at row X and column Y	A cell has a special character. Go to the error cell and remove the special characters.

3.3.5 Status Registers

Click on the tab next to *Memory Table* labeled *Status Registers*. This displays the stored values at the status and control registers of the device, shown in Figure 3-16. Only the *Data* column can be edited. These cells accept single bytes as valid entries. Refer to the BQF0008 8K bits Serial FRAM with SDQ Interface data sheet for more information on these values.

3.3.5.1 Status Registers Auto Corrections

All entered bytes in the Status Register section are automatically capitalized. However, entering an invalid byte throws a fatal error. Do not ignore. Make sure entered bytes are valid.

3.3.5.2 Status Registers Controls

The Status Registers Table Controls refer to the controls shown in the red box. These commands are only available when accessing the *Status Registers* tab.
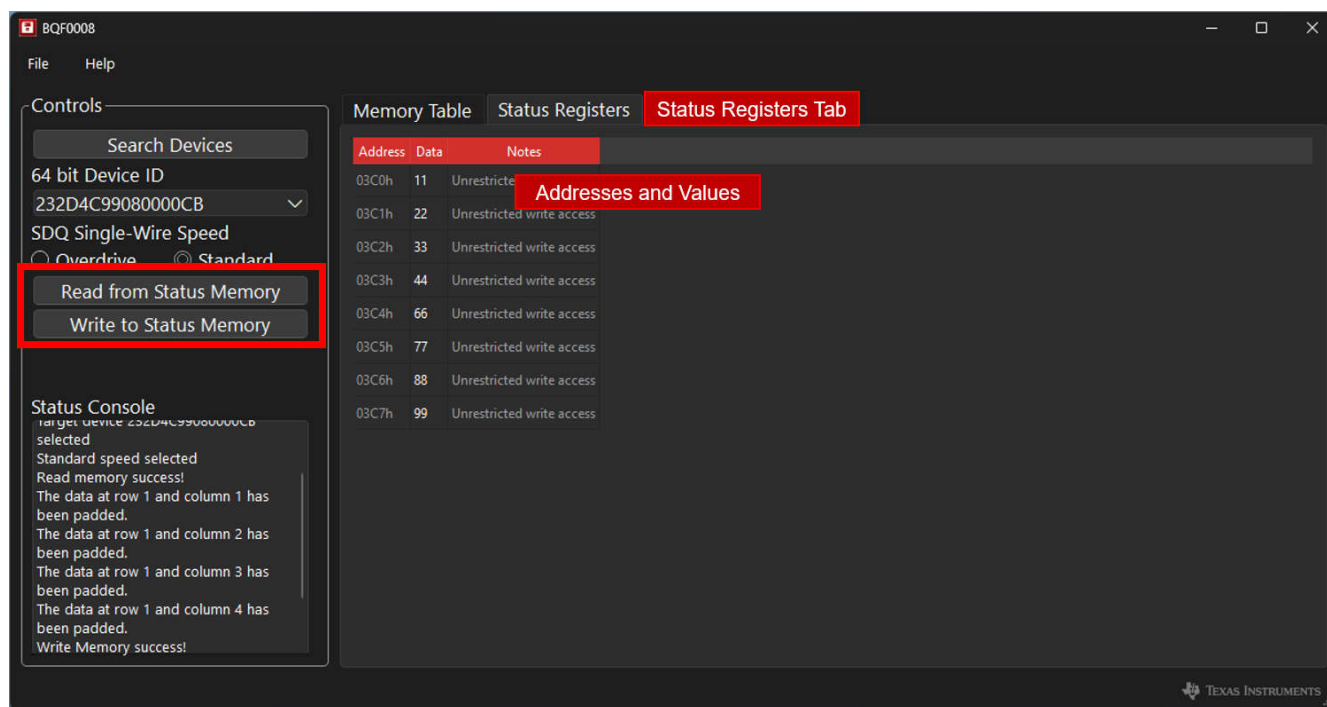
Figure 3-16. Status Registers Table and Controls

3.3.5.2.1 Read from Status Memory

The *Read from Status Memory* button, shown in Figure 3-17, is used to read from the status memory of the selected device and automatically populates that memory data into the table.
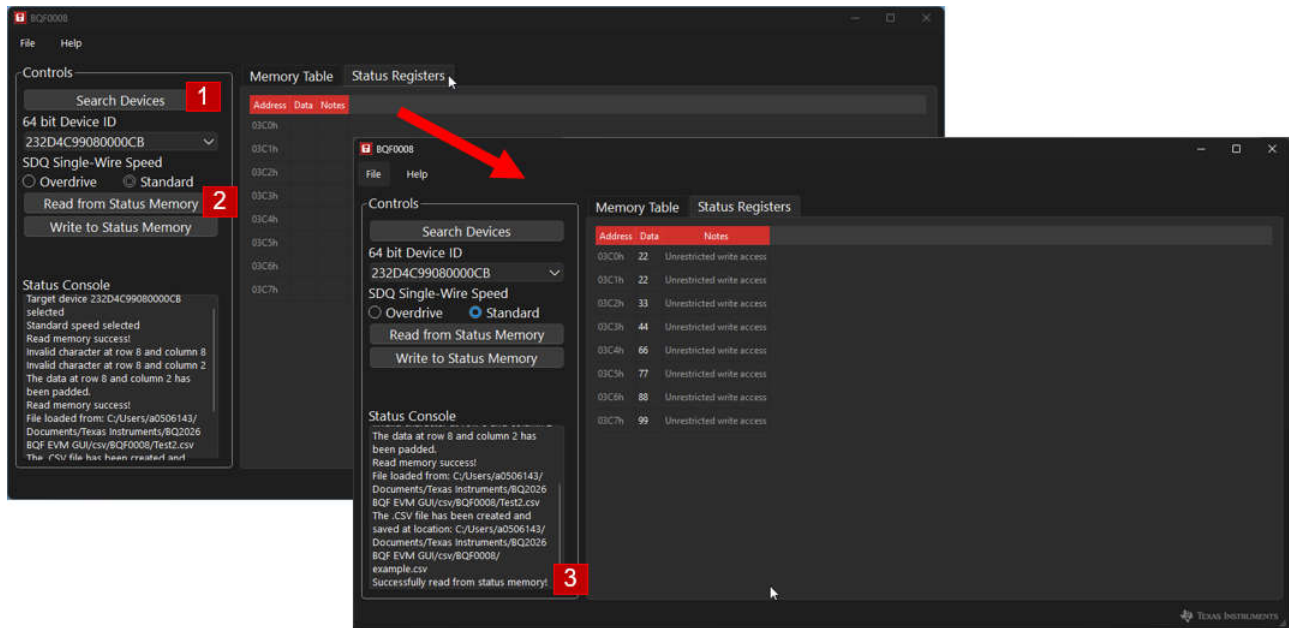
Figure 3-17. Read from Status Memory

3.3.5.2.2 Write to Status Memory

The *Write to Status Memory* button, shown in Figure 3-18, writes the status register table to the device.
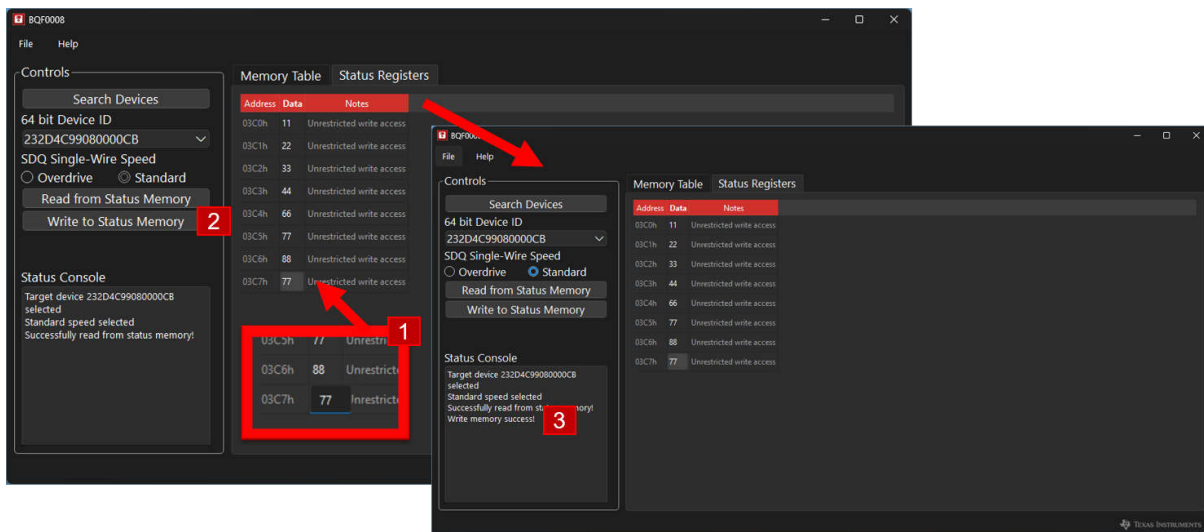
Figure 3-18. Write to Status Registers

Table 3-9. Status Register Error Messages

Error	Explanation
CRC Fail	The status memory stored values are bitwise AND'ed with the input values. For Version 1.0.1, the Status Register section does not warn for writing a *1* to a bit already written to '0'. The CRC values do not match in this situation.

4 Hardware Design Files

4.1 Schematics

Figure 4-1 shows the schematic of the BQF0008 EVM. Other variations of the BQF EVM are similar.
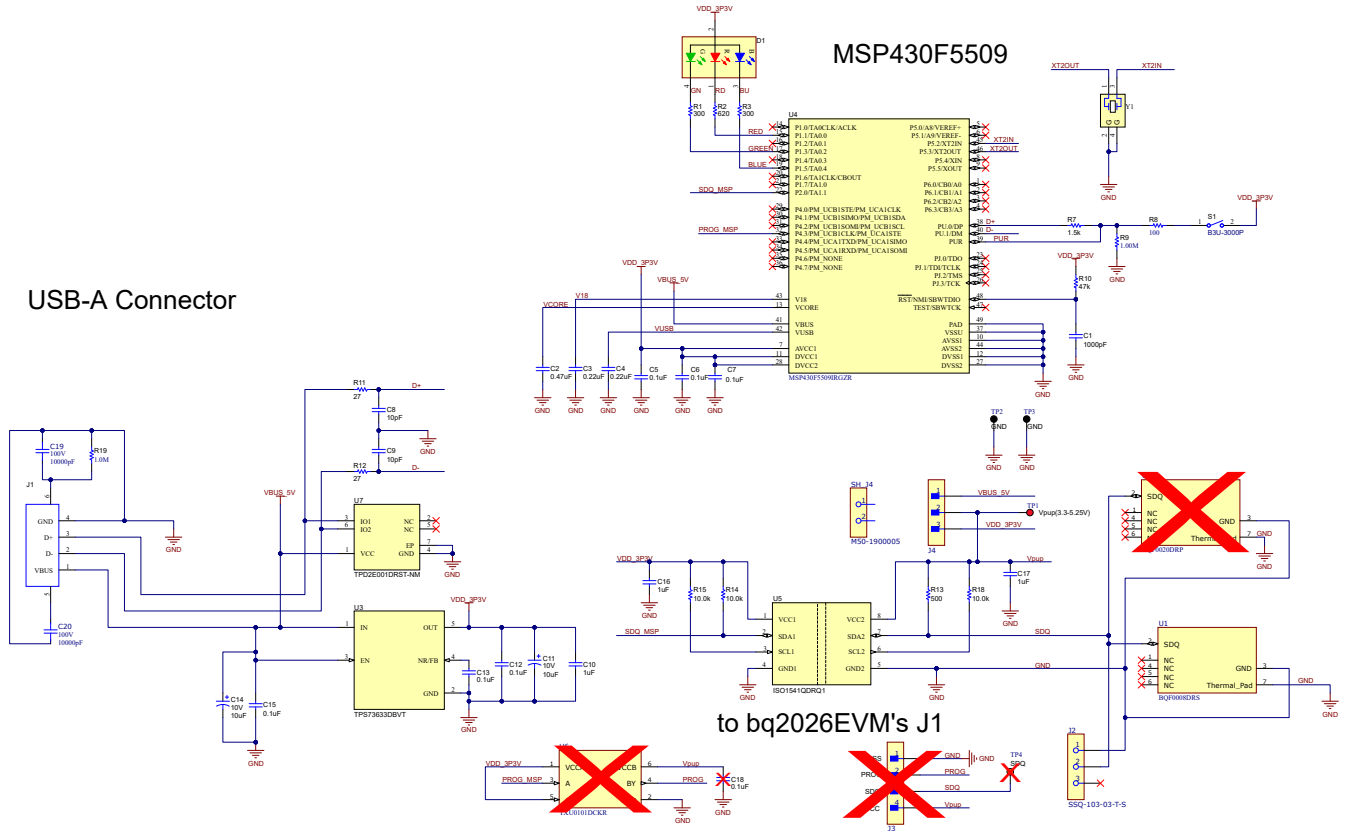
Figure 4-1. BQF0008EVM Schematic

4.2 PCB Layouts

Figure 4-2 through Figure 4-4 show the top PCB layers. These layers are from the BQF0008 EVM. Other variations of the BQF EVM are similar.
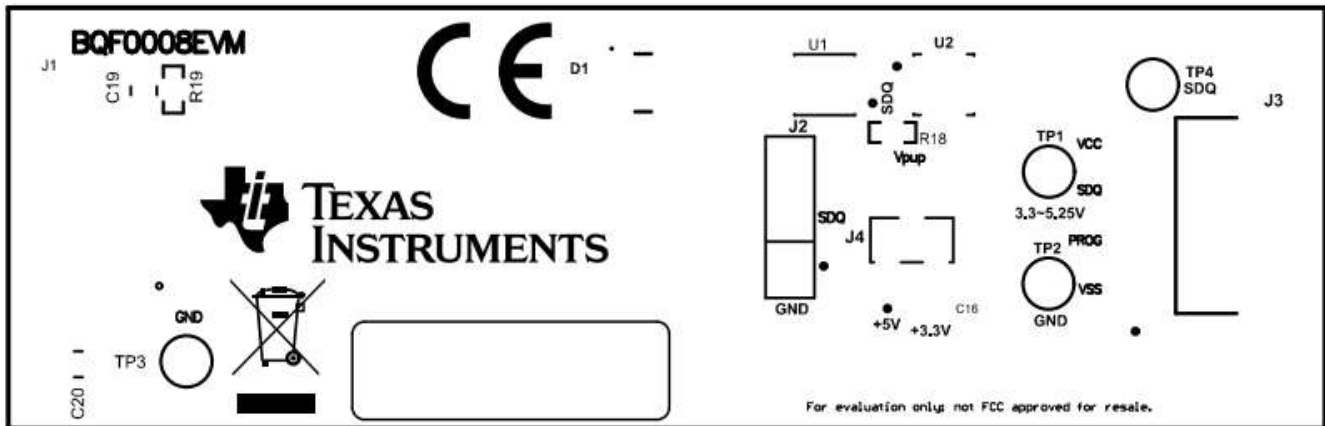
Figure 4-2. BQF0008EVM Silkscreen (Top)
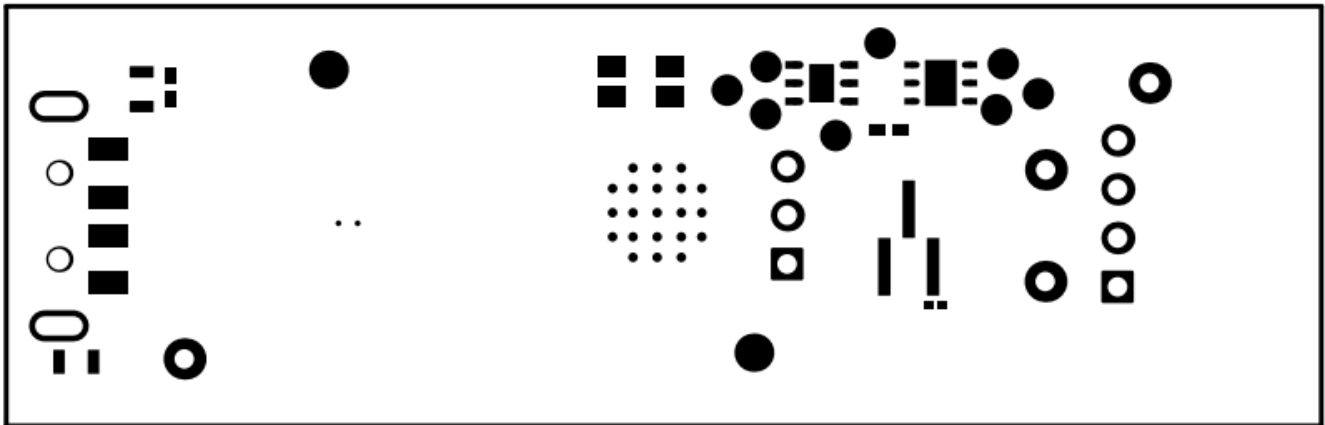
Figure 4-3. BQF0008EVM Solder Mask (Top)
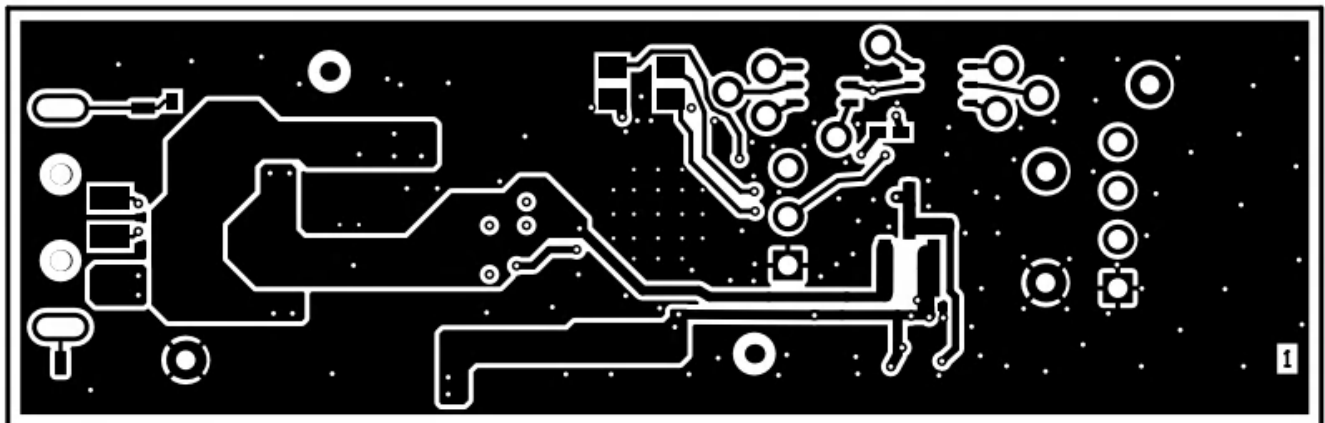
Figure 4-4. BQF0008EVM Copper (Top)

Figure 4-5 through Figure 4-7 show the bottom PCB layers. These layers are from the BQF0008 EVM. Other variations of the BQF EVM are similar.
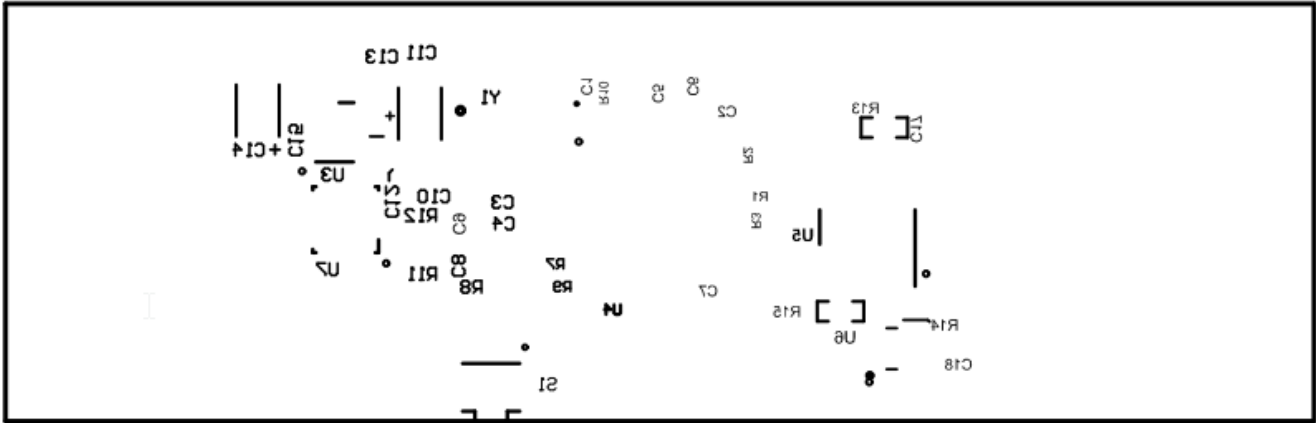
Figure 4-5. BQF0008EVM Silkscreen (Bottom)
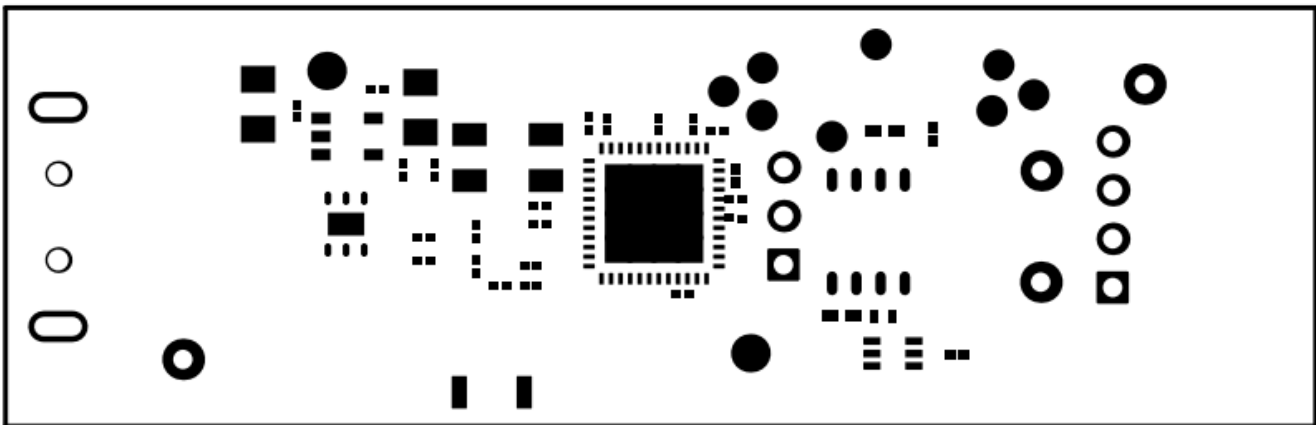
Figure 4-6. BQF0008EVM Solder Mask (Bottom)
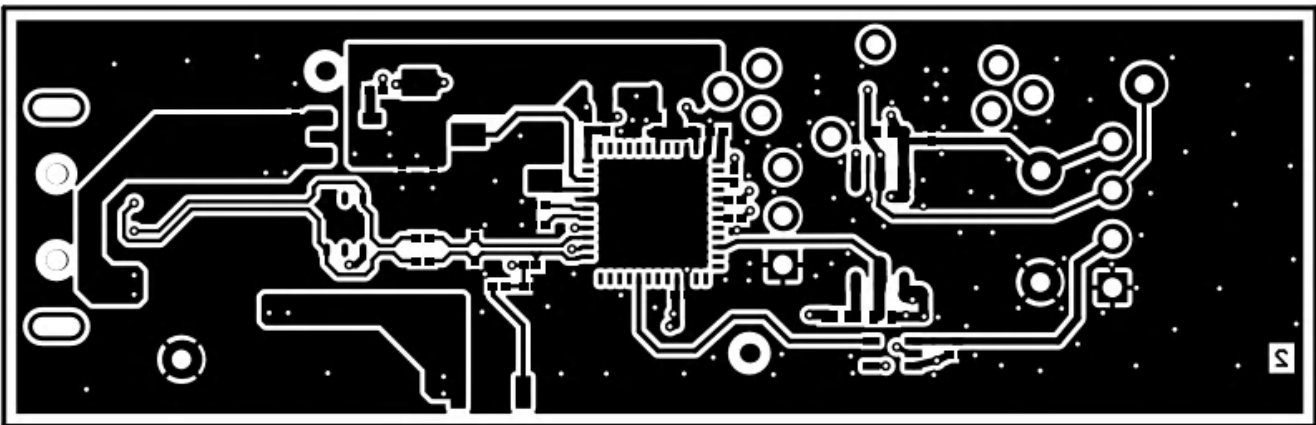
Figure 4-7. BQF0008EVM Copper (Bottom)

4.2.1 Assembly Files

Figure 4-8 and Figure 4-9 show the assembly drawings of the top and bottom PCB layers, respectively. These drawings are from the BQF0008 EVM. Other variations of the BQF EVM are similar.

Figure 4-8. PCB Assembly Drawing (Top)

Figure 4-9. PCB Assembly Drawing (Bottom)

4.3 Bill of Materials (BOM)

Table 4-1 lists the bill of materials for the BQF0008EVM.

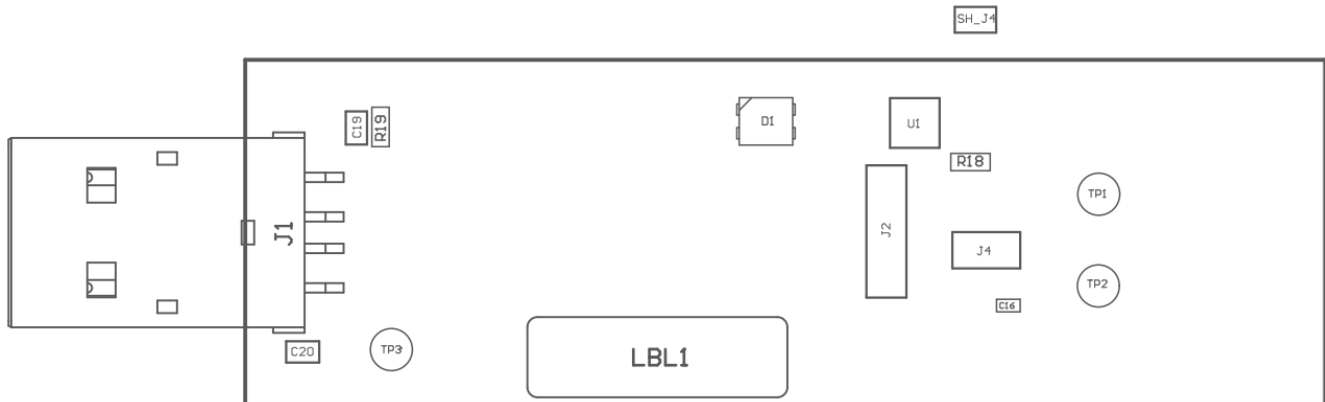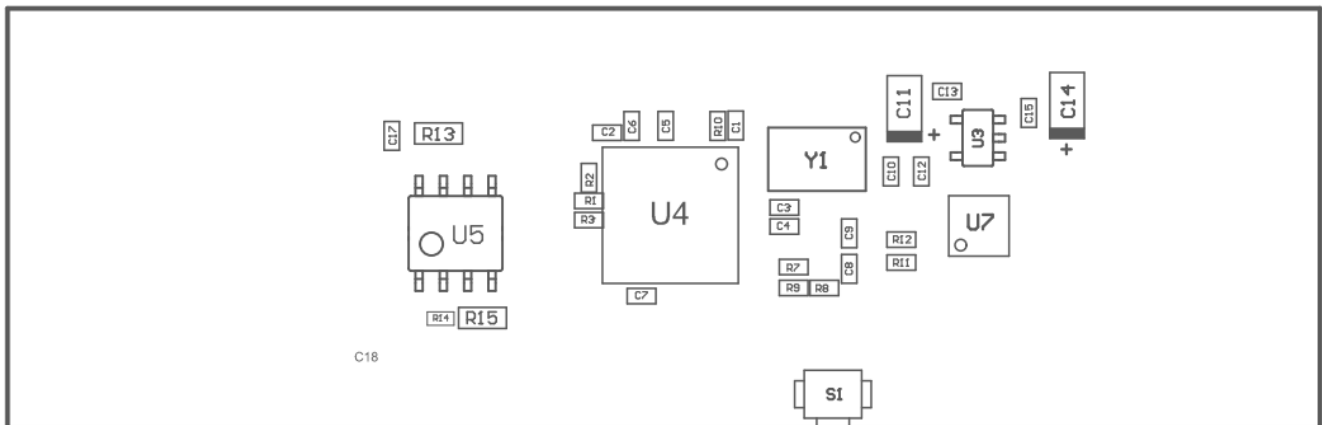| Reference	Quantity	Part Number	Manufacturer	Description
C1	1	CGA1A2X7R1E102K030BA	TDK	CAP, CERM, 1000pF, 25V, +/- 10%, X7R, AEC-Q200 Grade 1, 0201
C2	1	CL03A474KQ3NNNC	Samsung Electro-Mechanics	CAP, CERM, 0.47uF, 6.3V, +/- 10%, X5R, 0201
C3, C4	2	LMK063BJ224MP-F	Taiyo Yuden	CAP, CERM, 0.22uF, 10V, +/- 20%, X5R, 0201
C5, C6, C7, C12, C13, C15	6	GRM033R61E104KE14J	MuRata	CAP, CERM, 0.1uF, 25V, +/- 10%, X5R, 0201
C8, C9	2	GJM0335C1E100JB01D	MuRata	CAP, CERM, 10pF, 25V, +/- 5%, C0G/NP0, 0201
C10, C16, C17	3	CL03A105MP3NSNC	Samsung Electro-Mechanics	CAP, CERM, 1uF, 10V, +/- 20%, X5R, 0201
C11, C14	2	TPSA106M010R1800	AVX	CAP, TA, 10uF, 10V, +/- 20%, 1.8 ohm, SMD
C19, C20	2	GRM2165C2A103JA01D	Murata	Chip Multilayer Ceramic Capacitors for General Purpose, 0805, 10000pF, C0G, 30ppm/°C, 5%, 100V
D1	1	CLVBA-FKA-CAEDH8BBB7A363	Cree	LED, RGB, SMD
J1	1	48037-1000	Molex	Connector, Plug, USB Type A, R/A, Top Mount SMT
J2	1	SSQ-103-03-T-S	Samtec	Conn Socket Strip SKT 3 POS 2.54mm Solder ST Thru-Hole
J4	1	M50-3630342R	Harwin	Connector Header Surface Mount 3 position 0.050" (1.27mm)
LBL1	1	THT-14-423-10	Brady	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll
R1, R3	2	RC0201FR-07300RL	Yageo America	RES, 300, 1%, 0.05 W, 0201
R2	1	RC0201JR-07620RL	Yageo America	RES, 620, 5%, 0.05 W, 0201
R7	1	RC0201JR-071K5L	Yageo America	RES, 1.5 k, 5%, 0.05 W, 0201
R8	1	RC0201FR-07100RL	Yageo America	RES, 100, 1%, 0.05 W, 0201
R9	1	RC0201FR-071ML	Yageo America	RES, 1.00M, 1%, 0.05W, 0201
R10	1	RC0201JR-0747KL	Yageo America	RES, 47 k, 5%, 0.05 W, 0201
R11, R12	2	RC0201JR-0727RL	Yageo America	RES, 27, 5%, 0.05 W, 0201
R13	1	PNM0402E5000BST1	Vishay Thin Film	RES, 500, 0.1%, 0.05 W, 0402
R14	1	MCS0402MD1002BE100	Vishay/Beyschlag	RES, 10.0 k, 0.1%, 0.1 W, AEC-Q200 Grade 0, 0402
R15, R18	2	RT0402BRD0710KL	Yageo America	RES, 10.0 k, .1%, .0625 W, 0402
R19	1	CRCW04021M00JNED	Vishay-Dale	RES, 1.0M, 5%, 0.063W, AEC-Q200 Grade 0, 0402
S1	1	B3U-3000P	Omron Electronic Components	Switch, SPST-NO, Off-Mom, 0.05A, 12 VDC, SMT
SH_J4	1	M50-1900005	Harwin	CONN SHUNT 1.27MM BLACK
TP1	1	5000	Keystone	Test Point, Miniature, Red, TH
TP2, TP3	2	5001	Keystone	Test Point, Miniature, Black, TH

Reference	Quantity	Part Number	Manufacturer	Description
U1	1	BQF0008DRS	Texas Instruments	8k-bit Serial FRAM with SDQ Interface
U3	1	TPS73633DBVT	Texas Instruments	Single Output Low Noise LDO, 400mA, Fixed 3.3V Output, 1.7 to 5.5V Input, with Reverse Current Protection, 5-pin SOT-23 (DBV), -40 to 85 degC, Green (RoHS & no Sb/Br)
U4	1	MSP430F5509IRGZR	Texas Instruments	Mixed Signal Microcontroller, RGZ0048A (VQFN-48)
U5	1	ISO1541QDRQ1	Texas Instruments	Low-Power Bidirectional I2C Isolators, D0008B (SOIC-8)
U7	1	TPD2E001DRST-NM	Texas Instruments	Low-Capacitance + / - 15 kV ESD-Protection Array for High-Speed Data Interfaces, 2 Channels, -40 to +85 degC, 6-pin SON (DRS), Green (RoHS & no Sb/Br)
Y1	1	ABM3B-24.000MHZ-10-1-U-T	Abracon Corporation	Crystal, 24MHz, 10pF, SMD

5 Additional Information

5.1 Trademarks

Windows® and Excel® are registered trademarks of Microsoft Corporation.

All trademarks are the property of their respective owners.

6 Related Documentation from Texas Instruments

The following documents provide information regarding Texas Instruments' integrated circuits used in the assembly of the BQF EVM. This user's guide is available from the TI website under literature number SLAU918. Access to device data sheets, application notes, and product briefs can also be found on the TI website. Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. The latest revision can be found by clicking the link and is also available from the TI website, the Texas Instruments' Literature Response Center at (800) 477-8924, and the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number.

Table 6-1. Related Documentation

Document	Literature Number
Texas Instruments, *BQF0008 8K bits Serial FRAM with SDQ Interface*, data sheet	SLASF14
Texas Instruments, *Applications Driving the Need for Single-Wire FRAM Devices*, application brief	SLAAEI8

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.

【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２４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/lsds/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.

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, INDEMITY 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.

IMPORTANT NOTICE AND DISCLAIMER