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Research Article

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Flash Memory Design

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Abstract

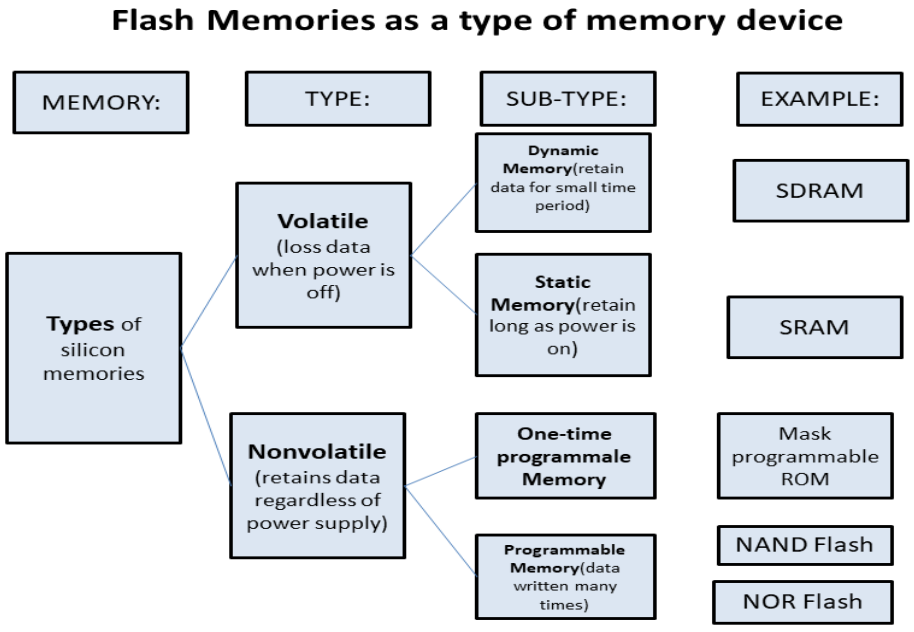
In this paper, I introduce a new design for Flash Memory Device. In this design, an attempt is made to use the existing ICs of the market.

Keywords: Memory, Nonvolatile, Flash Memory, I/O, Address Logic, Control Logic

1. Introduction

In this design, a basic design for a named flash Memory is presented based on the existing and manufactured ICs. The Micron company has produced a variety of memories, which I will mention in this article one of the ICs. At first the specification of Flash Memories will be introduced and then structure of a nominal Flash will be,

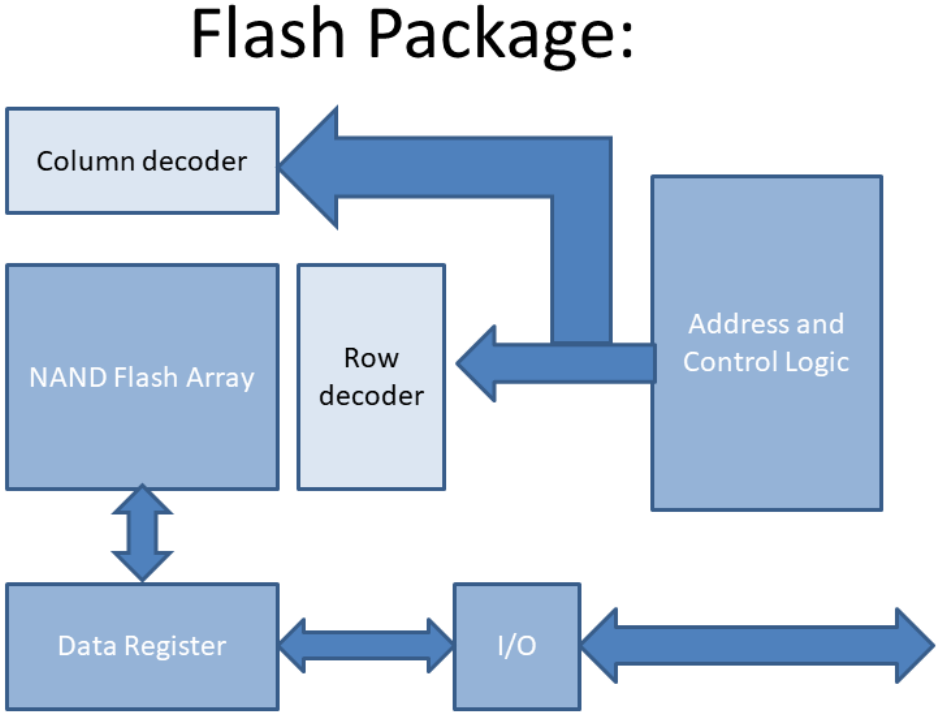
• Different Kinds of Memories



In this chart, you can see a flash memory is a nonvolatile memory that is programmable means it can be written many times in 2 kind categories: NAND and NOR architecture [1-4].

• Architecture

Below, the architecture of a memory revelation is depicted. As you can see, in addition to memory design, we need a controller and the right input/output, as well as a register.



• Hardware

For hardware design, the following ICs are mentioned, which are related to the products of several companies.

In below, it will be introduced a Flash memory from Micron Chip Company. This company has produced flash memory IC toward 128GB .

• QLED NAND FLASH 16GB: Micron Chip Manufacture

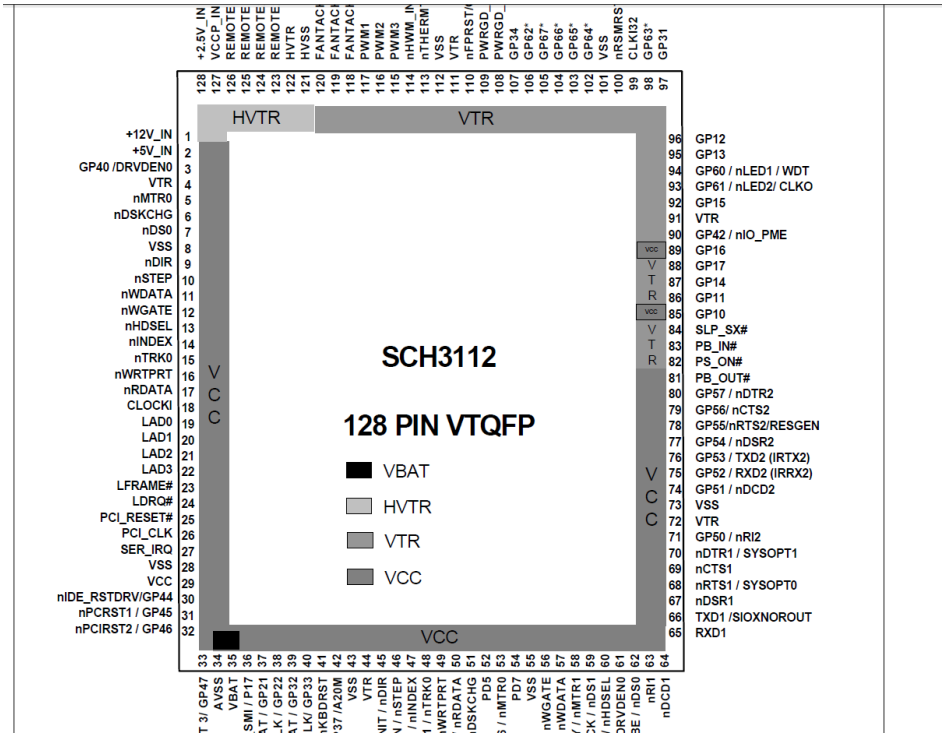
Details:

I/O Voltage	1.2V
Operating Temp	0C to +70C
Component Density	16Tb

• Part Spec For QLC NAND Flash Memory PART MT29F16T08GWLDHD8-T:D

Component Density	16Tb
MT/s	NSR
Operating Temp	OC to +70C
Technology	MAS FLASH
Family	NAND FLASH
Part Status Code	Contact Factory
PLP	NO
Pin Count	154-ball
Package	LFBGA
I/O Voltage	1.2 v
Package Type	GREEN
Number of Components	16
Bus Width	X8
Component Config	2T*8
Speed	800MHz
Capacity	16Tb

• Microchip Manufacture
SCH3112/SCH3114/SCH3116: I/O CONTROLLER
LPC IO with 8042 KBC, Reset Generation, HWM and Multiple Serial Ports



Programming this I/O, can be designed for work with this memory.

• Software
Below, a

sample for Software Driver has com.

```
//Software Driver

//SST39VF6401B/SST39VF6402B
//64 Mbit Multi-Purpose Flash (MPF+)
//
//June 2005
//
//ABOUT THE SOFTWARE
//
//This application note provides a software driver example for 39VF6401B/39VF6402B
//64 Mbit Multi-Purpose Flash (MPF+) that can be used in any microprocessor based
//system.
//
//The SST39VF6401B supports bottom boot block protection, and the SST39VF6402B
//supports top boot block protection. The boot block memory area is protected when
//WP# is low and unprotected when WP# is high.
//
//Software driver example routines provided in this document utilize high-level
//"C" programming language for broad platform support. In many cases, software
//driver routines can be inserted "as is" into the main body of code being
//developed by the system software developers. Extensive comments are included
//in each routine to describe the function of each routine. The software driver
//routines in "C" can be used with many microprocessors and microcontrollers.
//
//ABOUT THE SST39VF6401B/SST39VF6402B
//
//Companion product datasheet for 39VF6401/39VF6402 should be reviewed in
//conjunction with this application note for a complete understanding of the device.
//
//The C code in this document contains the following routines, which are listed
//in this order:
//
//Name                    Function
//-------------------------------------------------------------------
```

```
//Check_SST_39VF640XB      Check manufacturer and device ID
//CFI_Query                CFI Query Entry/Exit command sequence
//SecID_Query                 SecID Query Entry/Exit command sequence
//Erase_One_Sector         Erase a sector of 2048 words
//Erase_One_Block          Erase a block of 32K words
//Erase_Entire_Chip        Erase the contents of the entire chip
//Program_One_Word         Alter data in one word
//Program_One_Sector       Alter data in 2048-word sector
//Program_One_Block        Alter data in 32K-word block
//SecID_Lock_StatusCheck the Lock Status of Security ID segment
//User_SecID_Word_Program Write data into User Security ID Segment
//User_SecID_Lock_Out        Lock out the User Security ID Segment
//Erase_Suspend              Suspend Sector/Block Erase operation
//Erase_Resume               Resume Sector/Block Erase operation
//Check_Toggle_Ready       End of internal program or erase detection using
//                         Toggle bit
//Check_Data_Polling       End of internal program or erase detection using
//                         Data# polling
//
//"C" LANGUAGE DRIVERS


/*************************************************************************/
/* Copyright Silicon Storage Technology, Inc. (SST), 1994-2005         */
/* Example "C" language Driver of 39VF640X 64 Mbit MPF+ Device            */
/* Verified by Yonglin, Silicon Storage Technology, Inc.                        */
/*                                                                       */
/* Revision 1.0, June 17, 2005                                           */
/*                                                                       */
/* This file requires these external "timing"  routines:                 */
/*                                                                       */
/*      1.)  Delay_10_Micro_Seconds                                      */
/*      2.)  Delay_20_Micro_Seconds                                      */
/*      3.)  Delay_150_Nano_Seconds                                      */
/*      4.)  Delay_25_Milli_Seconds                                      */
/*      5.)  Delay_50_Milli_Seconds                                      */
/*************************************************************************/

#define FALSE                   0

#define TRUE                    1

#define SECTOR_SIZE             2048    // Must be 2048 words for 39VF640XB
#define BLOCK_SIZE              32768   // Must be 32K words for 39VF640XB

#define SST_ID                  0x00BF  // SST Manufacturer's ID code
#define SST_39VF6401B            0x236D  // SST39VF6401B device code
#define SST_39VF6402B            0x236C  // SST39VF6402B device code

typedef unsigned char           BYTE;     // BYTE is 8-bit in length
//typedef unsigned int            WORD;     // WORD is 16-bit in length
typedef unsigned short            WORD;     // WORD is 16-bit in length, ARM
//typedef unsigned long int       Uint32;   // Uint32 is 32-bit in length
typedef unsigned int       Uint32;   // Uint32 is 32-bit in length, ARM

//Uint32 system_base = 0x4000000;  // 4GByte System Memory Address.

#define system_base  0x4000000
         // This sample code uses 0x4000000 as the system_base address in ARM system.
         // The user should modify this address accordingly.

//#define sysAddress(offset) ((volatile WORD *)(system_base + offset))
#define sysAddress(offset) ((volatile WORD *)(system_base + (((WORD)offset)<<1))) //For ARM CPU


#define MAX_TIMEOUT0x07FFFFFF   // A ceiling constant used by Check_Toggle_
         // Ready() and Check_Data_Polling().
         // The user should modify this constant accordingly.

// ----------------------------------------------------------------------
//                      EXTERNAL ROUTINES
// ----------------------------------------------------------------------
extern void     Delay_10_Micro_Seconds();
extern void     Delay_20_Micro_Seconds();
extern void     Delay_150_Nano_Seconds();
extern void     Delay_25_Milli_Seconds();
extern void     Delay_50_Milli_Seconds();
```

```
// ---------------------------------------------------------------------

int Check_SST_39VF640XB(void);
void CFI_Query(WORD*);
void SecID_Query(WORD*, WORD*);
int Erase_One_Sector(Uint32);
int Erase_One_Block (Uint32);
int Erase_Entire_Chip(void);
int Program_One_Word (WORD*, Uint32);
int Program_One_Sector (WORD*, Uint32);
int Program_One_Block (WORD *Src, Uint32 Dst);
int SecID_Lock_Status(void);
int User_SecID_Word_Program (WORD*, WORD*, int);
void User_SecID_Lock_Out (void);
void Erase_Suspend (void);
void Erase_Resume (void);
int Check_Toggle_Ready (Uint32);
int Check_Data_Polling (Uint32, WORD);


/*********************************************************************/
/* PROCEDURE:   Check_SST_39VF640XB                                  */
/*                                                                   */
/* This procedure decides whether a physical hardware device has a   */
/* SST39VF640XB 64 Mbit MPF+ Device installed or not.                    */
/*                                                                   */
/* Input:                                                            */
/*          None                                                     */
/*                                                                   */
/* Output:                                                           */
/*          return TRUE:  indicates a SST39VF640XB                   */

/*          return FALSE: indicates not a SST39VF640XB               */
/*********************************************************************/
int Check_SST_39VF640XB(void)
{
    WORD SST_id1;
    WORD SST_id2;
    int  ReturnStatus;


    //  Issue the Software Product ID code to 39VF640XB
    *sysAddress(0x555) = 0x00AA;  // write data 0x00AA to device addr 0x555

    *sysAddress(0x2AA) = 0x0055;  // write data 0x0055 to device addr 0x2AA

    *sysAddress(0x555) = 0x0090;  // write data 0x0090 to device addr 0x555

    Delay_150_Nano_Seconds();   // Tida Max 150ns for 39VF640XB

    // Read the product ID from 39VF640XB
    SST_id1  = *sysAddress(0x0000);   // get first ID byte
    SST_id2  = *sysAddress(0x0001);   // get second ID byte

    // ------------------------------------------------------------
    // Determine whether there is a SST 39VF6401B installed or not
    // use the following code:

    //if ((SST_id1 == SST_ID) && (SST_id2 == SST_39VF6401B))
    //        ReturnStatus = TRUE;
    //else
    //        ReturnStatus = FALSE;
    // ------------------------------------------------------------
    // Or determine whether there is a SST 39VF6402B installed or not
    // use the following code:

    if ((SST_id1 == SST_ID) && (SST_id2 == SST_39VF6402B))
            ReturnStatus = TRUE;
    else
            ReturnStatus = FALSE;
    // ------------------------------------------------------------

    // Issue the Software Product ID Exit code, thus returning the
    // 39VF640X to the normal operation.
    *sysAddress(0x555) = 0x00AA;  // write data 0x00AA to device addr 0x555
    *sysAddress(0x2AA) = 0x0055;  // write data 0x0055 to device addr 0x2AA
    *sysAddress(0x555) = 0x00F0;  // write data 0x00F0 to device addr 0x555
    Delay_150_Nano_Seconds();   // Tida Max 150ns for 39VF640XB
```

```
    return (ReturnStatus);
}


/*************************************************************************/
/* PROCEDURE:   CFI_Query                                                */
/*                                                                       */
/* This procedure should be used to query for CFI information            */
/*                                                                       */
/* Input:                                                                */
/*          Src    Source address to store CFI_Query data string             */
/*                                                                       */
/* Output:                                                               */
/*          None                                                         */
/*************************************************************************/
void CFI_Query(WORD *Src)
{
    WORD index;
    //  Issue the CFI Query entry code to 39VF640X
    *sysAddress(0x555) = 0x00AA;  // write data 0x00AA to device addr 0x555
    *sysAddress(0x2AA) = 0x0055;  // write data 0x0055 to device addr 0x2AA
    *sysAddress(0x555) = 0x0098;  // write data 0x0098 to device addr 0x555
    Delay_150_Nano_Seconds();     // insert delay time = Tida
    // ----------------------------------------------------------
    //  Perform all CFI operations here:
    //  CFI_Query_address is from 0010H--0034H

    for ( index = 0x0010; index <= 0x0034; index++)
    {
          *Src = *sysAddress(index);
         ++Src;
         // CFI query data is stored in user-defined memory space.
    }
    // ----------------------------------------------------------

        // Issue the CFI Exit code thus returning the 39VF640X
        // to the read operating mode

    *sysAddress(0x555) = 0x00AA;  // write data 0x00AA to device addr 0x555
    *sysAddress(0x2AA) = 0x0055;  // write data 0x0055 to device addr 0x2AA
    *sysAddress(0x555) = 0x00F0;  // write data 0x00F0 to device addr 0x555
    Delay_150_Nano_Seconds();     // insert delay time = Tida
}


/*************************************************************************/
/* PROCEDURE:   SecID_Query                                              */
/*                                                                       */
/* This procedure should be used to query for Security ID information.   */
/*                                                                       */
/* Input:                                                                */
/*          SST_SecID       Source address to store SST SecID string         */
/*          User_SecID      Source address to store User SecID string        */
/*                                                                       */
/* Output:                                                               */
/*          None                                                         */
/*************************************************************************/
void SecID_Query(WORD *SST_SecID, WORD *User_SecID)
{
    WORD index;
         //  Issue the SecID Entry code to 39VF640X
    *sysAddress(0x555) = 0x00AA;  // write data 0x00AA to device addr 0x555
    *sysAddress(0x2AA) = 0x0055;  // write data 0x0055 to device addr 0x2AA
    *sysAddress(0x555) = 0x0088;  // write data 0x0088 to device addr 0x555
    Delay_150_Nano_Seconds();      // insert delay time = Tida

         //  Perform all Security ID operations here:
         //        SST programmed segment is from address 000000H--000007H,
         //        User programmed segment is from address 000010H--000017H.

    for (index = 0x0000; index <= 0x0007; index++)
    {
          *SST_SecID = *sysAddress(index);
         ++SST_SecID;
         *User_SecID = *sysAddress(index+0x0010);
         ++User_SecID;
         // Security query data is stored in user-defined memory space.
    }
```

```
        // Issue the Sec ID Exit code thus returning the 39VF640X
        // to the read operating mode
    *sysAddress(0x555) = 0x00AA;  // write data 0x00AA to device addr 0x555
    *sysAddress(0x2AA) = 0x0055;  // write data 0x0055 to device addr 0x2AA
    *sysAddress(0x555) = 0x00F0;  // write data 0x00F0 to device addr 0x555
    Delay_150_Nano_Seconds();      // insert delay time = Tida
}


/*********************************************************************/
/* PROCEDURE:   Erase_One_Sector                                     */
/*                                                                   */
/* This procedure can be used to erase a total of 2048 words.        */
/*                                                                   */
/* Input:                                                            */
/*      Dst     DESTINATION address where the erase operation starts */

/*                                                                   */
/* Output:                                                           */
/*          return TRUE:  indicates success in sector-erase          */
/*          return FALSE: indicates failure in sector-erase          */
/*********************************************************************/
int Erase_One_Sector(Uint32 Dst)
{
         Uint32 DestBuf = Dst;
   int  ReturnStatus;

         //  Issue the Sector Erase command to 39VF640X
         *sysAddress(0x555) = 0x00AA;     // write data 0x00AA to device addr 0x555
         *sysAddress(0x2AA) = 0x0055;     // write data 0x0055 to device addr 0x2AA
         *sysAddress(0x555) = 0x0080;     // write data 0x0080 to device addr 0x555
         *sysAddress(0x555) = 0x00AA;     // write data 0x00AA to device addr 0x555
         *sysAddress(0x2AA) = 0x0055;     // write data 0x0055 to device addr 0x2AA
         *sysAddress(DestBuf) = 0x0050;    // write data 0x0050 to device sector addr

   ReturnStatus = Check_Toggle_Ready(DestBuf);  // wait for TOGGLE bit ready

   return ReturnStatus;
}


/*********************************************************************/
/* PROCEDURE:   Erase_One_Block                                      */
/*                                                                   */
/* This procedure can be used to erase a total of 32K words.         */
/*                                                                   */
/* Input:                                                            */
/*      Dst     DESTINATION address where the erase operation starts */
/*                                                                   */
/* Output:                                                           */
/*          return TRUE:  indicates success in block-erase           */
/*          return FALSE: indicates failure in block-erase           */
/*********************************************************************/
int Erase_One_Block (Uint32 Dst)
{
   Uint32 DestBuf = Dst;
   int ReturnStatus;

    //  Issue the Block Erase command to 39VF640X
         *sysAddress(0x555) = 0x00AA;     // write data 0x00AA to device addr 0x555
         *sysAddress(0x2AA) = 0x0055;     // write data 0x0055 to device addr 0x2AA
         *sysAddress(0x555) = 0x0080;     // write data 0x0080 to device addr 0x555
         *sysAddress(0x555) = 0x00AA;     // write data 0x00AA to device addr 0x555
         *sysAddress(0x2AA) = 0x0055;     // write data 0x0055 to device addr 0x2AA
         *sysAddress(DestBuf) = 0x0030;    // write data 0x0030 to device sector addr

   ReturnStatus = Check_Toggle_Ready(DestBuf);           // wait for TOGGLE bit ready

   return ReturnStatus;
}


/*********************************************************************/
/* PROCEDURE:   Erase_Entire_Chip                                    */
/*                                                                   */
/* This procedure can be used to erase the entire chip.              */
/*                                                                   */
/* Input:                                                            */
/*      NONE                                                         */
/*                                                                   */
```

```
/* Output:                                                              */
/*      NONE                                                            */
/**********************************************************************/
int Erase_Entire_Chip(void)
{
   //  Issue the Chip Erase command to 39VF640X
         *sysAddress(0x555) = 0x00AA;     // write data 0x00AA to device addr 0x555
         *sysAddress(0x2AA) = 0x0055;     // write data 0x0055 to device addr 0x2AA

         *sysAddress(0x555) = 0x0080;     // write data 0x0080 to device addr 0x555
         *sysAddress(0x555) = 0x00AA;     // write data 0x00AA to device addr 0x555
         *sysAddress(0x2AA) = 0x0055;     // write data 0x0055 to device addr 0x2AA
         *sysAddress(0x555) = 0x0010;     // write data 0x0010 to device addr 0x555

   //Delay_50_Milli_Seconds();        // Delay Tsce time
   if (Check_Data_Polling (0,0xFFFF))
         return TRUE;
   else
    return FALSE;
}


/**********************************************************************/
/* PROCEDURE:   Program_One_Word                                       */
/*                                                                     */
/* This procedure can be used to program ONE word of data to the       */
/* 39VF640X.                                                           */
/*                                                                     */
/* NOTE:  It is necessary to first erase the sector containing the     */
/*        word to be programmed.                                  */
/*                                                                     */
/* Input:                                                              */
/*           SrcWord The WORD which will be written to the 39VF640XB   */
/*           Dst     DESTINATION address which will be written with the */
/*                   data passed in from Src                           */
/*                                                                     */
/* Output:                                                             */
/*          return TRUE:  indicates success in word-program            */
/*          return FALSE: indicates failure in word-program            */
/**********************************************************************/
int Program_One_Word (WORD *SrcWord,   Uint32 Dst)
{
    Uint32 DestBuf = Dst;
    WORD *SourceBuf = SrcWord;
    int ReturnStatus;

    *sysAddress(0x555) = 0x00AA; // write data 0x00AA to device addr 0x555
    *sysAddress(0x2AA) = 0x0055; // write data 0x0055 to device addr 0x2AA
    *sysAddress(0x555) = 0x00A0; // write data 0x00A0 to device addr 0x555
    *sysAddress(DestBuf) = *SourceBuf; // transfer the WORD to destination

    ReturnStatus = Check_Toggle_Ready(DestBuf); // wait for TOGGLE bit ready

    return ReturnStatus;
}
/**********************************************************************/
/* PROCEDURE:   Program_One_Sector                                     */
/*                                                                     */
/* This procedure can be used to program a total of 2048 words of data  */
/* to the SST39VF640X.                                                 */
/*                                                                     */
/* NOTES: 1. It is necessary to first erase the sector before the  */
/*        programming.                                                    */
/*        2. This sample code assumes the destination address passed      */
/*        from the calling function is the starting address of the */
/*        sector.                                                         */
/*                                                                     */
/* Input:                                                              */
/*           Src     SOURCE address containing the data which will be   */
/*                   written to the 39VF640XB                          */
/*           Dst     DESTINATION address which will be written with the */
/*                   data passed in from Src                           */
/*                                                                     */
/* Output:                                                             */
/*          return TRUE:  indicates success in sector-program          */
/*          return FALSE: indicates failure in sector-program          */
/**********************************************************************/
int Program_One_Sector (WORD *Src, Uint32 Dst)
```

```
{

    WORD *SourceBuf;
    Uint32 DestBuf;
    int Index, ReturnStatus;

    SourceBuf = Src;
    DestBuf = Dst;
    ReturnStatus = Erase_One_Sector(DestBuf);   // erase the sector first
    if (!ReturnStatus)
          return ReturnStatus;

    for (Index = 0; Index < SECTOR_SIZE; Index++)
    {     // transfer data from source to destination
          ReturnStatus = Program_One_Word( SourceBuf, DestBuf);
          ++DestBuf;
          ++SourceBuf;

        if (!ReturnStatus)
            return ReturnStatus;
    }

    return ReturnStatus;
}


/*************************************************************************/
/* PROCEDURE:   Program_One_Block                                        */
/*                                                                       */
/* This procedure can be used to program a total of 32k words of data   */
/* to the SST39VF640XB.                                                   */
/*                                                                       */
/* NOTES: 1. It is necessary to first erase the block before the   */
/*        programming.                                                        */
/*        2. This sample code assumes the destination address passed        */
/*        from the calling function is the starting address of the */
/*        block.                                                             */
/*                                                                                  */
/* Input:                                                                */
/*           Src     SOURCE address containing the data which will be   */
/*                   written to the 39VF640X                            */
/*           Dst     DESTINATION address which will be written with the */
/*                   data passed in from Src                            */
/*                                                                       */
/* Output:                                                               */
/*          return TRUE:  indicates success in block-program            */
/*          return FALSE: indicates failure in block-program            */
/*************************************************************************/
int Program_One_Block (WORD *Src, Uint32 Dst)
{
    WORD *SourceBuf;
    Uint32 DestBuf;
    int Index, ReturnStatus;

    SourceBuf = Src;
    DestBuf = Dst;
    ReturnStatus = Erase_One_Block(DestBuf);    // erase the block first
    if (!ReturnStatus)
          return ReturnStatus;

    for (Index = 0; Index < BLOCK_SIZE; Index++)
    {     // transfer data from source to destination
          ReturnStatus = Program_One_Word( SourceBuf, DestBuf);
          ++DestBuf;
          ++SourceBuf;

        if (!ReturnStatus)
          return ReturnStatus;
    }

    return ReturnStatus;
}


/*************************************************************************/
/* PROCEDURE:   SecID_Lock_Status                                        */
/*                                                                       */
/* This procedure should be used to check the Lock Status of SecID */
```

```
/*                                                                      */
/* Input:                                                               */
/*          None                                                        */
/*                                                                      */
/* Output:                                                              */
/*          return TRUE:  indicates SecID is Locked                          */
/*          return FALSE: indicates SecID is Unlocked              */
/************************************************************************/
int SecID_Lock_Status(void)
{
    WORD SecID_Status;

         //  Issue the Sec ID Entry code to 39VF640X
    *sysAddress(0x555) = 0x00AA;  // write data 0x00AA to device addr 0x555
    *sysAddress(0x2AA) = 0x0055;  // write data 0x0055 to device addr 0x2AA
    *sysAddress(0x555) = 0x0088;  // write data 0x0088 to device addr 0x555
    Delay_150_Nano_Seconds();      // insert delay time = Tida

         //  Read Lock Status of SecID segment
    SecID_Status = *sysAddress(0x00FF);
    SecID_Status &= 0x0008; // Unlocked: DQ3=1; Locked: DQ3=0

        // Issue the Sec ID Exit code thus returning the 39VF640X
        // to the read operating mode
    *sysAddress(0x555) = 0x00AA;  // write data 0x00AA to device addr 0x555
    *sysAddress(0x2AA) = 0x0055;  // write data 0x0055 to device addr 0x2AA
    *sysAddress(0x555) = 0x00F0;  // write data 0x00F0 to device addr 0x555
    Delay_150_Nano_Seconds();      // insert delay time = Tida

    if (!SecID_Status)
         return TRUE;                    // SecID segment is Locked

    return FALSE;                        // SecID segment is Unlocked
}


/************************************************************************/
/* PROCEDURE:   User_SecID_Word_Program                                 */
/*                                                                      */
/* This procedure can be used to program data into the User SecID       */
/* segment (from 000010H--000017H) in 39VF640XB.                            */
/*                                                                      */
/* NOTE:  1. It's recommended to lock out the SecID segment after the       */
/*          completion of program.                                      */
/*          2. There's no way to unlock the SecID segment once it's*/
/*          locked.                                                     */
/*                                                                      */
/* Input:                                                               */
/*           SrcWord        Source address to fetch data                    */
/*           Dst   Destination address to write data              */
/*           length          number of word needs to be programmed           */
/*                                                                      */
/* Output:                                                              */
/*          return TRUE:  indicates SecID program is successful         */
/*          return FALSE: indicates SecID program is failed or SecID    */
/*                           is locked.                                                 */
/************************************************************************/
int User_SecID_Word_Program (WORD *SrcWord, WORD *Dst, int length)
{
    WORD *DestBuf;
    WORD *SourceBuf;
    int test, index=length;

    DestBuf = Dst;

    SourceBuf = SrcWord;

    test = SecID_Lock_Status ();  // check whether the SecID is Locked or not
    if (test)                     // TRUE: SecID is Locked
         return FALSE;

    while (index--)
    {
         *sysAddress(0x555) = 0x00AA; // write data 0x00AA to device addr 0x555
         *sysAddress(0x2AA) = 0x0055; // write data 0x0055 to device addr 0x2AA
         *sysAddress(0x555) = 0x00A5; // write data 0x00A5 to device addr 0x555
         *sysAddress(DestBuf) = *SourceBuf; // transfer the WORD to destination
      ++DestBuf;
      ++SourceBuf;
```

```
          // Read the toggle bit to detect end-of-write for the Sec ID.
          // Do Not use Data# Polling for User_SecID_Word_Program.
      test = Check_Toggle_Ready((Uint32)DestBuf); // wait for TOGGLE bit to get ready
      if (!test)
          return FALSE;   // SecID Word-Program failed!
    }

    return TRUE;
}


/*************************************************************************/
/* PROCEDURE:   User_SecID_Lock_Out                                      */
/*                                                                       */
/* This procedure can be used to Lock Out the User Seccurity ID.         */
/* User Security ID segment, from 000010H--000017H, in 39VF640XB.         */
/*                                                                       */
/* NOTE:  1. Call SecID_Lock_Status() first to verify the SecID is           */
/*          unlocked.                                                                */
/*          2. SecID segment can't be erased.                            */
/*          3. SecID segment can't be unlocked once it's locked.         */
/*                                                                       */
/* Input:    None                                                        */
/*                                                                       */
/* Output:   None                                                        */
/*************************************************************************/
void User_SecID_Lock_Out (void)
{
    *sysAddress(0x555) = 0x00AA; // write data 0x00AA to device addr 0x555
    *sysAddress(0x2AA) = 0x0055; // write data 0x0055 to device addr 0x2AA
    *sysAddress(0x555) = 0x0085; // write data 0x0085 to device addr 0x555
    *sysAddress(0x00FF) = 0x0000; // write data 0x0000 to any addr

    Delay_10_Micro_Seconds();         // Wait for Word-Program timeout, Tbp=10us
}


/*************************************************************************/
/* PROCEDURE:   Erase_Suspend                                                */
/*                                                                       */
/* This procedure can be used to temporarily suspend a Sector/Block-         */
/* Erase operation in 39VF640XB.                                             */
/*                                                                       */
/* Input:    None                                                        */
/*                                                                       */
/* Output:   None                                                        */
/*************************************************************************/
void Erase_Suspend (void)
{
    *sysAddress(0x555) = 0x00B0; // write data 0x00B0 to any addr, i.e. 0x555

    Delay_20_Micro_Seconds();         // The device automatically enters read mode
                  // typically within 20 us after the Erase-Suspend command issued.
}


/*************************************************************************/

/* PROCEDURE:   Erase_Resume                                                 */
/*                                                                       */
/* This procedure can be used to resume a Sector-Erase or Block-Erase    */
/* operation that had been suspended in 39VF640XB.                           */
/*                                                                       */
/* Input:    None                                                        */
/*                                                                       */
/* Output:   None                                                        */
/*************************************************************************/
void Erase_Resume (void)
{
    *sysAddress(0x555) = 0x0030; // write data 0x0030 to any addr, i.e. 0x555
}


/*************************************************************************/
/* PROCEDURE:    Check_Toggle_Ready                                      */
/*                                                                       */
/* During the internal program cycle, any consecutive read operation     */
/* on DQ6 will produce alternating 0's and 1's i.e. toggling between     */
/* 0 and 1. When the program cycle is completed, DQ6 of the data will    */
```

```
/* stop toggling. After the DQ6 data bit stops toggling, the device is  */
/* ready for next operation.                                            */
/*                                                                      */
/* Input:                                                               */
/*           Dst        must already be set-up by the caller            */
/*                                                                      */
/* Output:   TRUE   Data toggling success                               */
/*           FALSE  Time out                                            */
/************************************************************************/
int Check_Toggle_Ready (Uint32 Dst)
{
    WORD PreData;
    WORD CurrData;
    unsigned long TimeOut = 0;

    PreData = *sysAddress(Dst);
    PreData = PreData & 0x0040;          // read DQ6
    while (TimeOut < MAX_TIMEOUT)      // MAX_TIMEOUT=0x07FFFFFF
    {
        CurrData = *sysAddress(Dst);
        CurrData = CurrData & 0x0040;    // read DQ6 again
        if (PreData == CurrData)
        {
             return TRUE;
        }
          PreData = CurrData;
        TimeOut++;
    }
    return FALSE;
}


/************************************************************************/
/* PROCEDURE:   Check_Data_Polling                                      */
/*                                                                      */
/* During the internal program cycle, any attempt to read DQ7 of the    */
/* last byte loaded during the page/byte-load cycle will receive the    */
/* complement of the true data.  Once the program cycle is completed,   */
/* DQ7 will show true data.                                             */
/*                                                                      */
/* Input:                                                               */
/*           Dst        must already be set-up by the caller            */
/*           TrueData       this is the original (true) data                */
/*                                                                      */
/* Output:                                                              */
/*           TRUE   Data polling success                                */
/*           FALSE  Time out                                            */
/************************************************************************/
int Check_Data_Polling (Uint32 Dst, WORD TrueData)
{

    WORD CurrData;
    unsigned long int TimeOut = 0;

    TrueData = TrueData & 0x0080;     // read D7
    while (TimeOut < MAX_TIMEOUT)     // MAX_TIMEOUT=0x07FFFFFF
    {
          CurrData = *sysAddress(Dst);
          CurrData = CurrData & 0x0080;   // read DQ7
          if (TrueData == CurrData)
        {
            return TRUE;
        }
          TimeOut++;
    }
    return FALSE;
}
```

2. Result

In this article, an overview a flash momory and related IC has introduced.

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