

Renesas 4-Mbit Products Overview

This application note describes and compares the 4-Mbit Flash products Renesas Electronics offers.

Contents

| | |
|--|----|
| 1. Renesas 4-Mbit Products Overview..... | 1 |
| 2. Feature Comparison..... | 2 |
| 3. Command Set (Opcode) Comparison..... | 3 |
| 4. Device ID Comparison..... | 5 |
| 5. Status Register Comparison | 6 |
| 6. SDFP Table Comparison..... | 8 |
| 7. Packaging Options | 8 |
| 8. XE Family Special Features | 9 |
| 9. Revision History | 10 |

1. Renesas 4-Mbit Products Overview

This document describes 4-Mbit products available from Renesas Serial Flash Memory family.

The AT25EU0041A is the newest member of Ultra-Low Energy serial flash memory. It incorporates features geared towards achieving low energy consumption for fundamental flash operations with very fast erase times of 8 ms typical from page erase to chip erase, in addition to low power read, erase, and program. Energy consumption is calculated multiplying power and time.

The AT25EU0041A supports 1.65 V to 3.6 V operations making it ideal for battery powered systems that have finite storage of energy.

This document compares the differences between the 4-Mbit products (listed in the following table) in more detail.

| Family ¹ | Part Number | Product Status | Nominal System Voltage | SPI Support |
|---------------------|-------------|-----------------|------------------------|----------------------|
| SF | AT25SF041B | Mass Production | 3 V | Single / Dual / Quad |
| FF | AT25FF041A | Mass Production | 1.65 V to 3.6 V | Single / Dual / Quad |
| XE | AT25XE041D | Mass Production | 1.65 V to 3.6 V | Single / Dual / Quad |
| EU | AT25EU0041A | Sampling | 1.65 V to 3.6 V | Single / Dual / Quad |

- SF = Standard 3 V Flash Family.
 FF = Wide Vcc Standard Flash Family.
 XE = Wide Vcc FusionHD Flash Family with System Enhanced Features.
 EU = Wide Vcc Ultra-Low Energy Flash Family.

2. Feature Comparison

The following table describes major feature differences between the 4-Mbit products.

| Parameter | AT25SF041B | AT25FF041A | AT25XE041D | AT25EU0041A |
|---------------------------------------|----------------------|----------------------|----------------------|----------------------|
| Total Memory (Bits) | 4 Mbit | 4 Mbit | 4 Mbit | 4 Mbit |
| Total Memory (Bytes) | 0.5 MB | 0.5 MB | 0.5 MB | 0.5 MB |
| Total 64 kB block # | 8 | 8 | 8 | 8 |
| Total 32 kB block # | 16 | 16 | 16 | 16 |
| Total 4 kB sector # | 128 | 128 | 128 | 128 |
| Page Size (Bytes) | 256 | 256 | 256 | 256 |
| Total Page # | 2048 | 2048 | 2048 | 2048 |
| Page Erase Size | N/A | N/A | 256B | 256B |
| Block Erase Size | 64 kB / 32 kB / 4 kB | 64 kB / 32 kB / 4 kB | 64 kB / 32 kB / 4 kB | 64 kB / 32 kB / 4 kB |
| OTP Organization | 3 x 256 byte | 3 x 128 byte | 3 x 128 byte | 3x512 byte |
| UID Register Size | 64-bit | 128-byte | 128-byte | 128-byte |
| SFDP Table | Y | Y | Y | Y |
| Single SPI (1-1-1) 03h/0Bh | Y | Y | Y | Y |
| Dual Read (1-1-2) 3Bh | Y | Y | Y | Y |
| Dual I/O (1-2-2) BBh | Y | | | Y |
| Quad Read (1-1-4) 6Bh | Y | Y | Y | Y |
| Quad I/O (1-4-4, 0-4-4) EBh [XiP] | Y | Y | Y | Y |
| Quad I/O (1-4-4, 0-4-4) E7h [XiP] | Y | Y | Y | |
| QPI (4-4-4) | | | | |
| SRAM buffer access and RMW | | | Y | |
| Battery Monitor with Active Interrupt | | | Y | |
| JEDEC Hardware Reset | | Y | Y | |
| Operating Voltage Range (V) | 2.5 – 3.6 | 1.65 – 3.6 | 1.65 – 3.6 | 1.65 – 3.6 |
| Operating Temperature (°C) | -40 to 85 | -40 to 85 | -40 to 85 | -40 to 85 |
| Endurance ¹ | 100K | 100K | 100K | 10K |
| Data Retention | 20 yrs | 20 yrs | 20 yrs | 20 yrs |

1. Tested per JEDEC Non-Volatile Memory Cycling Endurance Standard.

3. Command Set (Opcode) Comparison

The following table shows the comparisons in Command Set or Opcode for all 4-Mbit products.

| Command | AT25SF041B | AT25FF041A | AT25XE041D | AT25EU0041A |
|--------------------------------------|------------|------------|------------|-------------|
| System Commands | | | | |
| Enable Reset | 66h | 66h | 66h | 66h |
| Reset Device | 99h | 99h | 99h | 99h |
| Deep Power-down | B9h | B9h | B9h | B9h |
| Release/Resume from Deep Power-Down | ABh | ABh | ABh | ABh |
| Ultra Deep Power-Down | | 79h/B9h | 79h/B9h | |
| Terminate / Abort operation | | F0h | F0h | |
| Active Status Interrupt | | | 25h | 25h |
| Start Low Battery Detect | | | EFh | |
| Read Commands | | | | |
| Normal Read Data | 03h | 03h | 03h | 03h |
| Fast Read | 0Bh | 0Bh | 0Bh | 0Bh |
| Dual Output Fast Read | 3Bh | 3Bh | 3Bh | 3Bh |
| Dual I/O Fast Read | BBh | | | BBh |
| Dual I/O Fast Read (Continuous Mode) | BBh | | | BBh |
| Quad Output Fast Read | 6Bh | 6Bh | 6Bh | 6Bh |
| Quad I/O Fast Read | EBh | EBh | EBh | EBh |
| Quad I/O Fast Read (Continuous Mode) | EBh | EBh | EBh | EBh |
| Word Read Quad I/O | E7h | E7h | E7h | |
| Word Read Quad I/O (Continuous Mode) | E7h | E7h | E7h | |
| Set Burst with Wrap | 77h | 77h | 77h | 77h |
| Write Commands | | | | |
| Write Enable | 06h | 06h | 06h | 06h |
| Volatile SR Write Enable | 50h | 50h | 50h | 50h |
| Write Disable | 04h | 04h | 04h | 04h |
| Program Commands | | | | |
| Page Program | 02h | 02h | 02h | 02h |
| Sequential Program Mode | | ADh/AFh | ADh/AFh | |
| Dual Page Program | | A2h | A2h | A2h |
| Quad Page Program (1-1-4) | 32h | 32h | 32h | 32h |

| Erase Commands | | | | |
|--|---------|---------|---------|---------|
| Page Erase (256B) | | | 81h/DBh | 81h/DBh |
| Sector Erase (4KB) | 20h | 20h | 20h | 20h |
| Block Erase (32KB) | 52h | 52h | 52h | 52h |
| Block Erase (64KB) | D8h | D8h | D8h | D8h |
| Chip Erase | C7h/60h | C7h/60h | C7h/60h | C7h/60h |
| Suspend / Resume Commands | | | | |
| Program/Erase Suspend | 75h | 75h/B0h | 75h/B0h | 75h |
| Program/Erase Resume | 7Ah | 7Ah/D0h | 7Ah/D0h | 7Ah |
| Status Register Commands | | | | |
| Read Status Register 1 | 05h | 05h | 05h | 05h |
| Read Status Register 2 | 35h | 35h | 35h | 35h |
| Read Status Register 3 | | 15h | 15h | 15h |
| Write Status Register 1 | 01h | 01h | 01h | 01h |
| Write Status Register 2 | 31h | 31h | 31h | 31h |
| Write Status Register 3 | | 11h | 11h | 11h |
| Read Status Register 1-5/6 (1-1-0 using Indirect Addressing) | | 65h | 65h | |
| Write Status Register 1-5/6 (1-1-1 using Indirect Addressing) | | 71h | 71h | |
| Status Register Lock | | 6Fh | 6Fh | |
| Device ID Information | | | | |
| Manuf/Device ID | 90h | 90h | 90h | 90h |
| Manuf/Device ID Dual I/O | 92h | | | 92h |
| Manuf/Device ID Quad I/O | 94h | 94h | 94h | 94h |
| Read JEDEC ID | 9Fh | 9Fh | 9Fh | 9Fh |
| Read Serial Flash Discoverable Parameter | 5Ah | 5Ah | 5Ah | 5Ah |
| Resume from DPD and read ID | ABh | ABh | ABh | ABh |
| OTP Commands | | | | |
| Erase Security Registers | 44h | | | 44h |
| Program Security Registers | 42h | 9Bh | 9Bh | 42h |
| Read Security Registers | 48h | 4Bh | 4Bh | 48h |
| Read Unique ID number | 4Bh | 4Bh | 4Bh | 4Bh |

| SRAM Buffer Commands | | | | |
|--|--|---------|---------|--|
| Buffer Read | | | D4h | |
| Buffer Write | | | 84h | |
| Buffer to Main Memory Page Program w/o Erase | | | 88h | |
| Read-Modify-Write | | | 0Ah | |
| Lock Commands | | | | |
| Individual Block Lock | | 36h | 36h | |
| Individual Block UnLock | | 39h | 39h | |
| Read Block Lock | | 3Ch/3Dh | 3Ch/3Dh | |
| Global Block Lock | | 7Eh | 7Eh | |
| Global Block UnLock | | 98h | 98h | |

4. Device ID Comparison

All Renesas 4-Mbit products have a different device ID to allow identification by the host system, as shown in the following table.

| Device ID Commands | AT25SF041B | AT25FF041A | AT25XE041D | AT25EU0041A |
|---|---------------|---------------|---------------|---------------|
| Release Power-down / Read ID [ABh] | 12h | 44h | 44h | 14h |
| Manufacturer and Device ID Single I/O [90h] | 1Fh, 12h | 1Fh, 44h | 1Fh, 44h | 1Fh, 14h |
| Manufacturer and Device ID Dual I/O [92h] | 1Fh, 12h | | | 1Fh, 14h |
| Manufacturer and Device ID Quad I/O [94h] | 1Fh, 12h | 1Fh, 44h | 1Fh, 44h | 1Fh, 14h |
| Read JEDEC ID [9Fh] | 1Fh, 84h, 01h | 1Fh, 44h, 08h | 1Fh, 44h, 0Ch | 1Fh, 14h, 01h |
| Read SFDP [5Ah] | Yes | Yes | Yes | Yes |

Note that the AT25FF041A and AT25XE041D do not support opcode 92h.

5. Status Register Comparison

The following table lists the comparisons in Status Register definitions and access method for all Renesas 4-Mbit products.

| Device ID Commands | AT25SF041B | AT25FF041A | AT25XE041D | AT25EU0041A |
|-------------------------|------------|----------------|----------------|-------------|
| Read Status Register 1 | 05h | 05h/65h | 05h/65h | 05h |
| Read Status Register 2 | 35h | 35h/65h | 35h/65h | 35h |
| Read Status Register 3 | | 15h/65h | 15h/65h | 15h |
| Read Status Register 4 | | 65h (addr 04h) | 65h (addr 04h) | |
| Read Status Register 5 | | 65h (addr 05h) | 65h (addr 05h) | |
| Read Status Register 6 | | | 65h (addr 06h) | |
| Write Status Register 1 | 01h | 01h/71h | 01h/71h | 01h |
| Write Status Register 2 | 31h | 31h/71h | 31h/71h | 31h |
| Write Status Register 3 | | 11h/71h | 11h/71h | 11h |
| Write Status Register 4 | | 71h (addr 04h) | 71h (addr 04h) | |
| Write Status Register 5 | | 71h (addr 05h) | 71h (addr 05h) | |
| Write Status Register 6 | | | 71h (addr 06h) | |

For AT25SF041B, each opcode (01h, 31h) is followed by one byte of data. The second byte is ignored. To write Status Registers 1 and 2, the host must send 01h with one byte, then 31h with another byte.

For the AT25FF041A and AT25XE041D, opcodes 01h, 31h, and 11h are followed by one byte of data. To write Status Registers 1 and 2, the host sends 01h with one byte, then 31h with another byte. For compatibility with legacy devices, command (01h) also can be used with two bytes of data. In this case, the second byte is written to Status Register 2. 11h is used for Status Register 3. Status Register 4, 5, and 6 use indirect addressing. For read operations, the opcode is 65h, and the address matches the status register # (for example: address 04h for Status Register 4). For write operations, the opcode is 71h, and the address matches status register #.

The following table provides a bit-level comparison for the Renesas 4-Mbit products.

| Register | Bit | AT25SF041B | AT25FF041A | AT25XE041D | AT25EU0041A |
|-------------------|-----|------------|------------|------------|-------------|
| Status Register 1 | 0 | RDY/BSY | RDY/BSY | RDY/BSY | RDY/BSY |
| | 1 | WEL | WEL | WEL | WEL |
| | 2 | BP0 | BP0 | BP0 | BP0 |
| | 3 | BP1 | BP1 | BP1 | BP1 |
| | 4 | BP2 | BP2 | BP2 | BP2 |
| | 5 | TB | TB | TB | BP3 |
| | 6 | SEC | BPSIZE | BPSIZE | BP4 |
| | 7 | SRP0 | SRP0 | SRP0 | SRP0 |

| Register | Bit | AT25SF041B | AT25FF041A | AT25XE041D | AT25EU0041A |
|--------------------------|-----|------------|------------|------------|-------------|
| Status Register 2 | 0 | SRP1 | SRP1 | SRP1 | SRP1 |
| | 1 | QE | QE | QE | QE |
| | 2 | P_SUS | Reserved | Reserved | Reserved |
| | 3 | LB1 | Lock1 | Lock1 | LB1 |
| | 4 | LB2 | Lock2 | Lock2 | LB2 |
| | 5 | LB3 | Lock3 | Lock3 | LB3 |
| | 6 | CMP | CMP | CMP | CMP |
| | 7 | E_SUS | SUS | SUS | SUS |
| Status Register 3 | 0 | | Reserved | Reserved | Reserved |
| | 1 | | Reserved | Reserved | Reserved |
| | 2 | | WPS | WPS | Reserved |
| | 3 | | Reserved | Reserved | Reserved |
| | 4 | | Reserved | Reserved | Reserved |
| | 5 | | DRV0 | DRV0 | Reserved |
| | 6 | | DRV1 | DRV1 | Reserved |
| | 7 | | Hold/RST | Hold/RST | Hold/RST |
| Status Register 4 | 0 | | BWS0 | BWS0 | |
| | 1 | | BWS1 | BWS1 | |
| | 2 | | BWS2 | BWS2 | |
| | 3 | | XiP | XiP | |
| | 4 | | EE | EE | |
| | 5 | | PE | PE | |
| | 6 | | SPM | SPM | |
| | 7 | | PDM | PDM | |
| Status Register 5 | 0 | | DWA | DWA | |
| | 1 | | STPE | STPE | |
| | 2 | | PS | PS | |
| | 3 | | ES | ES | |
| | 4 | | DC0 | DC0 | |
| | 5 | | DC1 | DC1 | |
| | 6 | | DC2 | DC2 | |
| | 7 | | SRLOCK | SRLOCK | |
| Status Register 6 | 0 | | | LBD | |
| | 1 | | | LBLD0 | |
| | 2 | | | LBLD1 | |
| | 3 | | | LBVL0 | |
| | 4 | | | LBVL1 | |
| | 5 | | | LBVL2 | |
| | 6 | | | LBS0 | |
| | 7 | | | LBS1 | |

6. SDFP Table Comparison

All Renesas 4-Mbit products support a Serial Flash Discoverable Parameters (SFPD) table. Each product family has different SFPD table definitions. Contact Renesas for detailed SFPD table documents for a specific product.

The following table lists the availability of SFPD documentation for Renesas 4-Mbit products.

| Renesas Part Number | JESD216 | | | | | SFPD Table Doc # |
|---|---------|---------|---------|---------|---------|------------------|
| | (v1.0) | A(v1.5) | B(v1.6) | C(v1.7) | D(v1.8) | |
| Wide Vcc FusionHD Flash Family with System Enhanced Features | | | | | | |
| AT25XE041D | | | Y | | | SFDP-T009 |
| 3.0 V Standard Flash | | | | | | |
| AT25SF041B | | | | | Y | SFDP-T022 |
| Wide Vcc Standard Flash | | | | | | |
| AT25FF041A | | | Y | | | SFDP-T014 |
| Ultra-Low Energy | | | | | | |
| AT25EU0041A | | | | | Y | SFDP-T025 |

7. Packaging Options

The following table provides the current packaging options available for all Renesas 4-Mbit products. Contact Renesas for questions regarding packaging options. Most Renesas 4-Mbit products are also available in KGD form.

| Package Type | AT25SF041B | AT25FF041A | AT25XE041D | AT25EU0041A |
|---------------------------------|------------|------------|------------|-------------|
| SOIC Package | | | | |
| 8-pin SOIC (0.150" narrow body) | Y | Y | Y | Y |
| 8-pin SOIC (0.208" wide body) | Y | Y | Y | |
| UDFN Package | | | | |
| 8-pad 5 x 6 mm UDFN | Y | | | |
| 8-pad 2 x 3 mm UDFN | Y | Y | Y | Y |
| WLCSP Package | | | | |
| 8-ball (3 x 2 x 3) WLCSP | | Y | Y | |

8. XE Family Special Features

AT25XE041D contains special function blocks for special applications. For example, EEPROM emulation can be done using the RMW command (0Ah). Data logging and temporary data storage can be supported using Buffer operation commands such as Buffer Read, Buffer Write, and Buffer to Main Memory Program without Erase.

Renesas Electronics provides separate Technical Notes and Application Notes to cover these features in more detail.

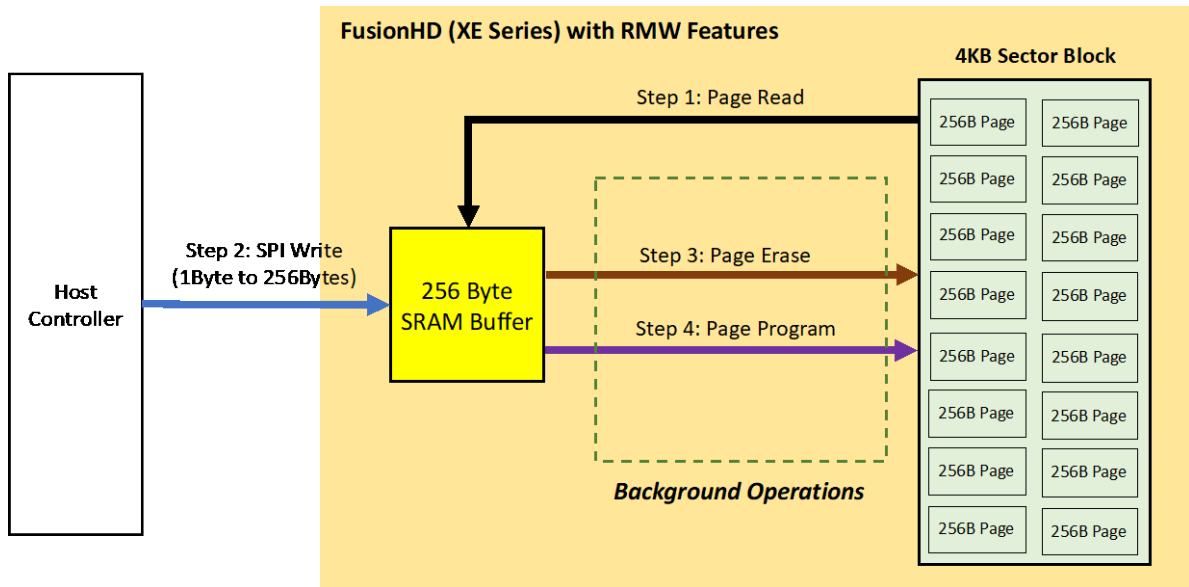


Figure 1: AT25XE041D 256Byte SRAM Page Buffer Block with RMW Feature

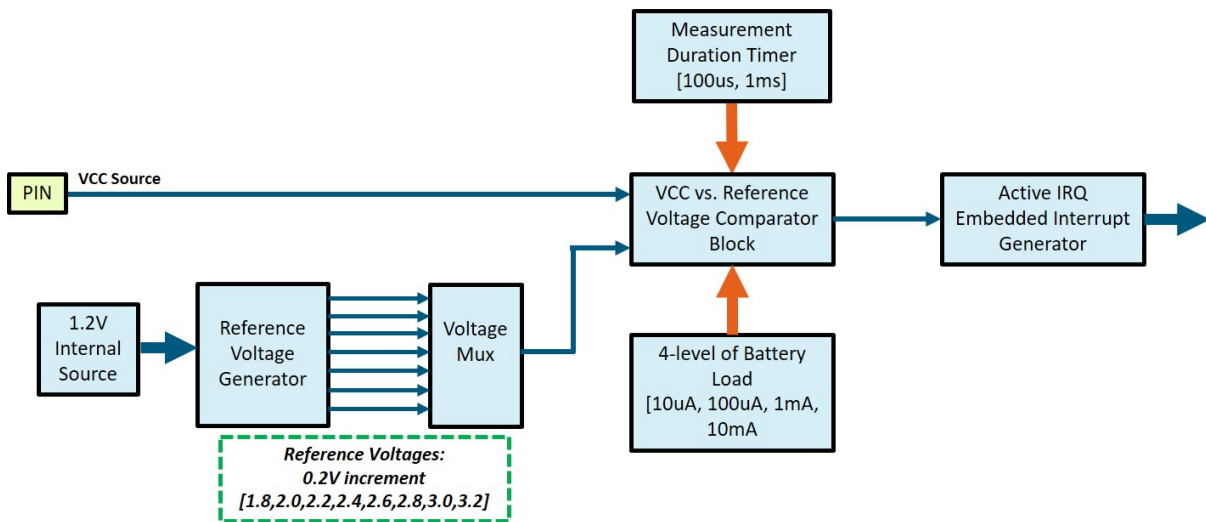


Figure 2: AT25XE041D Battery Monitor Block

9. Revision History

| Version | Date | Description |
|---------|-------|---|
| A1 | 05/20 | Initial release. |
| A2 | 05/20 | Clarified Section 1. Added 2.5 V support for AT25SF041B in Table 2. Updated Table 7 to be specific to 4-Mbit products. Corrected Figure 1 and Figure 2. |
| A3 | 10/20 | Removed the status register 3 read and write for AT25SF041B in Table 3 and Table 5 since Status Register 3 is not supported. Corrected the AT25SF081B to AT25SF041B, and removed Status Register 3 functions in Table 6 since Status Register 3 is not supported. Added 5x6 UDFN package support for AT25SF041B in table 8. |
| A4 | 08/22 | Changed template to Renesas. Removed AT25SF041 from all sections. Added AT25EU0041A to all sections. Updated section 1 |

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