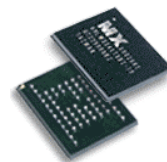# Application Note

Replacing Atmel 45DB161D Serial Flash
with Macronix MX25L1605A Serial Flash

April 27, 2006

Introduction

Macronix offers a family of serial flash (SPI) products from 512Kb to 64Mb densities. This application note explains how the Atmel 45DB161D, 16Mb DataFlash® can be replaced with a similar Macronix MX25L1605A, 16Mb flash product.

There are several compelling reasons to replace the Atmel device with a Macronix part. Speed (performance) and costs are typical factors. For a successful design in, system designers need to know the product feature differences, as well as similarities, of the two devices. This is summarized in the comparison table below.

Comparison between Macronix and Atmel Flash product

Macronix 16Mb and Atmel 16Mb Flash Memory Comparison

Specification	Macronix MX25L1605A	Atmel[*] 45DB161D
Vcc voltage	2.7V – 3.6V	2.7V – 3.6V or 2.5V- 3.6V
Bus Width	1x I/O, SPI compliance	1x I/O, SPI compliance
Erase unit	Equal 4KB/ Equal 64KB	Equal 256B/ Equal 4KB/ Equal 128KB
SPI clock rate	33MHz normal read/ 85MHz fast read	33MHz normal read / 66MHz fast read @ 2.7V
Page Program Buffer	256B	512B or 528B
Erase Performance	-- 4KB- 60ms(typ) 64KB- 1s(typ) Chip (16Mb)- 14s(typ)	256B- 15ms(typ) 4KB- 45ms(typ) 128KB- 1.6s(typ) --
Program Performance	256B- 1.4ms(typ)	512B- 3ms(typ)
Write/Erase cycles (Endurance)	100k	100k
Sector lock down register	NA	Additional sector lock down register (16 bytes)
Sector (block) Protection	1. Area: 1/32, 1/16, 1/8, 1/4, 1/2, all 2. Register: Status register bit2-4 and bit 7	1. Area: sector o and the rest 2. Register: Additional sector protection register (16 bytes)

* The terms used to identify companies and products may be trademarks of their respective owners.

AN 015

Replacing Atmel 45DB161D Serial Flash
with Macronix MX25L1605A Serial Flash

Protection Register (OTP Sector)	NA	128 byte
Read Current	4mA(max.) @ 33MHz	4mA(typ.)/8mA(max.) @ 33MHz
Erase/Program Current	15 mA (max.)	12 mA (typ.)/17mA(max)
Standby current	20uA(max.)	25uA(typ)/ 50uA(max)
Package	8-pin 209mil SOP/ 16-pin 300mil SOP/ 8-SON(8x6mm)	8-pin 209mil SOP/ 28-TSOP/ 8-MLF(6x5mm)

Hardware Considerations

From a hardware perspective, replacing the Atmel 45DB161D DataFlash® with Macronix MX25L1605A is a relatively straightforward task for two reasons: Firstly, the major pin functions are compatible to each other and secondly, it might be feasible to accommodate both footprints in one board area.

The major pin functions (SI, SO, SCLK, CS#) from both suppliers are compatible

Macronix and Atmel pinout compatibility (by pin and function):

Macronix pin(s) and function	Atmel pin(s) and function	Comments
Pin 1: CS#	Pin 4: CS#	Same pin definition and function
Pin 2: SO	Pin 8: SO	Same pin definition and function
Pin 3: WP#	Pin 5: WP#	Similar function
Pin 4: GND	Pin 7: GND	Ground pin
Pin 5: SI	Pin 1: SI	Same pin definition and function
Pin 6: SCLK	Pin 2: SCK	Same function, but different name
Pin 7: HOLD#	Pin 3: RESET#	Different function, but both active low
Pin 8: VCC	Pin 6: VCC	Power supply pin

＊ *Other names and brands are the property of the respective companies.

AN 015

Replacing Atmel 45DB161D Serial Flash
with Macronix MX25L1605A Serial Flash
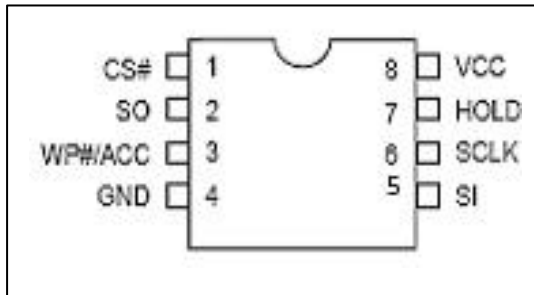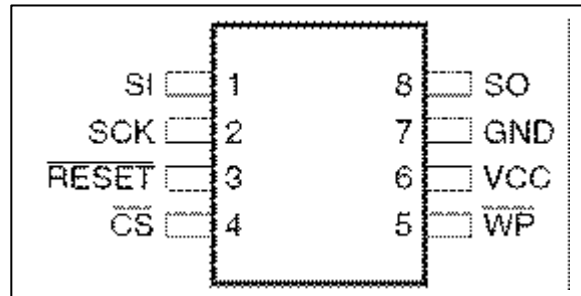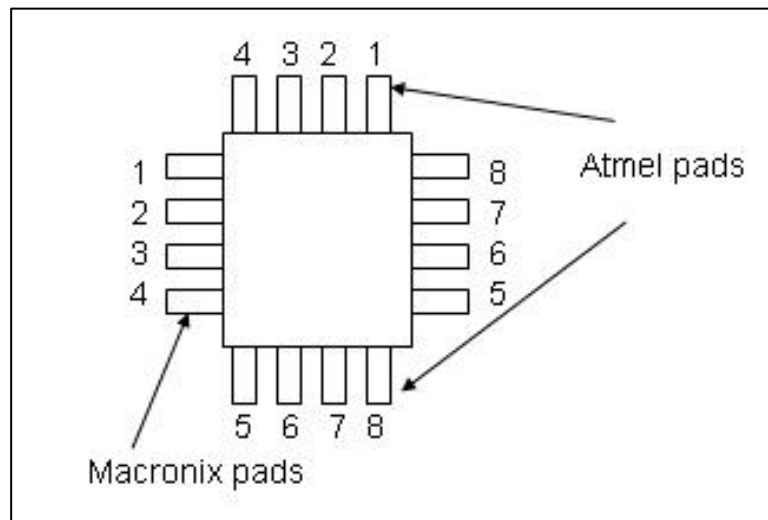

MX25L1605A   AT45DB161D

One possibility of a dual footprint layout is by rotating the Atmel part by 90º and overlaying the footprint on top of a normally positioned Macronix device as shown below. This way, the same PCB board area is maintained.

Dual footprint example – Atmel and Macronix part in the same area

Software Considerations

From a software point of view, both Macronix and Atmel command sets follow the industry standard but each has its own unique command set. The manufacturer and device ID are different between Macronix and Atmel parts and one could make use of the Read ID command (which is common in both parts) to select the appropriate command sets for use with the device. This is shown in the flowchart on page 6.

3

Replacing Atmel 45DB161D Serial Flash
with Macronix MX25L1605A Serial Flash

The main software differences shown below are:

(i)   Manufacturer ID/Device ID

(ii)   Command Instruction

Manufacturer ID and Device ID

Macronix MX25L1605A		Atmel 45DB161D	
Command Cycle (Address/Data)	ID	Command Cycle	ID
9F	Mfr. ID: C2h 2-byte Device ID: 20h and 15h	9F	Mfr. ID: 1Fh Device ID: 26h and 00h and 00h

Command Instruction
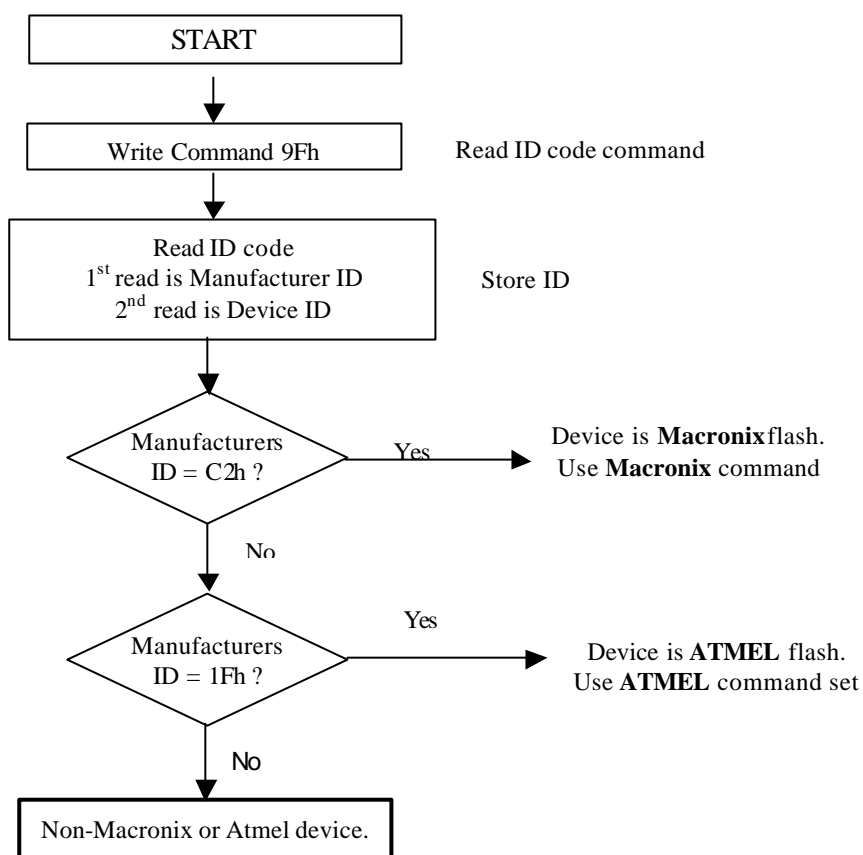
Command Set and Software Compatibility

	Macronix	Atmel
Part Number	MX25L1605A	AT45DB161D
WREN (write Enable)	06 Hex	
WRDI (write disable)	04 Hex	
RDID (read identification)	9F Hex	9F Hex
RDSR (read status register)	05 Hex	**D7 hex**
WRSR (write status register)	01 Hex	
AD (read data)	03 Hex	03 Hex
Fast READ (fast read data)	0B Hex	0B Hex
Page Erase	--	**81 hex**
SE (4KBSector Erase)	20 Hex	**4KB block erase: 50 Hex**
SE (32KB Sector Erase)	--	
Block (64KB) Erase	52 or D8 Hex	**128KB block erase: 7C Hex**
CE (Chip Erase)	60 or C7 Hex	
PP(Page Program)	02 Hex	
DP (Deep Power Down)	B9 Hex	B9 Hex
Release from Deep Power-down (RDP) and Device ID	AB Hex	AB Hex
RES(Read Electronic Id)	AB Hex	
REMS(Read Manufacturer Electronic Id)	90 Hex	

Replacing Atmel 45DB161D Serial Flash
with Macronix MX25L1605A Serial Flash

Atmel unique command set:

For read:	Command
main memory page read	D2 hex
continuous array read	E8 hex
buffer 1 read(low freq.)	D1 hex
buffer 2 read(low freq.)	D3 hex
buffer 1 read	D4 hex
buffer 2 read	D6 hex
For write	**Command**
buffer 1 write	84 hex
buffer 2 write	87 hex
buffer 1 to main memory program w. erase	83 hex
buffer 2 to main memory program w. erase	86 hex
buffer 1 to main memory program w/o. erase	88 hex
buffer 2 to main memory program w/o. erase	89 hex
main memory pgm thru buffer 1	82 hex
main memory pgm thru buffer 2	85 hex
For Protection/Security	**Command**
Enable Sector Protection	3DH+2AH+7F+A9H
Disable Sector Protection	3DH+2AH+7F+9AH
Erase Sector Protection Register	3DH+2AH+7F+CFH
Program Sector Protection Register	3DH+2AH+7F+FCH
Read Sector Protection Register	32H
Sector Lockdown	3DH+2AH+7F+30H
Read Sector Lockdown Register	35H
Program Security Register	9BH+00H+00H+00H
Read Security Register	77H
Additional Commands	**Command**
Main Memory page to buffer 1 transfer	53H
Main Memory page to buffer 2 transfer	50H
Main Memory page to buffer 1 compare	60H
Main Memory page to buffer 2 compare	61H
Auto page rewrite through buffer 1	58H
Auto page rewrite through buffer 2	59H

AN 015

Replacing Atmel 45DB161D Serial Flash
with Macronix MX25L1605A Serial Flash

```
                        ┌─────────────────────┐
                        │        START        │
                        └─────────────────────┘
                                  │
                                  ▼
                        ┌─────────────────────┐
                        │  Write Command 9Fh  │        Read ID code command
                        └─────────────────────┘
                                  │
                                  ▼
                        ┌─────────────────────┐
                        │     Read ID code    │
                        │ 1ˢᵗ read is Manufacturer ID │   Store ID
                        │ 2ⁿᵈ read is Device ID │
                        └─────────────────────┘
```

Read ID code
1st read is Manufacturer ID
2nd read is Device ID

Manufacturers
ID = C2h ?   Yes → Device is **Macronix** flash. Use **Macronix** command

No

Manufacturers
ID = 1Fh ?   Yes → Device is **ATMEL** flash. Use **ATMEL** command set

No

Non-Macronix or Atmel device.

Multi-Source algorithm flowchart

6

**Replacing Atmel 45DB161D Serial Flash
with Macronix MX25L1605A Serial Flash**

Conclusion

For hardware considerations, in order to minimize board area, it might be feasible that the pads for both Atmel and Macronix parts overlay on top of each other rotated by 90º . In the case of software, the appropriate command set can be selected by screening for the manufacturer and device IDs. For both cases, a multi-source strategy is provided for the system designer with the aim that this will ease procurement effort during a tight market condition.

 In the following appendix, numerous examples of sample code for various device operations are provided to the designer.

For the 16Mb serial Flash, although Macronix does not offer the same pinout that Atmel uses, Macronix does provide industry compatible parts. Replacing Atmel serial Flash with Macronix serial Flash is not a trivial matter and does require some effort on the part of the user. However, given the definite speed advantage of the Macronix product offering, applications that require higher speeds will experience noticeable difference in performance.

For additional technical support, please contact the Macronix sales office in your local area.

AN 015

Replacing Atmel 45DB161D Serial Flash
with Macronix MX25L1605A Serial Flash

Appendix: Sample code

Read_ID_Op()
```
{
      CS# low;
      Write Read ID command = 0x9F;
      MfrID= read flash at 1st;          // read manufacturer ID
      DevID1= read flash at 2nd;         // read memory type ID
      DevID2= read flash at 3rd;         // read memory density ID
      CS # high;
}
```

Sector_Erase_Op()
```
{
 eraseOkFlag = TRUE;                  /* clear the erase ok flag to be TRUE */

 CS# low;
 Write WREN command = 0x06;      // Setting Write Enable Latch bit
 CS# high;

 CS# low;
  Write Block Erase command = 0x26;   // 4KB Sector-Erase command
  Write Block address = AD1;       // AD1 = A23 – A16;
  Write Block address = AD2;       // AD2 = A15 – A8;
  Write Block address = AD3;       // AD3 = A7 – A0
 CS# high;

  CS# low;
  Write Read Status command = 0x05;

  While(1)                           // set a loop to check the flash's Status Register till ready or time out
  {
      statusReg = read status of flash;  // read status from flash
      if( (statusReg & 0x01) == 0x00)  // if the Q0(write in progress bit) == '0' is ready or '1' busy
        break;
      else if( time-out)
      {
        set eraseOkFlag = FALSE;
        break;
      }
  }
  CS# high;
 return (eraseOkFlag);                 /* report the final result to main program */
}                                      /* end of Sector_erase_Op */
```

8

Replacing Atmel 45DB161D Serial Flash
with Macronix MX25L1605A Serial Flash

Block_Erase_Op()
```
{
 eraseOkFlag = TRUE;                    /* clear the erase ok flag to be TRUE */

 CS# low;
 Write WREN command = 0x06;     // Setting Write Enable Latch bit
 CS# high;

 CS# low;
  Write Block Erase command = 0xD8 or 0x52;  // 64KB Block-Erase (both command 0x52/0xd8 are accepted)
  Write Block address = AD1;      // AD1 = A23 – A16;
  Write Block address = AD2;      // AD2 = A15 – A8;
  Write Block address = AD3;      // AD3 = A7 – A0
  CS# high;

  CS# low;
  Write Read Status command = 0x05;

  While(1)                        // set a loop to check the flash's Status Register till ready or time out
  {
      statusReg = read status of flash;  // read status from flash
      if( (statusReg & 0x01) == 0x00)  // if the Q0(write in progress bit) == '0' is ready or '1' busy
        break;
      else if( time-out)
      {
        set eraseOkFlag = FALSE;
        break;
      }
  }
  CS# high;
 return (eraseOkFlag);                  /* report the final result to main program */
}                                        /* end of Block_erase_Op */
```

9

Page_Program_Op()

```
{
  int i;
 ProgramOkFlag = TRUE;              // clear the program ok flag to be TRUE

  CS# low;
 Write WREN command = 0x06;     // Setting Write Enable Latch bit
 CS# high;

  CS# low;
  Write Page Program command = 0x02;
  Write Block address = AD1;      // AD1 = A23 – A16;
  Write Block address = AD2;      // AD2 = A15 – A8;
  Write Block address = AD3;      // AD3 = A7 – A0

  For (i=0; i<256 ; i++)                  // set a loop to down load whole page data into flash's buffer
  {                    // the page number is 256 bytes
    write data = WDi;                // WDi stands for write data 0 ~ 255 bytes
  }
  CS# high;

  CS# low;
  Write Read Status command = 0x05;

  While(1)               // set a loop to check the flash's Status Register till ready or time out
  {
     statusReg = read status of flash;    // read status from flash
     if( (statusReg & 0x01) == 0x00)   // If the Q0(write in progress bit) == '0' is ready or '1' busy
       break;
     else if( time-out )
     {
       set ProgramOkFlag = FALSE;
       break;
     }
  }
  CS# high;

 return (ProgramOkFlag);                    /* report the final result to main program */
}                                   /* end of Program_Op */
```

10

Replacing Atmel 45DB161D Serial Flash
with Macronix MX25L1605A Serial Flash

Chip_Erase_ Op()
```
{
 eraseOkFlag = TRUE;                 /* clear the erase ok flag to be TRUE */

  CS# low;
 Write WREN command = 0x06;         // Setting Write Enable Latch bit
 CS# high;

 CS# low;
  Write Chip Erase command = 0x60 or 0xC7;
  CS# high;

  CS# low;
  Write Read Status command = 0x05;

  While(1)                          // set a loop to check the flash's Status Register till ready or time out
  {
     statusReg = read status of flash;   // read status from flash
     if( (statusReg & 0x01) == 0x00)     // If the Q 0(write in progress bit) == '0' is ready or '1' busy
      break;
     else if( time-out )
     {
       set eraseOkFlag = FALSE;
       break;
     }
  }
  CS# high;

 return (eraseOkFlag);              /* report the final result to main program */
}                                   /* end of Chip_erase_Op */
```

11

AN 015

Replacing Atmel 45DB161D Serial Flash
with Macronix MX25L1605A Serial Flash

Read_Op( )
```
{
  CS# low;
  Write Read Array comma nd = 0x03;
  Write Sector address = AD1;      /* AD1 = A23 – A16 */
  Write Sector address = AD2;      /* AD2 = A15 – A8; */
  Write Sector address = AD3;      /* AD3 = A 7 – A0; */

  For (i=0; i<n ; i++)             // set a loop to read data into flash's buffer
  {                               // n bytes read out until /CS goes high
    array_data = read flash;
  }
  CS# high;
}
```

Fast_Read_Op( )
```
{
  CS# low;
  Write Read Array command = 0x0B;
  Write Sector address = AD1;      /* AD1 = A23 – A16 */
  Write Sector address = AD2;      /* AD2 = A15 – A8; */
  Write Sector address = AD3;      /* AD3 = A 7 – A0; */
  Write dummy address = data;

  For (i=0; i<n ; i++)             // set a loop to read data into flash's buffer
  {                               // n bytes read out until /CS goes high
    array_data = read flash;
  }
  CS# high;
}
```

AN 015