AN1971

USB to SPI Bridging with Microchip USB 2.0 Hubs

Author: *Andrew Rogers*
Microchip Technology Inc.

INTRODUCTION

The USB to SPI bridging feature of Microchip hubs provides system designers with expanded system control and potential BOM reductions. When using Microchip's USB hubs, a separate USB to SPI device is no longer required and a downstream USB port is not lost, as occurs when a standalone USB to SPI device is implemented. This feature is available on Microchip hubs which contain the internal Hub Feature Controller and a SPI Interface. These hubs include USB3613, USB3813, USB4604, and USB4624.

Commands may be sent from the USB Host to the internal Hub Feature Controller device in the Microchip hub to perform the following functions:

- Enable SPI Pass-Through Interface
- SPI Write/Read
- Disable SPI Pass-Through Interface

SECTIONS

REFERENCES

Consult the following documents for details on the specific parts referred to in this document:

- *USB3613 Data Sheet*
- *USB3813 Data Sheet*
- *USB4604 Data Sheet*
- *USB4624 Data Sheet*
- *AN 26.18 Configuration of the USB253x / USB3x13 / USB46x4*

1.0 GENERAL INFORMATION

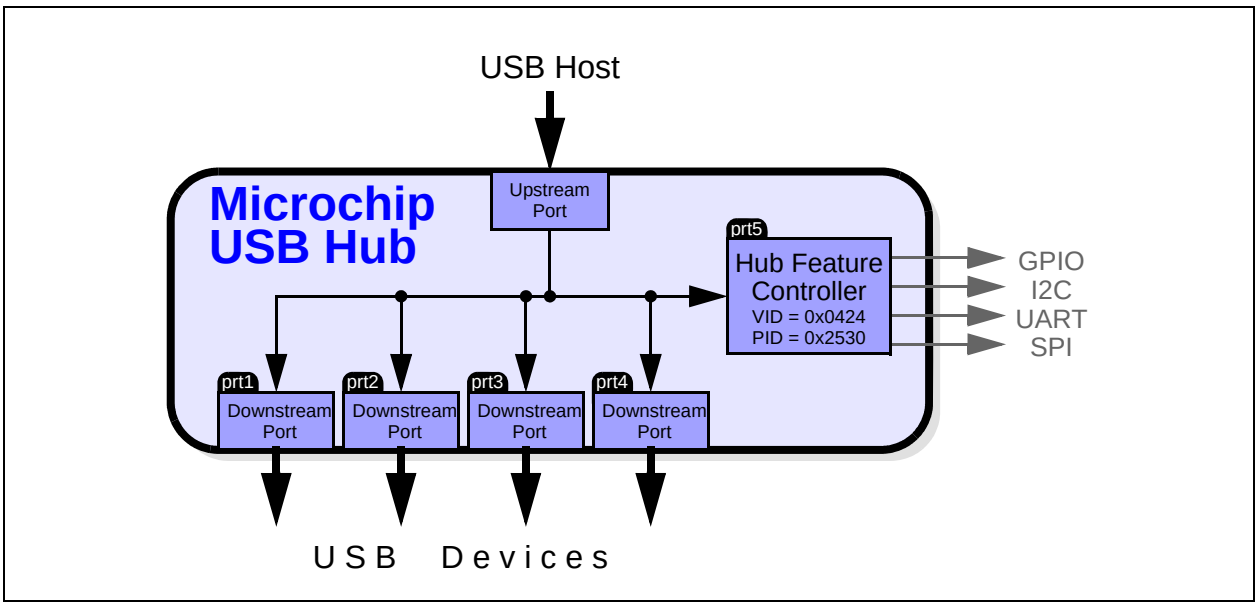
Microchip's USB hub bridging features operate via host commands which are sent to an embedded Hub Feature Controller located on an additional internal USB port. In order for the bridging features to work correctly, this internal Hub Feature Controller must be enabled by default. See the table below for details on default Hub Feature Controller settings by part.

TABLE 1: DEFAULT SETTINGS FOR HUB FEATURE CONTROLLER ENABLE

Part Number	Part Summary	Hub Controller Default Setting
USB2532	2-Port USB 2.0 Hub	Disabled (enable via config)
USB2533	3-Port USB 2.0 Hub	Disabled (enable via config)
USB2534	4-Port USB 2.0 Hub	Disabled (enable via config)
USB3613	3-Port USB 2.0 Mobile Hub (HSIC Upstream / 1 HSIC Downstream Port)	Disabled (enable via config)
USB3813	3-Port USB 2.0 Mobile Hub (1 HSIC Downstream Port)	Disabled (enable via config)
USB4604-1080	4-Port USB 2.0 Hub (USB or HSIC Upstream)	Enabled
USB4604-1070	4-Port USB 2.0 Hub (USB or HSIC Upstream)	Disabled (order 1080 SKU)
USB464-1080	4-Port USB 2.0 Hub (USB or HSIC Upstream / 2 Downstream HSIC Ports)	Enabled
USB4624-1070	4-Port USB 2.0 Hub (USB or HSIC Upstream / 2 Downstream HSIC Ports)	Disabled (order 1080 SKU)

The Hub Feature Controller is connected to an extra internal port in the hub. For example, in a four port hub, the Hub Feature Controller is connected to port 5. The Product ID (PID) for the Hub Feature Controller is 0x2530. All bridging commands are addressed to the Hub Feature Controller, not the Hub.

FIGURE 1-1: MICROCHIP HUB FEATURE CONTROLLER BLOCK DIAGRAM



1.1 SPI Bridging Commands

The following SPI Functions are supported:

- Enable SPI Pass-Through Interface
- SPI Write/Read
- Disable SPI Pass-Through Interface

1.1.1 ENABLE THE SPI PASS-THROUGH INTERFACE

A single command to enable the SPI interface is required before performing any SPI Write or Read commands. The SPI interface may operate at either 30MHz or 60HHz (based on pin-strapping).

1.1.2 SPI WRITE/(READ)

The SPI interface works as a complete pass-through. This means that the host must properly arrange data payloads in the appropriate SPI compatible format and bit order, including the SPI slave device address. Up to 256 Bytes of data payload may be sent per SPI write command sequence.

Data may also be read from a SPI device via the SPI Write command. Up to 512 bytes of data may be read from the SPI device per read. The read data is stored in the internal registers of the hub starting at register 0x4A10. To retrieve the data, you must use a USB to Register Read command. Further details can be found in *AN 26.18 Configuration of the USB253x / USB3x13 / USB46x4.*

1.1.3 DISABLE THE SPI PASS-THROUGH INTERFACE

The SPI interface may be disabled after writing/reading to the device is complete.

1.2 SPI Interface Setup Requirements

1.2.1 SPI MASTER INTERFACE

The SPI Interface always acts as a SPI master.

1.2.2 SELECTING SPI FREQUENCY

The SPI Interface may operate at either 30MHz or 60MHz. The speed is selected by pin strapping the SPI_SPD_SEL pin (also the SPI_DO pin during runtime) and is detected at power on or reset. The strapping options are:

- GND (Logical 0) = 30MHz
- 3.3V (Logical 1) = 60MHz

When running in 30MHz mode, the SPI_DO/SPI_SPD_SEL pin will drive to 0V during a suspend state. When running in 60MHz mode, the SPI_DO/SPI_SPD_SEL pin will tri-state during a suspend state.

1.2.3 SPI MODES OF OPERATION

Both SPI Modes 0 and 3 are supported:

- Mode 0: Clock Polarity = 0, Clock Edge = 1
- Mode 3: Clock Polarity = 1, Clock Edge = 0

Dual Output Enable mode is also supported.

The default mode of operation is Mode 0 with Dual Output Enable mode disabled. If the mode of operation is to be modified, a register write to the SPI_CONTROL register must be performed. See *AN 26.18 Configuration of the USB253x / USB3x13 / USB46x4* for details on how to modify that register.

2.0 PART NUMBER SPECIFIC INFORMATION

2.1 Part Summary

The following tables display the SPI interface pins by part number as well as any notes on those pins.

2.2 USB3613 and USB3813

TABLE 2: USB3613 AND USB3813 SPI INTERFACE PINS

Pin #	Name	Notes
E2	SPI_DI	-
E1	SPI_CE_EN	-
D3	SPI_DO	This pin is also the SPI_SPD_SEL Strap which selects between 30MHz and 60MHz speed of operation.
D2	SPI_CLK	-

2.3 USB4604 and USB4624

TABLE 3: USB4604 AND USB4624 SPI INTERFACE PINS

Pin #	Name	Notes
31	SPI_DI	-
25	SPI_CE_EN	-
26	SPI_DO	This pin is also the SPI_SPD_SEL Strap which selects between 30MHz and 60MHz speed of operation.
27	SPI_CLK	-

3.0 SDK IMPLEMENTATION

The simplest method for implementing the USB to SPI bridging functions is to use the publicly available USB2530 SDK (Software Development Kit). The SDK is available for Windows and Linux operating systems. Visit the product page for any of the hubs listed in this document on microchip.com to download the SDK package for the desired Operating System. Using the libraries available in the SDK, the bridging features can be implemented in C-code.

The SDK package contains the following:

- User's Manual: Detail description of how to use the SDK and call each function
- Release Notes:
- Library Files:
  - For Windows: A ".dll" and a ".lib" file
  - For Linux: a ".cpp" file that can be built into a ".a" file
- Example code

3.1 Commands included in the SDK

- **MchpUsbSpiSetConfig:** Enables or Disables the SPI interface.
- **MchpUsbSpiWrite:** Write up to 255 Bytes of data to an SPI slave device.
- **MchpUsbSpiRead:** Read up to 255 Bytes of data from an SPI slave device.

For additional details on how to use the SDK to implement USB to SPI bridging, download the SDK package and read the User's Manual.

4.0 MANUAL IMPLEMENTATION

The USB to SPI bridging features may be implemented at the lowest level if you have the ability to build USB packets. This approach is required if you are not using a Windows or Linux host system and cannot use the SDK.

The details of the SPI pass-through control packets are shown below.

4.1 Enable SPI Pass-Through Interface Command

The following SETUP packet command is required to enable the SPI pass-through interface. The interface must be enabled before any Write or Read commands may be performed. Note that there is no data phase to this USB transaction,

TABLE 4: USB SETUP COMMAND

Setup Parameter	Value	Description
bmRequestType	0x41	Vendor specific command, Host-to-device data transfer
bRequest	0x60	Register read command: CMD_SPI_ENTER_PASSTHRU
wValue	0x0000	Reserved
wIndex	0x0000	Reserved
wLength	0x00	No data stage

4.2 SPI Write Command

This command is used to write data to or read data from a SPI peripheral connected to the USB hub.

TABLE 5: USB SETUP COMMAND

Setup Parameter	Value	Description
bmRequestType	0x41	Vendor specific command, Host-to-device data transfer
bRequest	0x61	Register read command: CMD_SPI_WRITE
wValue	0xXXXX	The total length of data to be sent to the SPI peripheral (the size of the data following the SETUP packet).
wIndex	0x0000	Reserved
wLength	0xNN	The number of bytes the SPI interface will return for the command sent

The maximum amount of data that can be read from one USB command is 512 Bytes by specifying wValue = 517 and wLength = 5.

The maximum amount of data that can be written to a SPI peripheral is 256 Bytes by specifying wValue = wLength = 260.

4.2.1 SPI WRITE USB TRANSACTION SEQUENCE:

1. SETUP PACKET: To send ‘Write Enable’ OpCode to SPI ROM (wValue = wLength = 1)
2. DATA: 0x06 (opcode for ‘Write Enable’).
3. STATUS: An IN-Zero Length Packet is sent from hub.
4. SETUP PACKET: To send data payload
5. DATA: EP0 Data to SPI ROM with 0x02 + 24bit SPI address + Data Stream
6. STATUS: If an IN-Zero Length Packet is sent from hub, transfer was a success. If an IN-STALL packet is sent from hub, there was an error during transfer.

4.2.2 SPI READ USB TRANSACTION SEQUENCE:

1. SETUP PACKET: As defined above.
2. DATA: EP0 OUT Data to SPI ROM with 0x0B + 24Bit SPI Address + 0x00 (dummy byte).
3. STATUS: If an IN-Zero Length Packet is sent from hub, transfer was a success. If an IN-STALL packet is sent from hub, there was an error during transfer, likely due to missing ACK from the SPI slave.
4. Perform Configuration Register Read on hub starting at register 0x4A10 to retrieve read data. See *AN 26.18 Configuration of the USB253x / USB3x13 / USB46x4*

4.3 Disable SPI Pass-Through Interface Command

The following SETUP packet command is required to disable the SPI pass-through interface. Note that there is no data phase to this USB transaction,

TABLE 6: USB SETUP COMMAND

Setup Parameter	Value	Description
bmRequestType	0x41	Vendor specific command, Host-to-device data transfer
bRequest	0x62	Register read command: CMD_SPI_ENTER_PASSTHRU
wValue	0x0000	Reserved
wIndex	0x0000	Reserved
wLength	0x00	No data stage

5.0 EXAMPLES

5.1 Write 512 Bytes to a SPI ROM

1. Enable the SPI Pass-Through Interface

TABLE 7: ENABLE SPI INTERFACE SETUP COMMAND

Setup Parameter	Value
bmRequestType	0x41
bRequest	0x60
wValue	0x0000
wIndex	0x0000
wLength	0x00

2. Send a SPI Write/Read Command to read 512 Bytes of data.

TABLE 8: SPI WRITE SETUP COMMAND

Setup Parameter	Value
bmRequestType	0x41
bRequest	0x61
wValue	0x0205 (517)
wIndex	0x0000
wLength	0x0005

3. EP0 OUT data = 0x0B, 0xXX, 0xYY, 0xZZ, 0x00, 0xXX, 0xYY, 0xZZ.

Note: 0xXX, 0xYY, 0xZZ is the 24 Bit physical SPI address of the SPI peripheral.

4. Read response via USB to Configuration Register Read from register 0x4A10. Further details can be found in *AN 26.18 Configuration of the USB253x / USB3x13 / USB46x4.*
5. Do one of the following:
   - Close the SPI Interface with the Disable SPI Pass-Through Command
   - Wait for the manufacturer specified time before performing another Read/Write command.
   - Send RDSR commands until the BUSY field is cleared before performing another Read/Write command.

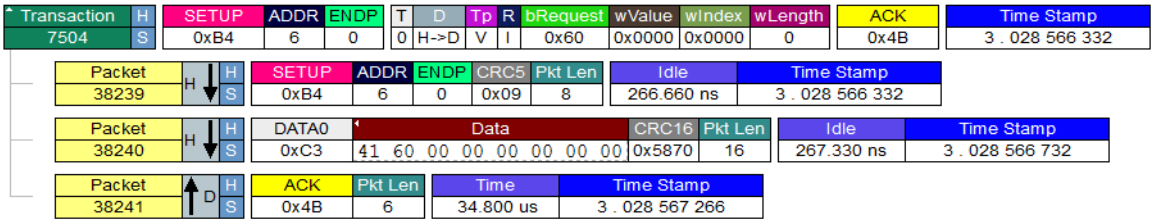
5.2 Enable the SPI Pass-Through Interface

1. **Command Phase (SETUP Transaction):** Send the following SETUP Register Read Command to Endpoint 0 of the Hub Feature Controller to enable the SPI pass-through interface:

TABLE 9: EXAMPLE SPI WRITE SETUP PACKET

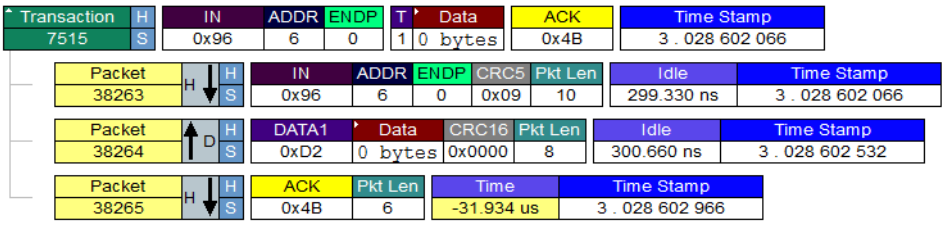
Field	Value	Note
bmRequestType	0x41	
bRequest	0x60	
wValue	0x0000	
wIndex	0x0000	
wLength	0x0000	

FIGURE 1: SETUP TRANSACTION EXAMPLE



2. **Status (IN Transaction):** The host sends an IN packet to the Hub Feature Controller, to which the Hub Feature controller replies with a zero data length packet. The host ACKs to complete the bridging command.

FIGURE 2: IN TRANSACTION EXAMPLE



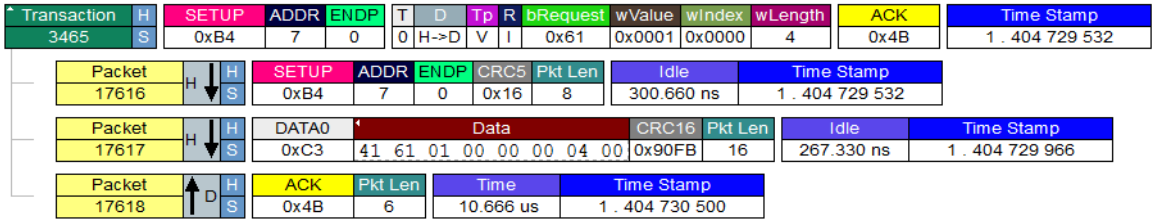
5.3 Read the JEDEC ID from an attached SPI Device

1. **Command Phase 1 (SETUP Transaction 1):** The JEDEC ID gives manufacturer information and memory information. This example shows how to read the JEDEC ID from an attached SPI device. Send the following SETUP Register Read Command to Endpoint 0 of the Hub Feature Controller send a SPI Write command to the attached SPI device.

TABLE 10: SPI JEDEC ID READ SETUP PACKET EXAMPLE

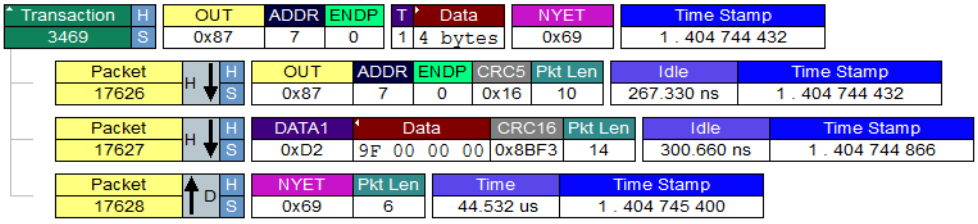
Field	Value	Note
bmRequestType	0x41	
bRequest	0x61	
wValue	0x0001	
wIndex	0x0000	
wLength	0x0004	

FIGURE 3: SPI JEDEC ID READ SETUP TRANSACTION EXAMPLE



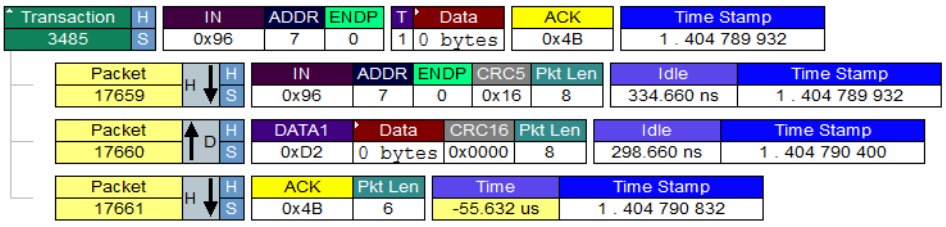
2. **Data Phase 1 (OUT Transaction 1):** Host sends an OUT packet followed by the data bytes of length wLength. In this example, the 0x9F data is the opcode for reading a JEDEC ID in a SPI device. Hub Feature Controller responds with a NYET after receiving the data.

FIGURE 4: SPI JEDEC ID OUT TRANSACTION EXAMPLE



3. **Status Phase 1 (IN Transaction 1):** Host sends an IN packet to complete the USB Transfer. Hub Feature Controller responds with a zero length data packet. The host ACKs to complete the bridging command.

FIGURE 5: SPI JEDEC ID IN TRANSACTION EXAMPLE

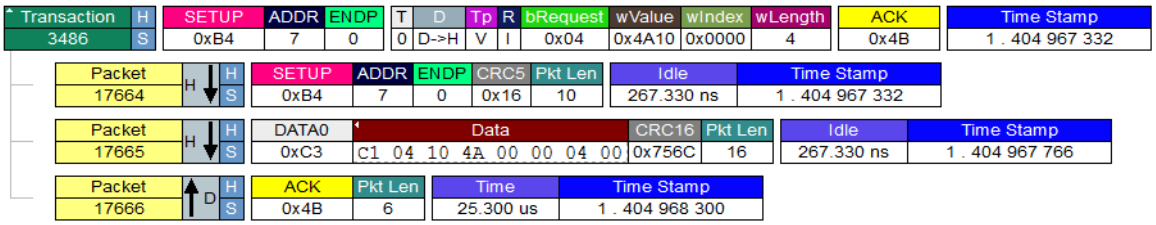


4. **Retrieve the Returned Data (SETUP Transaction 2):** The SPI device will respond to the opcode command and the returned data will be stored in the hub's internal register starting at address 0x4A10. A USB to Register Read command can retrieve the data. This command is setup as:

TABLE 11: SPI JEDEC ID REGISTER READ SETUP PACKET EXAMPLE

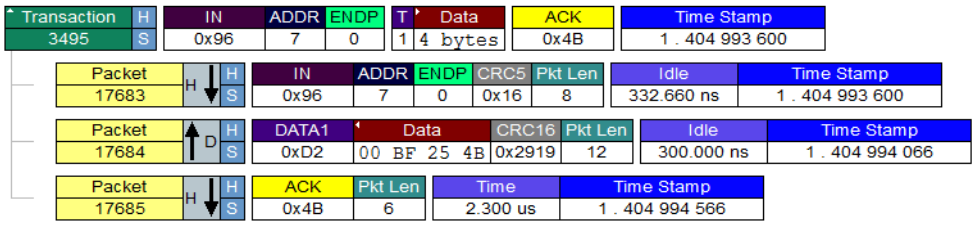
Field	Value	Note
bmRequestType	0xC1	
bRequest	0x04	
wValue	0x4A10	The hub's internal register address
wIndex	0x0000	
wLength	0x0004	A JEDEC ID request will return 4 bytes. The first byte will be a dummy 0x00.

FIGURE 6: SPI JEDEC ID REGISTER READ SETUP TRANSACTION EXAMPLE



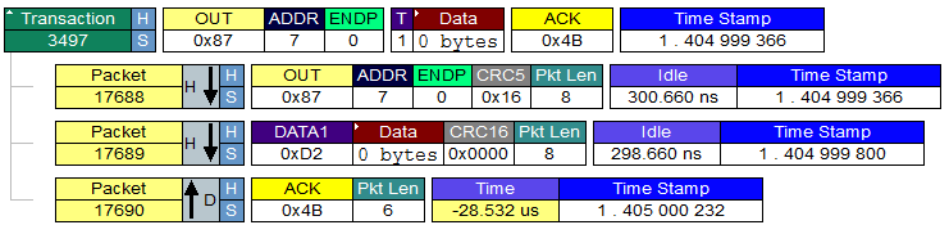
5. **Data Phase 2 (IN Transaction 2):** Host sends an IN packet to retrieve the data from the 0x4A10 register. In this example, the JEDEC ID that is returned is 0xBF, 0x25, 0x4B. The host replies with an ACK after receiving the data.

FIGURE 7: SPI JEDEC ID REGISTER READ IN TRANSACTION EXAMPLE



6. **Status Phase 2 (OUT Transaction 2):** Host sends an OUT packet followed by a zero length data packet. The Hub Feature Controller ACKs to complete the bridging command.

FIGURE 8: SPI JEDEC ID REGISTER READ OUT TRANSACTION EXAMPLE



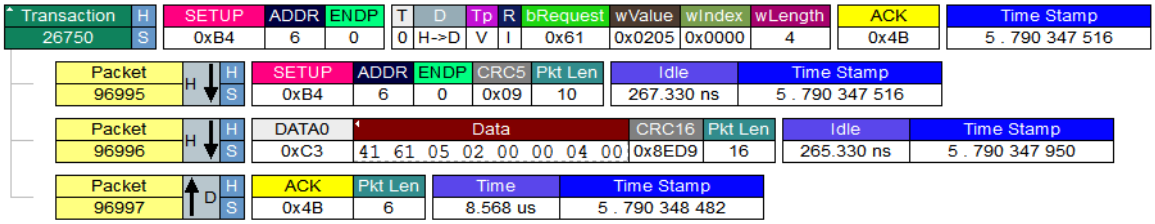
5.4 Read 512 Bytes from an attached SPI Device

1. **Command Phase 1 (SETUP Transaction 1):** This example shows how to perform a block read of 512 bytes (the maximum number of bytes per command) from an attached SPI device. Send the following SETUP Register Read Command to Endpoint 0 of the Hub Feature Controller send a SPI Write command to the attached SPI device

TABLE 12: SPI BLOCK READ COMMAND SETUP PACKET EXAMPLE

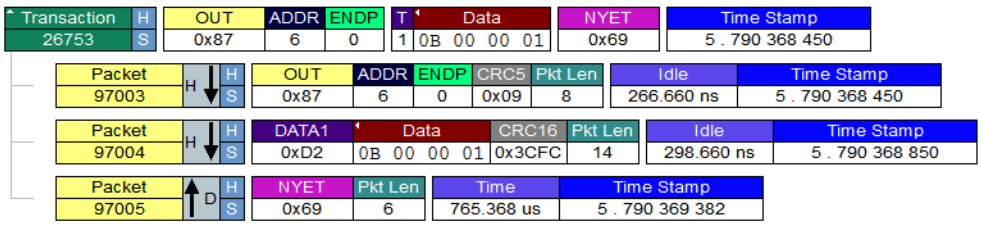
Field	Value	Note
bmRequestType	0x41	
bRequest	0x61	
wValue	0x0205 (517)	The first 5 Bytes of any SPI read must be ignored; Therefore, 5 must be added to the number of Bytes to be read.
wIndex	0x0000	
wLength	0x0004	

FIGURE 9: SPI BLOCK READ COMMAND SETUP TRANSACTION EXAMPLE



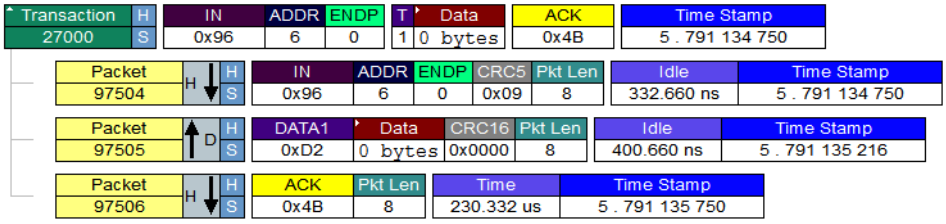
2. **Data Phase 1 (OUT Transaction 1):** Host sends an OUT packet followed by the data bytes of length wLength. In this example, the 0x0B is the opcode for a block read in this specific SPI device, the next 0x00,0x00,0x01 is the register address to begin reading from the SPI device. The Hub Feature Controller responds with a NYET after receiving the data.

FIGURE 10: SPI BLOCK READ COMMAND OUT TRANSACTION EXAMPLE



3. **Status Phase 1 (IN Transaction 1):** Host sends an IN packet to complete the USB Transfer. Hub Feature Controller responds with a zero length data packet. The host ACKs to complete the bridging command.

FIGURE 11: SPI BLOCK READ COMMAND IN TRANSACTION EXAMPLE

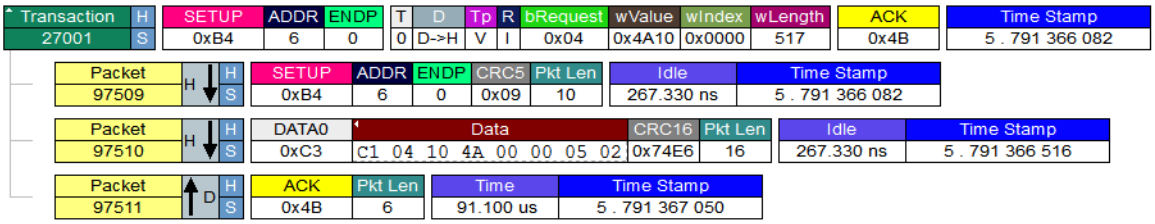


4. **Retrieve the Returned Data (SETUP Transaction 2):** The SPI device will respond to the opcode command and the returned data will be stored in the hub's internal register starting at address 0x4A10. For a SPI Block Read, the first 5 bytes must be ignored. A USB to Register Read command can retrieve the data. This command is setup as:

TABLE 13: REGISTER READ SETUP PACKET EXAMPLE

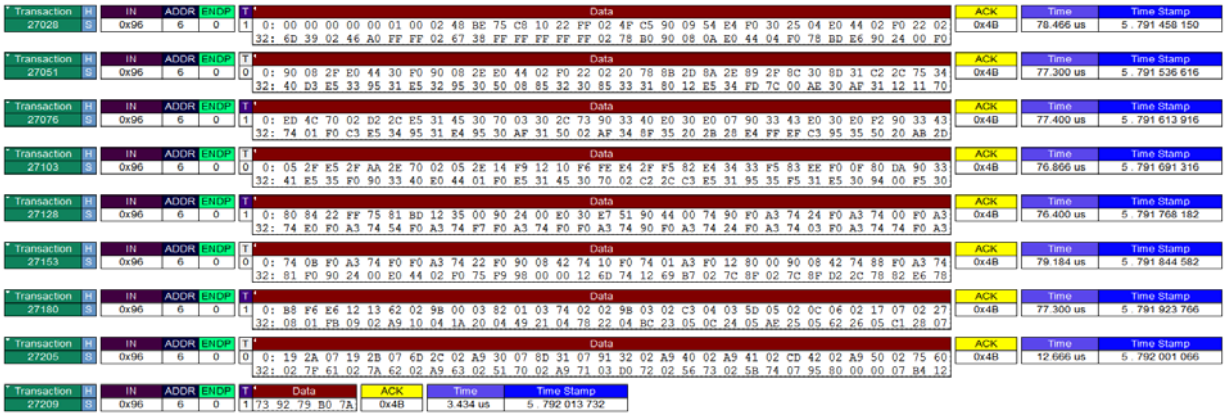
Field	Value	Note
bmRequestType	0xC1	
bRequest	0x04	
wValue	0x4A10	The hub's internal register address
wIndex	0x0000	
wLength	0x0205	517 Bytes will be read (512 + 5 dummy bytes)

FIGURE 12: REGISTER READ SETUP TRANSACTION EXAMPLE



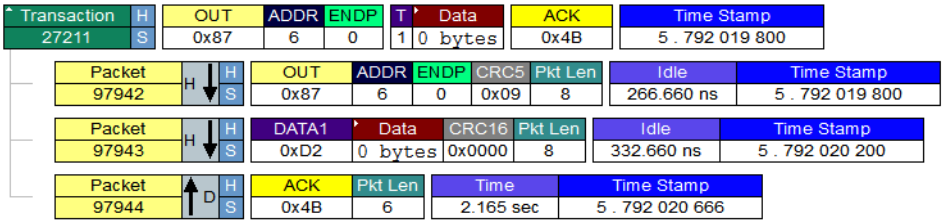
5. **Data Phase 2 (IN Data Payload Transaction):** Hub sends a series of IN packets (64 Bytes per packet) until all 517 bytes are read. The first 5 bytes should always be ignored.

FIGURE 13: REGISTER READ IN TRANSACTION EXAMPLE



6. **Status Phase 2 (OUT Transaction 2):** Host sends an OUT packet followed by a zero length data packet. The Hub Feature Controller ACKs to complete the bridging command.

FIGURE 14: REGISTER READ OUT TRANSACTION EXAMPLE



7. After completing the SPI Read, do one of the following:
   - Close the SPI Interface with the Disable SPI Pass-Through command.
   - Wait for the manufacturer specified time before performing another Read/Write command.
   - Send RDSR commands until the BUSY field is cleared before performing another Read/Write command.

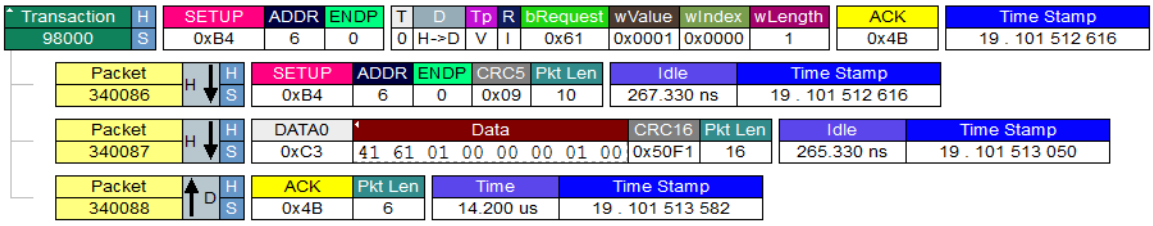
5.5 Write 256 Bytes to an attached SPI Device

1. **Command Phase 1 (SETUP Transaction 1):** This example shows how to perform a block write of 256 bytes to an attached SPI device. Send the following SETUP Register Read Command to Endpoint 0 of the Hub Feature Controller to enable the SPI write feature.

TABLE 14: SPI WRITE ENABLE SETUP PACKET EXAMPLE

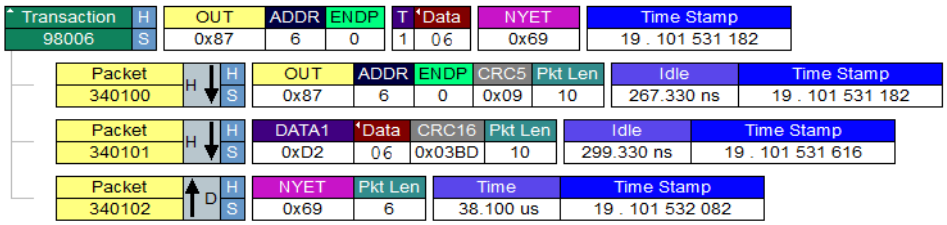
Field	Value	Note
bmRequestType	0x41	
bRequest	0x61	
wValue	0x0001	
wIndex	0x0000	
wLength	0x0001	

FIGURE 15: SPI WRITE ENABLE SETUP TRANSACTION EXAMPLE



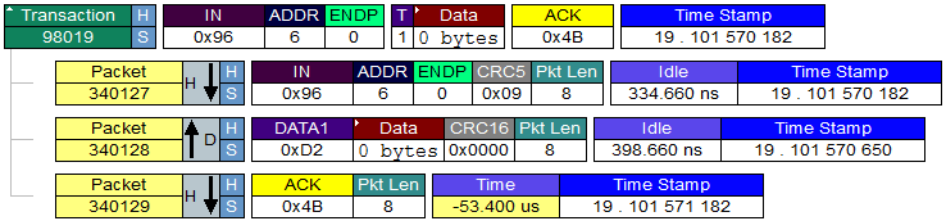
2. **Data Phase 1 (OUT Transaction 1):** Host sends an OUT packet followed by a single byte data payload of 0x06. 0x06 is the SPI write enable command. The Hub Feature Controller responds with a NYET after receiving the data.

FIGURE 16: SPI WRITE ENABLE TRANSACTION EXAMPLE



3. **Status Phase 1 (IN Transaction 1):** Host sends an IN packet to complete the USB Transfer. Hub Feature Controller responds with a zero length data packet. The host ACKs to complete the bridging command.

FIGURE 17: SPI WRITE DATA IN TRANSACTION EXAMPLE

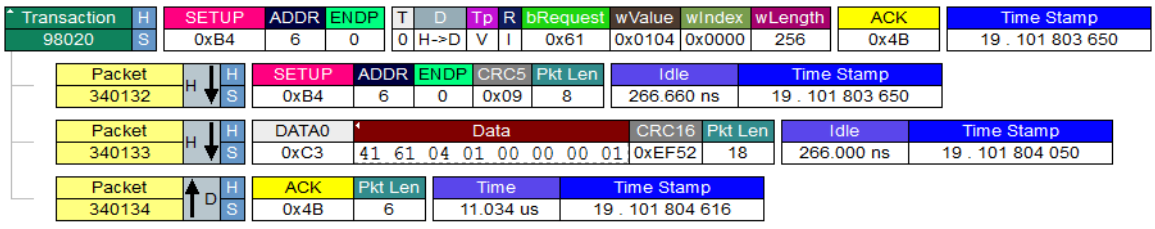


4. **Send the SPI Write Data Payload (SETUP Transaction 2):** The SPI device is now ready to receive the data payload. For a SPI Block Write of 256 bytes, the SETUP command is:

TABLE 15: SPI WRITE DATA SETUP PACKET EXAMPLE

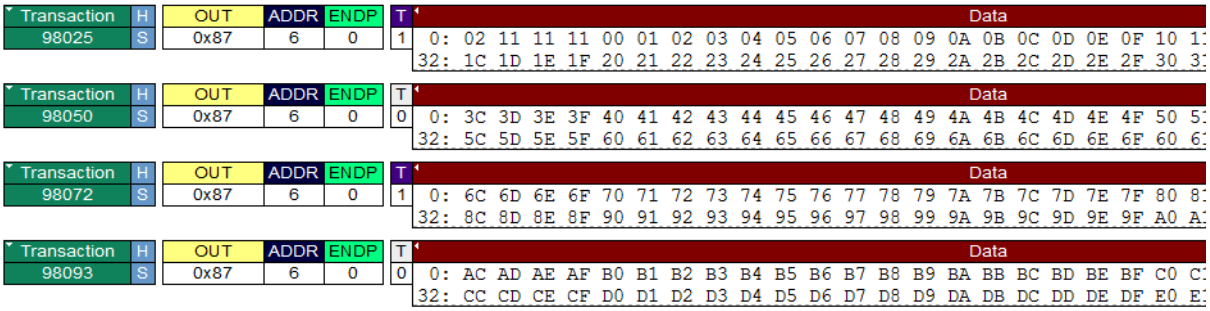
Field	Value	Note
bmRequestType	0x41	
bRequest	0x61	
wValue	0x0104 (260)	The 256 byte data payload + 4 extra command bytes
wIndex	0x0000	
wLength	0x0100 (256)	The 256 byte data payload

FIGURE 18: SPI WRITE DATA TRANSACTION EXAMPLE



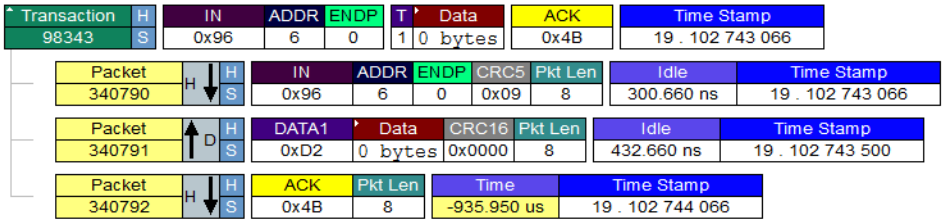
5. **Data Phase 2 (OUT Data Payload Transaction):** Host sends a series of OUT packets (64 Bytes per packet) until all 256 + 4 command bytes are sent. The first 4 bytes must be 0x02, 0xXX, 0xYY, 0xZZ where 0xXX, 0xYY, 0xZZ is the 24 bit physical address of the SPI Flash. In this example, the SPI address is 0x111111.

FIGURE 19: SPI WRITE DATA OUT TRANSACTIONS EXAMPLE



6. **Status Phase 2 (IN Transaction 2):** Host sends an IN packet and the hub responds with a zero length data packet. The Host ACKs to complete the bridging command.

FIGURE 20: SPI WRITE DATA IN TRANSACTION EXAMPLE



7. After completing the SPI Write, do one of the following:
   - Close the SPI Interface with the Disable SPI Pass-Through command.
   - Wait for the manufacturer specified time before performing another Read/Write command.
   - Send RDSR commands until the BUSY field is cleared before performing another Read/Write command.

APPENDIX A: APPLICATION NOTE REVISION HISTORY

TABLE A-1: REVISION HISTORY

Revision Level & Date	Section/Figure/Entry	Correction
DS00001971B (04-22-16)	Section 1.2.2, "Selecting SPI Frequency"	Corrected pin name typo to “SPI_SPD_SEL”
	Table 2, "USB3613 and USB3813 SPI Interface Pins", Table 3, "USB4604 and USB4624 SPI Interface Pins", Table 9, "Example SPI Write Setup Packet"	Corrected table title typo: “I2C” changed to “SPI”
	Section 4.1, "Enable SPI Pass-Through Interface Command"	Corrected typo in first sentence: “follow” changed to “following”
	Section 4.2.1, "SPI Write USB Transaction Sequence:"	Corrected typo in step 2: Added end quotation mark to “Write Enable”
	Section 4.3, "Disable SPI Pass-Through Interface Command"	Corrected typos in first sentence: “follow” changed to “following”, “enable” changed to “disable”
	Figure 4, Figure 10	Changed title “IN” to “OUT”
	Figure 5, Figure 11, Figure 17	Changed title “OUT” to “IN”
DS00001971A (06-17-15)	All	Initial release.

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

ISBN: 9781522405214

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
═ ISO/TS 16949 ═

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

THE MICROCHIP WEB SITE

Microchip provides online support via our WWW site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQ), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

CUSTOMER CHANGE NOTIFICATION SERVICE

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip web site at www.microchip.com. Under "Support", click on "Customer Change Notification" and follow the registration instructions.

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: http://microchip.com/support

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://www.microchip.com/support
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX
Tel: 512-257-3370

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Cleveland
Independence, OH
Tel: 216-447-0464
Fax: 216-447-0643

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Novi, MI
Tel: 248-848-4000

Houston, TX
Tel: 281-894-5983

Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

New York, NY
Tel: 631-435-6000

San Jose, CA
Tel: 408-735-9110

Canada - Toronto
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Asia Pacific Office
Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon

Hong Kong
Tel: 852-2943-5100
Fax: 852-2401-3431

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8569-7000
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

China - Chongqing
Tel: 86-23-8980-9588
Fax: 86-23-8980-9500

China - Dongguan
Tel: 86-769-8702-9880

China - Hangzhou
Tel: 86-571-8792-8115
Fax: 86-571-8792-8116

China - Hong Kong SAR
Tel: 852-2943-5100
Fax: 852-2401-3431

China - Nanjing
Tel: 86-25-8473-2460
Fax: 86-25-8473-2470

China - Qingdao
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8864-2200
Fax: 86-755-8203-1760

China - Wuhan
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xian
Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

ASIA/PACIFIC

China - Xiamen
Tel: 86-592-2388138
Fax: 86-592-2388130

China - Zhuhai
Tel: 86-756-3210040
Fax: 86-756-3210049

India - Bangalore
Tel: 91-80-3090-4444
Fax: 91-80-3090-4123

India - New Delhi
Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

India - Pune
Tel: 91-20-3019-1500

Japan - Osaka
Tel: 81-6-6152-7160
Fax: 81-6-6152-9310

Japan - Tokyo
Tel: 81-3-6880- 3770
Fax: 81-3-6880-3771

Korea - Daegu
Tel: 82-53-744-4301
Fax: 82-53-744-4302

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Kuala Lumpur
Tel: 60-3-6201-9857
Fax: 60-3-6201-9859

Malaysia - Penang
Tel: 60-4-227-8870
Fax: 60-4-227-4068

Philippines - Manila
Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu
Tel: 886-3-5778-366
Fax: 886-3-5770-955

Taiwan - Kaohsiung
Tel: 886-7-213-7828

Taiwan - Taipei
Tel: 886-2-2508-8600
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Dusseldorf
Tel: 49-2129-3766400

Germany - Karlsruhe
Tel: 49-721-625370

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Venice
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Poland - Warsaw
Tel: 48-22-3325737

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820

07/14/15