

MR25H00-EVAL MRAM Evaluation Board

The MR25H00-EVAL MRAM evaluation board from Everspin is an Arduino-derived MRAM Shield that will interface with any Arduino-derived microcontroller host board with standardized UNO pinout.

The Evaluation Board

The evaluation board is populated with a 4Mbit Everspin MR25H40 SPI MRAM for evaluation of any of the Everspin Product Families listed below.



Everspin Product Family	Density	Temperature Grades
MR25H256	256 Kb / 40MHz	Industrial / AEC-Q100 Grade 1
MR25H10	1 Mb / 40MHz	Industrial / AEC-Q100 Grade 1
MR20H40	4Mb / 50MHz	Industrial
MR25H40	4 Mb / 40MHz	Industrial / AEC-Q100 Grade 1

Host Board Support

The MR25H00-EVAL Evaluation board employs a pin out that is compatible with the Arduino form factor UNO pinout. The board utilizes the SPI interface on UNO pins D10, D11, D12, and D13. The HOLD and WP pins are connected to digital pins D8 and D9. See **Appendix A – MR25H00-EVAL Schematic and Layout** for more detail.

By using this common MCU evaluation board pinout, the MR25H00-EVAL board is compatible with a large number of MCU evaluation boards. For example, the following four MCU series listed below with Arduino-derived host boards will work for evaluation using the SPI MRAM Evaluation board.

Host Board Supplier	MCU	Host Board
ST Micro	STM32F411RET6 Series	NUCLEO-F411RE
Freescale	Kinetis MCU Series	Kinetis Freedom
NXP	LCP Series MCU	LPCXpresso
Renesas	ARM Cortex [™] -A9 processor Series	GR-PEACH: RZ/A1H

We use the NUCLEO-F411RE host board as the example for setup in this Guide.



SETUP: MR25H00 - EVAL MRAM EVALUATION BOARD

Besides the MCU host board and the Everspin MR25H00-EVAL Evaluation board, you will need:

- Computer with Internet access and USB port.
- A USB cable, with standard A to mini B connectors.
- Everspin example code from www.mbed.org.

Step 1: Download the USB Driver for your MCU Host Board

Host Board	USB Driver
NUCLEO-F411RE	Host Board Description and Drivers
Kinetis Freedom	Host Board Description and Drivers
LPCXpresso	Host Board Description and Drivers
GR-PEACH: RZ/A1H	Host Board Description and Drivers
Other	Host Board home page

Step 2: Plug in the SPI Evaluation board and connect it to your computer via the USB port.

First, plug the MR25H00-EVAL board into your MCU host board, then connect the host board to your PC using the USB cable. The MCU host board will enumerate as a composite USB device that includes a built in debugger, storage device and a virtual com port.

A new drive will be created on your computer with a drive name as assigned by the host board. We are using the NUCLEO-411RE as an example for this Setup description.

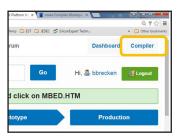


🖉 🔄 – 🔽 🕨 Compi	uter 🕨			✓ 49 Se	arch Computer	
Organize 👻 System	properties Uninstall or c	hange a program	Map network of	drive Open Control Pa	anel 📗 🔹 🗍	
★ Favorites ■ Desktop	Name Hard Disk Drives (3) 	Type	Total Size	Free Space		
 Downloads OneDrive Recent Places 	OSDisk (C:)Devices with Remo		224 GB	178 GB		
Libraries	WDVD RW Drive (D:)	CD Drive Removable Disk	528 KB	512 KB		

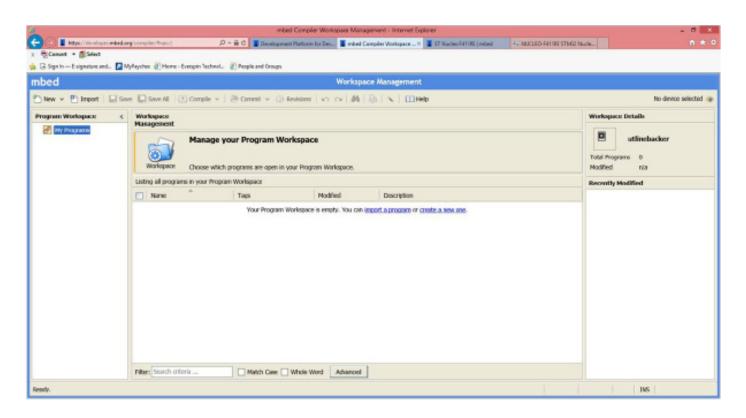


Step 3: Log in to ARM mbed and create a Workspace on your computer.

- 1. Log in to <u>developer.mbed.org</u>. (If you do not already have an **mbed** account, you will need to create one.)
- 2. After logging in, click on the **Compiler** button on the upper right section of the screen.



3. The **mbed** compiler will bring up the **Workspace Management** screen.

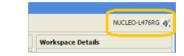




Step 4: Load the platform for the host board you are using

1. The button on the upper right of the Workspace Management screen will read **No device selected** or, if you have previously loaded a platform, the name of the host board for that platform will appear, as in the **NUCLEO-411RE** case shown.

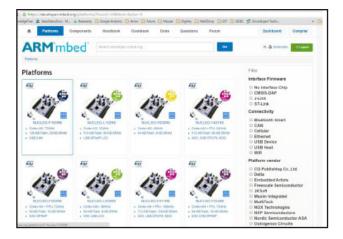




2. In either case, click on the button to open the available compiler platforms screen. Select the host board platform you wish to load or, if it is not present, then select **Add**.

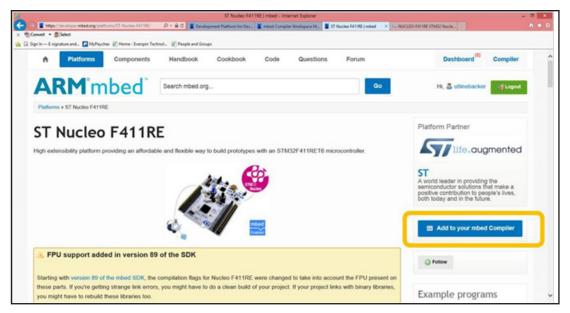


3. Adding a platform to your Workspace. If you selected Add, mbed will display a scrolling list of available platforms. Find the MCU host board you are using and click on the image.





4. mbed will open a new window as an information page for that host platform, such as the NUCLEO-411RE example here. To add this platform to your workspace, click on the **Add to your mbed Compiler** button.



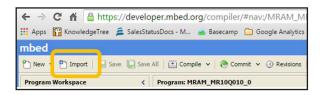
5. The platform will be added to your registered platforms list.

Select a Platform	8
You are currently compiling for the NUCLEO	0-F411RE platform.
	Description Pinout Affordable and flexible platform to ease prototyping using a STM32F411RET6 microcontroller.
	Overview
STM2 Nucleo	The STM32 Nucleo board provides an affordable and flexible way for users to try out new ideas and build prototypes with any STM32 microcontroller line, choosing from the various combinations of performance, power consumption and features.
	The Arduino connectivity support and ST Morpho headers make it easy to expand the
	functionality of the STM32 Nucleo open development platform with a wide choice of specialized shields.
	The STM32 Nucleo board does not require any separate probe as it integrates the ST-LINK/V2-1
and a start and a start and a start a	debugger/programmer.
mbed	{https://www.youtube.com/watch?v
	g3p6iX_RpEc&index
. More Info	(
Your registered platforms	
NUCLEO- NUCLEO- NUCLEO- NUCLEO- NUCLEO- NUCLEO- NUCLEO- NUCLEO-	AS
F103RB F072RB F411RE	Platform



Step 5: Import the Everspin Serial MRAM demonstration program. The example code is available on www.mbed.org.

1. In your Workspace, click **Import**.



2. The **Import a program** dialog box will open. Click on the **Programs** tab.

mbed	Select prog	a program f gram from the lis to import from U	t. You can als	-	m in your worksp	ace.	Import!
Programs	Libraries	Bookmarked	Upload		Search	criteria	Search
Name		Tags	if with	Author	Imports	Modified	Descrip
				ria to search for ne "Search" butto		rams.	

- 3. Search for the "MR25H00-EVAL" program, select it and click Import!
- 4. The demonstration program will now appear in the Program Workspace.



Setup (Concluded)

Step 6: Compile the binary file and and load to your MCU evaluation board.

- 1. Highlight the **MRAM_MR25H00-EVAL** program folder in your **Program Workspace** tree in the lefthand column.
- 2. Click **Compile** in the top menu.

mbed	_				
New 🗸 🎦 Import 📄 Save 📄 Save Al	I 🗋	🖞 Compile 🗸 🛛 🕭 Commit 🗸	Revision 10 Revisio 10 Revision 10 Revision 10 Revision 10 Revision 10 Revi	on 🗠 😋 🏘 🗞	🍾 🛄 Help
Program Workspace <	Pro	gram: /MRAM_MR25H00-EV/	AL		
E My Programs	7	Type to filter the list	Match (Case 📃 Whole Word	
MRAM_MR25H00-EVAL main.cpp		Name	Size	Туре	Modified
🗉 😳 mbed	e.	main.cpp	4.9 kB	C/C++ Source File	moments ago
	٢	mbed		Library Build	moments ago

- 3. The program will be compiled and the binary (.bin) file created will automatically be downloaded to your computer's designated download location.
- 4. Drag and drop the binary file into the host board drive that you created in **Step 2.** When the file is dropped into the folder, your MCU host board will begin to program. The LED on you host board may blink a few times to confirm that the program is loading. When the program is fully loaded, the binary file will automatically delete from your MCU host board drive.



Run the Demonstration

Step 1: Use a terminal emulator to run the demonstration.

- 1. Use your favorite terminal emulator. For this example, we used the Tera Term emulator from SourceForge at <u>http://en.osdn.jp/projects/ttssh2/releases/.</u>
- 2. After installing, open Tera Term and select the serial port associated with your host board to create a new connection.
- 3. Configure the serial port under **Setup->Serial port with: 115200 baud, 8-N-1**.

	<mark> </mark>	TCP <u>p</u> oi	rt#: 22	
	@ <u>\$</u> \$H	SSH version:	SSH2	
	© Other	Proto <u>c</u> ol:	UNSPEC	*
9 Serial	Po <u>r</u> t: COM3: STM	licroelectronics S	TLink Virte	. •

- 4. Press any key on the keyboard or the **Reset** button on your MCU host board to run the demonstration and view the demonstration output on the terminal emulator.
- 5. Every time the demo is run, the test count is incremented to demonstrate memory non-volatility and the performance is calculated for reading/writing the full array.



Run the Demonstration (Concluded)

The time to access the memory is extremely fast and does not require any wait states like flash. Read performance will be observed to be slightly slower than writes due to the error checking performed by the program. In reality, Write / Read performance for MRAM is symmetrical.

📒 со	M8:11	.5200	bau	id - '	Tera	Terr	m V	г								
<u>F</u> ile <u>F</u>	Edit	<u>S</u> etu	p (C <u>o</u> nt	rol	<u>W</u> i	ndo	N F	<u>H</u> elp							
															·	-
::			Eve	ersi	oin	Tec	en e	===: 0100	ries	===: S						
				The	M	RAM	Co	npai	īУ							
		MJ	25H	00	-EVf	ìL i	nbe	l E						::		
	===== Read	: S}		_											-	
05 0 05 0	505 505	Ø5 Ø5	Ø5 Ø5	05 05	05 05	05 05	05 05	Ø5 Ø5	Ø5 Ø5	Ø5 Ø5	05 05	05 05	Ø5 Ø5	Ø5 Ø5		
05 0 05 0	_	Ø5 Ø5		05 05	Ø5 Ø5	05 05	05 05	Ø5 Ø5	Ø5 Ø5	Ø5 Ø5	05 05	05 05	Ø5 Ø5	05 05		
05 0	5 Ø5	05 05	05 05	05 05	05 05	05 05	05 05	05 05	05 05	05 05	05 05	05 05	05 05	05 05	5	
05 0	5 05	ØŠ	Ø 5	ØŠ	ŎŠ	õš	05	Ø 5	Ø5	05	õŠ	05	05	Ø5		
05 0 05 0		Ø5 Ø5		05 05	05 05	05 05	Ø5 Ø5	Ø5 Ø5	Ø5 Ø5	05 05	05 05	05 05	Ø5 Ø5	Ø5 Ø5		
05 0 05 0		Ø5 Ø5	Ø5 Ø5	05 05	Ø5 Ø5	Ø5 Ø5	Ø5 Ø5	Ø5 Ø5	Ø5 Ø5	Ø5 Ø5	Ø5 Ø5	Ø5 Ø5	Ø5 Ø5	Ø5 Ø5		
05 0 05 0	5 05	Ø5 Ø5	Ø5 Ø5	05 05	Ø5 Ø5	05 05	05 05	05 05	05 05	05 05	05 05	05 05	Ø5 Ø5	05 05	5	4
05 0	5 05	Ø5	Ø5	05	Ø5	05	05	Ø5	05	05	05	Ø5	05	05		
05 0 05 0		Ø5 Ø5	05 05	05 05	05 05	05 05	05 05	05 05	05 05	05 05	05 05	05 05	05 05	05 05		
															· · · · · · · · · · · · · · · · · · ·	

NOTE: In order to evaluate smaller memory densities, simply change the value of *MRAM_SIZE* at the top of main.cpp file and recompile:

Desired Density	MRAM_SIZE value
256Kbit	0x2000
1Mbit	0x8000
4Mbit	0x20000



Export the Demonstration Code to Other Toolchains

You may export the demonstration code to work with other ARM-based toolchains.

- 1. Once you have the Everspin MR25H00-EVAL example program loaded into ARM mbed you may export it for development in production ARM tool chains.
- 2. Right click on the MRAM_MR25H00-EVAL program in the left column of the workspace and select **Export Program**.
- 3. Using **Export Target** and **Export Toolchain** in the dialog box, pick the target MCU host board and Toolchain for export and click on the **Export** button. The Everspin MR25H00-EVAL example code will be exported to the tool chain you selected.

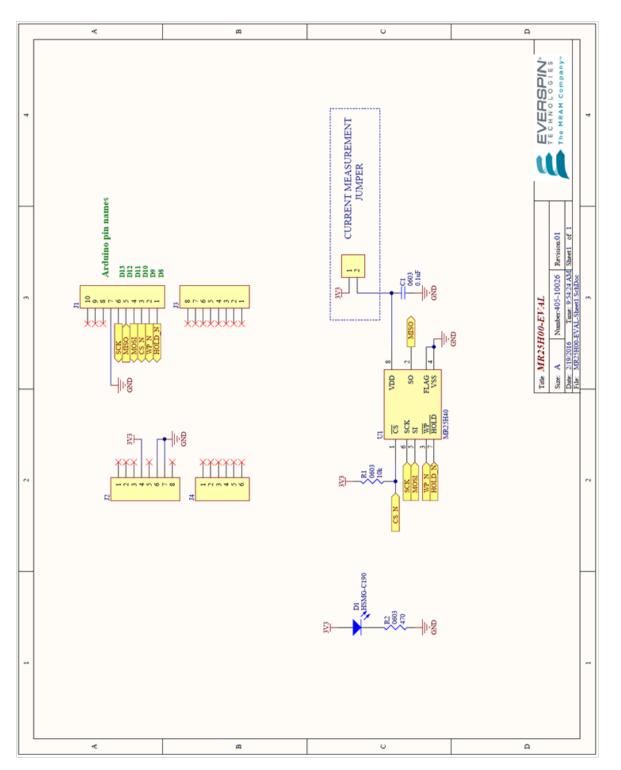
mbed			/MRAM_MR25	HOO-EVAL						
🎱 New 👻 🎦 Import 📄 Save 💭 Save All	🖭 Compile 👻 🕭 Commit	✓ ③ Revision <>>	~ M &	N Help					NUC	LEO-F411RE
Program Workspace <	Program: /MRAM_MR25H00-	Program Details								
E My Programs	Type to filter the list	Match Case	Whole Word				G. Find	Summary	Build	
E MRAM_MR25H00-EVAL	Name	Size Type		Modified				Memory Usage		
	main.cpp	4.8 kB C/C++	Source File	3 minutes ago						
	6 mbed	Ubrary	Build	7 minutes ago						
		2								
		Export program			×					
		Export program			TT I			Flash		RAM
		This will export prog specified target boa	ram 'MRAM_MR25H rd and toolchain.	00-EVAL" for the	<u> </u>			Type	Size	Max A
		Export Target:	FRDM-KL25Z		•			Code (Flash)		1,024.0 kB
		Export Tookhain:	Keil uVision4		•			Code Data RO Data (Flash	2.0 kB	n/a
								KO Data (Hash	1) 2.0 KD	1,024.0 kB 💌
	Compile output for program: I			Export	Cancel		Vert	Errors: 0	Warnings	0 Infos: 1
	Description					Error Number	Resource	In Folder	6	cation
	Success!						Build Details			
	Compile Output Find Results	Notifications								~
Ready.								1	s 🎟	

Questions?

We are here to help. Please use the Information Request on our web site to let us know how we can be of assistance.



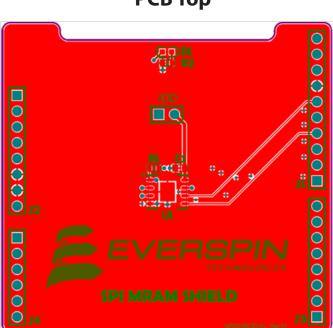
MR25H00-EVAL Everspin SPI MRAM Evaluation Board User Guide



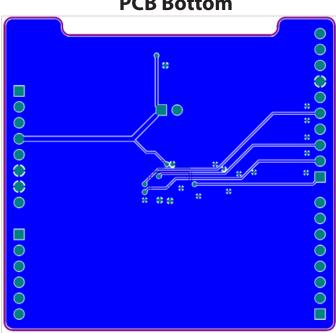
Appendix A: MR25H00-EVAL Schematic



Appendix A (Cont'd): MR25H00-EVAL PCB Layout



PCBTop



PCB Bottom



Everspin SPI MRAM Evaluation Board User Guide

REVISION HISTORY

Revision	Date	Description of Change
1.0	February 24, 2016	Initial Release MR25H00-EVAL User Guide.



HOW TO REACH US

Everspin Technologies, Inc.

Home Page: www.everspin.com

World Wide Information Request

WW Headquarters - Chandler, AZ

5670 W. Chandler Blvd, Suite 100 Chandler, Arizona 85226 Tel: +1-877-480-MRAM (6726) Local Tel: +1-480-347-1111

Fax: +1-480-347-1175

Europe, Middle East and Africa

Everspin Sales Office Tel: +49 171 8040905

Japan

Everspin Sales Office Tel: 81-(0)50-3579-5147

Asia Pacific

Everspin Sales Office Tel: +86-136-0307-6129 Fax: +1-480-347-1175 Information in this document is provided solely to enable system and software implementers to use Everspin Technologies products. There are no express or implied licenses granted hereunder to design or fabricate any integrated circuit or circuits based on the information in this document. Everspin Technologies reserves the right to make changes without further notice to any products herein. Everspin makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Everspin Technologies assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters, which may be provided in Everspin Technologies data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters including "Typicals" must be validated for each customer application by customer's technical experts. Everspin Technologies does not convey any license under its patent rights nor the rights of others. Everspin Technologies products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Everspin Technologies product could create a situation where personal injury or death may occur. Should Buyer purchase or use Everspin Technologies products for any such unintended or unauthorized application, Buyer shall indemnify and hold Everspin Technologies and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Everspin Technologies was negligent regarding the design or manufacture of the part. Everspin[™] and the Everspin logo are trademarks of Everspin Technologies, Inc. All other product or service names are the property of their respective owners. Copyright © 2016 Everspin Technologies, Inc.

Filename: MR25H00-EVAL SPI Evaluation Board Guide Revision1.1 04092020

