SFDP Introduction

Serial Flash Discoverable Parameter Structure

SFDP Introduction

Contents

1. Introduction

Serial Flash Discoverable Parameter (SFDP) standard provides a consistent method of describing the functional and feature capabilities of Serial Flash devices in a standard set of internal parameter tables. These parameter tables can be interrogated by host system software to enable adjustments needed to accommodate divergent features from multiple vendors.

SFDP provides more flexibility in vendor selection; reduces engineering resources for firmware upgrades and effectively shortens the time to bring product to the market. The value of SFDP mirrors that of Common Flash Interface (CFI) for Parallel Flash. The software engineers have been asking for a standard like this since the increased adoption of Serial Flash.

Right now, SFDP was approved by JEDEC BOD on the end of April, 2011 which is named as JESD 216.

SFDP Introduction

2. SFDP Structure

SFDP specification defines the structure of SFDP database in flash device and the method is to read data out. The basic database is constructed by header and table. The JEDEC-defined header and basic flash parameter table is mandatory. Additional flash vender-defined header and tables can be added.

2-1. SFDP Specification

SFDP specification is the combination of SFDP Header, SFDP Parameter and Parameter tables.
(1) SFDP Header: Indicate existed SFDP function information
(2) SFDP Parameter Header: Indicate SFDP table information, and is defined by JEDEC or vender.
(3) SFDP Parameter Table: The database stores the functions and capabilities of serial flash, and is defined by JEDEC or vender.

Table 1: Brief SFDP Table Structure

Table Type	Maker	Description
SFDP Header	JEDEC STD	Identify SFDP signatures, number of parameter header and revision
Parameter Header (0)	JEDEC STD	Identify JEDEC ID, revision, length and table pointer
Parameter Header (n)	JEDEC/Vender define	Identify JECEC or vender ID, revision, length and table pointer (optional)
Parameter Table (0)	JEDEC STD	Identify the basic features of flash memory device
Parameter Table (n)	JEDEC/Vender define	Identify features by JEDEC or flash vender (optional)

SFDP Introduction

2-2. SFDP Header & Parameter Header Definition

The 'SFDP Header' is located at address 0x0000 of the SFDP data structure and use 2 DWords (8 bytes). Each 'Parameter Header' also uses 2 DWords following by the 'SFDP Header'.
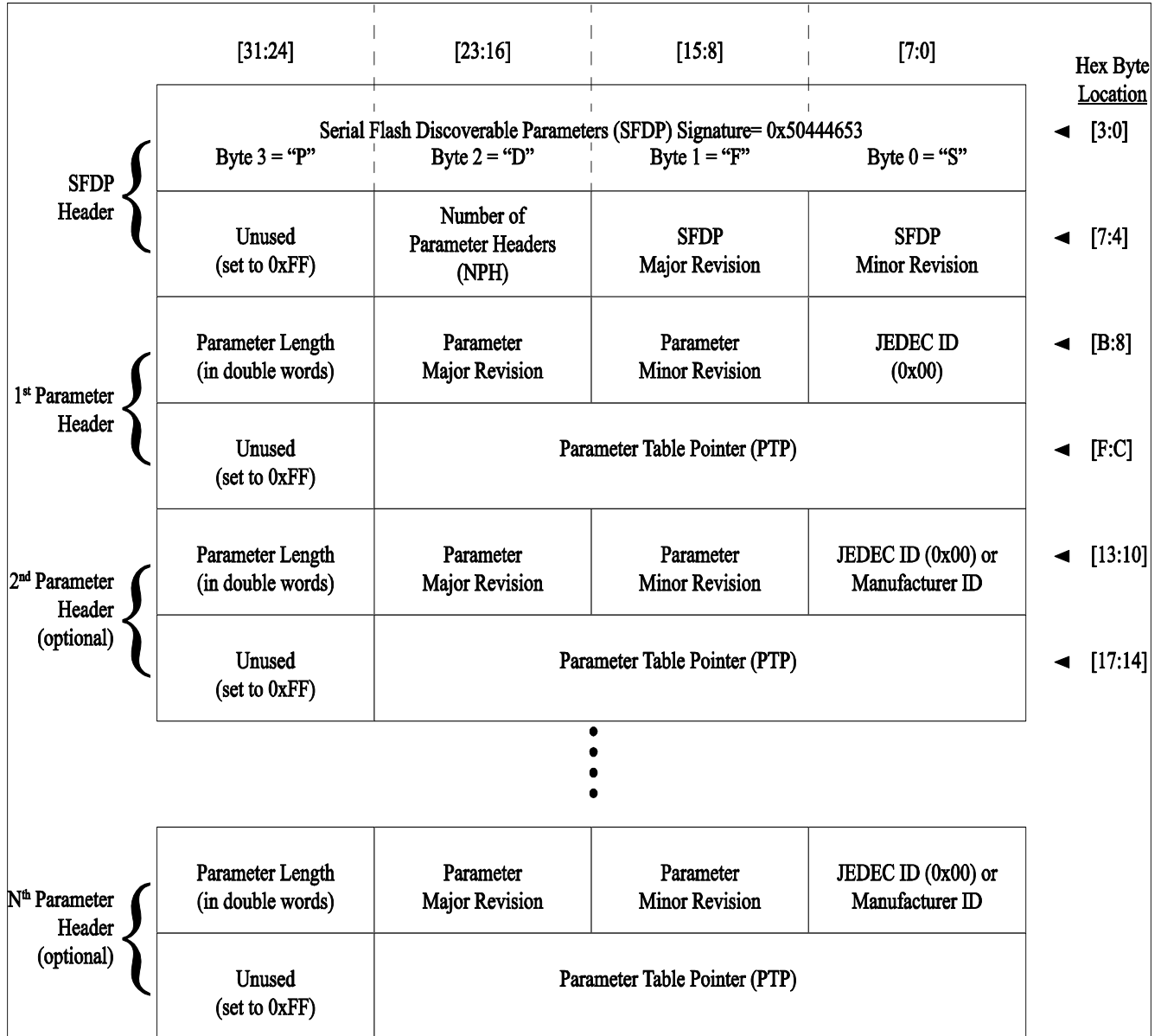
(1) SFDP Header: It combines with 2 DWords. 1st DWord is SFDP signature, and it indicates serial flash supporting SFDP. 2nd DWord defines SFDP revision, and the total number of parameter header.

(2) Parameter Header: SFDP may include one or more parameter headers; each header is fixed to 2 DWords length. The 1st parameter header is defined by 3rd and 4th DWords from JEDEC, which includes parameter table length, revision, JEDEC ID and parameter table pointer that specified mapping parameter table. Following header may be defined by JEDEC or flash vender, and the format is same as first parameter header. (Each header will be mapped to an individual parameter table.)

Figure 1 displays the 'SFDP Header' & 'Parameter Header' structure; address 0x00 ~ 0x07 (2 DWords or 8 bytes) are for the SFDP Header, and address 0x08 ~ 0x0F are the '1st Parameter Header' area. Other headers are optional, which continue after the 1st parameter header.

SFDP Introduction

Figure 1: Overall SFDP Header Structure

	[31:24]	[23:16]	[15:8]	[7:0]	Hex Byte Location
SFDP Header	Serial Flash Discoverable Parameters (SFDP) Signature= 0x50444653				◄ [3:0]
	Byte 3 = "P"	Byte 2 = "D"	Byte 1 = "F"	Byte 0 = "S"	
	Unused (set to 0xFF)	Number of Parameter Headers (NPH)	SFDP Major Revision	SFDP Minor Revision	◄ [7:4]
1st Parameter Header	Parameter Length (in double words)	Parameter Major Revision	Parameter Minor Revision	JEDEC ID (0x00)	◄ [B:8]
	Unused (set to 0xFF)	Parameter Table Pointer (PTP)			◄ [F:C]
2nd Parameter Header (optional)	Parameter Length (in double words)	Parameter Major Revision	Parameter Minor Revision	JEDEC ID (0x00) or Manufacturer ID	◄ [13:10]
	Unused (set to 0xFF)	Parameter Table Pointer (PTP)			◄ [17:14]
Nth Parameter Header (optional)	Parameter Length (in double words)	Parameter Major Revision	Parameter Minor Revision	JEDEC ID (0x00) or Manufacturer ID	
	Unused (set to 0xFF)	Parameter Table Pointer (PTP)			

SFDP Introduction

2-3. SFDP Parameter Table Definition

The SFDP Parameter Table locates after the Parameter Header; each 'Parameter Table' will be mapped by a pointer of individual 'Parameter Header', and parameter table address is re-locatable. Parameter tables may be located anywhere in the SFDP space, and they don't need to immediately follow the parameter headers. The table content shows serial flash specifications, which value may be various depending on different density and different serial flash product lines.

Macronix Serial Flash provides two parameter tables currently, Parameter Table (0) is JEDEC standard, which defines serial flash standard features, and Parameter Table (1) is defined by Macronix, which includes enhanced functions of serial flash.

Table 2 is the summary of SFDP parameter tables' definition, including JEDEC-defined table and Macronix-defined table.

Table 2. SFDP Parameter Table Definition and Content

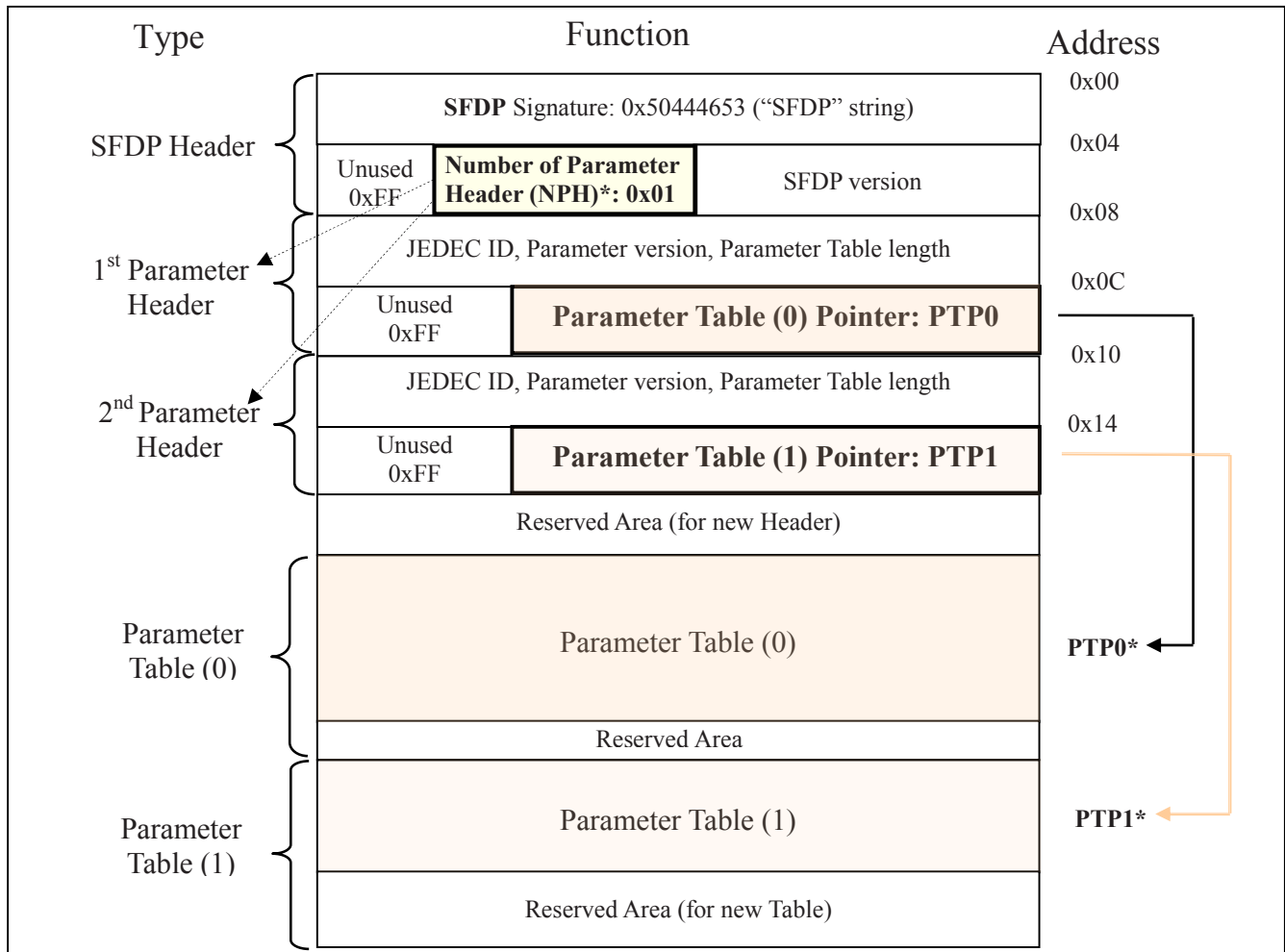| Table	Length	Maker	Definition / Function
Parameter Table (0)	9 DWords	JEDEC STD	Sector size, BP bits type
			4KB Erase opcode
			Read mode, Address mode, DTR mode
			Flash density
			Read mode interface, Mode bits, dummy cycle
			Sector size, Sector erase opcode
Parameter Table (1)	4 DWords	Macronix defines	Voltage range
			Reset#, Hold# pin, Deep Power Down, S/W Reset function, Suspend/Resume,Wrap-Around read
			Security function

2-4. SFDP Parameter Header and Table Mapping

Number of Parameter (NPH) information can be received from SFDP Header; Macronix supports 2 Parameter Header now. The SFDP parameter table located address is from Header's pointer, so designer should get Header's pointer address first, then knows parameter table location. Each Header's pointer indicates one individual table.

Figure 2 shows the SFDP Structure of NPH and how Parameter Table Pointer indicates parameter table location. The flowchart will be introduced by the following section.

Figure 2: SFDP Mapping Diagram

Type	Function	Address
	SFDP Signature: 0x50444653 ("SFDP" string)	0x00
SFDP Header	Unused 0xFF / **Number of Parameter Header (NPH)*: 0x01** / SFDP version	0x04
		0x08
1st Parameter Header	JEDEC ID, Parameter version, Parameter Table length	
	Unused 0xFF / **Parameter Table (0) Pointer: PTP0**	0x0C
		0x10
2nd Parameter Header	JEDEC ID, Parameter version, Parameter Table length	
	Unused 0xFF / **Parameter Table (1) Pointer: PTP1**	0x14
	Reserved Area (for new Header)	
Parameter Table (0)	Parameter Table (0)	**PTP0***
	Reserved Area	
Parameter Table (1)	Parameter Table (1)	**PTP1***
	Reserved Area (for new Table)	

Remark:
* Number of Parameter Header (NPH): 0x01 means 2 Parameter Headers
* PTP0: Parameter Table Pointer for Table 0, Macronix defines as 0x30
* PTP1: Parameter Table Pointer for Table 1, Macronix defines as 0x60
Parameter Table (0) starts from address 0x30, Parameter Table (1) starts from address 0x60

SFDP Introduction

3. SFDP Timing Diagram

The simple 5Ah command enters SFDP mode and a uniform timing to access SFDP data.

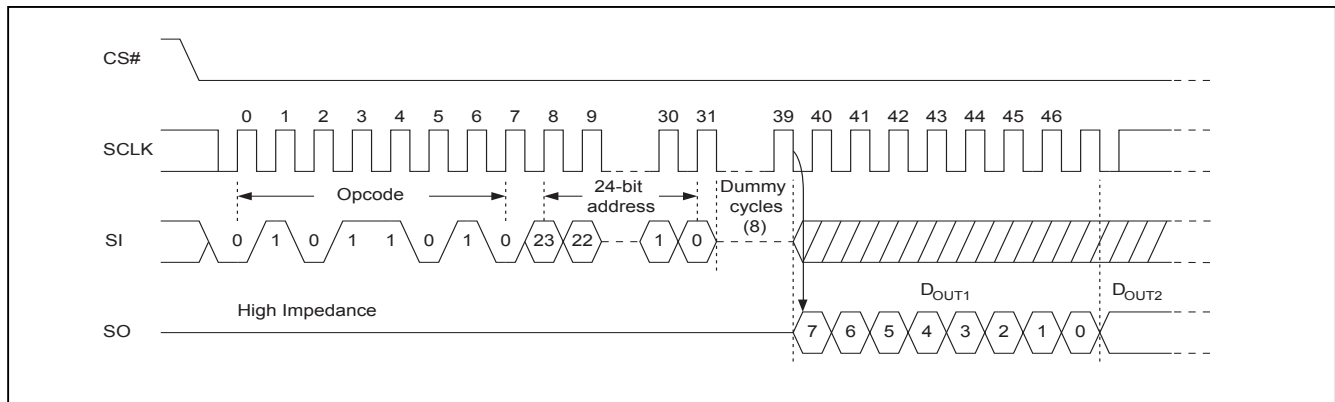### 3-1. Single I/O (1-1-1*) read timing diagram

Single I/O read is the basic I/O mode to read SFDP.
The sequence of issuing RDSFDP instruction with single I/O mode:
"CS# low → RDSFDP (5Ah) command → 24-bit address on SI pin → 8-bit dummy cycles on SI pin → read SFDP data … → CS# high."

Remark: *(x-y-z): Indicate the opcode (x), address (y), and data (z).*

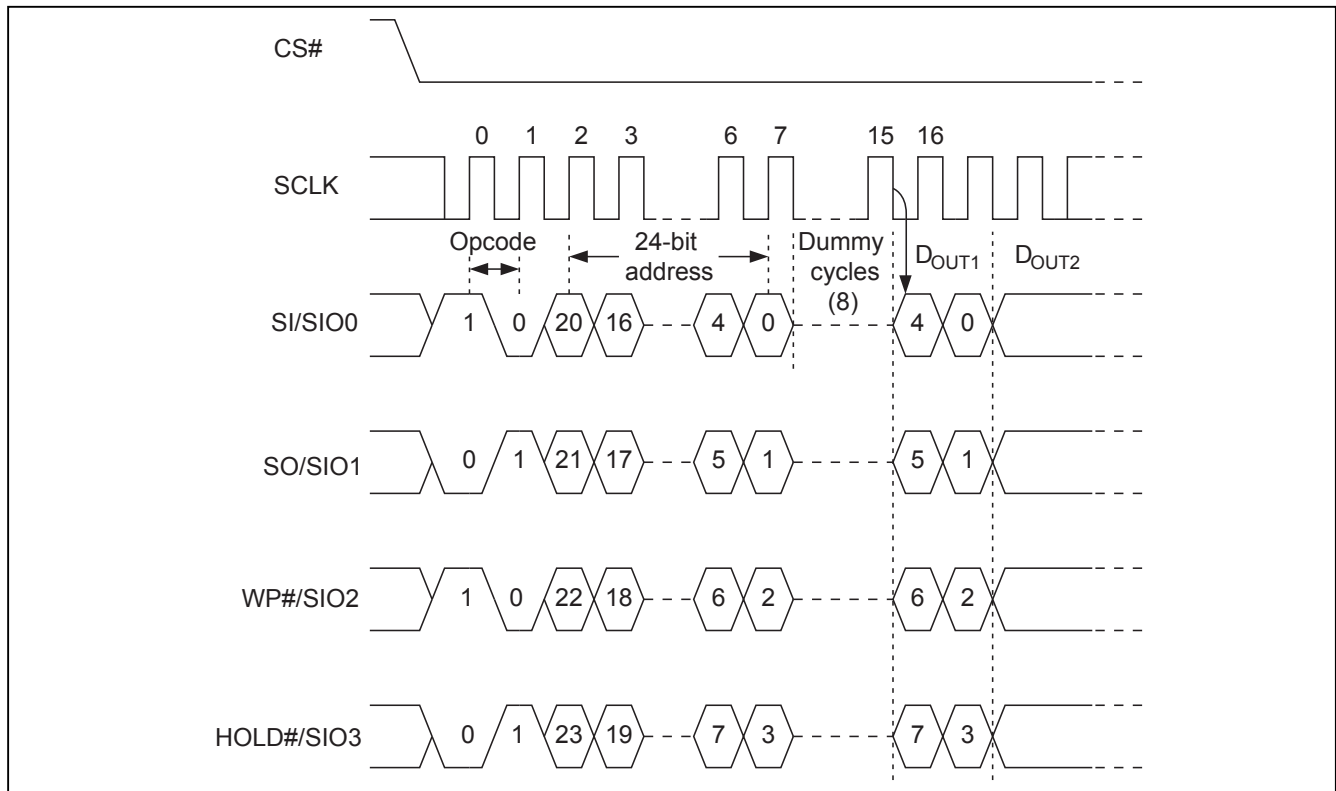**Figure 3: Single I/O Timing Diagram for SFDP Read**

SFDP Introduction

3-2. Quad I/O (4-4-4, QPI) read timing diagram

Some flash support QPI read mode. The sequence of issuing RDSFDP instruction in QPI mode:
"CS# low → RDSFDP 5Ah command (2 cycles) → 24-bit address (6 cycles) → send 8 dummy cycles (8 cycles) → read SFDP data … → CS# high."

Remark: *(x-y-z): Indicate the opcode (x), address (y), and data (z).*

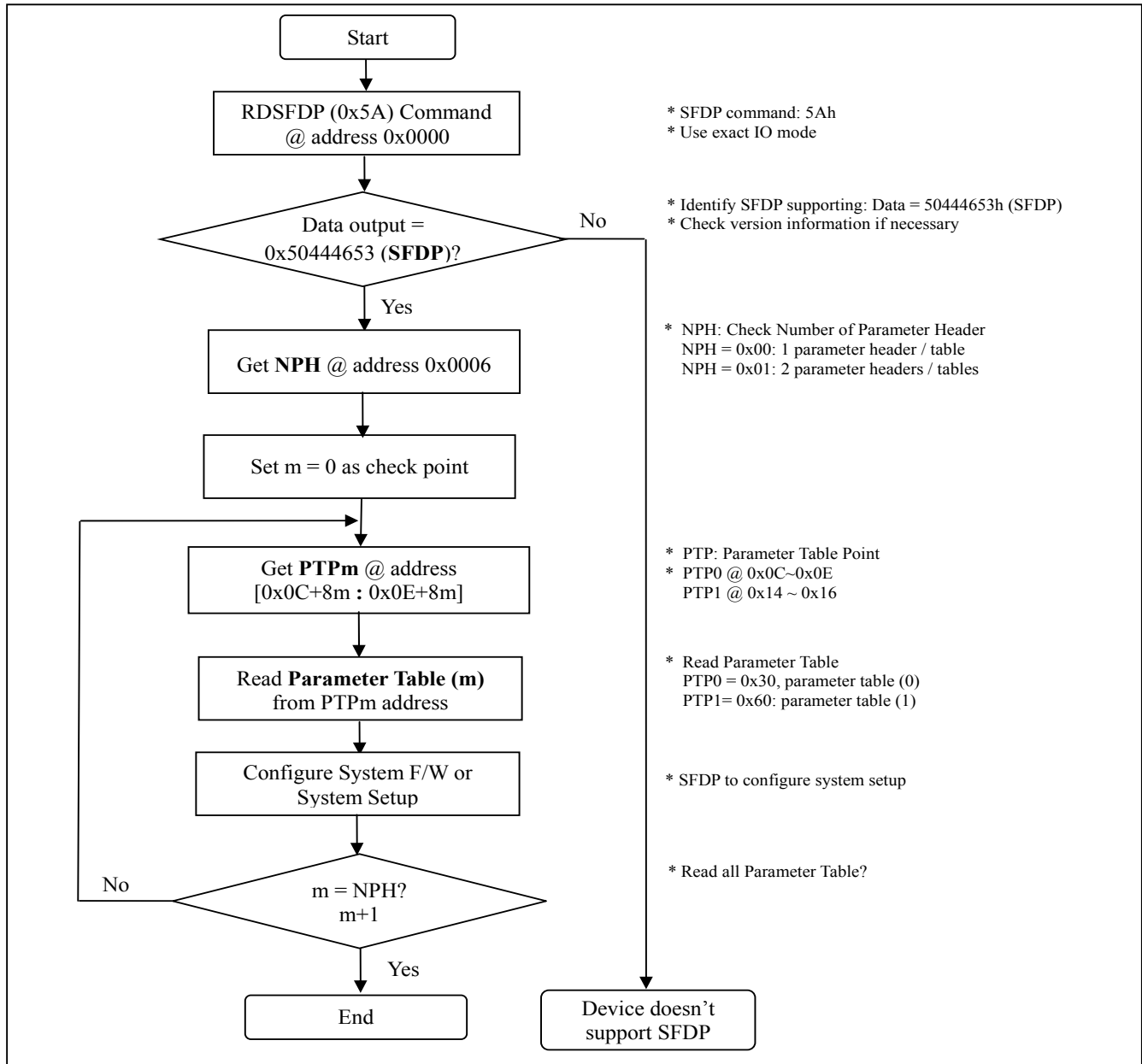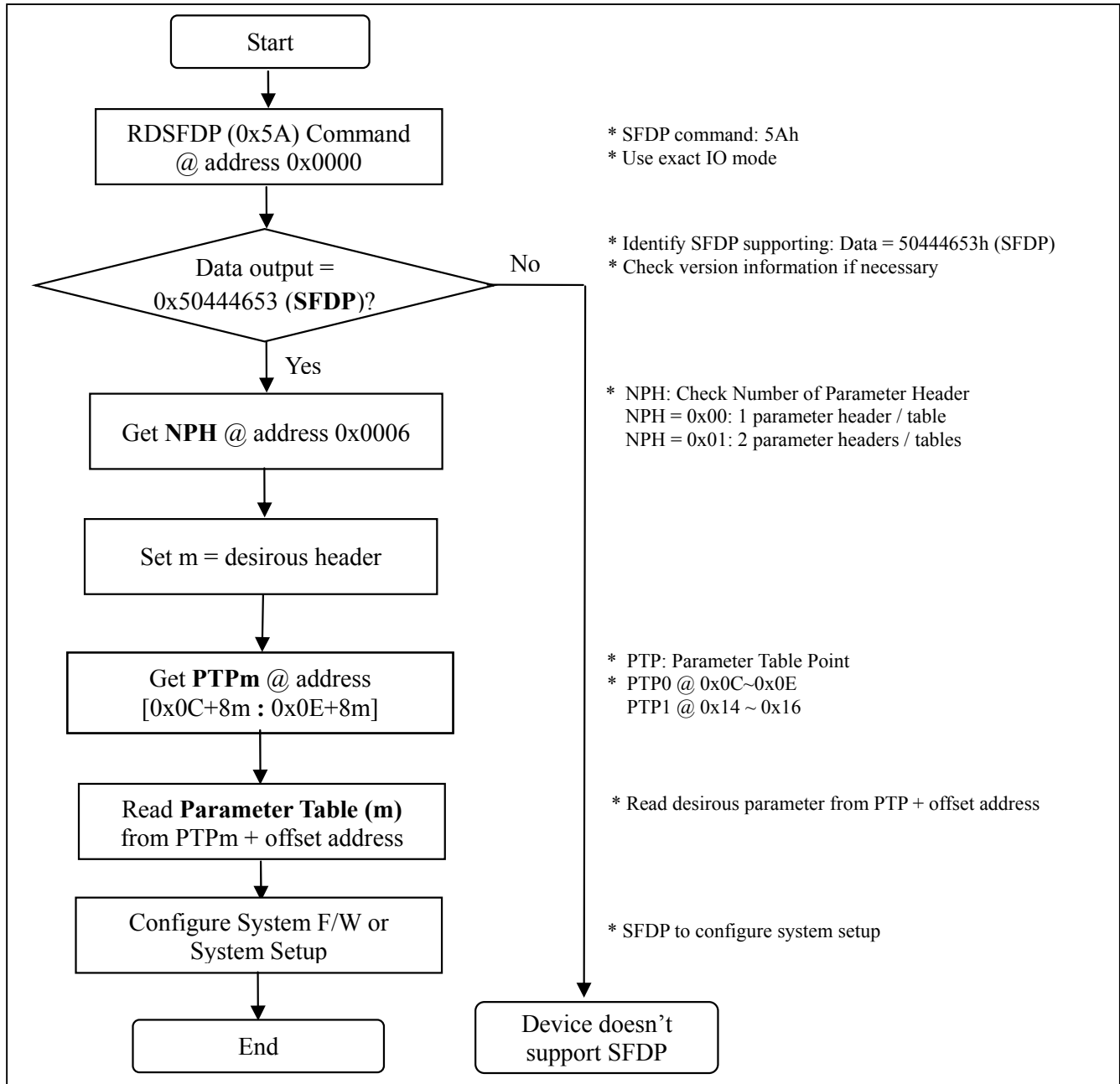**Figure 4: QPI Timing Diagram for SFDP Read**

SFDP Introduction

4. Access SFDP

RDSFDP (0x5A) command could identify SFDP supporting. Designer gets serial flash specfication information from parameter table. Figure 5 shows the continuous read SFDP, and Figure 6 shows random read SFDP.

Figure 5: SFDP Read Flow by Continuous Read

SFDP Introduction

Figure 6: SFDP Read Flow by Random Read

Start

RDSFDP (0x5A) Command @ address 0x0000

* SFDP command: 5Ah
* Use exact IO mode

Data output = 0x50444653 (**SFDP**)?

* Identify SFDP supporting: Data = 50444653h (SFDP)
* Check version information if necessary

No

Yes

Get **NPH** @ address 0x0006

* NPH: Check Number of Parameter Header
  NPH = 0x00: 1 parameter header / table
  NPH = 0x01: 2 parameter headers / tables

Set m = desirous header

Get **PTPm** @ address [0x0C+8m : 0x0E+8m]

* PTP: Parameter Table Point
* PTP0 @ 0x0C~0x0E
  PTP1 @ 0x14 ~ 0x16

Read **Parameter Table (m)** from PTPm + offset address

* Read desirous parameter from PTP + offset address

Configure System F/W or System Setup

* SFDP to configure system setup

End

Device doesn't support SFDP

SFDP Introduction

5. Summary

Serial Flash Discoverable Parameter (SFDP) provides a standard to describe the features of serial flash. It provides a format of table and is similar as CFI mode in parallel flash. Core chip designers can more simply identify serial flash with different vender and density by SFDP read. It not only save development time but also make users use serial flash easily.

6. References

The following document content was partially cited for preparing this application note:

Document	Location	Date Issued
JEDEC Standard No. 216 Serial Flash Discoverable Parameters (SFDP), for Serial NOR Flash	www.jedec.org	Apr., 2011

For more functional and parametric specifications, please refer to the datasheet on the Macronix Website at http://www.macronix.com/ and go to: Products/Flash Memory/Serial Flash.

SFDP Introduction

7. Appendix: Sample Code

The Section briefly introduces SFDP read sample code. It is a simple example how designer modifies S/W to read SFDP data out from serial flash. Blue words show main SFDP read action.

```
Read SFDP( )
{
   U16 i;
   CS# low ();                // CS# goes low, serial flash starts receive command
   Send data (0x5A);          // Write Read SFDP command
   Send data (AD1);           // Write Sector address = AD1 = A23 – A16
   Send data (AD2);           // Write Sector address = AD2 = A15 – A8
   Send data (AD3);           // Write Sector address = AD3 A7 – A0
   Send data (0xFF);          // Write dummy 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 = Get data();
   }
   CS# high ();               // CS# goes high, SFDP read end
}


Send data (unsigned char indata)    // Send 1 byte data to Serial flash
{
   unsigned char k;
   for ( k = 0; k++; k< 8)
   {
      if( (indata & 0x80) == 0x80)
         SI = 1;
      else
         SI = 0;
      SCLK = 1; SCLK = 0;
      indata = (indata << 1);
   }
}


Unsigned char Get data ()    //Receive a byte from Serial flash
{
   unsigned char k, temdata =0, i;
   for ( k = 0; k++; k< 8)
   {
      if ( SO == 1 )
      {
         i = (0x80 >> k);
         temdata = (temdata || i);
      }
      SCLK = 1; SCLK = 0;
   }
   return (temdata);
}
```

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