# 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 (Vcc/Vccq) | 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

## Contents

# 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.

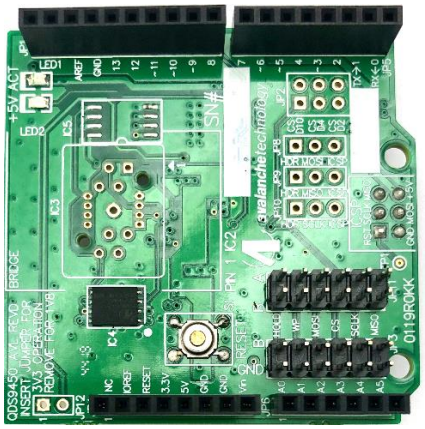


*Figure 1: Renesas MRAM Evaluation Board populated with a DFN (WSON)-8 MRAM device*

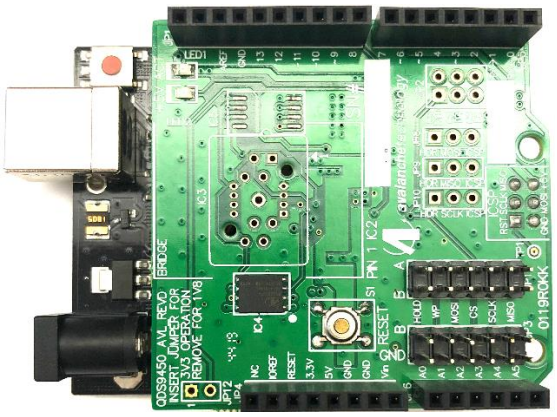


*Figure 2: Arduino Uno Host with Renesas MRAM Evaluation Board on Top with DFN (WSON)-8 MRAM device*

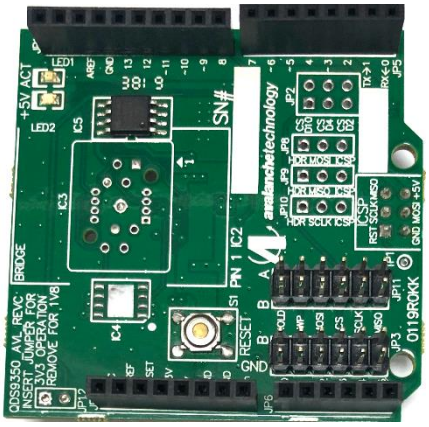


*Figure 3: Renesas MRAM Evaluation Board populated with an SOIC-8 MRAM device*

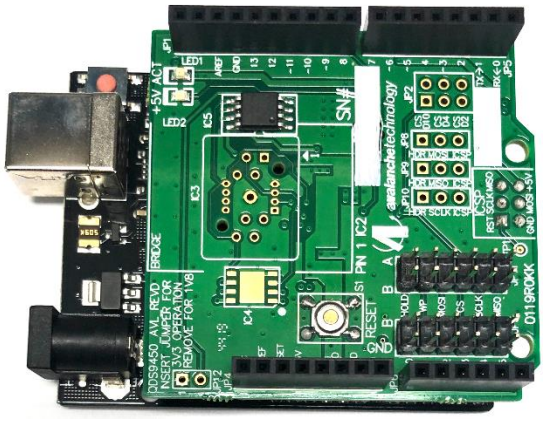


*Figure 4: Arduino Uno Host with Renesas MRAM Evaluation Board on Top with SOIC-8 MRAM device*

## 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 (https://www.arduino.cc/en/Main)


***Figure 5: USB Driver Installation***

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.

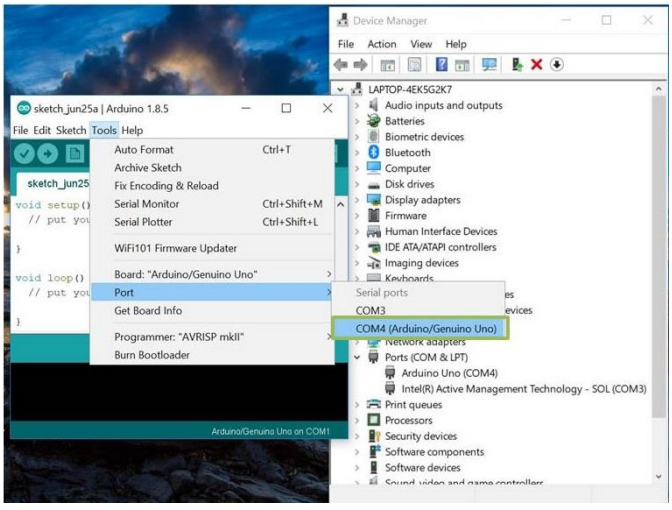



***Figure 6: Selecting COM Port for Arduino UNO***

### 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).

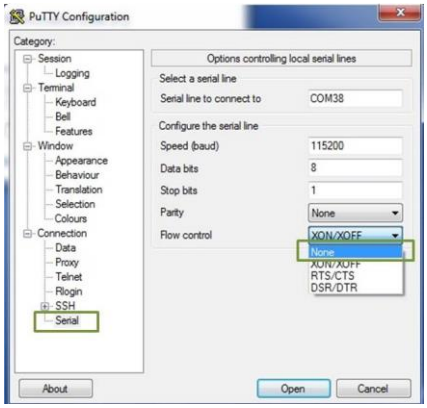



*Figure 7: PuTTY Configuration - 1*

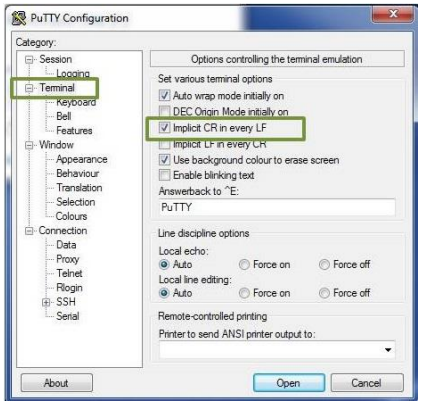



*Figure 8: PuTTY Configuration - 2*

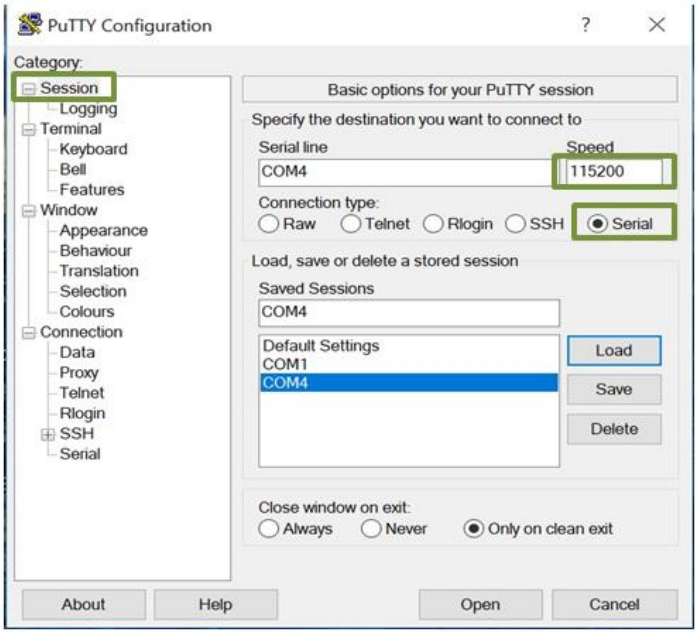



*Figure 9: PuTTY Configuration - 3*

```
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: unint32_t (address); unit16_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: unint32_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: unint32_t (address); unit16_t (write data); unint32_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: unint32_t (address); unit8_t (read_data_ptr); unint32_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

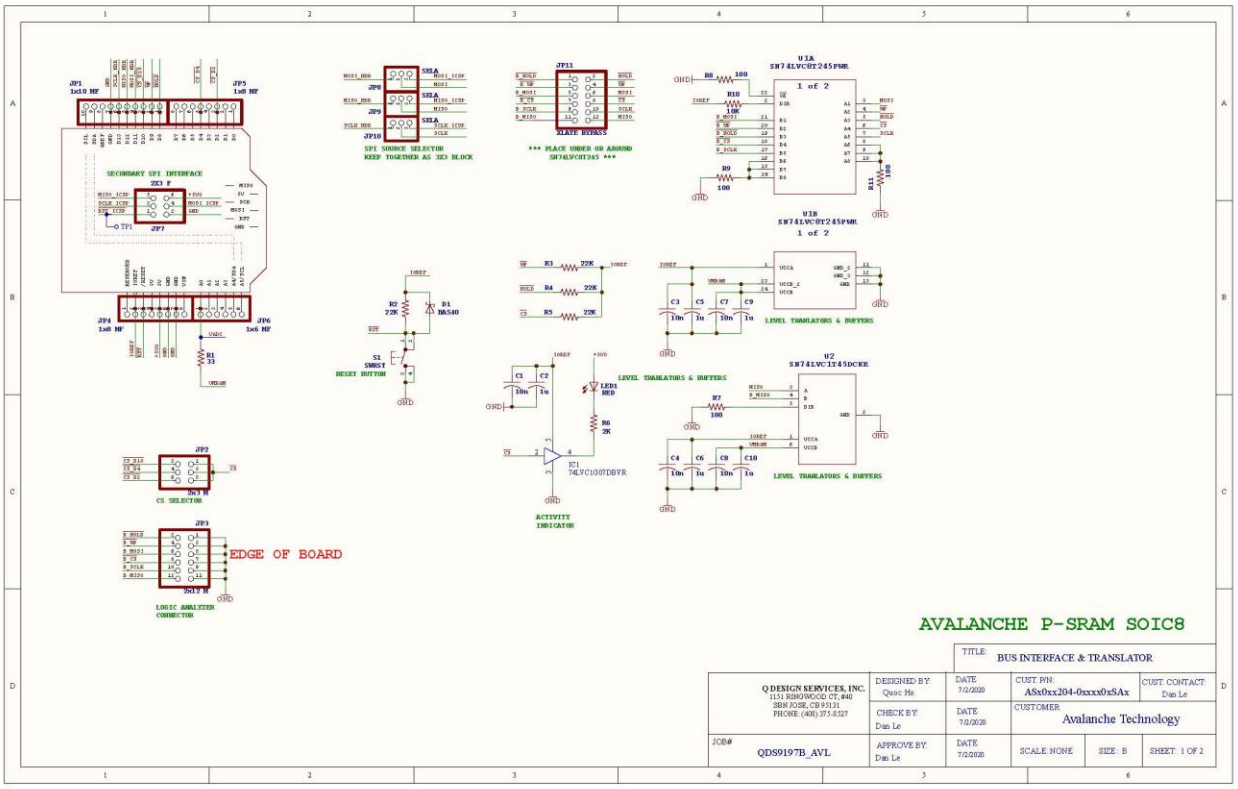
Arguments: 1-byte status register data

Return: None

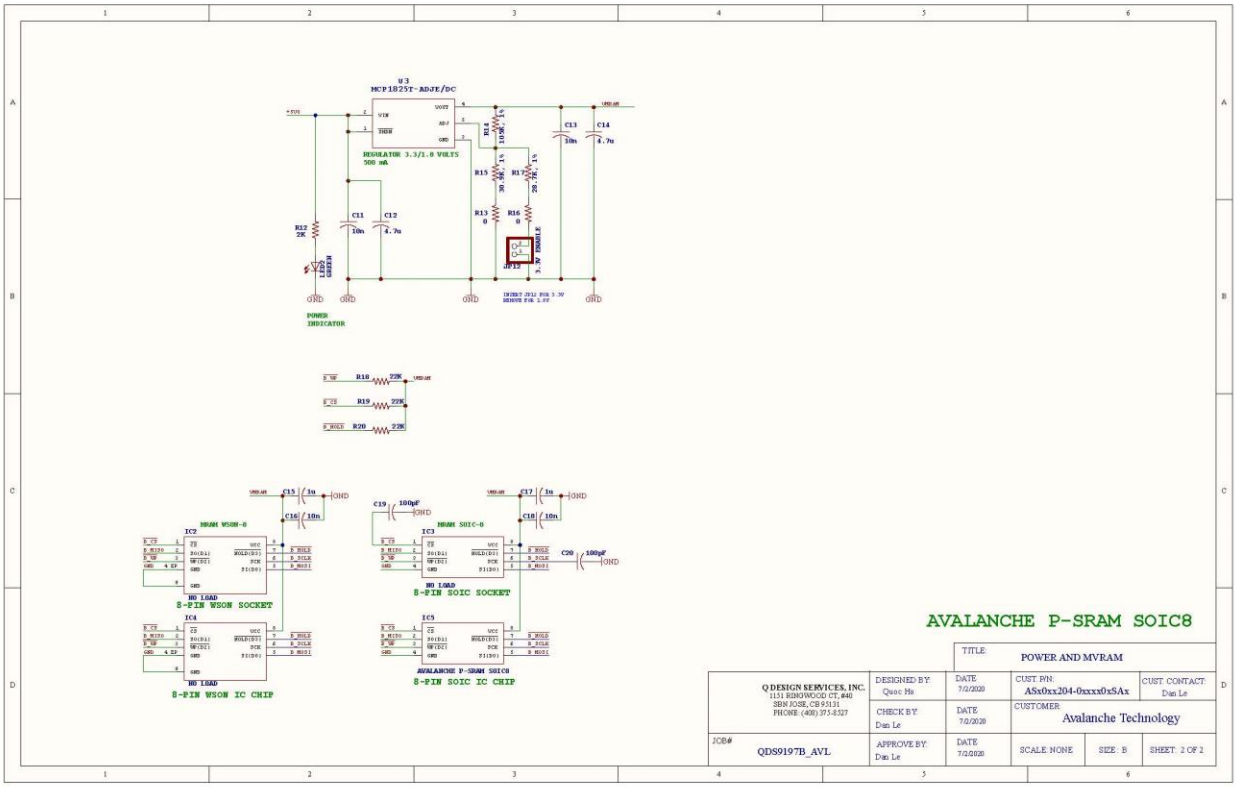
Usage: SPI_Status_Reg_Read (); Read one byte data from status register, and assigns to variable ‘status’

# 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 | Wurth Electronics |
| 1 | LED 0805 032906 | GREEN | LED2 | 732-4983-1-ND | Wurth 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 40x20 010819 | No Load | TP1 | N/A | N/A |
| 1 | TSSOP24 071405 | SN74LVC8T245PWR | U1 | 296-18593-1-ND | TI |
| 1 | TSSOP363-6 040914 | SN74LVC1T45DCKR | 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 |

## IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES (“RENESAS”) PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers skilled in the art designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only for development of an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising out of your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Rev.1.0 Mar 2020)


### Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

### Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/


### Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.