# SmartFusion2 MSS SPI Driver User's Guide

## Version 2.2

Microsemi

# Table of Contents

# Introduction

The SmartFusion2™ microcontroller subsystem (MSS) includes two serial peripheral interface (SPI) peripherals for serial communication. This driver provides a set of functions for controlling the MSS SPIs as part of a bare metal system where no operating system is available. These drivers can be adapted for use as part of an operating system, but the implementation of the adaptation layer between this driver and the operating system's driver model is outside the scope of this driver.

## Features

The MSS SPI driver provides the following features:

- Support for configuring each MSS SPI peripheral
- SPI master operations
- SPI slave operations

The MSS SPI driver is provided as C source code.

## Supported Hardware IP

The MSS SPI bare metal driver can be used with the SmartFusion2 MSS version 0.0.500 or higher.

# Files Provided

The files provided as part of the MSS SPI driver fall into three main categories: documentation, driver source code, and example projects. The driver is distributed via the Microsemi SoC Products Group's Firmware Catalog, which provides access to the documentation for the driver, generates the driver's source files into an application project, and generates example projects that illustrate how to use the driver. The Firmware Catalog is available from: www.microsemi.com/soc/products/software/firmwarecat/default.aspx.

## Documentation

The Firmware Catalog provides access to the following documents for the driver:

- User's guide (this document)
- Release notes

## Driver Source Code

The Firmware Catalog generates the driver's source code into the *drivers\mss_spi* subdirectory of the selected software project directory. The files making up the driver are detailed below.

### mss_spi.h

This header file contains the public application programming interface (API) of the MSS SPI software driver. This file should be included in any C source file that uses the MSS SPI software driver.

### mss_spi.c

This C source file contains the implementation of the MSS SPI software driver.

## Example Code

The Firmware Catalog provides access to example projects illustrating the use of the driver. Each example project is self-contained and is targeted at a specific processor and software tool chain combination. The example projects are targeted at the FPGA designs in the hardware development tutorials supplied with the SoC Products Group's development boards. The tutorial designs can be found on the Microsemi SoC Development Kit web page.

# Driver Deployment

This driver is deployed from the Firmware Catalog into a software project by generating the driver's source files into the project directory. The driver uses the SmartFusion2 Cortex Microcontroller Software Interface Standard Hardware Abstraction Layer (CMSIS HAL) to access MSS hardware registers. You must ensure that the SmartFusion2 CMSIS HAL is included in the project settings of the software tool chain used to build your project and that it is generated into your project. The most up-to-date SmartFusion2 CMSIS HAL files can be obtained using the Firmware Catalog.

The following example shows the intended directory structure for a SoftConsole ARM® Cortex™-M3 project targeted at the SmartFusion2 MSS. This project uses the MSS SPI and MSS watchdog drivers. Both of these drivers rely on the SmartFusion2 CMSIS HAL for accessing the hardware. The contents of the *drivers* directory result from generating the source files for the driver into the project. The contents of the *CMSIS* and *hal* directories result from generating the source files for the SmartFusion2 CMSIS HAL into the project. The contents of the *drivers_config* directory are generated by the Libero project and must be copied into the into the software project.

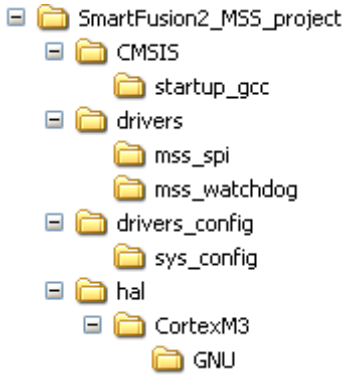



Figure 1 · SmartFusion2 MSS Project Example

# Driver Configuration

The configuration of all features of the MSS SPI peripherals is covered by this driver with the exception of the SmartFusion2 IOMUX configuration. SmartFusion2 allows multiple non-concurrent uses of some external pins through IOMUX configuration. This feature allows optimization of external pin usage by assigning external pins for use by either the microcontroller subsystem or the FPGA fabric. The MSS SPI serial signals are routed through IOMUXs to the SmartFusion2 device external pins. The MSS SPI serial signals may also be routed through IOMUXs to the SmartFusion2 FPGA fabric

The IOMUXs are configured using the SmartFusion2 MSS configurator tool. You must ensure that the MSS SPI peripherals are enabled and configured in the SmartFusion2 MSS configurator if you wish to use them. For more information on IOMUXs, refer to the IOMUX section of the *SmartFusion2 Microcontroller Subsystem (MSS) User's Guide*.

The base address, register addresses and interrupt number assignment for the MSS SPI peripherals are defined as constants in the SmartFusion2 CMSIS HAL. You must ensure that the latest SmartFusion2 CMSIS HAL is included in the project settings of the software tool chain used to build your project and that it is generated into your project.

# Application Programming Interface

This section describes the driver's API. The functions and related data structures described in this section are used by the application programmer to control the MSS SPI peripheral.

## Theory of Operation

The MSS SPI driver functions are grouped into the following categories:

- Initialization
- Configuration for either master or slave operations
- SPI master frame transfer control
- SPI master block transfer control
- SPI slave frame transfer control
- SPI slave block transfer control
- DMA block transfer

Frame transfers allow the MSS SPI to write or read up to 32 bits of data in a SPI transaction. For example, a frame transfer of 12 bits might be used to read the result of an ADC conversion from a SPI analog to digital converter.

Block transfers allow the MSS SPI to write or read a number of bytes in a SPI transaction. Block transfer transactions allow data transfers in multiples of 8 bits (8, 16, 24, 32, 40…). Block transfers are typically used with byte oriented devices like SPI FLASH devices.

### Initialization

The MSS SPI driver is initialized through a call to the *MSS_SPI_init()* function. The *MSS_SPI_init()* function takes only one parameter, a pointer to one of two global data structures used by the driver to store state information for each MSS SPI. A pointer to these data structures is also used as first parameter to any of the driver functions to identify which MSS SPI will be used by the called function. The names of these two data structures are *g_mss_spi0* and *g_mss_spi1*. Therefore any call to an MSS SPI driver function should be of the form MSS_SPI_function_name( &g_mss_spi0, ... ) or MSS_SPI_function_name( &g_mss_spi1, ... ).

The *MSS_SPI_init() function* resets the specified MSS SPI hardware block and clears any pending interrupts from that MSS SPI in the Cortex-M3 NVIC.

The *MSS_SPI_init()* function must be called before any other MSS SPI driver functions can be called.

### Configuration

An MSS SPI block can operate either as a master or slave SPI device. There are two distinct functions for configuring a MSS SPI block for master or slave operations.

#### Master configuration

The *MSS_SPI_configure_master_mode()* function configures the specified MSS SPI block for operations as a SPI master. It must be called once for each remote SPI slave device which the MSS SPI block will communicate with. It is used to provide the following information about each SPI slave's communication characteristics:

- The SPI protocol mode
- The SPI clock speed
- The frame bit length

This information is held by the driver and will be used to alter the configuration of the MSS SPI block each time a slave is selected through a call to *MSS_SPI_set_slave_select()*. The SPI protocol mode defines the

initial state of the clock signal at the start of a transaction and which clock edge will be used to sample the data signal (Motorola SPI modes), or it defines whether the SPI block will operate in Texas Instruments (TI) synchronous serial mode or in National Semiconductor (NSC) MICROWIRE mode.

### Slave configuration

The *MSS_SPI_configure_slave_mode()* function configures the specified MSS SPI block for operations as a SPI slave. It configures the following SPI communication characteristics:

- The SPI protocol mode
- The frame bit length

The SPI protocol mode defines the initial state of the clock signal at the start of a transaction and which clock edge will be used to sample the data signal (Motorola SPI modes), or it defines whether the SPI block will operate in TI synchronous serial mode or in NSC MICROWIRE mode.

## SPI master frame transfer control

The following functions are used as part of SPI master frame transfers:

- *MSS_SPI_set_slave_select()*
- *MSS_SPI_transfer_frame()*
- *MSS_SPI_clear_slave_select()*

The master must first select the target slave through a call to *MSS_SPI_set_slave_select()*. This causes the relevant slave select line to become asserted while data is clocked out onto the SPI data line.

A call is then made to *MSS_SPI_transfer_frame()* specifying the value of the data frame to be sent.

The function *MSS_SPI_clear_slave_select()* can be used after the transfer is complete to prevent this slave select line from being asserted during subsequent SPI transactions. A call to this function is only required if the master is communicating with multiple slave devices.

## SPI master block transfer control

The following functions are used as part of SPI master block transfers:

- *MSS_SPI_set_slave_select()*
- *MSS_SPI_clear_slave_select()*
- *MSS_SPI_transfer_block()*

The master must first select the target slave through a call to *MSS_SPI_set_slave_select()*. This causes the relevant slave select line to become asserted while data is clocked out onto the SPI data line.

A call is then made to *MSS_SPI_transfer_block()*. The parameters of this function specify:

- the number of bytes to be transmitted
- a pointer to the buffer containing the data to be transmitted
- the number of bytes to be received
- a pointer to the buffer where received data will be stored

The number of bytes to be transmitted can be set to zero to indicate that the transfer is purely a block read transfer. Alternatively, the number of bytes to be received can be set to zero to specify that the transfer is purely a block write transfer.

The *MSS_SPI_clear_slave_select() function* can be used after the transfer is complete to prevent this slave select line from being asserted during subsequent SPI transactions. A call to this function is only required if the master is communicating with multiple slave devices.

Note: Unlike in previous versions of this driver, the SPS bit is set in the CONTROL register in Motorola modes so that the Slave Select line remains asserted throughout block transfers.

## SPI slave frame transfer control

The following functions are used as part of SPI slave frame transfers:

- *MSS_SPI_set_slave_tx_frame()*
- *MSS_SPI_set_frame_rx_handler()*

The *MSS_SPI_set_slave_tx_frame()* function specifies the frame data that will be returned to the SPI master. The frame data specified through this function is the value that will be read over the SPI bus by the remote SPI master when it initiates a transaction. A call to *MSS_SPI_set_slave_tx_frame()* is only required if the MSS SPI slave is the target of SPI read transactions, i.e. if data is meant to be read from the SmartFusion2 device over SPI.

The *MSS_SPI_set_frame_rx_handler()* function specifies the receive handler function that will be called when a frame of data has been received by the MSS SPI, when configured as a slave. The receive handler function specified through this call will process the frame data written over the SPI bus to the MSS SPI slave by the remote SPI master. The receive handler function must be implemented as part of the application. It is only required if the MSS SPI slave is the target of SPI frame write transactions.

Successive master writes need to take into account the time taken to execute the receive handler if the interface is to work reliably.

## SPI slave block transfer control

The following functions are used as part of SPI slave block transfers:

- *MSS_SPI_set_slave_block_buffers()*
- *MSS_SPI_set_cmd_handler()*
- *MSS_SPI_set_cmd_response()*

The *MSS_SPI_set_slave_block_buffers()* function is used to configure an MSS SPI slave for block transfer operations. It specifies:

- The buffer containing the data that will be returned to the remote SPI master
- The buffer where data received from the remote SPI master will be stored
- The handler function that will be called after the receive buffer has been filled

The *MSS_SPI_set_cmd_handler()* function specifies a command handler function that will be called by the driver once a specific number of bytes have been received, after the SPI chip select signal becoming active. The number of bytes making up the command part of the transaction is specified as part of the parameters to *MSS_SPI_set_cmd_handler()*. The command handler function is implemented as part of the application making use of the SPI driver and would typically call *MSS_SPI_set_cmd_response()* .

The *MSS_SPI_set_cmd_response()* function specifies the data that will be returned to the master. Typically the *MSS_SPI_set_slave_block_buffers()* will have been called as part of the system initialization to specify the data sent to the master while the command bytes are being received. The transmit buffer specified through *MSS_SPI_set_slave_block_buffers()* would also typically include one or more bytes allowing for the turnaround time required for the command handler to execute and call *MSS_SPI_set_cmd_response()*.

## DMA block transfer control

The following functions are used as part of MSS SPI DMA transfers:

- *MSS_SPI_disable()*
- *MSS_SPI_set_transfer_byte_count()*
- *MSS_SPI_enable()*
- *MSS_SPI_tx_done()*

The MSS SPI must first be disabled through a call to function *MSS_SPI_disable()*. The number of bytes to be transferred is then set through a call to *MSS_SPI_set_transfer_byte_count()*. The DMA transfer is then initiated by a call to the *MSS_PDMA_start()* function provided by the MSS PDMA driver. The actual DMA transfer will only start once the MSS SPI block has been re-enabled through a call to *MSS_SPI_enable()*. The completion of the DMA driven SPI transfer can be detected through a call to *MSS_SPI_tx_done()*. The direction of the SPI transfer, write or read, depends on the DMA channel configuration. A SPI write transfer

occurs when the DMA channel is configured to write data to the MSS SPI block. A SPI read transfer occurs when the DMA channel is configured to read data from the MSS SPI block.

The configuration of the DMA channels is outside the scope of this User Guide and is a matter for the particular application program to manage.

# Types

## mss_spi_protocol_mode_t

### Prototype

```
typedef enum __mss_spi_protocol_mode_t {
    MSS_SPI_MODE0     = 0x00000000,
    MSS_SPI_TI_MODE   = 0x00000004,
    MSS_SPI_NSC_MODE  = 0x00000008,
    MSS_SPI_MODE2     = 0x01000000,
    MSS_SPI_MODE1     = 0x02000000,
    MSS_SPI_MODE3     = 0x03000000
} mss_spi_protocol_mode_t;
```

### Description

This enumeration is used to define the settings for the SPI protocol mode bits which select the different modes of operation for the MSS SPI. It is used as a parameter to the *MSS_SPI_configure_master_mode() and MSS_SPI_configure_slave_mode()* functions.

## mss_spi_slave_t

### Prototype

```
typedef enum __mss_spi_slave_t {
    MSS_SPI_SLAVE_0 = 0,
    MSS_SPI_SLAVE_1 = 1,
    MSS_SPI_SLAVE_2 = 2,
    MSS_SPI_SLAVE_3 = 3,
    MSS_SPI_SLAVE_4 = 4,
    MSS_SPI_SLAVE_5 = 5,
    MSS_SPI_SLAVE_6 = 6,
    MSS_SPI_SLAVE_7 = 7,
    MSS_SPI_MAX_NB_OF_SLAVES = 8
} mss_spi_slave_t;
```

### Description

This enumeration is used to select a specific SPI slave device (0 to 7). It is used as a parameter to the *MSS_SPI_configure_master_mode()*, *MSS_SPI_set_slave_select(),* and *MSS_SPI_clear_slave_select ()* functions.

## mss_spi_frame_rx_handler_t

### Prototype

```
void (*mss_spi_frame_rx_handler_t)( uint32_t rx_frame );
```

### Description

This defines the function prototype that must be followed by MSS SPI slave frame receive handler functions. These functions are registered with the MSS SPI driver through the *MSS_SPI_set_frame_rx_handler ()* function.

### Declaring and Implementing Slave Frame Receive Handler Functions

Slave frame receive handler functions should follow the following prototype:

```
void slave_frame_receive_handler ( uint32_t rx_frame );
```

The actual name of the receive handler is unimportant. You can use any name of your choice for the receive frame handler. The *rx_frame* parameter will contain the value of the received frame.

## mss_spi_block_rx_handler_t

### Prototype

```
void (*mss_spi_block_rx_handler_t)( uint8_t * rx_buff , uint16_t rx_size );
```

### Description

This defines the function prototype that must be followed by MSS SPI slave block receive handler functions. These functions are registered with the MSS SPI driver through the *MSS_SPI_set_slave_block_buffers()* function.

### Declaring and Implementing Slave Block Receive Handler Functions

Slave block receive handler functions should follow the following prototype:

```
void mss_spi_block_rx_handler ( uint8_t * rx_buff, uint16_t rx_size );
```

The actual name of the receive handler is unimportant. You can use any name of your choice for the receive frame handler. The *rx_buff* parameter will contain a pointer to the start of the received block. The *rx_size* parameter specifies the number of bytes contained in the block received.

# Constant Values

## MSS_SPI_BLOCK_TRANSFER_FRAME_SIZE

This constant defines a frame size of 8 bits when configuring an MSS SPI to perform block transfer data transactions.

It must be used as the value for the *frame_bit_length* parameter of *MSS_SPI_configure_master_mode()* when performing block transfers between the MSS SPI master and the target SPI slave.

This constant must also be used as the value for the *frame_bit_length* parameter of function *MSS_SPI_configure_slave_mode()* when performing block transfers between the MSS SPI slave and the remote SPI master.

# Data structures

## mss_spi_instance_t

There is one instance of this structure for each of the microcontroller subsystem's SPIs. Instances of this structure are used to identify a specific SPI. A pointer to an instance of the *mss_spi_instance_t* structure is passed as the first parameter to MSS SPI driver functions to identify which SPI should perform the requested operation.

# Global Variables

## g_mss_spi0

### Prototype

```
mss_spi_instance_t g_mss_spi0;
```

### Description

This instance of *mss_spi_instance_t* holds all data related to the operations performed by MSS SPI 0. A pointer to *g_mss_spi0* is passed as the first parameter to MSS SPI driver functions to indicate that MSS SPI 0 should perform the requested operation.

## g_mss_spi1

### Prototype

```
mss_spi_instance_t g_mss_spi1;
```

### Description

This instance of *mss_spi_instance_t* holds all data related to the operations performed by MSS SPI 1. A pointer to *g_mss_spi1* is passed as the first parameter to MSS SPI driver functions to indicate that MSS SPI 1 should perform the requested operation.

# Functions

## MSS_SPI_init

### Prototype

```
void MSS_SPI_init
(
    mss_spi_instance_t * this_spi
);
```

### Description

The *MSS_SPI_init()* function initializes the hardware and data structures of one of the MSS SPIs. The *MSS_SPI_init()* function must be called before any other MSS SPI driver functions can be called.

### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block to be initialized. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

### Return Value

This function does not return a value.

### Example

```
MSS_SPI_init( &g_mss_spi0 );
```

## MSS_SPI_configure_master_mode

### Prototype

```
void MSS_SPI_configure_master_mode
(
    mss_spi_instance_t * this_spi,
    mss_spi_slave_t slave,
    mss_spi_protocol_mode_t protocol_mode,
    uint32_t clk_div,
    uint8_t frame_bit_length
);
```

### Description

The *MSS_SPI_configure_master_mode()* function configures the protocol mode, serial clock speed and frame size for a specific target SPI slave device. It is used when the MSS SPI hardware block is used as a SPI master. This function must be called once for each target SPI slave which the MSS SPI master wishes to communicate with. The MSS SPI master hardware will be configured with the configuration specified by this function during calls to *MSS_SPI_set_slave_select()*.

### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block to be configured. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

**slave**

The *slave* parameter is used to identify a target SPI slave. The driver will hold the MSS SPI master configuration required to communicate with this slave, as specified by the other function parameters. Allowed values are:

- MSS_SPI_SLAVE_0
- MSS_SPI_SLAVE_1
- MSS_SPI_SLAVE_2
- MSS_SPI_SLAVE_3
- MSS_SPI_SLAVE_4
- MSS_SPI_SLAVE_5
- MSS_SPI_SLAVE_6
- MSS_SPI_SLAVE_7

**protocol_mode**

This parameter is used to specify the SPI operating mode. Allowed values are:

- MSS_SPI_MODE0
- MSS_SPI_MODE1
- MSS_SPI_MODE2
- MSS_SPI_MODE3
- MSS_SPI_TI_MODE
- MSS_SPI_NSC_MODE

**clk_div**

SPI clock divider value used to generate the serial interface clock signal from PCLK. Allowed values are even numbers in the range from 2 to 512. The PCLK frequency is divided by the specified value to give the serial interface clock frequency.

**frame_bit_length**

Number of bits making up the frame. The maximum frame length is 32 bits. You must use the MSS_SPI_BLOCK_TRANSFER_FRAME_SIZE constant as the value for *frame_bit_length* when configuring the MSS SPI master for block transfer transactions with the target SPI slave.

## Return Value

This function does not return a value.

## Example

```
MSS_SPI_init( &g_mss_spi0 );

MSS_SPI_configure_master_mode
  (
      &g_mss_spi0,
      MSS_SPI_SLAVE_0,
      MSS_SPI_MODE2,
      64,
      12
   );

MSS_SPI_configure_master_mode
  (
      &g_mss_spi0,
      MSS_SPI_SLAVE_1,
      MSS_SPI_TI_MODE,
      128,
      MSS_SPI_BLOCK_TRANSFER_FRAME_SIZE
  ) ;

/* Send 12 bit frame to first slave */
MSS_SPI_set_slave_select(&g_mss_spi0, MSS_SPI_SLAVE_0);
MSS_SPI_transfer_frame(&g_mss_spi0, 0xaaa);
MSS_SPI_clear_slave_select(&g_mss_spi0, MSS_SPI_SLAVE_0);

/* Send 8 bit frame to second slave */
MSS_SPI_set_slave_select(&g_mss_spi0, MSS_SPI_SLAVE_1);
MSS_SPI_transfer_frame(&g_mss_spi0, 0x55);
MSS_SPI_clear_slave_select(&g_mss_spi0, MSS_SPI_SLAVE_1);
```

## MSS_SPI_configure_slave_mode

### Prototype

```
void MSS_SPI_configure_slave_mode
(
    mss_spi_instance_t * this_spi,
    mss_spi_protocol_mode_t protocol_mode,
    uint8_t frame_bit_length
);
```

### Description

The *MSS_SPI_configure_slave_mode()* function configure a MSS SPI block for operations as a slave SPI device. It configures the SPI hardware with the selected SPI protocol mode and frame size for communication with a specific SPI master.

### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block to be configured. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

**protocol_mode**

This parameter is used to specify the SPI operating mode. Allowed values are:

- MSS_SPI_MODE0
- MSS_SPI_MODE1
- MSS_SPI_MODE2
- MSS_SPI_MODE3
- MSS_TI_MODE
- MSS_NSC_MODE

**frame_bit_length**

Number of bits making up the frame. The maximum frame length is 24 bits in NSC Microwire mode and 32 bits for other modes. You must use the MSS_SPI_BLOCK_TRANSFER_FRAME_SIZE constant as the value for *frame_bit_length* when configuring the MSS SPI master for block transfer transactions with the target SPI slave.

### Return Value

This function does not return a value.

### Example

```
MSS_SPI_init( &g_mss_spi0 );
MSS_SPI_configure_slave_mode
(
    &g_mss_spi0,
    MSS_SPI_MODE2,
    MSS_SPI_BLOCK_TRANSFER_FRAME_SIZE
);
```

## MSS_SPI_enable

### Prototype

```
void MSS_SPI_enable
(
    mss_spi_instance_t * this_spi
);
```

### Description

The *MSS_SPI_enable()* function is used to re-enable a MSS SPI hardware block after it was disabled using the *SPI_disable()* function.

### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block to operate on. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

### Return Value

This function does not return a value.

### Example

```
uint32_t transfer_size;
uint8_t tx_buffer[8] = { 1, 2, 3, 4, 5, 6, 7, 8 };

transfer_size = sizeof(tx_buffer);

MSS_SPI_disable( &g_mss_spi0 );
MSS_SPI_set_transfer_byte_count( &g_mss_spi0, transfer_size );
PDMA_start
(
    PDMA_CHANNEL_0,
    (uint32_t)tx_buffer,
    PDMA_SPI0_TX_REGISTER,
    transfer_size
);
MSS_SPI_enable( &g_mss_spi0 );

while ( !MSS_SPI_tx_done( &g_mss_spi0 ) )
{
    ;
}
```

## MSS_SPI_disable

### Prototype

```
void MSS_SPI_disable
(
    mss_spi_instance_t * this_spi
);
```

### Description

The *MSS_SPI_disable()* function is used to temporarily disable a MSS SPI hardware block. This function is typically used in conjunction with the *SPI_set_transfer_byte_count()* function to setup a DMA controlled SPI transmit transaction as the *SPI_set_transfer_byte_count()* function must only be used when the MSS SPI hardware is disabled.

### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block to operate on. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

### Return Value

This function does not return a value.

### Example

```
uint32_t transfer_size;
uint8_t tx_buffer[8] = { 1, 2, 3, 4, 5, 6, 7, 8 };

transfer_size = sizeof(tx_buffer);

MSS_SPI_disable( &g_mss_spi0 );
MSS_SPI_set_transfer_byte_count( &g_mss_spi0, transfer_size );
PDMA_start
(
    PDMA_CHANNEL_0,
    (uint32_t)tx_buffer,
    PDMA_SPI0_TX_REGISTER,
    transfer_size
);
MSS_SPI_enable( &g_mss_spi0 );

while ( !MSS_SPI_tx_done( &g_mss_spi0 ) )
{
    ;
}
```

## MSS_SPI_set_slave_select

### Prototype

```
void MSS_SPI_set_slave_select
(
    mss_spi_instance_t * this_spi,
    mss_spi_slave_t slave
);
```

### Description

The *MSS_SPI_set_slave_select()* function is used by an MSS SPI master to select a specific slave. This function causes the relevant slave select signal to be asserted while data is clocked out onto the SPI data line. This function also configures the MSS SPI master with the configuration settings necessary for communication with the specified slave. These configuration settings must be specified in a previous call to the *MSS_SPI_configure_master_mode()* function.

### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block to operate on. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

**slave**

The *slave* parameter is one of the *mss_spi_slave_t* enumerated constants identifying the slave.

### Return Value

This function does not return a value.

### Example

```
const uint8_t frame_size = 25;
const uint32_t master_tx_frame = 0x0100A0E1;

MSS_SPI_init( &g_mss_spi0 );
MSS_SPI_configure_master_mode
(
    &g_mss_spi0,
    MSS_SPI_SLAVE_0,
    MSS_SPI_MODE1,
    256,
    frame_size
);

MSS_SPI_set_slave_select( &g_mss_spi0, MSS_SPI_SLAVE_0 );
MSS_SPI_transfer_frame( &g_mss_spi0, master_tx_frame );
MSS_SPI_clear_slave_select( &g_mss_spi0, MSS_SPI_SLAVE_0 );
```

## MSS_SPI_clear_slave_select

### Prototype

```
void MSS_SPI_clear_slave_select
(
    mss_spi_instance_t * this_spi,
    mss_spi_slave_t slave
);
```

### Description

The *MSS_SPI_clear_slave_select()* function is used by a MSS SPI master to deselect a specific slave. This function causes the relevant slave select signal to be de-asserted.

### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block to operate on. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

**slave**

The *slave* parameter is one of the *mss_spi_slave_t* enumerated constants identifying a slave.

### Return Value

This function does not return a value.

### Example

```
const uint8_t frame_size = 25;
const uint32_t master_tx_frame = 0x0100A0E1;

MSS_SPI_init( &g_mss_spi0 );
MSS_SPI_configure_master_mode
(
    &g_mss_spi0,
    MSS_SPI_SLAVE_0,
    MSS_SPI_MODE1,
    256,
    frame_size
);
MSS_SPI_set_slave_select( &g_mss_spi0, MSS_SPI_SLAVE_0 );
MSS_SPI_transfer_frame( &g_mss_spi0, master_tx_frame );
MSS_SPI_clear_slave_select( &g_mss_spi0, MSS_SPI_SLAVE_0 );
```

## MSS_SPI_transfer_frame

### Prototype

```
uint32_t MSS_SPI_transfer_frame
(
    mss_spi_instance_t * this_spi,
    uint32_t tx_bits
);
```

### Description

The *MSS_SPI_transfer_frame()* function is used by an MSS SPI master to transmit and receive a frame up to 32 bits long. This function is typically used for transactions with a SPI slave where the number of transmit and receive bits is not divisible by 8.

Note: The maximum frame size in NSC Microwire mode is 24 bits organized as an 8 bit command followed by up to 16 bits of data.

### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block to operate on. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

**tx_bits**

The *tx_bits* parameter is a 32-bit word containing the data that will be transmitted.

Note: The bit length of the value to be transmitted to the slave must be specified as the *frame_bit_length* parameter in a previous call to the *MSS_SPI_configure_master_mode()* function.

### Return Value

This function returns a 32-bit word containing the data that is received from the slave.

### Example

```
const uint8_t frame_size = 25;
const uint32_t master_tx_frame = 0x0100A0E1;
uint32_t master_rx;

MSS_SPI_init( &g_mss_spi0 );
MSS_SPI_configure_master_mode
(
    &g_mss_spi0,
    MSS_SPI_SLAVE_0,
    MSS_SPI_MODE1,
    256,
    frame_size
);

MSS_SPI_set_slave_select( &g_mss_spi0, MSS_SPI_SLAVE_0 );
master_rx = MSS_SPI_transfer_frame( &g_mss_spi0, master_tx_frame );
MSS_SPI_clear_slave_select( &g_mss_spi0, MSS_SPI_SLAVE_0 );
```

## MSS_SPI_transfer_block

### Prototype

```
void MSS_SPI_transfer_block
(
    mss_spi_instance_t * this_spi,
    const uint8_t * cmd_buffer,
    uint16_t cmd_byte_size,
    uint8_t * rd_buffer,
    uint16_t rd_byte_size
);
```

### Description

The *MSS_SPI_transfer_block()* function is used by MSS SPI masters to transmit and receive blocks of data organized as a specified number of bytes. It can be used for:

- Writing a data block to a slave
- Reading a data block from a slave
- Sending a command to a slave followed by reading the response to the command in a single SPI transaction. This function can be used alongside peripheral DMA functions to perform the actual moving to and from the SPI hardware block using peripheral DMA.

### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block to operate on. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

**cmd_buffer**

The *cmd_buffer* parameter is a pointer to the buffer containing the data that will be sent by the master from the beginning of the transfer. This pointer can be null (0) if the master does not need to send a command before reading data or if the command part of the transfer is written to the SPI hardware block using DMA.

**cmd_byte_size**

The *cmd_byte_size* parameter specifies the number of bytes contained in *cmd_buffer* that will be sent. A value of 0 indicates that no data needs to be sent to the slave. A non-zero value while the *cmd_buffer* pointer is 0 is used to indicate that the command data will be written to the SPI hardware block using DMA.

**rd_buffer**

The *rd_buffer* parameter is a pointer to the buffer where the data received from the slave after the command has been sent will be stored.

**rd_byte_size**

The *rd_byte_size* parameter specifies the number of bytes to be received from the slave and stored in the *rd_buffer*. A value of 0 indicates that no data is to be read from the slave. A non-zero value while the *rd_buffer* pointer is null (0) is used to specify the receive size when using DMA to read from the slave.

Note: When using DMA, all bytes received from the slave, including the bytes received while the command is sent, will be read through DMA.

## Return Value

This function does not return a value.

## Example

### Polled write transfer example

```
uint8_t master_tx_buffer[MASTER_TX_BUFFER] =
{
    0x31, 0x32, 0x33, 0x34, 0x35, 0x36, 0x37, 0x38, 0x39, 0x3A
};
MSS_SPI_init( &g_mss_spi0 );
MSS_SPI_configure_master_mode
(
    &g_mss_spi0,
    MSS_SPI_SLAVE_0,
    MSS_SPI_MODE1,
    256u,
    MSS_SPI_BLOCK_TRANSFER_FRAME_SIZE
);

MSS_SPI_set_slave_select( &g_mss_spi0, MSS_SPI_SLAVE_0 );
MSS_SPI_transfer_block
(
    &g_mss_spi0,
    master_tx_buffer,
    sizeof(master_tx_buffer),
    0,
    0
);
MSS_SPI_clear_slave_select( &g_mss_spi0, MSS_SPI_SLAVE_0 );
```

### DMA transfer

In this example, the transmit and receive buffers are not specified as part of the call *to MSS_SPI_transfer_block()*. *MSS_SPI_transfer_block()* will only prepare the MSS SPI hardware for a transfer. The MSS SPI transmit hardware FIFO is filled using one DMA channel and a second DMA channel is used to read the content of the MSS SPI receive hardware FIFO. The transmit and receive buffers are specified by two separate calls to *PDMA_start()* to initiate DMA transfers on the channel used for transmit data and the channel used for receive data.

```
uint8_t master_tx_buffer[MASTER_RX_BUFFER] =
{
    0xC1, 0xC2, 0xC3, 0xC4, 0xC5, 0xC6, 0xC7, 0xC8, 0xC9, 0xCA
};
uint8_t slave_rx_buffer[MASTER_RX_BUFFER] =
{
    0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x07, 0x08, 0x09, 0x0A
};
MSS_SPI_init( &g_mss_spi0 );

MSS_SPI_configure_master_mode
(
    &g_mss_spi0,
    MSS_SPI_SLAVE_0,
```

```
    MSS_SPI_MODE1,
    256u,
    MSS_SPI_BLOCK_TRANSFER_FRAME_SIZE
);
MSS_SPI_set_slave_select( &g_mss_spi0, MSS_SPI_SLAVE_0 );
MSS_SPI_transfer_block( &g_mss_spi0, 0, 0, 0, 0 );
PDMA_start
(
    PDMA_CHANNEL_1,
    PDMA_SPI0_RX_REGISTER,
    (uint32_t)master_rx_buffer,
    sizeof(master_rx_buffer)
);
PDMA_start
(
    PDMA_CHANNEL_2,
    (uint32_t)master_tx_buffer,
    PDMA_SPI0_TX_REGISTER,
    sizeof(master_tx_buffer)
);
while( PDMA_status(PDMA_CHANNEL_1) == 0 )
{
   ;
}
MSS_SPI_clear_slave_select( &g_mss_spi0, MSS_SPI_SLAVE_0 );
```

## MSS_SPI_set_slave_tx_frame

### Prototype

```
void MSS_SPI_set_slave_tx_frame
(
    mss_spi_instance_t * this_spi,
    uint32_t frame_value
);
```

### Description

The *MSS_SPI_set_slave_tx_frame()* function is used by MSS SPI slaves to specify the frame that will be transmitted when a transaction is initiated by the SPI master.

### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block to operate on. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

**frame_value**

The *frame_value* parameter contains the value of the frame to be sent to the master.

Note: The bit length of the value to be transmitted to the master must be specified as the *frame_bit_length* parameter in a previous call to the *MSS_SPI_configure_slave_mode()* function.

### Return Value

This function does not return a value.

### Example

```
const uint16_t frame_size = 25;
const uint32_t slave_tx_frame = 0x0110F761;
uint32_t master_rx;

MSS_SPI_init( &g_mss_spi1 );
MSS_SPI_configure_slave_mode
(
    &g_mss_spi1,
    MSS_SPI_MODE2,
    frame_size
);
MSS_SPI_set_slave_tx_frame( &g_mss_spi1, slave_tx_frame );
```

## MSS_SPI_set_slave_block_buffers

### Prototype

```
void MSS_SPI_set_slave_block_buffers
(
    mss_spi_instance_t * this_spi,
    const uint8_t * tx_buffer,
    uint32_t tx_buff_size,
    uint8_t * rx_buffer,
    uint32_t rx_buff_size,
    mss_spi_block_rx_handler_t block_rx_handler
);
```

### Description

The *MSS_SPI_set_slave_block_buffers()* function is used to configure an MSS SPI slave for block transfer operations. It specifies one or more of the following:

- The data that will be transmitted when accessed by a master.
- The buffer where data received from a master will be stored.
- The handler function that must be called after the receive buffer has been filled.
- The maximum number of bytes that the slave will accept from the master (excess bytes are discarded).

These parameters allow the following use cases:

- Slave performing an action, after receiving a block of data from a master containing a command. The action will be performed by the receive handler based on the content of the receive data buffer.
- Slave returning a block of data to the master. The type of information is always the same but the actual values change over time. For example, returning the voltage of a predefined set of analog inputs.
- Slave returning data based on a command contained in the first part of the SPI transaction. For example, reading the voltage of the analog input specified by the first data byte by the master. This is achieved by using the *MSS_SPI_set_slave_block_buffers()* function in conjunction with functions *MSS_SPI_set_cmd_handler()* and *MSS_SPI_set_cmd_response()*.
  Refer to the *MSS_SPI_set_cmd_handler()* function description for details of this use case.

### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block to operate on. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

**tx_buffer**

The *tx_buffer* parameter is a pointer to a buffer containing the data that will be sent to the master. This parameter can be set to 0 if the MSS SPI slave is not intended to be the target of SPI read.

**tx_buff_size**

The *tx_buff_size* parameter specifies the number of bytes that will be transmitted by the SPI slave. It is the number of bytes contained in the *tx_buffer*. This parameter can be set to 0 if the MSS SPI slave is not intended to be the target of SPI read transactions.

**rx_buffer**

The *rx_buffer* parameter is a pointer to the buffer where data received from the master will be stored. This parameter can be set to 0 if the MSS SPI slave is not intended to be the target of SPI write or write-read transactions.

**rx_buff_size**

The *rx_buff_size* parameter specifies the size of the receive buffer. It is also the number of bytes that must be received before the receive handler is called, if a receive handler is specified using the *block_rx_handler* parameter. This parameter can be set to 0 if the MSS SPI slave is not intended to be the target of SPI write or write-read transactions.

**block_rx_handler**

The *block_rx_handler* parameter is a pointer to a function that will be called when the receive buffer has been filled. This parameter can be set to 0 if the MSS SPI slave is not intended to be the target of SPI write or write-read transactions.

## Return Value

This function does not return a value.

## Example

**Slave Performing Operation Based on Master Command**

In this example the SPI slave is configured to receive 10 bytes of data or command from the SPI master and process the data received.

```
uint32_t nb_of_rx_handler_calls = 0;

void spi1_block_rx_handler_b
(
    uint8_t * rx_buff,
    uint16_t rx_size
)
{
    ++nb_of_rx_handler_calls;
}

void setup_slave( void )
{
    uint8_t slave_rx_buffer[10] =
    {
        0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00
    };

    MSS_SPI_init( &g_mss_spi1 );
    MSS_SPI_configure_slave_mode
    (
        &g_mss_spi1,
        MSS_SPI_MODE2,
        MSS_SPI_BLOCK_TRANSFER_FRAME_SIZE
    );

    MSS_SPI_set_slave_block_buffers
    (
        &g_mss_spi1,
        0,
        0,
        slave_rx_buffer,
        sizeof(slave_rx_buffer),
        spi1_block_rx_handler_b
    );
```

```
}
```

### Slave Responding to Command

In this example the slave will return data based on a two byte command sent by the master. The first part of the transaction involves the slave reading the command bytes sent by the remote SPI master. Once slave select is de-asserted, the receive handler is called, which determines the response data to be returned to the master during the next block transfer. The second part of the transaction, where the slave returns data based on the command value, is sent using a DMA transfer initiated from within the receive handler.

The *MSS_SPI_set_slave_block_buffers()* function specifies that two commands must be received from the master before the receive handler is called. A delay time must be defined in the application program to delay the master from initiating the second transfer to receive the response data from the MSS SPI slave until the receive handler has executed, determined the response data and set up the DMA transfer.

```
#define MASTER_NB_OF_COMMANDS   2
#define SLAVE_RESPONSE_LENGTH   4

#define RESET_CHANNEL           1
#define CONVERT                 2

void spi1_rx_handler_d
(
    uint8_t * rx_buff,
    uint32_t rx_size
)
{
    uint8_t cmd;
    uint8_t channel;
    const uint8_t * p_response;

    cmd = rx_buff[0];
    channel = rx_buff[1];

    if(RESET_CHANNEL == cmd)
    {
        p_response = rst_chan( channel );
    }
    else if(CONVERT == cmd)
    {
        p_response = conv_strt( channel );
    }
    else
    {
        p_response = rd_response_regs( channel );
    }

    MSS_SPI_disable( &g_mss_spi1 );
    MSS_SPI_set_transfer_byte_count( &g_mss_spi1, SLAVE_RESPONSE_LENGTH );
    PDMA_start
    (
        PDMA_CHANNEL_0,
        (uint32_t)p_response,
        PDMA_SPI1_TX_REGISTER,
```

```
        SLAVE_RESPONSE_LENGTH
    );
    MSS_SPI_enable( &g_mss_spi1 );
    while(!MSS_SPI_tx_done(&g_mss_spi1))
    {
        ;
    }
}

void setup_slave( void )
{
    uint8_t slave_tx_buffer[MASTER_NB_OF_COMMANDS] = {0};
    uint8_t slave_rx_buffer[MASTER_NB_OF_COMMANDS];

    PDMA_init();
    PDMA->RATIO_HIGH_LOW = 0xFF;
    PDMA_configure
    (
        PDMA_CHANNEL_0,
        PDMA_TO_SPI_1,
        PDMA_LOW_PRIORITY | PDMA_BYTE_TRANSFER | PDMA_INC_SRC_ONE_BYTE,
        PDMA_DEFAULT_WRITE_ADJ
    );

    MSS_SPI_init( &g_mss_spi1 );

    MSS_SPI_configure_slave_mode
    (
        &g_mss_spi1,
        MSS_SPI_MODE1,
        MSS_SPI_BLOCK_TRANSFER_FRAME_SIZE
    );

    MSS_SPI_set_slave_block_buffers
    (
        &g_mss_spi1,
        slave_tx_buffer,
        sizeof(slave_rx_buffer),
        slave_rx_buffer,
        sizeof(slave_rx_buffer),
        spi1_rx_handler_d
    );
}
```

## MSS_SPI_set_frame_rx_handler

### Prototype

```
void MSS_SPI_set_frame_rx_handler
(
    mss_spi_instance_t * this_spi,
    mss_spi_frame_rx_handler_t rx_handler
);
```

### Description

The *MSS_SPI_set_frame_rx_handler()* function is used by MSS SPI slaves to specify the receive handler function that will be called by the MSS SPI driver interrupt handler when a frame of data is received by the MSS SPI slave.

### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block to operate on. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

**rx_handler**

The *rx_handler* parameter is a pointer to the frame receive handler that must be called when a frame is received by the MSS SPI slave.

### Return Value

This function does not return a value.

### Example

```
uint32_t g_slave_rx_frame = 0;

void slave_frame_handler( uint32_t rx_frame )
{
    g_slave_rx_frame = rx_frame;
}

int setup_slave( void )
{
    const uint16_t frame_size = 25;
    MSS_SPI_init( &g_mss_spi1 );
    MSS_SPI_configure_slave_mode
    (
        &g_mss_spi1,
        MSS_SPI_MODE2,
        frame_size
    );
    MSS_SPI_set_frame_rx_handler( &g_mss_spi1, slave_frame_handler );
}
```

## MSS_SPI_set_transfer_byte_count

### Prototype

```
void MSS_SPI_set_transfer_byte_count
(
    mss_spi_instance_t * this_spi,
    uint16_t byte_count
);
```

### Description

The *MSS_SPI_set_transfer_byte_count()* function is used as part of setting up a SPI transfer using DMA. It specifies the number of bytes that must be transferred before *MSS_SPI_tx_done()* indicates that the transfer is complete.

As well as setting the frame count, this function also sets the frame size to 8 bits.

### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block to operate on. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

**Byte_count**

The *byte_count* parameter specifies the number of bytes that must be transferred by the SPI hardware block before *MSS_SPI_tx_done()* indicates that the transfer is complete.

### Return Value

This function does not return a value.

### Example

```
uint32_t transfer_size;
uint8_t tx_buffer[8] = { 1, 2, 3, 4, 5, 6, 7, 8 };

transfer_size = sizeof(tx_buffer);

MSS_SPI_disable( &g_mss_spi0 );

MSS_SPI_set_transfer_byte_count( &g_mss_spi0, transfer_size );

PDMA_start( PDMA_CHANNEL_0, (uint32_t)tx_buffer, PDMA_SPI0_TX_REGISTER, transfer_size );

MSS_SPI_enable( &g_mss_spi0 );

while ( !MSS_SPI_tx_done( &g_mss_spi0) )
{
    ;
}
```

## MSS_SPI_tx_done

### Prototype

```
uin32_t MSS_SPI_tx_done
(
    mss_spi_instance_t * this_spi
);
```

### Description

The *MSS_SPI_tx_done()* function is used to find out if a DMA controlled transfer has completed.

### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block to operate on. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

### Return Value

This function indicates if a SPI transfer has completed. It returns 1 if the number of bytes specified through a previous call to *MSS_SPI_set_transfer_byte_count()* has been sent by the MSS SPI. It returns 0 if some bytes remain to be sent.

### Example

```
uint32_t transfer_size;
uint8_t tx_buffer[8] = { 1, 2, 3, 4, 5, 6, 7, 8 };

transfer_size = sizeof(tx_buffer);

MSS_SPI_disable( &g_mss_spi0 );

MSS_SPI_set_transfer_byte_count( &g_mss_spi0, transfer_size );

PDMA_start
(
    PDMA_CHANNEL_0,
    (uint32_t)tx_buffer,
    PDMA_SPI0_TX_REGISTER,
    transfer_size
);

MSS_SPI_enable( &g_mss_spi0 );

while ( !MSS_SPI_tx_done(&g_mss_spi0) )
{
    ;
}
```

## MSS_SPI_set_cmd_handler

### Prototype

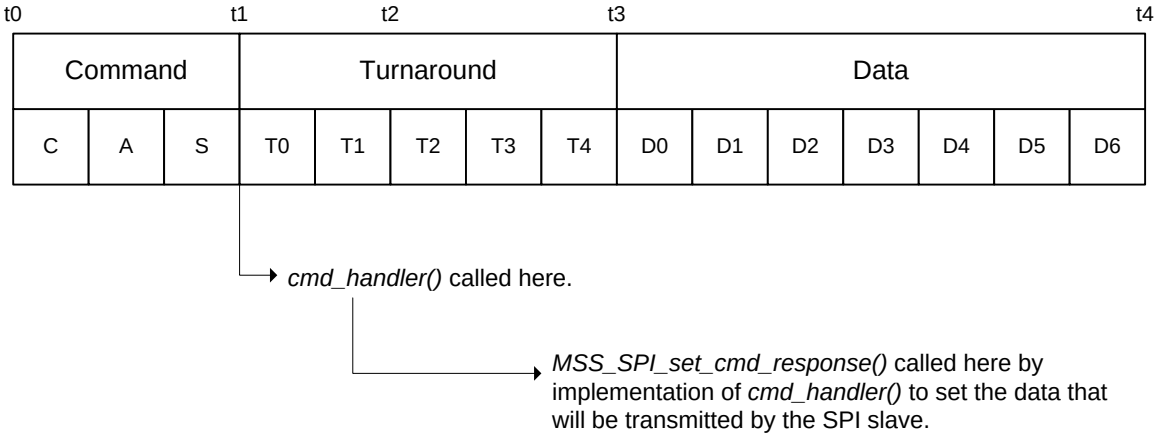
```
void MSS_SPI_set_cmd_handler
(
    mss_spi_instance_t * this_spi,
    mss_spi_block_rx_handler_t cmd_handler,
    uint32_t cmd_size
);
```

### Description

The *MSS_SPI_set_cmd_handler()* function specifies a command handler function that will be called when the number of bytes received reaches the command size specified as parameter.

This function is used by SPI slaves performing block transfers. Its purpose is to allow a SPI slave to decide the data that will be returned to the master while a SPI transaction is taking place. Typically, one or more command bytes are sent by the master to request some specific data. The slave interprets the command byte(s) while one or more turn-around bytes are transmitted. The slave adjusts its transmit data buffer based on the command during the turnaround time.

The diagram below provides an example of the use of this function where the SPI slave returns data bytes D0 to D6 based on the value of a command. The 3 bytes long command is made up of a command opcode byte, followed by an address byte, followed by a size byte. The *cmd_handler()* function specified through an earlier call to *MSS_SPI_set_cmd_handler()* is called by the SPI driver once the third byte is received. The *cmd_handler()* function interprets the command bytes and calls *MSS_SPI_set_cmd_response()* to fill the SPI slave's response transmit buffer with the data to be transmitted after the turn around bytes (T0 to T3). The number of turnaround bytes must be sufficient to give enough time for the *cmd_handler()* to execute. The number of turnaround bytes is specified by the protocol used on top of the SPI transport layer, so both the master and slave must adhere to this.




### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block to operate on. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

**cmd_handler**

The *cmd_handler* parameter is a pointer to a function with prototype:

```
void cmd_handler(uint8_t * rx_buff, uint32_t rx_size);
```

It specifies the function that will be called when the number of bytes specified by the *cmd_size* parameter has been received.

Passing in a null pointer for this disables the command handler and the associated interrupt.

**cmd_size**

The *cmd_size* parameter specifies the number of bytes that must be received before the command handler function specified by *cmd_handler* parameter is called.

## Return Value

This function does not return a value.

## Example

The example below demonstrates how to configure SPI1 to implement the protocol given as example in the diagram above. The *configure_slave()* function configures SPI1. It sets the receive and transmit buffers. The transmit buffer specified through the call to *MSS_SPI_set_slave_block_buffers()* specifies the data that will be returned to the master in bytes between t0 and t3. These are the bytes that will be sent to the master while the master transmits the command and dummy bytes. The *spi1_slave_cmd_handler()* function will be called by the driver at time t1 after the 3 command bytes have been received. The *spi1_block_rx_handler()* function will be called by the driver at time t4 when the transaction completes when the slave select signal becomes de-asserted.

```
#define COMMAND_SIZE            3
#define NB_OF_DUMMY_BYTES       5
#define MAX_TRANSACTION_SIZE    15

uint8_t slave_tx_buffer[COMMAND_SIZE + NB_OF_DUMMY_BYTES];
uint8_t slave_rx_buffer[MAX_TRANSACTION_SIZE];

void configure_slave(void)
{
    MSS_SPI_init( &g_mss_spi1 );

    MSS_SPI_configure_slave_mode
    (
        &g_mss_spi1,
        MSS_SPI_MODE1,
        MSS_SPI_BLOCK_TRANSFER_FRAME_SIZE
    );

    MSS_SPI_set_slave_block_buffers
    (
        &g_mss_spi1,
        slave_tx_buffer,
        COMMAND_SIZE + NB_OF_DUMMY_BYTES,
        slave_rx_buffer,
        sizeof(slave_rx_buffer),
        spi1_block_rx_handler
    );

    MSS_SPI_set_cmd_handler
    (
        &g_mss_spi1,
        spi1_slave_cmd_handler,
```

```
        COMMAND_SIZE
    );
}

void spi1_slave_cmd_handler
(
    uint8_t * rx_buff,
    uint32_t rx_size
)
{
    uint8_t command;
    uint8_t address;
    uint8_t size;

    uint8_t * p_response;
    uint32_t response_size;

    command = rx_buff[0];
    address = rx_buff[1];
    size = rx_buff[2];

    p_response = get_response_data(command, address, size, &response_size);

    MSS_SPI_set_cmd_response(&g_mss_spi1, p_response, response_size);
}

void spi1_block_rx_handler
(
    uint8_t * rx_buff,
    uint32_t rx_size
)
{
    process_rx_data(rx_buff, rx_size);
}
```

## MSS_SPI_set_cmd_response

### Prototype

```
void MSS_SPI_set_cmd_response
(
    mss_spi_instance_t * this_spi,
    const uint8_t * resp_tx_buffer,
    uint32_t resp_buff_size
);
```

### Description

The *MSS_SPI_set_cmd_response()* function specifies the data that will be returned to the master, when a command has been received by the slave. This function is called as part of the *MSS_SPI_set_cmd_handler()* . See the description of *MSS_SPI_set_cmd_handler()* for more details.

### Parameters

**this_spi**

The *this_spi* parameter is a pointer to an *mss_spi_instance_t* structure identifying the MSS SPI hardware block used. There are two such data structures, *g_mss_spi0* and *g_mss_spi1*, associated with MSS SPI 0 and MSS SPI 1 respectively. This parameter must point to either the *g_mss_spi0* or *g_mss_spi1* global data structure defined within the SPI driver.

**resp_tx_buffer**

The *resp_tx_buffer* parameter is a pointer to the buffer containing the data that must be returned to the host in the data phase of a SPI command oriented transaction.

**resp_buff_size**

The *resp_buff_size* parameter specifies the size of the buffer pointed to by the *resp_tx_buffer* parameter.

### Return Value

This function does not return a value.

# Product Support

Microsemi SoC Products Group backs its products with various support services, including Customer Service, Customer Technical Support Center, a website, electronic mail, and worldwide sales offices. This appendix contains information about contacting Microsemi SoC Products Group and using these support services.

## Customer Service

Contact Customer Service for non-technical product support, such as product pricing, product upgrades, update information, order status, and authorization.

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From the rest of the world, call **650.318.4460**
Fax, from anywhere in the world **408.643.6913**

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## Technical Support

Visit the Microsemi SoC Products Group Customer Support website for more information and support (http://www.microsemi.com/soc/support/search/default.aspx). Many answers available on the searchable web resource include diagrams, illustrations, and links to other resources on website.

## Website

You can browse a variety of technical and non-technical information on the Microsemi SoC Products Group home page, at http://www.microsemi.com/soc/.

## Contacting the Customer Technical Support Center

Highly skilled engineers staff the Technical Support Center. The Technical Support Center can be contacted by email or through the Microsemi SoC Products Group website.

### Email

You can communicate your technical questions to our email address and receive answers back by email, fax, or phone. Also, if you have design problems, you can email your design files to receive assistance. We constantly monitor the email account throughout the day. When sending your request to us, please be sure to include your full name, company name, and your contact information for efficient processing of your request.

The technical support email address is soc_tech@microsemi.com.

### My Cases

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### Outside the U.S.

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## ITAR Technical Support

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