

1. Overview

The Renesas Serial MRAM evaluation board contains a Serial MRAM device utilizing Spin-Transfer Torque Magneto-Resistive Random-Access Memory (STT-MRAM) technology enabling users to develop interactive hardware solutions using the Renesas Serial MRAM evaluation board and an Arduino UNO Rev. 3 host board connected via standard SPI interface. The Arduino UNO host board communicates with a computer using a USB 2.0 cable type A/B and terminal emulator software. Renesas software bundled APIs and test program provide basic access to functionality of the Renesas Serial MRAM, also known as Persistent SRAM (P-SRAM) device. The Arduino UNO SPI can operate up to 8MHz.

The MRAM evaluation kit includes:

- One Arduino UNO REV 3 host board
- One Renesas MRAM evaluation board
 - One populated MRAM device (see Table 1 below)
- One USB 2.0 cable type A/B
- M30162040054X0ISA* MRAM device

*Alternatively MRAM device is marked as AS3016204-0054X0ISAY

2. Renesas Serial MRAM Product Support

The Renesas MRAM evaluation board is populated with the following Serial MRAM device:

Table 1: Renesas Product Support

Part Number	Density	Voltage (V _{CC} /V _{CCQ})	Frequency	Interface	Package
M30162040054XxxSAx*	16Mb	2.7V to 3.6V	Up to 54Mhz	SPI, QSPI	8-Pin SOIC

* Alternatively MRAM device is marked as AS3016204-0054X0ISAY

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3. Host Board Support

The Renesas MRAM evaluation board is compatible with the Arduino UNO REV3 host platform. For details of the Arduino UNO REV3 host board go to [Arduino UNO REV3](#).

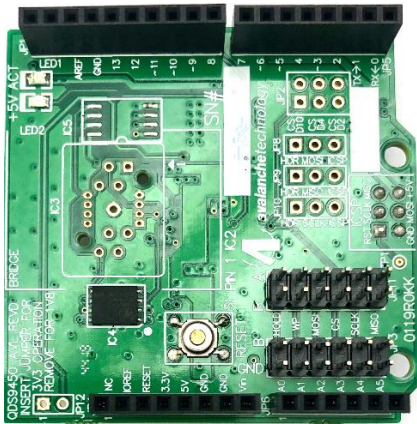


Figure 1: Renesas MRAM Evaluation Board populated with a DFN (WSON)-8 MRAM device

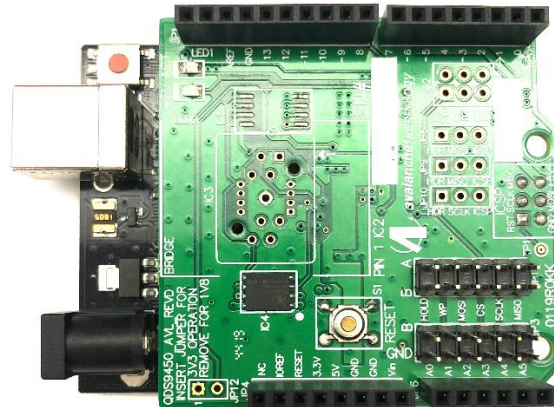


Figure 2: Arduino Uno Host with Renesas MRAM Evaluation Board on Top with DFN (WSON)-8 MRAM device

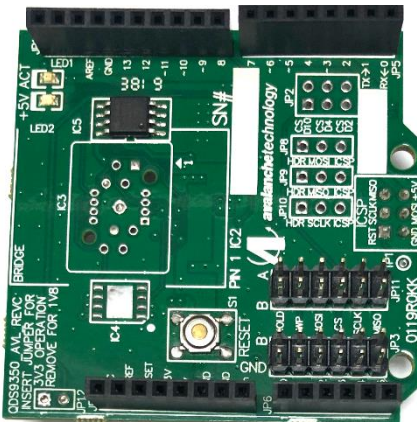


Figure 3: Renesas MRAM Evaluation Board populated with an SOIC-8 MRAM device

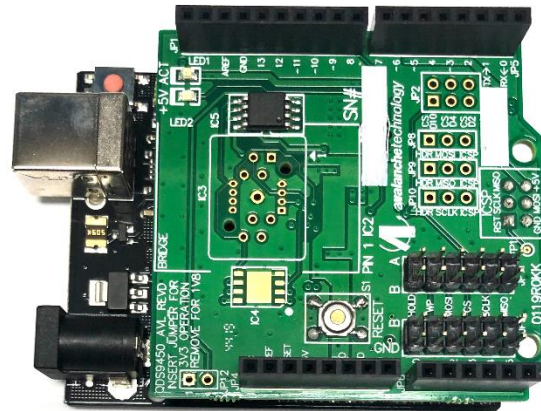


Figure 4: Arduino Uno Host with Renesas MRAM Evaluation Board on Top with SOIC-8 MRAM device

4.1 Requirements

- A PC system with one available USB 2.0/3.0 port
- Windows 7/8/10 with 32/64-bit Operation System
- An Arduino UNO host board R3
- A USB 2.0 cable Type A/B

4.2 Software Installations

1. Downloading the Arduino software IDE (Integrated Development Environment). This software is required to program the Arduino UNO host board.
 - Download the latest version of Windows installer from



Figure 5: USB Driver Installation

(<https://www.arduino.cc/en/Main>)

2. Installing Arduino application software and drivers
 - Click on “Arduino-x.x.x-windows.exe” file to install Arduino application software and USB drivers

4.3 Connecting the Arduino UNO Host Board

Follow the step-by-step instructions in the following order below to configure and connect the Arduino UNO host board to your computer:

1. Attach the Renesas MRAM evaluation board on top of the Arduino UNO host board via the UNO R3 headers (refer to Figures 1 and 2 or Figures 3 and 4).
2. Connect the Arduino UNO host board to your computer's USB port using the USB 2.0 cable Type A/B. The green power LEDs on both the Arduino UNO host board and the Renesas MRAM evaluation board should go on.
3. For first time installation, Windows should initiate the USB driver installation process. You can check to ensure the USB drivers have been properly installed by opening Windows Device Manager, and looking under "Ports (COM & LPT)". Windows should assign COM port # to the Arduino UNO host board. If no COM port has been assigned to the Arduino UNO host board, then remove and re-insert USB connector from/into PC's USB port for Windows to re-enumerate the USB port. If that still doesn't work, then you may need to re-install the USB drivers.

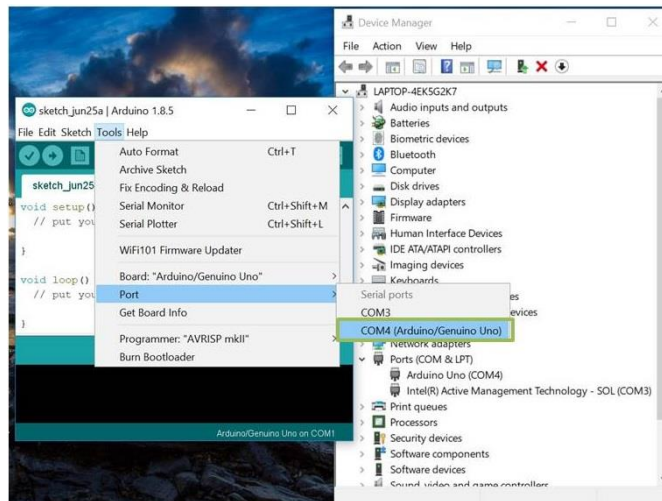


Figure 6: Selecting COM Port for Arduino UNO

4.3.1 Configuring PuTTY

Follow the step-by-step instructions below to configure the PuTTY UART terminal:

1. Double click on Putty icon to open PuTTY Configuration Window.
2. Under "SSH", select "Serial". Under "Flow control" pull-down menu, select "None" (refer to Figure 7).
3. Under Category, select "Terminal", and check "Implicit CR in every LF" checkbox (refer to Figure 8).
4. Select "Session" under "Connection Type", select "Serial" (refer to Figure 9).
5. In the "Serial line" box, type "COMx" where x is the COM port # that Windows has assigned to Arduino UNO board (refer to Figure 9).
6. In the "Speed" box, type "115200" to set the baud rate (refer to Figure 9).
7. In the "Saved Sessions" box, type "COMx" where x is the COM port # that Windows has assigned to Arduino UNO board (refer to Figure 9).
8. Click "Save" to save the COMx configuration file (refer to Figure 9).
9. Click "Open" to launch PuTTY (refer to Figure 9).
10. The Arduino UNO host board and the Renesas MRAM evaluation board are now up-and-running. The Terminal Monitor window will display a menu of read/write/compare tests for the Renesas MRAM device (refer to Figure 10).

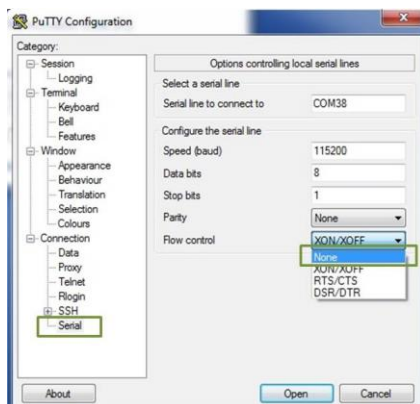


Figure 7: PuTTY Configuration - 1

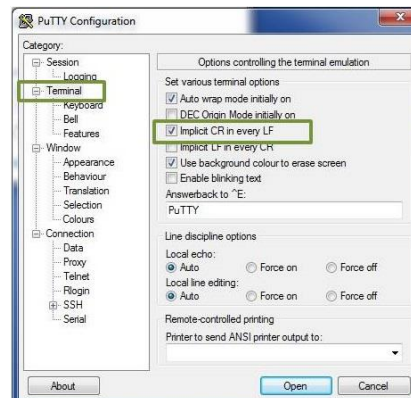


Figure 8: PuTTY Configuration - 2

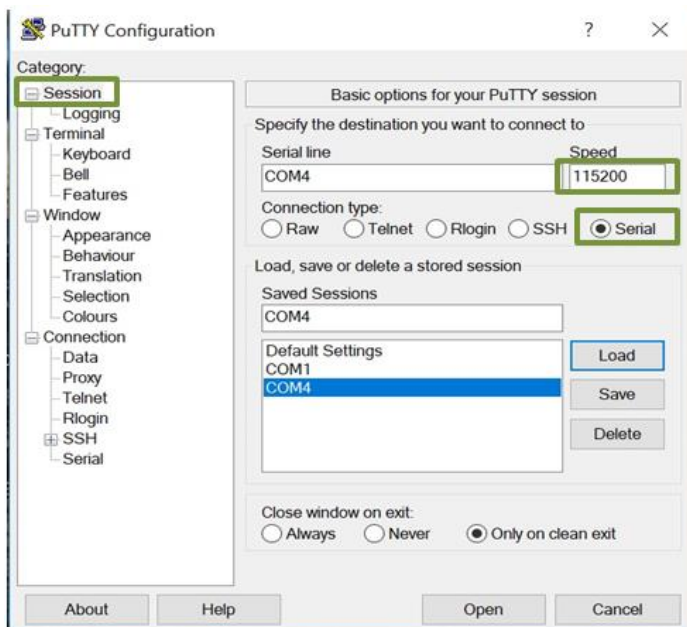


Figure 9: PuTTY Configuration - 3

```
Avalanche Technology STT-MRAM Test Program V4.6.0
Device ID: E6 01 02 02
Avalanche HP, 3V, 85C, 4Mb, 54MHz

Test Menu
a. Read Device ID
b. Read Status Register
c. Write Status Register
d. Read Configuration Registers
e. Write Configuration Registers
f. Read Serial Number Register
g. Write Serial Number Register
h. Read Unique ID Register
i. SDR Read Memory Device
j. SDR Write Memory Device
k. SDR Write-Read-Compare Memory Device
l. SDR Read 256-Byte Special Sector
m. SDR Write-Read-Compare 256-Byte Special Sector
n. Reset Status/Configuration Registers to Factory Default Values
o. Exit Menu

Selection ?
```

Figure 10: Renesas Test Menu on MRAM - PuTTY

4.4 APIs

4.4.1 SPI Write

Purpose:	API to write to MRAM
Arguments:	MRAM address (2-byte address; 3-byte address when THREEBYTEADDRESS is enabled) MRAM data: 2-byte data
Parameter:	uint32_t (address); uint16_t (write data)
Return:	None
Usage:	SPI_Write (0x0000, 0x55); Write 2-byte data 0x55 to MRAM starting address 0x0000

4.4.2 SPI Read

Purpose:	API to read from MRAM device
Arguments:	MRAM address (2-byte address; 3-byte address when THREEBYTEADDRESS is enabled) MRAM data: 2-byte data
Parameter:	uint32_t (address)
Return:	None
Usage:	SPI_Read (0x0000); Read 2-byte data from MRAM starting address 0x0000, and assigns to variable 'value'

4.4.3 SPI Burst Write

Purpose:	API to burst-write to P-SRAM device
Arguments:	P-SRAM address (2-byte address; 3-byte address when THREEBYTEADDRESS is enabled) SPnvSRAM_wr_data_ptr (data buffer which needs to be written into P-SRAM) Total_count (total number of words to write)
Parameter:	uint32_t (address); uint16_t (write data); uint32_t (total count)
Return:	None

Usage: SPI_BurstWrite (0x0000, wr_buf, 16); Write 16 bytes of data from wr_buf to
P-SRAM starting address 0x0000

4.4.4 SPI Burst Read

Purpose: API to burst-read to P-SRAM device

Arguments: P-SRAM address (2-byte address; 3-byte address when THREEBYTEADDRESS is enabled)
SPnvSRAM_rd_data_ptr (data buffer to hold the data being read from P-SRAM)
Total_count (total number of words to write)

Parameter: uint32_t (address); uint8_t (read_data_ptr); uint32_t (total_count)

Return: None

Usage: SPI_BurstWrite (0x0000, rd_buf, 16); Read 16 bytes of data from P-SRAM starting address 0x0000

4.4.5 SPI Status Register Write

Purpose: API to write status register byte

Arguments: 1-byte status register data

Return: None

Usage: SPI_Status_Reg_Write (0x00); Write one byte 0x00 to status register

4.4.6 SPI Status Register Read

Purpose: API to read status register byte

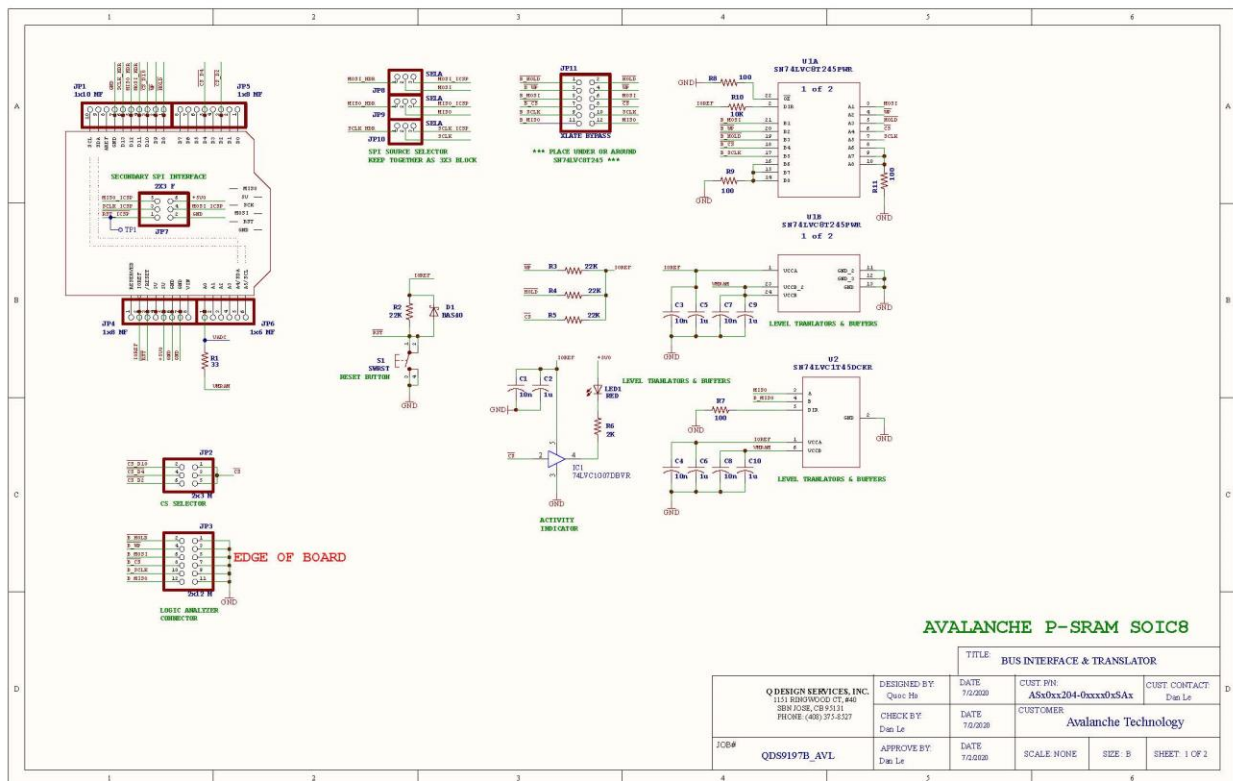
Arguments: 1-byte status register data

Return: None

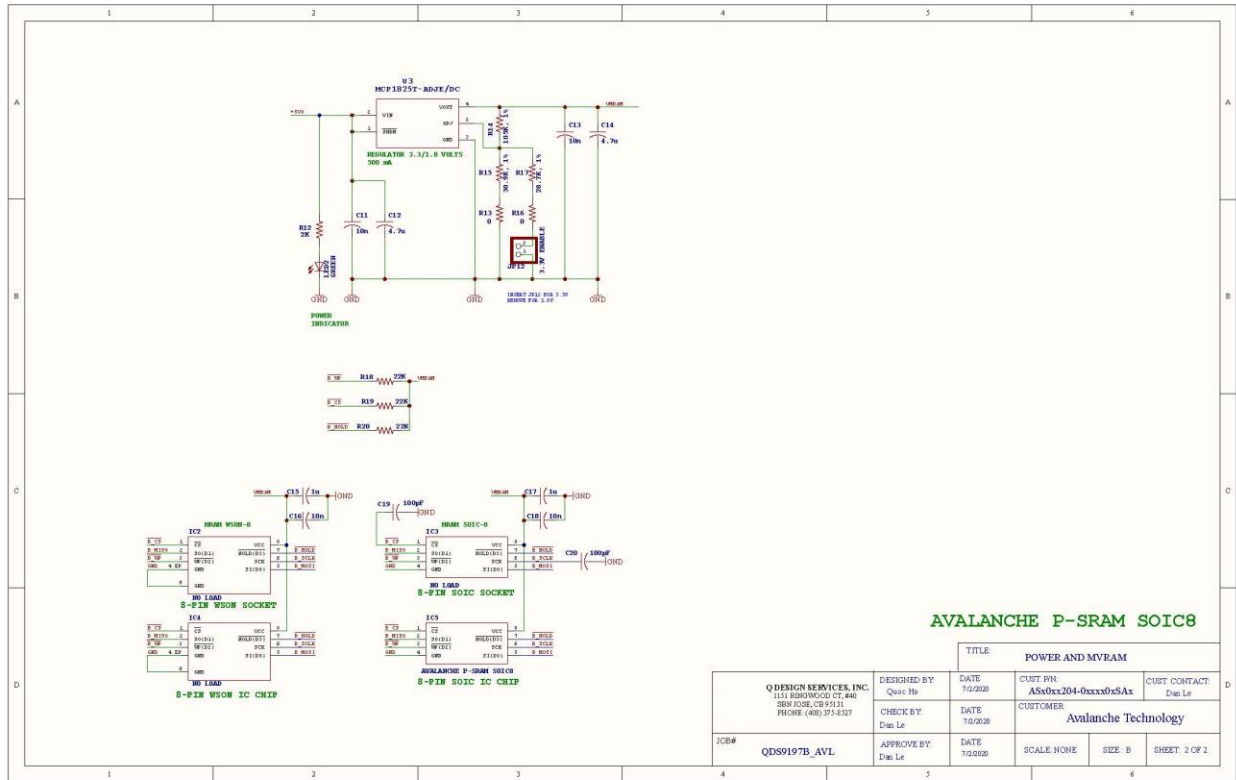
Usage: SPI_Status_Reg_Read (); Read one byte data from status register, and assigns to variable 'status'

Appendix A

Figure 11: M3016-EVK – Schematic (sheet 1)



M3016-EVK – Schematic (sheet 2)



Appendix B

Table 2: M3016-EVK – BOM

Qty	Footprint	Comment	Designator	DK	Manufacturer
9	0603 Capacitor 071713	10nF	C1, C3, C4, C7, C8, C11, C13, C16, C18	1276-1132-1-ND	Samsung
7	0603 Capacitor 071713	1uF	C2, C5, C6, C9, C10, C15, C17	1276-1942-1-ND	Samsung
2	0603 Capacitor 071713	4.7uF	C12, C14	1276-2087-1-ND	Samsung
2	0603 Capacitor 071713	100pF	C19, C20	478-06036C101Kat2ATR-ND	AVX
1	SOT23 012105	BAS40	D1	BAS40TPMSCT-ND	Micro Commercial
1	SOT25 030205	74LVC1G07DBVR	IC1	N/A	Plastronics
1	Socket WSON-8	No load	IC2	N/A	Plastronics
1	Socket SOIC-8	No load	IC3	3M5054-ND	3M
1	WSON-8 MRAM	No load	IC4	N/A	Avalanche
1	SOIC-8 MRAM	MRAM	IC5	N/A	Avalanche
1	1x10 Header Arduino Stackable 010719	1x10 MF	JP1	1568-1413-ND	SparkFun Electronics
1	2x3 Header 010819	2x3 M	JP2	609-3218-ND	Amphenol ICC
1	2x6 Header 082710	2x6 M	JP3	6093219-ND	Amphenol ICC
2	1x8 Header Arduino Stackable 010719	1x8 MF	JP4, JP5	1568-1413-ND	SparkFun Electronics
1	1x6 Header Arduino Stackable 010719	1x6 MF	JP6	1568-1413-ND	SparkFun Electronics
1	2x3 Header Arduino Stackable 010719	2x3 MF	JP7	1568-1413-ND	SparkFun Electronics
3	1x3 Male Header with Shunt 071513	SELA	JP8, JP9, JP10	WM50014-36-ND	Molex
1	2x6 Header 082710	Xlate Bypass	JP11	609-3219-ND	Amphenol
1	1x2 Header with Shunt 051914	3.3V/1.8V Enable	JP12	WM50014-36-ND	Molex
1	LED 0805 032906	RED	LED1	732-4984-1-ND	Würth Electronics
1	LED 0805 032906	GREEN	LED2	732-4983-1-ND	Würth Electronics
1	0603 Resistor 071013	33	R1	P33.0HCT-ND	Panasonic
7	0603 Resistor 071013	22K	R2, R3, R4, R5, R18, R19, R20	P22.0KHCT-ND	Panasonic
2	0603 Resistor 071013	2K	R6, R12	P2.00KHCT-ND	Panasonic
4	0603 Resistor 071013	100	R7, R8, R9, R11	P100HCT-ND	Panasonic
1	0603 Resistor 071013	10K	R10	P105KHCT-ND	Panasonic
2	0603 Resistor 071013	0	R13, R16	P0.0GCT-ND	Panasonic

Qty	Footprint	Comment	Designator	DK	Manufacturer
1	0603 Resistor 071013	105K, 1%	R14	P105KHCT-ND	Panasonic
1	0603 Resistor 071013	30.9K, 1%	R15	P30.9KHCT-ND	Panasonic
1	0603 Resistor 071013	28.7K, 1%	R17	P28.7KHCT-ND	Panasonic
1	Switch TE PB 1825910-6 112915	SWRST	S1	450-1650-ND	TE Connectivity
1	Test Point 40x20010819	No Load	TP1	N/A	N/A
1	TSSOP24 071405	SN74LVC8T245PW R	U1	296-18593-1-ND	TI
1	TSSOP363-6 040914	SN74LVC1T45DCK R	U2	296-16844-1-ND	TI
1	SOT223-6 Regulator 010419	MCP1825T- ADJE/DC	U3	MCP1825T-ADJE/DCCT- ND	Microchip

Revision History

Revision Date	History
Jul.21.20	Initial Release

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