



**Adesto**

Application Note AN401-A3

# **Adesto 4Mbit Products Overview**

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## Revision History

Version	Date	Description
A1	5/20	Initial release.
A2	5/20	<ul style="list-style-type: none"> <li>• Clarified Section 1</li> <li>• Added 2.5V support for AT25SF041B in Table 2</li> <li>• Updated Table 7 to be specific to 4Mbit products</li> <li>• Corrected Figure 1 and Figure 2</li> </ul>
A3	10/20	<ul style="list-style-type: none"> <li>• Removed the status register 3 read and write for AT25SF041B in table 3 and table 5 since status register 3 is not supported</li> <li>• Corrected the AT25SF081B to AT25SF041B and removed status register 3 functions in table 6 since status register 3 is not supported</li> <li>• Added 5x6 UDFN package support for AT25SF041B in table 8</li> </ul>

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## 1. Adesto 4Mbit Products Overview

This document describes 4Mbit products available from Adesto Serial Flash Memory family. It also provides information on migrating from the legacy AT25SF041 (planned for EOL) to other 4Mbit products available from Adesto. Adesto has the new AT25SF041B as a replacement and wide voltage (1.65V to 3.6V) 4Mbit products. The AT25XE041D product includes additional features designed to optimize system operation and power consumption, such as Small Page Erase, Read-Modify-Write and others. AT25XE041D also offers a small analog voltage comparator block that can be used to monitor battery health in embedded applications. The AT25FF041A is based on AT25XE041D architecture and optimized for lower system cost. This document compares the differences between the 4Mbit products in more detail.

Table 1: Adesto 4Mbit Products Overview

Family	Part Number	Product Status	Nominal System Voltage	SPI Support
SF	AT25SF041	EOL	3V	Single/Dual/Quad
SF	AT25SF041B	New Product	3V	Single/Dual/Quad
FF	AT25FF041A	Sampling	1.8V to 3V	Single/Dual/Quad
XE	AT25XE041D	Sampling	1.8V to 3V	Single/Dual/Quad

- SF Standard 3V Flash Family
- FF Wide Vcc Standard Flash Family
- XE Wide Vcc FusionHD Flash Family with Enhanced Features

## 2. Feature Comparison

Table 2 describes major feature differences between the 4Mbit products. AT25SF041B and AT25FF041A offer features close to legacy AT25SF041 where AT25XE041D provides additional special blocks for more versatile usage of memory in different applications

Table 2: Adesto 4Mbit Products Feature Comparison

	AT25SF041	AT25SF041B	AT25FF041A	AT25XE041D
Total Memory (Bits)	4Mbit	4Mbit	4Mbit	4Mbit
Total Memory (Bytes)	0.5MB	0.5MB	0.5MB	0.5MB
Total 64KB block #	8	8	8	8
Total 32KB block #	16	16	16	16
Total 4KB 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	N/A	256B
Block Erase Size	64KB / 32KB / 4 KB	64KB / 32KB / 4KB	64KB / 32KB / 4KB	64KB / 32KB / 4KB
OTP Organization	3 x 256 byte	3 x 256 byte	3 x 128 byte	3 x 128 byte
UID Register Size		64-bit	128-byte	128-byte
SFDP Table		x	x	x
Single SPI (1-1-1) 03/0B	x	x	x	x
Dual Read (1-1-2) 3B	x	x	x	x
Dual I/O (1-2-2) BB	x	x		
Quad Read (1-1-4) 6B	x	x	x	x
Quad I/O (1-4-4, 0-4-4) EB [XiP]	x	x	x	x
Quad I/O (1-4-4, 0-4-4) E7 [XiP]		x	x	x
QPI (4-4-4) EB/0C				
SRAM buffer commands (RMW)				x
Battery Monitor with Active Interrupt				x
JEDEC Hardware Reset			x	x
Operating Voltage Range (V)	2.5 – 3.6	2.5 – 3.6	1.65 – 3.6	1.65 – 3.6
Operating Temperature	-40 to 85	-40 to 85	-40 to 85	-40 to 85
Endurance (1)	100K	100K	100K	100K
Data Retention	20yr	20yr	20yr	20yr

(1) Tested per JEDEC47 Non-Volatile Memory Cycling Endurance Standard

### 3. Command Set (Opcode) Comparison

Table 3 shows the comparisons in Command Set or Opcode for all 4Mbit products.

Table 3: Adesto 4Mbit Products Command Set Comparison

	AT25SF041	AT25SF041B	AT25FF041A	AT25XE041D
<b>System Commands</b>				
Enable Reset	n/a	66h	66h	66h
Reset Device	n/a	99h	99h	99h
Deep Power-down	B9h	B9h	B9h	B9h
Release/Resume from Deep Power-down	ABh	ABh	ABh	ABh
Ultra Deep Power-down	n/a	n/a	79h/B9h	79h/B9h
Terminate / Abort operation	n/a	n/a	F0h	F0h
Active Status Interrupt	n/a	n/a	n/a	25h
Start Low Battery Detect	n/a	n/a	n/a	EFh
<b>Read Commands</b>				
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	n/a	n/a
Dual I/O Fast Read (Continuous Mode)	BBh	BBh	n/a	n/a
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	n/a	E7h	E7h	E7h
Word Read Quad I/O (Continuous Mode)	n/a	E7h	E7h	E7h
Set Burst with Wrap	n/a	77h	77h	77h
<b>Write Commands</b>				
Write Enable	06h	06h	06h	06h
Volatile SR Write Enable	50h	50h	50h	50h
Write Disable	04h	04h	04h	04h
<b>Program Commands</b>				
Page Program	02h	02h	02h	02h

	AT25SF041	AT25SF041B	AT25FF041A	AT25XE041D
Sequential Program Mode	n/a	n/a	ADh/AFh	ADh/AFh
Dual Page Program	n/a	n/a	A2h	A2h
Quad Page Program (1-1-4)	n/a	32h	32h	32h
Quad Page Program (1-4-4)	n/a	n/a	32h	32h
<b>Erase Commands</b>				
Page Erase (256B)	n/a	n/a	n/a	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
<b>Suspend/Resume Command</b>				
Program/Erase Suspend	75h	75h	75h/B0h	75h/B0h
Program/Erase Resume	7Ah	7Ah	7Ah/D0h	7Ah/D0h
<b>Status Register Commands</b>				
Read Status Register 1	05h	05h	05h	05h
Read Status Register 2	35h	35h	35h	35h
Read Status Register 3	n/a	n/a	15h	15h
Write Status Register 1	01h	01h	01h	01h
Write Status Register 2	n/a	31h	31h	31h
Write Status Register 3	n/a	n/a	11h	11h
Read Status Register 1-5/6 (1-1-0 using Indirect Addressing)	n/a	n/a	65h	65h
Write Status Register 1-5/6 (1-1-1 using Indirect Addressing)	n/a	n/a	71h	71h
Status Register Lock	n/a	n/a	6Fh	6Fh
<b>Device ID Information</b>				
Manuf/Device ID	90h	90h	90h	90h
Manuf/Device ID Dual I/O	n/a	92h	n/a	n/a
Manuf/Device ID Quad I/O	n/a	94h	94h	94h
Read JEDEC ID	9Fh	9Fh	9Fh	9Fh
Read Serial Flash Discoverable Parameter	n/a	5Ah	5Ah	5Ah
Resume from DPD and read ID	ABh	ABh	ABh	ABh
<b>OTP Commands</b>				

	AT25SF041	AT25SF041B	AT25FF041A	AT25XE041D
Erase Security Registers	44h	44h	n/a	n/a
Program Security Registers	42h	42h	9Bh	9Bh
Read Security Registers	48h	48h	4Bh	4Bh
Read Unique ID number	n/a	4Bh	4Bh	4Bh
<b>SRAM Buffer Commands</b>				
Buffer Read	n/a	n/a	n/a	D4h
Buffer Write	n/a	n/a	n/a	84h
Buffer to Main Memory Page Program w/o Erase	n/a	n/a	n/a	88h
Read-Modify-Write	n/a	n/a	n/a	0Ah
<b>Lock Commands</b>				
Individual Block Lock	n/a	n/a	36h	36h
Individual Block UnLock	n/a	n/a	39h	39h
Read Block Lock	n/a	n/a	3Ch/3Dh	3Ch/3Dh
Global Block Lock	n/a	n/a	7Eh	7Eh
Global Block UnLock	n/a	n/a	98h	98h

## Notes:

1. AT25XE041D and AT25FF041A have different OTP Security Register programming protocol vs AT25SF041 and AT25SF041B
2. AT25FF041A has Read Status Register 1-5 (1-1-0 using Indirect Addressing)
3. AT25FF041A has Write Status Register 1-5 (1-1-1 using Indirect Addressing)
4. AT25XE041D has Read Status Register 1-6 (1-1-0 using Indirect Addressing)
5. AT25XE041D has Write Status Register 1-6 (1-1-1 using Indirect Addressing)



## 4. Device ID Comparison

All Adesto 4Mbit products have a different device ID to allow identification by the host system.

Table 4: Adesto 4Mbit Products Device ID Comparison

	AT25SF041	AT25SF041B	AT25FF041A	AT25XE041D
<b>Device ID Commands</b>				
Release Power-down / Read ID [ABh]	12h	12h	44h	44h
Manufacturer and Device ID Single I/O [90h]	1Fh, 12h	1Fh, 12h	1Fh, 44h	1Fh, 44h
Manufacturer and Device ID Dual I/O [92h]	n/a	1Fh, 12h	n/a	n/a
Manufacturer and Device ID Quad I/O [94h]	n/a	1Fh, 12h	1Fh, 44h	1Fh, 44h
Read JEDEC ID [9Fh]	1Fh, 84h, 01h	1Fh, 84h, 01h	1Fh, 44h, 08h	1Fh, 44h, 0Ch
Read SFDP [5Ah]	n/a	Yes	Yes	Yes

### Note:

- The AT25SF041 and AT25SF041B have the same device ID but can be identified using the the SFDP table, refer to section 6
- The SFDP header can be read using 5Ah command with one dummy byte after power-on
- The AT25FF041A and AT25XE041D do not support opcode 92h

## 5. Status Register Comparison

Table 5 shows the comparisons in Status Register definitions and access method for all Adesto 4Mbit products.

Table 5: Adesto 4Mbit Products Status Register Comparison

	AT25SF041	AT25SF041B	AT25FF041A	AT25XE041D
Read Status Register 1	05h	05h	05h/65h	05h/65h
Read Status Register 2	35h	35h	35h/65h	35h/65h
Read Status Register 3			15h/65h	15h/65h
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	01h/71h	01h/71h
Write Status Register 2	01h	31h	31h/71h	31h/71h
Write Status Register 3			11h/71h	11h/71h
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)
AT25SF041	Use one command (01h) to write 2 bytes of data into Status Register 1 and 2. Two bytes must follow opcode 01h with valid two bytes of data. If only one byte is sent after 01h opcode, 2nd byte (Status Register 2) will be written with unknown values.			
AT25SF041B	Each opcode (01h, 31h) will follow with one byte of data. Second byte will be ignored. To write Status Register 1 & 2, host should send 01h with one byte then 31h with another byte.			
AT25FF041A AT25XE041D	Each opcode (01h, 31h, 11h) will follow with one byte of data. To write Status Registers 1 & 2, host should send 01h with one byte then 31h with another byte. For compatibility with legacy devices command (01h) can also be used with 2 bytes of data. In such case, second byte will be written to Status Register 2. 11h will be used for Status Register 3. Status Register 4, 5, 6 will use indirect addressing. For read operation, opcode will be 65h and address will match the status register # (ex: address 04h for status register 4). For write operation, opcode will be 71h and address will match status register #.			

Table 6: Adesto 4Mbit Products Status Register Bit Level Comparison

		AT25SF041	AT25SF041B	AT25FF041A	AT25XE041D
<b>Status Register 1</b>	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	TB
	6	SEC	SEC	BPSIZE	BPSIZE
	7	SRP0	SRP0	SRP0	SRP0
<b>Status Register 2</b>	0	SRP1	SRP1	SRP1	SRP1
	1	QE	QE	QE	QE
	2	Reserved	P_SUS	Reserved	Reserved
	3	LB1	LB1	Lock1	Lock1
	4	LB2	LB2	Lock2	Lock2
	5	LB3	LB3	Lock3	Lock3
	6	CMP	CMP	CMP	CMP
	7	Reserved	E_SUS	SUS	SUS
<b>Status Register 3</b>	0			Reserved	Reserved
	1			Reserved	Reserved
	2			WPS	WPS
	3			Reserved	Reserved
	4			Reserved	Reserved
	5			DRV0	DRV0
	6			DRV1	DRV1
	7			Hold/RST	Hold/RST
<b>Status Register 4</b>	0			BWS0	BWS0
	1			BWS1	BWS1
	2			BWS2	BWS2
	3			XiP	XiP
	4			EE	EE
	5			PE	PE
	6			SPM	SPM
	7			PDM	PDM

	AT25SF041	AT25SF041B	AT25FF041A	AT25XE041D
<b>Status Register 5</b>	0			DWA
	1			STPE
	2			PS
	3			ES
	4			DC0
	5			DC1
	6			DC2
	7			SRLOCK
<b>Status Register 6</b>	0			LBD
	1			LBLD0
	2			LBLD1
	3			LBVL0
	4			LBVL1
	5			LBVL2
	6			LBS0
	7			LBS1

## 6. SFDP Table Comparison

All Adesto 4Mbit products except the AT25SF041 contain a SFDP (Serial Flash Discoverable Parameters) table. Each product family will have different SFDP table definitions. Contact Adesto for detail SFDP table documents for specific product.

Table 7: Adesto 4Mbit SFDP Documentation Availability

Adesto Part Number	JESD216					SFDP Table Document Number
	(v1.0)	A(v1.5)	B(v1.6)	C(v1.7)	D(v1.8)	
<b>Wide Vcc FusionHD Flash Family with Enhanced Features</b>						
AT25XE041D			x			SFDP-T009
<b>3.0V Standard Flash</b>						
AT25SF041B					x	SFDP-T022
<b>Wide Vcc Standard Flash</b>						
AT25FF041A			x			SFDP-T014

## 7. Packaging Options

Table 8 provides the current packaging options available for all 4Mbit products. Contact Adesto for questions regarding packaging options. Most 4Mbit products are also available in KGD form.

Table 8: Adesto 4Mbit Packaging Options

	AT25SF041	AT25SF041B	AT25FF041A	AT25XE041D
<b>SOIC Package</b>				
8-pin SOIC (0.150" narrow body)	x	x	x	x
8-pin SOIC (0.208" wide body)	x	x	x	x
<b>UDFN Package</b>				
8-pad 5 x 6 mm UDFN	x	x		
8-pad 2 x 3 mm UDFN	x	x	x	x
<b>TSSOP Package</b>				
8-pad 4 x 4 mm TSSOP	x			
<b>WLCSP Package</b>				
8-ball (3 x 2 x 3) WLCSP			x	x

## 8. XE Family Special Features

AT25XE041D contains special function blocks for special applications. For example, EEPROM emulation can be done using 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 w/o Erase. Battery health monitoring can be done using Low Battery Detect circuit and Active Interrupt feature.

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

Figure 1: AT25XE041D Block Diagram

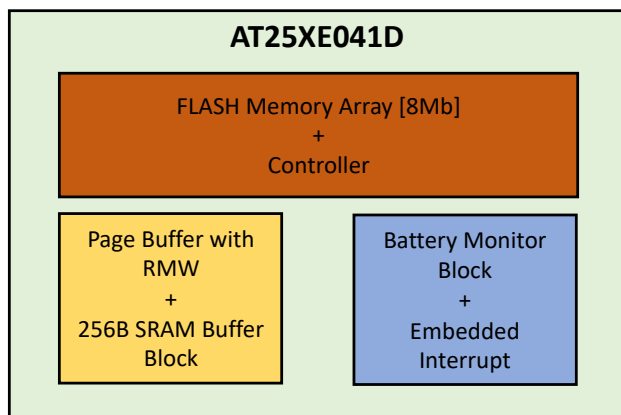


Figure 2: AT25XE041D 256Byte SRAM Page Buffer Block with RMW Feature

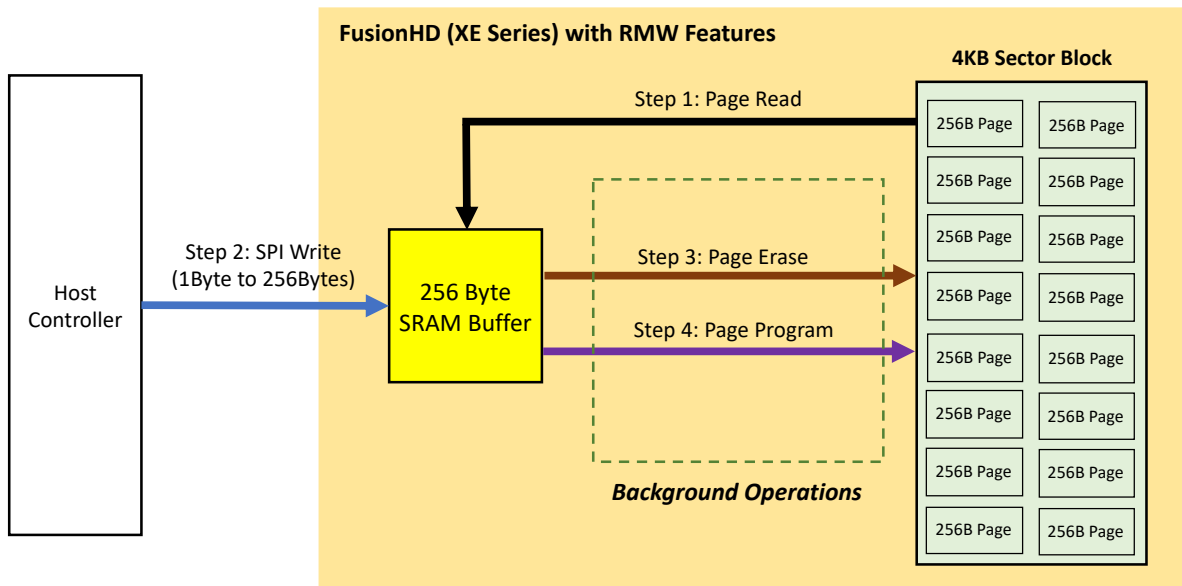
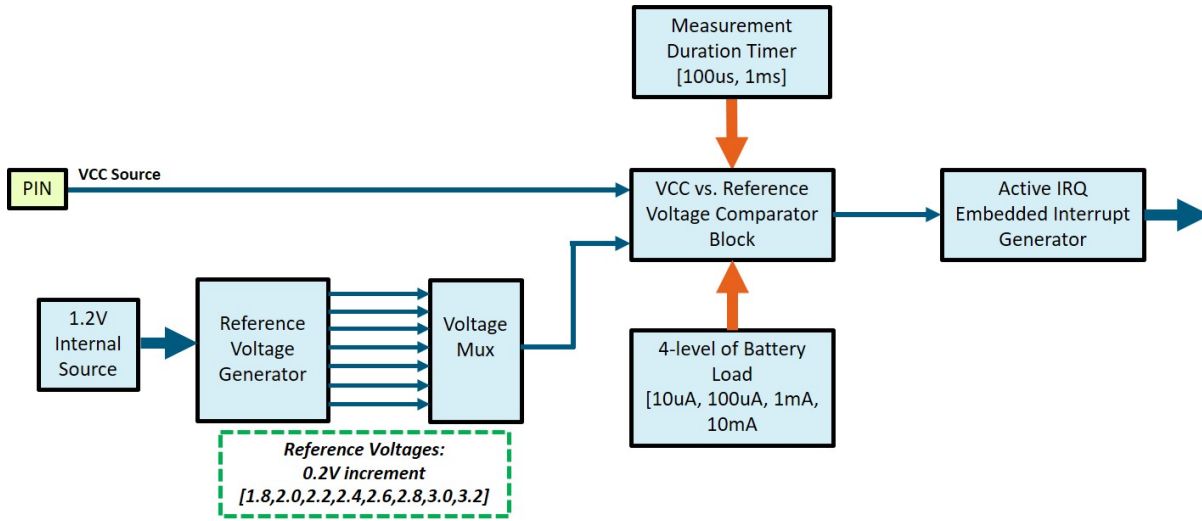


Figure 3: AT25XE041D Battery Monitor Block





## Additional Information

Adesto Technologies Corporation (NASDAQ: IOTS) is a leading provider of innovative application-specific semiconductors and embedded systems for the IoT. The company's technology is used by more than 5,000 customers worldwide who are creating differentiated solutions across industrial, consumer, medical and communications markets. With its growing portfolio of high-value technologies, Adesto is helping its customers usher in the era of the Internet of Things.

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