Future Technology Devices International Ltd.

Application Note AN_110

Programmers Guide for High Speed FTCJTAG DLL

Document Reference No.: FT_000111

Version 1.2

Issue Date: 2009-03-18

This document provides details of the function calls required when using the High Speed FTCJTAG dll.

Future Technology Devices International Limited (FTDI)

Unit1, 2 Seaward Place, Centurion Business Park, Glasgow G41 1HH United Kingdom
Tel.: +44 (0) 141 429 2777 Fax: + 44 (0) 141 429 2758
E-Mail (Support): **support1@ftdichip.com** Web: http://www.ftdichip.com

TABLE OF CONTENTS

1 Introduction

The FT2232D, FT2232H and FT4232H devices contains FTDI's multi-protocol synchronous serial engine (MPSSE) controller, which may be used to interface to many popular synchronous serial protocols including JTAG, SPI and I2C.

The FT2232 JTAG API will provide a set of function's to allow a programmer to control the FT2232D dual device MPSSE controller, the FT2232H dual device MPSSE hi-speed controller and the FT4232H quad device MPSSE hi-speed controller, to communicate with other devices using the Joint Test Action Group(JTAG) synchronous serial protocol interface. The FT2232 JTAG API will be contained within the **FTCJTAG.DLL**.

The FTCJTAG DLL has been created to allow application developers to use the FT2232D, FT2232H and FT4232H devices to create a USB to Joint Test Action Group(JTAG) protocol interface without any knowledge of the MPSSE command set. All of the functions in FTCJTAG.DLL can be replicated using calls to FTD2XX.DLL and sending the appropriate commands to the MPSSE.

The FT2232D MPSSE controller is only available through channel A of the FT2232D device; channel B of the FT2232D device does not support the MPSSE. Channel B may be controlled independently using FTDI's FTD2XX drivers while channel A is being used for JTAG communication.

The FT2232H MPSSE controller is available through channels A and B of the FT2232H device; both channels A and B can be used for JTAG communication.

The FT4232H MPSSE controller is only available through channels A and B of the FT4232H device; channels C and D of the FT4232H device do not support the MPSSE. Channels C and D may be controlled independently using FTDI's FTD2XX drivers while channels A and B are being used for JTAG communication.

This document lists all of the functions available in FTCJTAG.DLL.

2 Application Programming Interface(API)

2.1 Public Functions

The following section contains details of all the functions available in the FTCJTAG dll.

2.1.1 JTAG_GetNumDevices

FTC_STATUS JTAG_GetNumDevices(LPDWORD lpdwNumDevices)

This function must be used, if more than one FT2232D dual device will be connected to a system. This function returns the number of available FT2232D dual device(s) connected to a system.

Parameters

lpdwNumDevices	Pointer to a variable of type DWORD which receives the actual number of available FT2232D dual device(s) connected to a system.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_IO_ERROR

2.1.2 JTAG_GetNumHiSpeedDevices

FTC_STATUS JTAG_GetNumHiSpeedDevices(LPDWORD lpdwTotalNumHiSpeedDevices)

This function must be used, if more than one FT2232H dual/FT4232H quad hi-speed devices will be connected to a system. This function returns the number of available FT2232H dual and FT4232H quad hi-speed device(s) connected to a system.

Parameters

lpdwTotalNumHiSpeedDevices	Pointer to a variable of type DWORD which receives the total number of available FT2232H dual and FT4232H quad hi-speed device(s) connected to a system.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_IO_ERROR

2.1.3 JTAG_GetDeviceNameLocID

FTC_STATUS JTAG_GetDeviceNameLocID(DWORD dwDeviceNameIndex, LPSTR lpDeviceNameBuffer, DWORD dwBufferSize, LPDWORD lpdwLocationID)

This function returns the name and the location identifier of the specified FT2232D dual device connected to a system.

Parameters

dwDeviceNameIndex	Index of the FT2232D dual device. Use the FT2232D_GetNumDevices function call, see section 2.1.1, to get the number of available FT2232D dual device(s) connected to a system. Example: if the number of a specific FT2232D dual device returned is 2 then valid index values will be 0 and 1.
lpDeviceNameBuffer	Pointer to buffer that receives the device name of the specified FT2232D dual device connected to a system. The string will be NULL terminated.
dwBufferSize	Length of the buffer created for the device name string. Set buffer length to a minimum of 50 characters.
lpdwLocationID	Pointer to a variable of type DWORD which receives the location identifier of the specified FT2232D dual device connected to a system.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_DEVICE_NOT_FOUND
FTC_INVALID_DEVICE_NAME_INDEX
FTC_NULL_ DEVICE_NAME_BUFFER_POINTER
FTC_ DEVICE_NAME_BUFFER_TOO_SMALL
FTC_IO_ERROR

2.1.4 JTAG_GetHiSpeedDeviceNameLocIDChannel

FTC_STATUS JTAG_GetHiSpeedDeviceNameLocIDChannel(DWORD dwDeviceNameIndex, LPSTR lpDeviceNameBuffer, DWORD dwDeviceNameBufferSize, LPDWORD lpdwLocationID, LPSTR lpChannelBuffer)

This function returns the name, location identifier and the channel of the specified FT2232H dual hi-speed device or FT4232H quad hi-speed device connected to a system.

Parameters

dwDeviceNameIndex	Index of the FT2232H dual hi-speed device or FT4232H quad hi-speed device. Use the JTAG_GetNumHiSpeedDevices function call, see section 2.1.2, to get the number of available FT2232H dual and FT4232H quad hi-speed device(s) connected to a system. Example: if the number of FT2232H dual and FT4232H quad hi-speed device(s) returned is 2 then valid index values will be 0 and 1.
lpDeviceNameBuffer	Pointer to buffer that receives the device name of the specified FT2232H dual hi-speed device or FT4232H quad hi-speed device connected to a system. The string will be NULL terminated.
dwDeviceNameBufferSize	Length of the buffer created for the device name string. Set buffer length to a minimum of 100 characters.
lpdwLocationID	Pointer to a variable of type DWORD which receives the location identifier of the specified FT2232H dual hi-speed device or FT4232H quad hi-speed device connected to a system.
lpChannelBuffer	Pointer to a buffer that receives the channel of the specified FT2232H dual hi-speed device or FT4232H quad hi-speed device connected to a system. The buffer will only return a single character either A or B. The string will be NULL terminated.
dwChannelBufferSize	Length of the buffer created for the channel string. Set buffer length to a minimum of 5 characters.
lpdwHiSpeedDeviceType	Pointer to a variable of type DWORD which receives the actual type of hi-speed device, FT2232H dual hi-speed or FT4232H quad hi-speed. **Valid Hi-Speed Device Types** FT2232H_DEVICE_TYPE FT4232H_DEVICE_TYPE

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_DEVICE_NOT_FOUND
FTC_INVALID_DEVICE_NAME_INDEX
FTC_NULL_DEVICE_NAME_BUFFER_POINTER
FTC_ DEVICE_NAME_BUFFER_TOO_SMALL
FTC_NULL_CHANNEL_BUFFER_POINTER
FTC_CHANNEL_BUFFER_TOO_SMALL
FTC_IO_ERROR

2.1.5 JTAG_Open

FTC_STATUS JTAG_Open(FTC_HANDLE *pftHandle)

This function must only be used, if a maximum of one FT2232D dual device will be connected to a system.

This function first determines which attached application is invoking this function. If an attached application invokes this function again and it's assigned handle is still open then it's assigned handle will be returned again. If another application attempts to open this device, which is already in use, an error code is returned. This function first then determines if a FT2232D dual device is present then checks that an application is not already using this FT2232D dual device. If another application is not using this FT2232D dual device then an attempt is made to open it. If the open was not successful an error code will be returned. If the open is successful, the FT2232D dual device is initialized to its default state, see section 2.1.14. If the initialization was successful the handle is passed back to the application. If the initialization was not successful an error code will be returned.

Parameters

pftHandle	Pointer to a variable of type FTC_HANDLE where the handle to the open device will be returned. This handle must then be used in all subsequent calls to access this device.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_DEVICE_NOT_FOUND
FTC_DEVICE_IN_USE
FTC_TOO_MANY_DEVICES
FTC_FAILED_TO_SYNCHRONIZE_DEVICE_MPSSE
FTC_FAILED_TO_COMPLETE_COMMAND
FTC_IO_ERROR
FTC_INSUFFICIENT_RESOURCES

2.1.6 JTAG_OpenEx

FTC_STATUS JTAG_OpenEx (LPSTR lpDeviceName, DWORD dwLocationID, FTC_HANDLE *pftHandle)

This function first determines which attached application is invoking this function. If an attached application invokes this function again and it's assigned handle is still open then it's assigned handle will be returned again. If another application attempts to open this device, which is already in use, an error code is returned. This function first determines if the specified FT2232D dual device is present then checks that an application is not already using the specified FT2232D dual device. If another application is not using the specified FT2232D dual device then an attempt is made to open it. If the open was not successful an error code will be returned. If the open is successful, the specified FT2232D dual device is initialized to its default state, see section 2.1.14. If the initialization was successful the handle is passed back to the application. If the initialization was not successful an error code will be returned.

Parameters

lpDeviceName	Pointer to a NULL terminated string that contains the name of the specified FT2232D dual device to be opened.
dwLocationID	Specifies the location identifier of the specified FT2232D dual device to be opened.
pftHandle	Pointer to a variable of type FTC_HANDLE where the handle to the open device will be returned. This handle must then be used in all subsequent calls to access this device.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_NULL_DEVICE_NAME_BUFFER_POINTER
FTC_INVALID_DEVICE_NAME
FTC_INVALID_LOCATION_ID
FTC_DEVICE_NOT_FOUND
FTC_DEVICE_IN_USE
FTC_FAILED_TO_SYNCHRONIZE_DEVICE_MPSSE
FTC_FAILED_TO_COMPLETE_COMMAND
FTC_IO_ERROR
FTC_INSUFFICIENT_RESOURCES

2.1.7 JTAG_OpenHiSpeedDevice

FTC_STATUS JTAG_OpenHiSpeedDevice (LPSTR lpDeviceName, DWORD dwLocationID, LPSTR lpChannel, FTC_HANDLE *pftHandle)

This function first determines which attached application is invoking this function. If an attached application invokes this function again and it's assigned handle is still open then it's assigned handle will be returned again. If another application attempts to open this device, which is already in use, an error code is returned. This function first determines if the specified FT2232H dual hi-speed device or FT4232H quad hi-speed device is present then checks that an application is not already using the specified FT2232H dual hi-speed device or FT4232H quad hi-speed device. If another application is not using the specified FT2232H dual hi-speed device or FT4232H quad hi-speed device then an attempt is made to open it. If the open was not successful an error code will be returned. If the open is successful, the specified FT2232H dual hi-speed device or FT4232H quad hi-speed device is initialized to its default state, see section 2.1.14. If the initialization was successful the handle is passed back to the application. If the initialization was not successful an error code will be returned.

Parameters

lpDeviceName	Pointer to a NULL terminated string that contains the name of the specified FT2232H dual hi-speed device or FT4232H quad hi-speed device to be opened.
dwLocationID	Specifies the location identifier of the specified FT2232H dual hi-speed device or FT4232H quad hi-speed device to be opened.
lpChannel	Pointer to a NULL terminated string that contains the channel of the specified FT2232H dual hi-speed device or FT4232H quad hi-speed device to be opened. The channel identifier will be a single character either A or B.
pftHandle	Pointer to a variable of type FTC_HANDLE where the handle to the open device will be returned. This handle must then be used in all subsequent calls to access this device.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_NULL_DEVICE_NAME_BUFFER_POINTER
FTC_INVALID_DEVICE_NAME
FTC_INVALID_LOCATION_ID
FTC_INVALID_CHANNEL
FTC_DEVICE_NOT_FOUND
FTC_DEVICE_IN_USE
FTC_FAILED_TO_SYNCHRONIZE_DEVICE_MPSSE
FTC_FAILED_TO_COMPLETE_COMMAND
FTC_IO_ERROR
FTC_INSUFFICIENT_RESOURCES

2.1.8 JTAG_GetHiSpeedDeviceType

FTC_STATUS JTAG_GetHiSpeedDeviceType (FTC_HANDLE ftHandle, LPDWORD lpdwHiSpeedDeviceType)

This function returns the high speed device type detected. The type should either be FT2232H or FT4232H.

Parameters

ftHandle	Handle of the FT2232H dual hi-speed device or FT4232H quad hi-speed device opened.
lpdwHiSpeedDeviceType	Pointer to a variable of type DWORD which receives the device type.

Valid Hi-Speed Device Types

FT2232H_DEVICE_TYPE
FT4232H_DEVICE_TYPE

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_IO_ERROR

2.1.9 JTAG_Close

FTC_STATUS JTAG_Close(FTC_HANDLE ftHandle)

This function closes a previously opened handle to a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.

Parameters

ftHandle — Handle of the FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device to close.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_IO_ERROR

2.1.10 JTAG_CloseDevice

FTC_STATUS JTAG_CloseDevice (FTC_HANDLE ftHandle, PFTC_CLOSE_FINAL_STATE_PINS pCloseFinalStatePinsData)

This function closes a previously opened handle to a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.

Parameters

ftHandle	Handle of the FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device to close.
pCloseFinalStatePinsData	Pointer to the structure that contains the data that is used to set the final state of output pins TCK, TDI, TMS

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_IO_ERROR

2.1.11 JTAG_InitDevice

FTC_STATUS JTAG_InitDevice(FTC_HANDLE ftHandle, DWORD dwClockDivisor)

This function initializes the FT2232D dual device, by carrying out the following in the following order:

- resets the device and purge device USB input buffer
- sets the device USB input and output buffers to 64K bytes
- sets the special characters for the device, disable event and error characters
- sets the device read timeout to infinite
- sets the device write timeout to 5 seconds
- sets the device latency timer to 16 milliseconds
- reset MPSSE controller
- enable MPSSE controller
- synchronize the MPSSE
- resets the device and purge device USB input buffer
- set data in and data out clock frequency
- set MPSSE loopback state to off (default)

- resets the device and purge device USB input buffer
- reset Test Access Port(TAP) controller on an external device
- set the Test Access Port(TAP) controller on an external device to test idle mode

Parameters

ftHandle	Handle of a FT2232D dual device.
dwClockDivisor	Specifies a divisor, which will be used to set the frequency that will be used to clock data in and out of a FT2232D dual device. Valid range is 0 to 65535. The highest clock frequency is represented by 0, which is equivalent to 6MHz, the next highest clock frequency is represented by 1, which is equivalent to 3MHz and the lowest clock frequency is represented by 65535, which is equivalent to 91Hz. To obtain the actual frequency in Hz, represented by the specified divisor, see section 2.1.18. Note: the frequency in Hz, represented by the divisor, is calculated using the following formula: frequency = 12MHz/((1 + dwClockDivisor) * 2).

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_INVALID_CLOCK_DIVISOR
FTC_FAILED_TO_SYNCHRONIZE_DEVICE_MPSSE
FTC_FAILED_TO_COMPLETE_COMMAND
FTC_IO_ERROR
FTC_INSUFFICIENT_RESOURCES

2.1.12 JTAG_TurnOnDivideByFiveClockingHiSpeedDevice

FTC_STATUS **JTAG_TurnOnDivideByFiveClockinghiSpeedDevice** (FTC_HANDLE fthandle)

This function turns on the divide by five for the MPSSE clock to allow the hi-speed devices FT2232H and FT4232H to clock at the same rate as the FT2232D device. This allows for backward compatibility.

Parameters

ftHandle Handle of a FT2232H dual hi-speed device or FT4232H quad hi-speed device.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_IO_ERROR

2.1.13 JTAG_TurnOffDivideByFiveClockingHiSpeedDevice

FTC_STATUS **JTAG_TurnOffDivideByFiveClockinghiSpeedDevice** (FTC_HANDLE fthandle)

This function turns off the divide by five for the MPSSE clock to allow the hi-speed devices FT2232H and FT4232H to clock at the higher speeds. Maximum is 30Mbit/s

Parameters
ftHandle Handle of a FT2232H dual hi-speed device or FT4232H quad hi-speed device.
Return Value
Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_IO_ERROR

2.1.14 JTAG_TurnOnAdaptiveClockingHiSpeedDevice

FTC_STATUS JTAG_TurnOnAdaptiveClockingHiSpeedDevice (FTC_HANDLE ftHandle)

This function turns on adaptive clocking for a FT2232H dual hi-speed device or FT4232H quad hi-speed device.

Parameters

ftHandle Handle of a FT2232H dual hi-speed device or FT4232H quad hi-speed device.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_IO_ERROR

2.1.15 JTAG_TurnOffAdaptiveClockingHiSpeedDevice

FTC_STATUS JTAG_TurnOffAdaptiveClockingHiSpeedDevice (FTC_HANDLE ftHandle)

This function turns off adaptive clocking for a FT2232H dual hi-speed device or FT4232H quad hi-speed device.

Parameters

ftHandle Handle of a FT2232H dual hi-speed device or FT4232H quad hi-speed device.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_IO_ERROR

2.1.16 JTAG_SetDeviceLatencyTimer

FTC_STATUS JTAG_SetDeviceLatencyTimer(FTC_HANDLE ftHandle, BYTE timerValue)

This function sets the value in milliseconds of the latency timer for a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device. The latency timer is used to flush any remaining data received from a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device from the USB input buffer, when the latency timer times out.

Parameters

ftHandle	Handle of a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.
timerValue	Specifies the value, in milliseconds, of the latency timer. Valid range is 2 - 255.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_INVALID_TIMER_VALUE
FTC_IO_ERROR

2.1.17 JTAG_GetDeviceLatencyTimer

FTC_STATUS JTAG_GetDeviceLatencyTimer(FTC_HANDLE ftHandle, LPBYTE lpTimerValue)

This function gets the value in milliseconds of the latency timer for a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device. The latency timer is used to flush any remaining data received from a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device from the USB input buffer, when the latency timer times out.

Parameters

ftHandle	Handle of a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.
lpTimerValue	Pointer to a variable of type BYTE which receives the actual latency timer value in milliseconds.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_IO_ERROR

2.1.18 JTAG_GetClock

FTC_STATUS JTAG_GetClock (DWORD dwClockDivisor, LPDWORD lpdwClockFrequencyHz)

This function calculates the frequency in **Hz**, that data will be clocked in and out of a FT2232D dual device.

Parameters

dwClockDivisor	Specifies a divisor, which will be used to set the frequency that will be used to clock data in and out of a FT2232D dual device. Valid range is 0 to 65535. The highest clock frequency is represented by 0, which is equivalent to 6MHz, the next highest clock frequency is represented by 1, which is equivalent to 3MHz and the lowest clock frequency is represented by 65535, which is equivalent to 91Hz.
lpdwClockFrequencyHz	Pointer to a variable of type DWORD which receives the actual frequency in **Hz**, that data will be clocked in and out of a FT2232D dual device. Note: the frequency in Hz, represented by the divisor, is calculated using the following formula: frequency = 12MHz/((1 + dwClockDivisor) * 2).

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_CLOCK_DIVISOR

2.1.19 JTAG_GetHiSpeedDeviceClock

FTC_STATUS JTAG_GetHiSpeedDeviceClock (DWORD dwClockDivisor, LPDWORD lpdwClockFrequencyHz)

This function calculates the frequency in **Hz**, that data will be clocked in and out of a FT2232H dual hi-speed device or FT4232H quad hi-speed device.

Parameters

dwClockDivisor	Specifies a divisor, which will be used to set the frequency that will be used to clock data in and out of a FT2232H dual hi-speed device or FT4232H quad hi-speed device. Valid range is 0 to 65535. The highest clock frequency is represented by 0, which is equivalent to 30MHz, the next highest clock frequency is represented by 1, which is equivalent to 15MHz and the lowest clock frequency is represented by 65535, which is equivalent to 457Hz.
lpdwClockFrequencyHz	Pointer to a variable of type DWORD which receives the actual frequency in **Hz**, that data will be clocked in and out of a FT2232H dual hi-speed device or FT4232H quad hi-speed device. Note: the frequency in Hz, represented by the divisor, is calculated using the following formula: frequency = 60MHz/((1 + dwClockDivisor) * 2).

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_CLOCK_DIVISOR

2.1.20 JTAG_SetClock

FTC_STATUS JTAG_SetClock (FTC_HANDLE ftHandle, DWORD dwClockDivisor, LPDWORD lpdwClockFrequencyHz)

This function sets and calculates the frequency in **Hz**, that data will be clocked in and out of a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.

Parameters

ftHandle	Handle of a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.
dwClockDivisor	Specifies a divisor, which will be used to set the frequency that will be used to clock data in and out of a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device. Valid range is 0 to 65535. The highest clock frequency is represented by 0, which is equivalent to 6MHz for the FT2232D dual device and 30MHz for the FT2232H dual and FT4232H quad hi-speed devices, the next highest clock frequency is represented by 1, which is equivalent to 3MHz for the FT2232D dual device and 15MHz for the FT2232H dual and FT4232H quad hi-speed devices and the lowest clock frequency is represented by 65535, which is equivalent to 91Hz for the FT2232D dual device and 457Hz for the FT2232H dual and FT4232H quad hi-speed devices.
lpdwClockFrequencyHz	Pointer to a variable of type DWORD which receives the actual frequency in **Hz**, that data will be clocked in and out of a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device. For the FT2232D dual device the frequency in Hz, represented by the divisor, is calculated using the following formula: frequency = 12MHz/((1 + dwClockDivisor) * 2) For the FT2232H dual and FT4232H quad hi-speed devices the frequency in Hz, represented by the divisor, is calculated using the following formula: frequency = 60MHz/((1 + dwClockDivisor) * 2)

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_INVALID_CLOCK_DIVISOR
FTC_FAILED_TO_COMPLETE_COMMAND
FTC_IO_ERROR

2.1.21 JTAG_SetLoopback

FTC_STATUS JTAG_SetLoopback(FTC_HANDLE ftHandle, BOOL bLoopbackState)

This function controls the state of the FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device loopback. The FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device is set to loopback for testing purposes.

Parameters

ftHandle	Handle of the FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.
bLoopbackState	Controls the state of the FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device loopback. To switch loopback on(TRUE) or off(FALSE).

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_FAILED_TO_COMPLETE_COMMAND
FTC_IO_ERROR

2.1.22 JTAG_SetGPIOs

FTC_STATUS JTAG_SetGPIOs(FTC_HANDLE ftHandle, BOOL bControlLowInputOutputPins, PFTC_INPUT_OUTPUT_PINS pLowInputOutputPinsData, BOOL bControlHighInputOutputPins, PFTC_INPUT_OUTPUT_PINS pHighInputOutputPinsData)

This function controls the use of the 8 general purpose input/output pins (GPIOL1 – GPIOL4 and GPIOH1 – GPIOH4) of the FT2232D dual device.

Parameters

ftHandle	Handle of a FT2232D dual device.
bControlLowInputOutputPins	Controls the use of the 4 general purpose lower input/output pins (GPIOL1 – GPIOL4) of the FT2232D dual device. To control the 4 lower input/output pins(TRUE) or to not control the 4 lower input/output pins(FALSE).
pLowInputOutputPinsData	Pointer to the structure that contains the data that is used to control the 4 general purpose lower input/output pins (GPIOL1 – GPIOL4) of the FT2232D dual device.
bControlHighInputOutputPins	Controls the use of the 4 general purpose higher input/output pins (GPIOH1 – GPIOH4) of the FT2232D dual device. To control the 4 higher input/output pins(TRUE) or to not control the 4 higher input/output pins(FALSE).
pHighInputOutputPinsData	Pointer to the structure that contains the data that is used to control the 4 general purpose higher input/output pins (GPIOH1 – GPIOH4) of the FT2232D dual device.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_NULL_INPUT_OUTPUT_BUFFER_POINTER
FTC_FAILED_TO_COMPLETE_COMMAND
FTC_IO_ERROR

Example:

```
typedef struct FTC_Input_Output_Pins {
        BOOL    bPin1InputOutputState;   Set pin1 to input mode(FALSE), set pin1 to output mode(TRUE)
        BOOL    bPin1LowHighState;       If pin1 is set to output mode, set pin1 low(FALSE), high(TRUE)
        BOOL    bPin2InputOutputState;   Set pin2 to input mode(FALSE), set pin2 to output mode(TRUE)
        BOOL    bPin2LowHighState;       If pin2 is set to output mode, set pin2 low(FALSE), high(TRUE)
        BOOL    bPin3InputOutputState;   Set pin3 to input mode(FALSE), set pin3 to output mode(TRUE)
        BOOL    bPin3LowHighState;       If pin3 is set to output mode, set pin3 low(FALSE), high(TRUE)
        BOOL    bPin4InputOutputState;   Set pin4 to input mode(FALSE), set pin4 to output mode(TRUE)
        BOOL    bPin4LowHighState;       If pin4 is set to output mode, set pin4 low(FALSE), high(TRUE)
    } FTC_INPUT_OUTPUT_PINS *PFTC_INPUT_OUTPUT_PINS
```

2.1.23 JTAG_SetHiSpeedDeviceGPIOs

FTC_STATUS JTAG_SetHiSpeedDeviceGPIOs(FTC_HANDLE ftHandle, BOOL bControlLowInputOutputPins, PFTC_INPUT_OUTPUT_PINS pLowInputOutputPinsData, BOOL bControlHighInputOutputPins, PFTH_INPUT_OUTPUT_PINS pHighInputOutputPinsData)

This function controls the use of the 12 general purpose input/output pins (GPIOL1 – GPIOL4 and GPIOH1 – GPIOH8) of the FT2232H dual hi-speed device or the 4 general purpose lower input/output pins (GPIOL1 – GPIOL4) of the FT4232H quad hi-speed device.

Parameters

ftHandle	Handle of the FT2232H dual hi-speed device or FT4232H quad hi-speed device.
bControlLowInputOutputPins	Controls the use of the 4 general purpose lower input/output pins (GPIOL1 – GPIOL4) of the FT2232H dual hi-speed device or FT4232H quad hi-speed device. To control the 4 lower input/output pins(TRUE) or to not control the 4 lower input/output pins(FALSE).
pLowInputOutputPinsData	Pointer to the structure that contains the data that is used to control the 4 general purpose lower input/output pins (GPIOL1 – GPIOL4) of the FT2232H dual hi-speed device or FT4232H quad hi-speed device.
bControlHighInputOutputPins	Controls the use of the 8 general purpose higher input/output pins (GPIOH1 – GPIOH8) of the FT2232H dual hi-speed device. To control the 8 higher input/output pins(TRUE) or to not control the 8 higher input/output pins(FALSE).
pHighInputOutputPinsData	Pointer to the structure that contains the data that is used to control the general purpose 8 higher input/output pins (GPIOH1 – GPIOH8) of the FT2232H dual hi-speed device. Note: the 8 general purpose higher input/output pins (GPIOH1 – GPIOH8) do not physically exist on the FT4232H quad hi-speed device.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_NULL_INPUT_OUTPUT_BUFFER_POINTER
FTC_FAILED_TO_COMPLETE_COMMAND
FTC_IO_ERROR

Example:

```
typedef struct FTC_Input_Output_Pins {
        BOOL    bPin1InputOutputState;      Set pin1 to input mode(FALSE), set pin1
                                            to output mode(TRUE)
        BOOL    bPin1LowHighState;          If pin1 is set to output mode, set pin1
                                            low(FALSE), high(TRUE)
        BOOL    bPin2InputOutputState;      Set pin2 to input mode(FALSE), set pin2
                                            to output mode(TRUE)
        BOOL    bPin2LowHighState;          If pin2 is set to output mode, set pin2
                                            low(FALSE), high(TRUE)
        BOOL    bPin3InputOutputState;      Set pin3 to input mode(FALSE), set pin3
                                            to output mode(TRUE)
        BOOL    bPin3LowHighState;          If pin3 is set to output mode, set pin3
                                            low(FALSE), high(TRUE)
        BOOL    bPin4InputOutputState;      Set pin4 to input mode(FALSE), set pin4
                                            to output mode(TRUE)
        BOOL    bPin4LowHighState;          If pin4 is set to output mode, set pin4
                                            low(FALSE), high(TRUE)
    } FTC_INPUT_OUTPUT_PINS *PFTC_INPUT_OUTPUT_PINS


typedef struct FTH_Input_Output_Pins {
        BOOL    bPin1InputOutputState;      Set pin1 to input mode(FALSE), set pin1
                                            to output mode(TRUE)
        BOOL    bPin1LowHighState;          If pin1 is set to output mode, set pin1
                                            low(FALSE), high(TRUE)
        BOOL    bPin2InputOutputState;      Set pin2 to input mode(FALSE), set pin2
                                            to output mode(TRUE)
        BOOL    bPin2LowHighState;          If pin2 is set to output mode, set pin2
                                            low(FALSE), high(TRUE)
        BOOL    bPin3InputOutputState;      Set pin3 to input mode(FALSE), set pin3
                                            to output mode(TRUE)
        BOOL    bPin3LowHighState;          If pin3 is set to output mode, set pin3
                                            low(FALSE), high(TRUE)
        BOOL    bPin4InputOutputState;      Set pin4 to input mode(FALSE), set pin4
                                            to output mode(TRUE)
        BOOL    bPin4LowHighState;          If pin4 is set to output mode, set pin4
                                            low(FALSE), high(TRUE)
        BOOL    bPin5InputOutputState;      Set pin5 to input mode(FALSE), set pin5
                                            to output mode(TRUE)
        BOOL    bPin5LowHighState;          If pin5 is set to output mode, set pin5
                                            low(FALSE), high(TRUE)
        BOOL    bPin6InputOutputState;      Set pin6 to input mode(FALSE), set pin6
                                            to output mode(TRUE)
        BOOL    bPin6LowHighState;          If pin6 is set to output mode, set pin6
                                            low(FALSE), high(TRUE)
        BOOL    bPin7InputOutputState;      Set pin7 to input mode(FALSE), set pin7
                                            to output mode(TRUE)
        BOOL    bPin7LowHighState;          If pin7 is set to output mode, set pin7
                                            low(FALSE), high(TRUE)
        BOOL    bPin8InputOutputState;      Set pin8 to input mode(FALSE), set pin8
                                            to output mode(TRUE)
        BOOL    bPin8LowHighState;          If pin8 is set to output mode, set pin8
                                            low(FALSE), high(TRUE)
    } FTH_INPUT_OUTPUT_PINS *PFTH_INPUT_OUTPUT_PINS
```

2.1.24 JTAG_GetGPIOs

FTC_STATUS JTAG_GetGPIOs(FTC_HANDLE ftHandle, BOOL bControlLowInputOutputPins, PFTC_LOW_HIGH_PINS pLowPinsInputData, BOOL bControlHighInputOutputPins, PFTC_LOW_HIGH_PINS pHighPinsInputData)

This function gets the input states(low or high) of the 8 general purpose input/output pins (GPIOL1 – GPIOL4 and GPIOH1 – GPIOH4) of the FT2232D dual device.

Parameters

ftHandle	Handle of a FT2232D dual device.
bControlLowInputOutputPins	Controls the use of the 4 general purpose lower input/output pins (GPIOL1 – GPIOL4) of the FT2232D dual device. To enable the 4 lower input/output pins to be read(TRUE) or to disable the 4 lower input/output pins from being read(FALSE).
pLowPinsInputData	Pointer to the structure that contains the input states(low or high) of the 4 general purpose lower input/output pins (GPIOL1 – GPIOL4) of the FT2232D dual device.
bControlHighInputOutputPins	Controls the use of the 4 general purpose higher input/output pins (GPIOH1 – GPIOH4) of the FT2232D dual device. To enable the 4 higher input/output pins to be read(TRUE) or to disable the 4 higher input/output pins from being read(FALSE).
pHighPinsInputData	Pointer to the structure that contains the input states(low or high) of the 4 general purpose higher input/output pins (GPIOH1 – GPIOH4) of the FT2232D dual device.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_NULL_INPUT_OUTPUT_BUFFER_POINTER
FTC_FAILED_TO_COMPLETE_COMMAND
FTC_IO_ERROR

Example:

```
typedef struct FTC_Low_High_Pins {
  BOOL          bPin1LowHighState;     Pin1 input state low(FALSE), high(TRUE)
  BOOL          bPin2LowHighState;     Pin2 input state low(FALSE), high(TRUE)
  BOOL          bPin3LowHighState;     Pin3 input state low(FALSE), high(TRUE)
  BOOL          bPin4LowHighState;     Pin4 input state low(FALSE), high(TRUE)
} FTC_LOW_HIGH_PINS *PFTC_LOW_HIGH_PINS
```

2.1.25 JTAG_GetHiSpeedDeviceGPIOs

FTC_STATUS JTAG_GetHiSpeedDeviceGPIOs(FTC_HANDLE ftHandle, BOOL bControlLowInputOutputPins, PFTC_LOW_HIGH_PINS pLowPinsInputData, BOOL bControlHighInputOutputPins, PFTH_LOW_HIGH_PINS pHighPinsInputData)

This function gets the input states(low or high) of the 12 general purpose input/output pins (GPIOL1 – GPIOL4 and GPIOH1 – GPIOH8) of the FT2232H dual hi-speed device or the 4 general purpose lower input/output pins (GPIOL1 – GPIOL4) of the FT4232H quad hi-speed device.

Parameters

ftHandle	Handle of the FT2232H dual hi-speed device or FT4232H quad hi-speed device.
bControlLowInputOutputPins	Controls the use of the 4 general purpose lower input/output pins (GPIOL1 – GPIOL4) of the FT2232H dual hi-speed device or FT4232H quad hi-speed device. To enable the 4 lower input/output pins to be read(TRUE) or to disable the 4 lower input/output pins from being read(FALSE).
pLowPinsInputData	Pointer to the structure that contains the input states(low or high) of the 4 general purpose lower input/output pins (GPIOL1 – GPIOL4) of the FT2232H dual hi-speed device or FT4232H quad hi-speed device.
bControlHighInputOutputPins	Controls the use of the 8 general purpose higher input/output pins (GPIOH1 – GPIOH8) of the FT2232H dual hi-speed device. To enable the 8 higher input/output pins to be read(TRUE) or to disable the 8 higher input/output pins from being read(FALSE).
pHighPinsInputData	Pointer to the structure that contains the input states(low or high) of the 8 general purpose higher input/output pins (GPIOH1 – GPIOH8) of the FT2232H dual hi-speed device.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_NULL_INPUT_OUTPUT_BUFFER_POINTER
FTC_FAILED_TO_COMPLETE_COMMAND
FTC_IO_ERROR

Example:

```
typedef struct FTC_Low_High_Pins {
        BOOL        bPin1LowHighState;    Pin1 input state low(FALSE), high(TRUE)
        BOOL        bPin2LowHighState;    Pin2 input state low(FALSE), high(TRUE)
        BOOL        bPin3LowHighState;    Pin3 input state low(FALSE), high(TRUE)
        BOOL        bPin4LowHighState;    Pin4 input state low(FALSE), high(TRUE)
      } FTC_LOW_HIGH_PINS *PFTC_LOW_HIGH_PINS
typedef struct FTH_Low_High_Pins {
        BOOL        bPin1LowHighState;    Pin1 input state low(FALSE), high(TRUE)
        BOOL        bPin2LowHighState;    Pin2 input state low(FALSE), high(TRUE)
        BOOL        bPin3LowHighState;    Pin3 input state low(FALSE), high(TRUE)
        BOOL        bPin4LowHighState;    Pin4 input state low(FALSE), high(TRUE)
        BOOL        bPin5LowHighState;    Pin5 input state low(FALSE), high(TRUE)
        BOOL        bPin6LowHighState;    Pin6 input state low(FALSE), high(TRUE)
        BOOL        bPin7LowHighState;    Pin7 input state low(FALSE), high(TRUE)
        BOOL        bPin8LowHighState;    Pin8 input state low(FALSE), high(TRUE)
      } FTH_LOW_HIGH_PINS *PFTH_LOW_HIGH_PINS
```

2.1.26 JTAG_Write

FTC_STATUS JTAG_WriteFTC_HANDLE ftHandle, BOOL bInstructionTestData, DWORD dwNumBitsToWrite, PWriteDataByteBuffer pWriteDataBuffer, DWORD dwNumBytesToWrite, DWORD dwTapControllerState)

This function writes data to an external device ie a device attached to a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device. A FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device communicates with an external device by simulating the JTAG synchronous protocol.

Parameters

ftHandle	Handle of the FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.
bInstructionTestData	Specifies the type of register, that data is to be written to on an external device. Instruction(TRUE) or test data(FALSE).
dwNumBitsToWrite	Specifies the number of bits to be written to an external device. Valid range 2 to 524280. 524280 bits is equivalent to 64K bytes.
pWriteDataBuffer	Pointer to buffer that contains the data to be written to an external device.
dwNumBytesToWrite	Specifies the number of bytes in the write data buffer, which contains all the specified bits to be written to an external device. Valid range 1 to 65535 ie 64K bytes.
dwTapControllerState	Specifies the state, the Test Access Port(TAP) controller will be left in after the data has been written to an external device.

Valid TAP Controller States
TEST_LOGIC_STATE
RUN_TEST_IDLE_STATE
PAUSE_TEST_DATA_REGISTER_STATE
PAUSE_INSTRUCTION_REGISTER_STATE
SHIFT_TEST_DATA_REGISTER_STATE
SHIFT_INSTRUCTION_REGISTER_STATE

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_INVALID_NUMBER_BITS
FTC_NULL_WRITE_DATA_BUFFER_POINTER
FTC_INVALID_NUMBER_BYTES
FTC_NUMBER_BYTES_TOO_SMALL
FTC_INVALID_TAP_CONTROLLER_STATE
FTC_FAILED_TO_COMPLETE_COMMAND
FTC_IO_ERROR

Example:

```
#define MAX_WRITE_DATA_BYTES_BUFFER_SIZE        65536  // 64K bytes

typedef BYTE WriteDataByteBuffer[MAX_WRITE_DATA_BYTES_BUFFER_SIZE];
typedef WriteDataByteBuffer  *PWriteDataByteBuffer;
```

2.1.27 JTAG_Read

FTC_STATUS JTAG_Read (FTC_HANDLE ftHandle, BOOL bInstructionTestData, DWORD dwNumBitsToRead, PReadDataByteBuffer pReadDataBuffer, LPDWORD lpdwNumBytesReturned, DWORD dwTapControllerState)

This function reads data from an external device ie a device attached to a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device. A FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device communicates with an external device by simulating the JTAG synchronous protocol.

Parameters

ftHandle	Handle of a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.
bInstructionTestData	Specifies the type of register, that data is to be read from on an external device. Instruction(TRUE) or test data(FALSE).
dwNumBitsToRead	Specifies the number of bits to be read from an external device. Valid range 2 to 524280. 524280 bits is equivalent to 64K bytes.
pReadDataBuffer	Pointer to buffer that returns the data read from an external device. Size of buffer should be set to 65535.
lpdwNumBytesReturned	Pointer to a variable of type DWORD which receives the actual number of data bytes read from an external device. These bytes contain the specified number of bits read from an external device.
dwTapControllerState	Specifies the state, the Test Access Port(TAP) controller will be left in after the data has been read from an external device.

Valid TAP Controller States
TEST_LOGIC_STATE
RUN_TEST_IDLE_STATE
PAUSE_TEST_DATA_REGISTER_STATE
PAUSE_INSTRUCTION_REGISTER_STATE
SHIFT_TEST_DATA_REGISTER_STATE
SHIFT_INSTRUCTION_REGISTER_STATE

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_INVALID_NUMBER_BITS
FTC_NULL_READ_DATA_BUFFER_POINTER
FTC_INVALID_TAP_CONTROLLER_STATE
FTC_FAILED_TO_COMPLETE_COMMAND
FTC_IO_ERROR

Example:

```
#define MAX_READ_DATA_BYTES_BUFFER_SIZE          65536  // 64K bytes

typedef BYTE ReadDataByteBuffer[MAX_READ_DATA_BYTES_BUFFER_SIZE];
typedef ReadDataByteBuffer  *PReadDataByteBuffer;
```

2.1.28 JTAG_WriteRead

FTC_STATUS JTAG_WriteRead (FTC_HANDLE ftHandle, BOOL bInstructionTestData, DWORD dwNumBitsToWriteRead, PWriteDataByteBuffer pWriteDataBuffer, DWORD dwNumBytesToWrite, PReadDataByteBuffer pReadDataBuffer, LPDWORD lpdwNumBytesReturned, DWORD dwTapControllerState)

This function writes then read data to/from an external device ie a device attached to a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device. A FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device communicates with an external device by simulating the JTAG synchronous protocol.

Parameters

ftHandle	Handle of a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.
bInstructionTestData	Specifies the type of register, that data is to be written to and read from on an external device. Instruction(TRUE) or test data(FALSE).
dwNumBitsToWriteRead	Specifies the number of bits to be written to and read from an external device. Valid range 2 to 524280. 524280 bits is equivalent to 64K bytes.
pWriteDataBuffer	Pointer to buffer that contains the data to be written to an external device.
dwNumBytesToWrite	Specifies the number of bytes in the write data buffer, which contains all the specified bits to be written to an external device. Valid range 1 to 65535 ie 64K bytes.
pReadDataBuffer	Pointer to buffer that returns the data read from an external device. Size of buffer should be set to 65535.
lpdwNumBytesReturned	Pointer to a variable of type DWORD which receives the actual number of data bytes read from an external device. These bytes contain the specified number of bits read from an external device.
dwTapControllerState	Specifies the state, the Test Access Port(TAP) controller will be left in after the data has been written/read to/from an external device.

Valid TAP Controller States
TEST_LOGIC_STATE
RUN_TEST_IDLE_STATE
PAUSE_TEST_DATA_REGISTER_STATE
PAUSE_INSTRUCTION_REGISTER_STATE
SHIFT_TEST_DATA_REGISTER_STATE
SHIFT_INSTRUCTION_REGISTER_STATE

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_INVALID_NUMBER_BITS
FTC_NULL_WRITE_DATA_BUFFER_POINTER
FTC_INVALID_NUMBER_BYTES
FTC_NUMBER_BYTES_TOO_SMALL
FTC_NULL_READ_DATA_BUFFER_POINTER
FTC_INVALID_TAP_CONTROLLER_STATE
FTC_FAILED_TO_COMPLETE_COMMAND
FTC_IO_ERROR

Example:

```
#define MAX_WRITE_DATA_BYTES_BUFFER_SIZE        65536  // 64K bytes

typedef BYTE WriteDataByteBuffer[MAX_WRITE_DATA_BYTES_BUFFER_SIZE];
typedef WriteDataByteBuffer  *PWriteDataByteBuffer;

#define MAX_READ_DATA_BYTES_BUFFER_SIZE         65536  // 64K bytes

typedef BYTE ReadDataByteBuffer[MAX_READ_DATA_BYTES_BUFFER_SIZE];
typedef ReadDataByteBuffer  *PReadDataByteBuffer;
```

2.1.29 JTAG_GenerateClockPulses

FTC_STATUS JTAG_GenerateClockPulses (FTC_HANDLE ftHandle, DWORD dwNumClockPulses)

This function instructs a FT2232D dual device to generate a specified number of clock pulses. The clock pulses will be generated in the run test idle state. The data written to an external device ie a device attached to a FT2232D dual device during generation of the clock pulses will be 0. A FT2232D dual device communicates with an external device by simulating the JTAG synchronous protocol.

Parameters

ftHandle	Handle of a FT2232D dual device.
dwNumClockPulses	Specifies the number of clock pulses to be generated by a FT2232D dual device. Valid range 1 to 2000,000,000.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_INVALID_NUMBER_CLOCK_PULSES
FTC_FAILED_TO_COMPLETE_COMMAND
FTC_IO_ERROR

2.1.30 JTAG_ClearCmdSequence

FTC_STATUS JTAG_ClearCmdSequence

This function must only be used, if a maximum of one device will be connected to a system ie FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.

This function clears the sequence of commands and associated data from the internal command buffer.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_TOO_MANY_DEVICES

2.1.31 JTAG_AddWriteCmd

FTC_STATUS JTAG_AddWriteCmd (BOOL bInstructionTestData, DWORD dwNumBitsToWrite, PWriteDataByteBuffer pWriteDataBuffer, DWORD dwNumBytesToWrite, DWORD dwTapControllerState)

This function must only be used, if a maximum of one device will be connected to a system ie FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.

This function adds a write command and associated data to the internal command buffer(size 131070 ie 128K bytes). This enables a programmer to build up a sequence of commands ie write, read and write/read, before executing the sequence of commands, see section 2.1.38.

Warning: While constructing a sequence of commands, do not invoke JTAG_Write, JTAG_Read, JTAG_WriteRead or JTAG_GenerateClockPulses functions, as this will clear the sequence of commands and associated data from the internal command buffer.

Parameters

bInstructionTestData	Specifies the type of register, that data is to be written to on an external device. Instruction(TRUE) or test data(FALSE).
dwNumBitsToWrite	Specifies the number of bits to be written to an external device. Valid range 2 to 524280. 524280 bits is equivalent to 64K bytes.
pWriteDataBuffer	Pointer to buffer that contains the data to be written to an external device.
dwNumBytesToWrite	Specifies the number of bytes in the write data buffer, which contains all the specified bits to be written to an external device. Valid range 1 to 65535 ie 64K bytes.
dwTapControllerState	Specifies the state, the Test Access Port(TAP) controller will be left in after the data has been written to an external device.

Valid TAP Controller States
TEST_LOGIC_STATE
RUN_TEST_IDLE_STATE
PAUSE_TEST_DATA_REGISTER_STATE
PAUSE_INSTRUCTION_REGISTER_STATE
SHIFT_TEST_DATA_REGISTER_STATE
SHIFT_INSTRUCTION_REGISTER_STATE

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_TOO_MANY_DEVICES
FTC_INVALID_NUMBER_BITS
FTC_NULL_WRITE_DATA_BUFFER_POINTER
FTC_INVALID_NUMBER_BYTES
FTC_NUMBER_BYTES_TOO_SMALL
FTC_INVALID_TAP_CONTROLLER_STATE
FTC_COMMAND_SEQUENCE_BUFFER_FULL

Example:

```
#define MAX_WRITE_DATA_BYTES_BUFFER_SIZE        65536  // 64K bytes

typedef BYTE WriteDataByteBuffer[MAX_WRITE_DATA_BYTES_BUFFER_SIZE];
typedef WriteDataByteBuffer  *PWriteDataByteBuffer;
```

2.1.32 JTAG_AddReadCmd

FTC_STATUS JTAG_AddReadCmd (BOOL bInstructionTestData, DWORD dwNumBitsToRead, DWORD dwTapControllerState)

This function must only be used, if a maximum of one device will be connected to a system ie FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.

This function adds a read command to the internal command buffer(size 131070 ie 128K bytes). This enables a programmer to build up a sequence of commands ie write, read and write/read, before executing the sequence of commands, see section 2.1.38.

Warning: While constructing a sequence of commands, do not invoke JTAG_Write, JTAG_Read, JTAG_WriteRead or JTAG_GenerateClockPulses functions, as this will clear the sequence of commands and associated data from the internal command buffer.

Parameters

bInstructionTestData	Specifies the type of register, that data is to be read from on an external device. Instruction(TRUE) or test data(FALSE).
dwNumBitsToRead	Specifies the number of bits to be read from an external device. Valid range 2 to 524280. 524280 bits is equivalent to 64K bytes.
dwTapControllerState	Specifies the state, the Test Access Port(TAP) controller will be left in after the data has been read from an external device.

Valid TAP Controller States
TEST_LOGIC_STATE
RUN_TEST_IDLE_STATE
PAUSE_TEST_DATA_REGISTER_STATE
PAUSE_INSTRUCTION_REGISTER_STATE
SHIFT_TEST_DATA_REGISTER_STATE
SHIFT_INSTRUCTION_REGISTER_STATE

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_TOO_MANY_DEVICES
FTC_INVALID_NUMBER_BITS
FTC_INVALID_TAP_CONTROLLER_STATE
FTC_COMMAND_SEQUENCE_BUFFER_FULL
FTC_INSUFFICIENT_RESOURCES

2.1.33 JTAG_AddWriteReadCmd

FTC_STATUS JTAG_AddWriteReadCmd (BOOL bInstructionTestData, DWORD dwNumBitsToWriteRead, PWriteDataByteBuffer pWriteDataBuffer, DWORD dwNumBytesToWrite, DWORD dwTapControllerState)

This function must only be used, if a maximum of one device will be connected to a system ie FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.

This function adds a write/read command and associated data to the internal command buffer(size 131070 ie 128K bytes). This enables a programmer to build up a sequence of commands ie write, read and write/read, before executing the sequence of commands, see section 2.1.38.

Warning: While constructing a sequence of commands, do not invoke JTAG_Write, JTAG_Read, JTAG_WriteRead or JTAG_GenerateClockPulses functions, as this will clear the sequence of commands and associated data from the internal command buffer.

Parameters

bInstructionTestData	Specifies the type of register, that data is to be written to and read from on an external device. Instruction(TRUE) or test data(FALSE).
dwNumBitsToWriteRead	Specifies the number of bits to be written to and read from an external device. Valid range 2 to 524280. 524280 bits is equivalent to 64K bytes.
pWriteDataBuffer	Pointer to buffer that contains the data to be written to an external device.
dwNumBytesToWrite	Specifies the number of bytes in the write data buffer, which contains all the specified bits to be written to an external device. Valid range 1 to 65535 ie 64K bytes.
dwTapControllerState	Specifies the state, the Test Access Port(TAP) controller will be left in after the data has been written/read to/from an external device. **Valid TAP Controller States** TEST_LOGIC_STATE RUN_TEST_IDLE_STATE PAUSE_TEST_DATA_REGISTER_STATE PAUSE_INSTRUCTION_REGISTER_STATE SHIFT_TEST_DATA_REGISTER_STATE SHIFT_INSTRUCTION_REGISTER_STATE

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_TOO_MANY_DEVICES
FTC_INVALID_NUMBER_BITS
FTC_NULL_WRITE_DATA_BUFFER_POINTER
FTC_INVALID_NUMBER_BYTES
FTC_NUMBER_BYTES_TOO_SMALL
FTC_INVALID_TAP_CONTROLLER_STATE
FTC_COMMAND_SEQUENCE_BUFFER_FULL
FTC_INSUFFICIENT_RESOURCES

Example:

```
#define MAX_WRITE_DATA_BYTES_BUFFER_SIZE                65536  // 64K bytes

typedef BYTE WriteDataByteBuffer[MAX_WRITE_DATA_BYTES_BUFFER_SIZE];
typedef WriteDataByteBuffer  *PWriteDataByteBuffer;
```

2.1.34 JTAG_ClearDeviceCmdSequence

FTC_STATUS JTAG_ClearDeviceCmdSequence(FTC_HANDLE ftHandle)

This function clears the sequence of commands and associated data from the internal command buffer associated with a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.

Parameters

ftHandle — Handle of a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE

2.1.35 JTAG_AddDeviceWriteCmd

FTC_STATUS JTAG_AddDeviceWriteCmd (FTC_HANDLE ftHandle, BOOL bInstructionTestData, DWORD dwNumBitsToWrite, PWriteDataByteBuffer pWriteDataBuffer, DWORD dwNumBytesToWrite, DWORD dwTapControllerState)

This function adds a write command and associated data to the internal command buffer(size 131070 ie 128K bytes) associated with a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device. This enables a programmer to build up a sequence of commands ie write, read and write/read, before executing the sequence of commands, see section 2.1.38.

Warning: While constructing a sequence of commands, do not invoke JTAG_Write, JTAG_Read, JTAG_WriteRead or JTAG_GenerateClockPulses functions, as this will clear the sequence of commands and associated data from the internal command buffer.

Parameters

ftHandle	Handle of a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.
bInstructionTestData	Specifies the type of register, that data is to be written to on an external device. Instruction(TRUE) or test data(FALSE).
dwNumBitsToWrite	Specifies the number of bits to be written to an external device. Valid range 2 to 524280. 524280 bits is equivalent to 64K bytes.
pWriteDataBuffer	Pointer to buffer that contains the data to be written to an external device.
dwNumBytesToWrite	Specifies the number of bytes in the write data buffer, which contains all the specified bits to be written to an external device. Valid range 1 to 65535 ie 64K bytes.
dwTapControllerState	Specifies the state, the Test Access Port(TAP) controller will be left in after the data has been written to an external device.

Valid TAP Controller States
TEST_LOGIC_STATE
RUN_TEST_IDLE_STATE
PAUSE_TEST_DATA_REGISTER_STATE
PAUSE_INSTRUCTION_REGISTER_STATE
SHIFT_TEST_DATA_REGISTER_STATE
SHIFT_INSTRUCTION_REGISTER_STATE

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_INVALID_NUMBER_BITS
FTC_NULL_WRITE_DATA_BUFFER_POINTER
FTC_INVALID_NUMBER_BYTES
FTC_NUMBER_BYTES_TOO_SMALL
FTC_INVALID_TAP_CONTROLLER_STATE
FTC_COMMAND_SEQUENCE_BUFFER_FULL

Example:

```
#define MAX_WRITE_DATA_BYTES_BUFFER_SIZE              65536  // 64K bytes

typedef BYTE WriteDataByteBuffer[MAX_WRITE_DATA_BYTES_BUFFER_SIZE];
typedef WriteDataByteBuffer  *PWriteDataByteBuffer;
```

2.1.36 JTAG_AddDeviceReadCmd

FTC_STATUS JTAG_AddDeviceReadCmd (FTC_HANDLE ftHandle, BOOL bInstructionTestData, DWORD dwNumBitsToRead, DWORD dwTapControllerState)

This function adds a read command to the internal command buffer(size 131070 ie 128K bytes) associated with a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device. This enables a programmer to build up a sequence of commands ie write, read and write/read, before executing the sequence of commands, see section 2.1.38.

Warning: While constructing a sequence of commands, do not invoke JTAG_Write, JTAG_Read, JTAG_WriteRead or JTAG_GenerateClockPulses functions, as this will clear the sequence of commands and associated data from the internal command buffer.

Parameters

ftHandle	Handle of a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.
bInstructionTestData	Specifies the type of register, that data is to be read from on an external device. Instruction(TRUE) or test data(FALSE).
dwNumBitsToRead	Specifies the number of bits to be read from an external device. Valid range 2 to 524280. 524280 bits is equivalent to 64K bytes.
dwTapControllerState	Specifies the state, the Test Access Port(TAP) controller will be left in after the data has been read from an external device.

Valid TAP Controller States
TEST_LOGIC_STATE
RUN_TEST_IDLE_STATE
PAUSE_TEST_DATA_REGISTER_STATE
PAUSE_INSTRUCTION_REGISTER_STATE
SHIFT_TEST_DATA_REGISTER_STATE
SHIFT_INSTRUCTION_REGISTER_STATE

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_INVALID_NUMBER_BITS
FTC_INVALID_TAP_CONTROLLER_STATE
FTC_COMMAND_SEQUENCE_BUFFER_FULL
FTC_INSUFFICIENT_RESOURCES

2.1.37 JTAG_AddDeviceWriteReadCmd

FTC_STATUS JTAG_AddDeviceWriteReadCmd (FTC_HANDLE ftHandle, BOOL bInstructionTestData, DWORD dwNumBitsToWriteRead, PWriteDataByteBuffer pWriteDataBuffer, DWORD dwNumBytesToWrite, DWORD dwTapControllerState)

This function adds a write/read command and associated data to the internal command buffer(size 131070 ie 128K bytes) associated with a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device. This enables a programmer to build up a sequence of commands ie write, read and write/read, before executing the sequence of commands, see section 2.1.38.

Warning: While constructing a sequence of commands, do not invoke JTAG_Write, JTAG_Read, JTAG_WriteRead or JTAG_GenerateClockPulses functions, as this will clear the sequence of commands and associated data from the internal command buffer.

Parameters

ftHandle	Handle of a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.
bInstructionTestData	Specifies the type of register, that data is to be written to and read from on an external device. Instruction(TRUE) or test data(FALSE).
dwNumBitsToWriteRead	Specifies the number of bits to be written to and read from an external device. Valid range 2 to 524280. 524280 bits is equivalent to 64K bytes.
pWriteDataBuffer	Pointer to buffer that contains the data to be written to an external device.
dwNumBytesToWrite	Specifies the number of bytes in the write data buffer, which contains all the specified bits to be written to an external device. Valid range 1 to 65535 ie 64K bytes.
dwTapControllerState	Specifies the state, the Test Access Port(TAP) controller will be left in after the data has been written/read to/from an external device.

Valid TAP Controller States
TEST_LOGIC_STATE
RUN_TEST_IDLE_STATE
PAUSE_TEST_DATA_REGISTER_STATE
PAUSE_INSTRUCTION_REGISTER_STATE
SHIFT_TEST_DATA_REGISTER_STATE
SHIFT_INSTRUCTION_REGISTER_STATE

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_INVALID_NUMBER_BITS
FTC_NULL_WRITE_DATA_BUFFER_POINTER
FTC_INVALID_NUMBER_BYTES
FTC_NUMBER_BYTES_TOO_SMALL
FTC_INVALID_TAP_CONTROLLER_STATE
FTC_COMMAND_SEQUENCE_BUFFER_FULL
FTC_INSUFFICIENT_RESOURCES

Example:

```
#define MAX_WRITE_DATA_BYTES_BUFFER_SIZE              65536  // 64K bytes

typedef BYTE WriteDataByteBuffer[MAX_WRITE_DATA_BYTES_BUFFER_SIZE];
typedef WriteDataByteBuffer  *PWriteDataByteBuffer;
```

2.1.38 JTAG_ExecuteCmdSequence

FTC_STATUS JTAG_ExecuteCmdSequence (FTC_HANDLE ftHandle, PReadCmdSequenceDataByteBuffer pReadCmdSequenceDataBuffer, LPDWORD lpdwNumBytesReturned)

This function executes a sequence of commands, stored in the internal command buffer ie write, read, write/read data to/from an external device ie a device attached to a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device. A FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device communicates with an external device by simulating the JTAG synchronous protocol.

Parameters

ftHandle	Handle of a FT2232D dual device or FT2232H dual hi-speed device or FT4232H quad hi-speed device.
pReadCmdSequenceDataBuffer	Pointer to buffer that returns the data read from an external device. Size of buffer should be set to 131071.
lpdwNumBytesReturned	Pointer to a variable of type DWORD which receives the actual number of data bytes read from an external device. These bytes contain the total number of bits, read as specified in the sequence of read and write/read commands.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_INVALID_HANDLE
FTC_NO_COMMAND_SEQUENCE
FTC_NULL_READ_CMDS_DATA_BUFFER_POINTER
FTC_FAILED_TO_COMPLETE_COMMAND
FTC_IO_ERROR

Example:

```
#define MAX_READ_CMDS_DATA_BYTES_BUFFER_SIZE                131071          //
128K bytes

typedef BYTE
ReadCmdSequenceDataByteBuffer[MAX_READ_CMDS_DATA_BYTES_BUFFER_SIZE];
typedef ReadCmdSequenceDataByteBuffer  *PReadCmdSequenceDataByteBuffer;
```

2.1.39 JTAG_GetDllVersion

FTC_STATUS JTAG_GetDllVersion(LPSTR lpDllVersionBuffer, DWORD dwBufferSize)

This function returns the version of this DLL.

Parameters

lpDllVersionBuffer	Pointer to the buffer that receives the version of this DLL. The string will be NULL terminated.
dwBufferSize	Length of the buffer created for the device name string. Set buffer length to a minimum of 10 characters.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_NULL_DLL_VERSION_BUFFER_POINTER
FTC_DLL_VERSION_BUFFER_TOO_SMALL

2.1.40 JTAG_GetErrorCodeString

FTC_STATUS JTAG_GetErrorCodeString(LPSTR lpLanguage, FTC_STATUS StatusCode, LPSTR lpErrorMessageBuffer, DWORD dwBufferSize)

This function returns the error message for the specified error code, to be used for display purposes by an application programmer. The error code passed into this function must have been returned from a function within this DLL.

Parameters

lpLanguage	Pointer to a NULL terminated string that contains the language code. Default for this first version the default language will be English(EN).
StatusCode	Status code returned from a previous DLL function call.
lpErrorMessageBuffer	Pointer to the buffer that receives the error message. The error message represents the description of the status code. The string will be NULL terminated. If an unsupported language code or invalid status code is passed in to this function, the returned error message will reflect this.
dwBufferSize	Length of the buffer created for the error message string. Set buffer length to a minimum of 100 characters.

Return Value

Returns FTC_SUCCESS if successful, otherwise the return value will be one of the following error codes:

FTC_NULL_LANGUAGE_CODE_BUFFER_POINTER
FTC_INVALID_LANGUAGE_CODE
FTC_INVALID_STATUS_CODE
FTC_NULL_ERROR_MESSAGE_BUFFER_POINTER
FTC_ERROR_MESSAGE_BUFFER_TOO_SMALL

3 FTCJTAG.h

```
/*++

Copyright (c) 2005 Future Technology Devices International Ltd.

Module Name:

    ftcjtag.h

Abstract:

    API DLL for FT2232H and FT4232H Hi-Speed Dual Device and FT2232D Dual Device
setup to simulate the
    Joint Test Action Group(JTAG) synchronous serial protocol.
    FTCJTAG library definitions

Environment:

    kernel & user mode

Revision History:

    07/02/05    kra     Created.
    24/08/05    kra     Added new function JTAG_GenerateClockPulses and new
error code FTC_INVALID_NUMBER_CLOCK_PULSES
    07/07/08    kra     Added new functions for FT2232H and FT4232H hi-speed
devices.
    19/08/08    kra     Added new function JTAG_CloseDevice.

--*/


#ifndef FTCJTAG_H
#define FTCJTAG_H


// The following ifdef block is the standard way of creating macros
// which make exporting from a DLL simpler.  All files within this DLL
// are compiled with the FTCJTAG_EXPORTS symbol defined on the command line.
// This symbol should not be defined on any project that uses this DLL.
// This way any other project whose source files include this file see
// FTCJTAG_API functions as being imported from a DLL, whereas this DLL
// sees symbols defined with this macro as being exported.

#ifdef FTCJTAG_EXPORTS
#define FTCJTAG_API __declspec(dllexport)
#else
#define FTCJTAG_API __declspec(dllimport)
#endif

typedef DWORD FTC_HANDLE;
typedef ULONG FTC_STATUS;

// Hi-speed device types
enum {
      FT2232H_DEVICE_TYPE = 1,
      FT4232H_DEVICE_TYPE = 2
};

#define TEST_LOGIC_STATE 1
```

```
#define RUN_TEST_IDLE_STATE 2
#define PAUSE_TEST_DATA_REGISTER_STATE 3
#define PAUSE_INSTRUCTION_REGISTER_STATE 4
#define SHIFT_TEST_DATA_REGISTER_STATE 5
#define SHIFT_INSTRUCTION_REGISTER_STATE 6

#define FTC_SUCCESS 0 // FTC_OK
#define FTC_INVALID_HANDLE 1 // FTC_INVALID_HANDLE
#define FTC_DEVICE_NOT_FOUND 2 //FTC_DEVICE_NOT_FOUND
#define FTC_DEVICE_NOT_OPENED 3 //FTC_DEVICE_NOT_OPENED
#define FTC_IO_ERROR 4 //FTC_IO_ERROR
#define FTC_INSUFFICIENT_RESOURCES 5 // FTC_INSUFFICIENT_RESOURCES

#define FTC_FAILED_TO_COMPLETE_COMMAND 20          // cannot change, error code
mapped from FT2232c classes
#define FTC_FAILED_TO_SYNCHRONIZE_DEVICE_MPSSE 21  // cannot change, error code
mapped from FT2232c classes
#define FTC_INVALID_DEVICE_NAME_INDEX 22           // cannot change, error code
mapped from FT2232c classes
#define FTC_NULL_DEVICE_NAME_BUFFER_POINTER 23     // cannot change, error code
mapped from FT2232c classes
#define FTC_DEVICE_NAME_BUFFER_TOO_SMALL 24        // cannot change, error code
mapped from FT2232c classes
#define FTC_INVALID_DEVICE_NAME 25                 // cannot change, error code
mapped from FT2232c classes
#define FTC_INVALID_LOCATION_ID 26                 // cannot change, error code
mapped from FT2232c classes
#define FTC_DEVICE_IN_USE 27                       // cannot change, error code
mapped from FT2232c classes
#define FTC_TOO_MANY_DEVICES 28                    // cannot change, error code
mapped from FT2232c classes

#define FTC_NULL_CHANNEL_BUFFER_POINTER 29         // cannot change, error code
mapped from FT2232h classes
#define FTC_CHANNEL_BUFFER_TOO_SMALL 30            // cannot change, error code
mapped from FT2232h classes
#define FTC_INVALID_CHANNEL 31                     // cannot change, error code
mapped from FT2232h classes
#define FTC_INVALID_TIMER_VALUE 32                 // cannot change, error code
mapped from FT2232h classes

#define FTC_INVALID_CLOCK_DIVISOR 33
#define FTC_NULL_INPUT_OUTPUT_BUFFER_POINTER 34
#define FTC_INVALID_NUMBER_BITS 35
#define FTC_NULL_WRITE_DATA_BUFFER_POINTER 36
#define FTC_INVALID_NUMBER_BYTES 37
#define FTC_NUMBER_BYTES_TOO_SMALL 38
#define FTC_INVALID_TAP_CONTROLLER_STATE 39
#define FTC_NULL_READ_DATA_BUFFER_POINTER 40
#define FTC_COMMAND_SEQUENCE_BUFFER_FULL 41
#define FTC_NULL_READ_CMDS_DATA_BUFFER_POINTER 42
#define FTC_NO_COMMAND_SEQUENCE 43
#define FTC_INVALID_NUMBER_CLOCK_PULSES 44
#define FTC_INVALID_NUMBER_SINGLE_CLOCK_PULSES 45
#define FTC_INVALID_NUMBER_TIMES_EIGHT_CLOCK_PULSES 46
#define FTC_NULL_CLOSE_FINAL_STATE_BUFFER_POINTER 47
#define FTC_NULL_DLL_VERSION_BUFFER_POINTER 48
#define FTC_DLL_VERSION_BUFFER_TOO_SMALL 49
#define FTC_NULL_LANGUAGE_CODE_BUFFER_POINTER 50
#define FTC_NULL_ERROR_MESSAGE_BUFFER_POINTER 51
#define FTC_ERROR_MESSAGE_BUFFER_TOO_SMALL 52
#define FTC_INVALID_LANGUAGE_CODE 53
#define FTC_INVALID_STATUS_CODE 54
```

```
#ifdef __cplusplus
extern "C" {
#endif

FTCJTAG_API
FTC_STATUS WINAPI JTAG_GetNumDevices(LPDWORD lpdwNumDevices);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_GetNumHiSpeedDevices(LPDWORD lpdwNumHiSpeedDevices);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_GetDeviceNameLocID(DWORD dwDeviceNameIndex, LPSTR
lpDeviceNameBuffer, DWORD dwBufferSize, LPDWORD lpdwLocationID);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_GetHiSpeedDeviceNameLocIDChannel(DWORD dwDeviceNameIndex,
LPSTR lpDeviceNameBuffer, DWORD dwBufferSize, LPDWORD lpdwLocationID, LPSTR
lpChannel, DWORD dwChannelBufferSize, LPDWORD lpdwHiSpeedDeviceType);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_Open(FTC_HANDLE *pftHandle);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_OpenEx(LPSTR lpDeviceName, DWORD dwLocationID, FTC_HANDLE
*pftHandle);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_OpenHiSpeedDevice(LPSTR lpDeviceName, DWORD dwLocationID,
LPSTR lpChannel, FTC_HANDLE *pftHandle);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_GetHiSpeedDeviceType(FTC_HANDLE ftHandle, LPDWORD
lpdwHiSpeedDeviceType);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_Close(FTC_HANDLE ftHandle);

typedef struct Ft_Close_Final_State_Pins{
  BOOL  bTCKPinState;
  BOOL  bTCKPinActiveState;
  BOOL  bTDIPinState;
  BOOL  bTDIPinActiveState;
  BOOL  bTMSPinState;
  BOOL  bTMSPinActiveState;
}FTC_CLOSE_FINAL_STATE_PINS, *PFTC_CLOSE_FINAL_STATE_PINS;

FTCJTAG_API
FTC_STATUS WINAPI JTAG_CloseDevice(FTC_HANDLE ftHandle,
PFTC_CLOSE_FINAL_STATE_PINS pCloseFinalStatePinsData);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_InitDevice(FTC_HANDLE ftHandle, DWORD dwClockDivisor);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_TurnOnDivideByFiveClockingHiSpeedDevice(FTC_HANDLE
ftHandle);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_TurnOffDivideByFiveClockingHiSpeedDevice(FTC_HANDLE
ftHandle);

FTCJTAG_API
```

```
FTC_STATUS WINAPI JTAG_TurnOnAdaptiveClockingHiSpeedDevice(FTC_HANDLE ftHandle);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_TurnOffAdaptiveClockingHiSpeedDevice(FTC_HANDLE
ftHandle);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_SetDeviceLatencyTimer(FTC_HANDLE ftHandle, BYTE
timerValue);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_GetDeviceLatencyTimer(FTC_HANDLE ftHandle, LPBYTE
lpTimerValue);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_GetClock(DWORD dwClockDivisor, LPDWORD
lpdwClockFrequencyHz);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_GetHiSpeedDeviceClock(DWORD dwClockDivisor, LPDWORD
lpdwClockFrequencyHz);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_SetClock(FTC_HANDLE ftHandle, DWORD dwClockDivisor,
LPDWORD lpdwClockFrequencyHz);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_SetLoopback(FTC_HANDLE ftHandle, BOOL bLoopbackState);

typedef struct Ft_Input_Output_Pins{
  BOOL  bPin1InputOutputState;
  BOOL  bPin1LowHighState;
  BOOL  bPin2InputOutputState;
  BOOL  bPin2LowHighState;
  BOOL  bPin3InputOutputState;
  BOOL  bPin3LowHighState;
  BOOL  bPin4InputOutputState;
  BOOL  bPin4LowHighState;
}FTC_INPUT_OUTPUT_PINS, *PFTC_INPUT_OUTPUT_PINS;

FTCJTAG_API
FTC_STATUS WINAPI JTAG_SetGPIOs(FTC_HANDLE ftHandle, BOOL
bControlLowInputOutputPins,
                                PFTC_INPUT_OUTPUT_PINS pLowInputOutputPinsData,
                                BOOL bControlHighInputOutputPins,
                                PFTC_INPUT_OUTPUT_PINS
pHighInputOutputPinsData);

typedef struct FTH_Input_Output_Pins{
  BOOL  bPin1InputOutputState;
  BOOL  bPin1LowHighState;
  BOOL  bPin2InputOutputState;
  BOOL  bPin2LowHighState;
  BOOL  bPin3InputOutputState;
  BOOL  bPin3LowHighState;
  BOOL  bPin4InputOutputState;
  BOOL  bPin4LowHighState;
  BOOL  bPin5InputOutputState;
  BOOL  bPin5LowHighState;
  BOOL  bPin6InputOutputState;
  BOOL  bPin6LowHighState;
  BOOL  bPin7InputOutputState;
  BOOL  bPin7LowHighState;
```

```
  BOOL  bPin8InputOutputState;
  BOOL  bPin8LowHighState;
}FTH_INPUT_OUTPUT_PINS, *PFTH_INPUT_OUTPUT_PINS;

FTCJTAG_API
FTC_STATUS WINAPI JTAG_SetHiSpeedDeviceGPIOs(FTC_HANDLE ftHandle, BOOL
bControlLowInputOutputPins,
                                             PFTC_INPUT_OUTPUT_PINS
pLowInputOutputPinsData,
                                             BOOL bControlHighInputOutputPins,
                                             PFTH_INPUT_OUTPUT_PINS
pHighInputOutputPinsData);

typedef struct Ft_Low_High_Pins{
  BOOL  bPin1LowHighState;
  BOOL  bPin2LowHighState;
  BOOL  bPin3LowHighState;
  BOOL  bPin4LowHighState;
}FTC_LOW_HIGH_PINS, *PFTC_LOW_HIGH_PINS;

FTCJTAG_API
FTC_STATUS WINAPI JTAG_GetGPIOs(FTC_HANDLE ftHandle, BOOL
bControlLowInputOutputPins,
                                PFTC_LOW_HIGH_PINS pLowPinsInputData,
                                BOOL bControlHighInputOutputPins,
                                PFTC_LOW_HIGH_PINS pHighPinsInputData);

typedef struct FTH_Low_High_Pins{
  BOOL  bPin1LowHighState;
  BOOL  bPin2LowHighState;
  BOOL  bPin3LowHighState;
  BOOL  bPin4LowHighState;
  BOOL  bPin5LowHighState;
  BOOL  bPin6LowHighState;
  BOOL  bPin7LowHighState;
  BOOL  bPin8LowHighState;
}FTH_LOW_HIGH_PINS, *PFTH_LOW_HIGH_PINS;

FTCJTAG_API
FTC_STATUS WINAPI JTAG_GetHiSpeedDeviceGPIOs(FTC_HANDLE ftHandle, BOOL
bControlLowInputOutputPins,
                                             PFTC_LOW_HIGH_PINS
pLowPinsInputData,
                                             BOOL bControlHighInputOutputPins,
                                             PFTH_LOW_HIGH_PINS
pHighPinsInputData);

#define MAX_WRITE_DATA_BYTES_BUFFER_SIZE 65536    // 64k bytes

typedef BYTE WriteDataByteBuffer[MAX_WRITE_DATA_BYTES_BUFFER_SIZE];
typedef WriteDataByteBuffer *PWriteDataByteBuffer;

FTCJTAG_API
FTC_STATUS WINAPI JTAG_Write(FTC_HANDLE ftHandle, BOOL bInstructionTestData,
DWORD dwNumBitsToWrite,
                             PWriteDataByteBuffer pWriteDataBuffer, DWORD
dwNumBytesToWrite,
                             DWORD dwTapControllerState);

#define MAX_READ_DATA_BYTES_BUFFER_SIZE 65536    // 64k bytes

typedef BYTE ReadDataByteBuffer[MAX_READ_DATA_BYTES_BUFFER_SIZE];
typedef ReadDataByteBuffer *PReadDataByteBuffer;
```

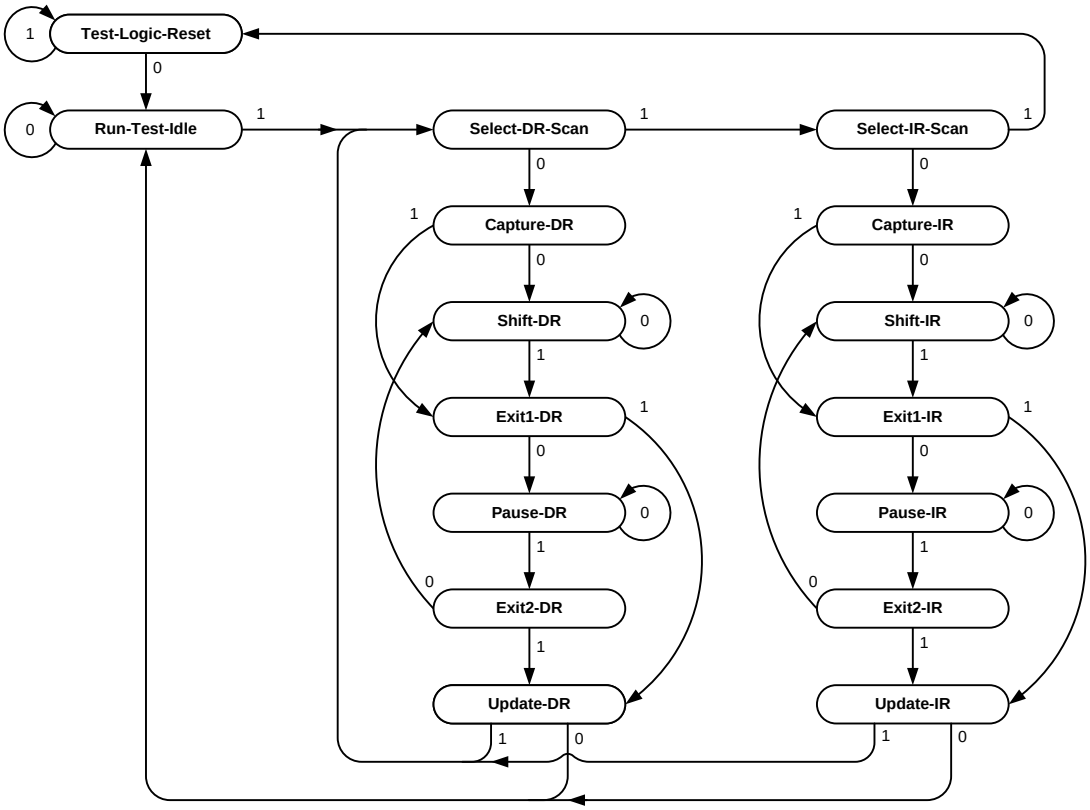
```
FTCJTAG_API
FTC_STATUS WINAPI JTAG_Read(FTC_HANDLE ftHandle, BOOL bInstructionTestData,
DWORD dwNumBitsToRead,
                            PReadDataByteBuffer pReadDataBuffer, LPDWORD
lpdwNumBytesReturned,
                            DWORD dwTapControllerState);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_WriteRead(FTC_HANDLE ftHandle, BOOL bInstructionTestData,
DWORD dwNumBitsToWriteRead,
                                 PWriteDataByteBuffer pWriteDataBuffer, DWORD
dwNumBytesToWrite,
                                 PReadDataByteBuffer pReadDataBuffer, LPDWORD
lpdwNumBytesReturned,
                                 DWORD dwTapControllerState);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_GenerateClockPulses(FTC_HANDLE ftHandle, DWORD
dwNumClockPulses);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_GenerateClockPulsesHiSpeedDevice(FTC_HANDLE ftHandle,
BOOL bPulseClockTimesEightFactor, DWORD dwNumClockPulses, BOOL
bControlLowInputOutputPin, BOOL bStopClockPulsesState);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_ClearCmdSequence(void);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_AddWriteCmd(BOOL bInstructionTestData, DWORD
dwNumBitsToWrite,
                                   PWriteDataByteBuffer pWriteDataBuffer, DWORD
dwNumBytesToWrite,
                                   DWORD dwTapControllerState);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_AddReadCmd(BOOL bInstructionTestData, DWORD
dwNumBitsToRead, DWORD dwTapControllerState);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_AddWriteReadCmd(BOOL bInstructionTestData, DWORD
dwNumBitsToWriteRead,
                                       PWriteDataByteBuffer pWriteDataBuffer,
DWORD dwNumBytesToWrite,
                                       DWORD dwTapControllerState);

#define MAX_READ_CMDS_DATA_BYTES_BUFFER_SIZE 131071  // 128K bytes

typedef BYTE
ReadCmdSequenceDataByteBuffer[MAX_READ_CMDS_DATA_BYTES_BUFFER_SIZE];
typedef ReadCmdSequenceDataByteBuffer *PReadCmdSequenceDataByteBuffer;

FTCJTAG_API
FTC_STATUS WINAPI JTAG_ClearDeviceCmdSequence(FTC_HANDLE ftHandle);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_AddDeviceWriteCmd(FTC_HANDLE ftHandle, BOOL
bInstructionTestData, DWORD dwNumBitsToWrite,
                                         PWriteDataByteBuffer pWriteDataBuffer,
DWORD dwNumBytesToWrite,
                                         DWORD dwTapControllerState);
```



```
FTCJTAG_API
FTC_STATUS WINAPI JTAG_AddDeviceReadCmd(FTC_HANDLE ftHandle, BOOL
bInstructionTestData, DWORD dwNumBitsToRead, DWORD dwTapControllerState);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_AddDeviceWriteReadCmd(FTC_HANDLE ftHandle, BOOL
bInstructionTestData, DWORD dwNumBitsToWriteRead,
                                             PWriteDataByteBuffer
pWriteDataBuffer, DWORD dwNumBytesToWrite,
                                             DWORD dwTapControllerState);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_ExecuteCmdSequence(FTC_HANDLE ftHandle,
PReadCmdSequenceDataByteBuffer pReadCmdSequenceDataBuffer,
                                          LPDWORD lpdwNumBytesReturned);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_GetDllVersion(LPSTR lpDllVersionBuffer, DWORD
dwBufferSize);

FTCJTAG_API
FTC_STATUS WINAPI JTAG_GetErrorCodeString(LPSTR lpLanguage, FTC_STATUS
StatusCode,
                                          LPSTR lpErrorMessageBuffer, DWORD
dwBufferSize);


#ifdef __cplusplus
}
#endif


#endif  /* FTCJTAG_H */
```

4 JTAG TAP Controller State Diagram

All transitions occur based on the state of TMS on the rising edge of TCK.



5 Contact Information

Head Office – Glasgow, UK

Future Technology Devices International Limited
Unit 1, 2 Seaward Place, Centurion Business Park
Glasgow G41 1HH
United Kingdom

Tel: +44 (0) 141 429 2777
Fax: +44 (0) 141 429 2758

E-mail (Sales) sales1@ftdichip.com
E-mail (Support) support1@ftdichip.com
E-mail (General Enquiries) admin1@ftdichip.com
Web Site URL http://www.ftdichip.com
Web Shop URL http://www.ftdichip.com

Branch Office – Taipei, Taiwan

Future Technology Devices International Limited (Taiwan)
2F, No 516, Sec. 1 NeiHu Road
Taipei 114
Taiwan, R.O.C.
Tel: +886 (0) 2 8797 1330
Fax: +886 (0) 2 8751 9737

E-mail (Sales) tw.sales1@ftdichip.com
E-mail (Support) tw.support1@ftdichip.com
E-mail (General Enquiries) tw.admin1@ftdichip.com
Web Site URL http://www.ftdichip.com

Branch Office – Hillsboro, Oregon, USA

Future Technology Devices International Limited (USA)
7235 NW Evergreen Parkway, Suite 600
Hillsboro, OR 97123-5803
USA
Tel: +1 (503) 547 0988
Fax: +1 (503) 547 0987

E-Mail (Sales) us.sales@ftdichip.com
E-Mail (Support) us.support@ftdichip.com
E-Mail (General Enquiries) us.admin@ftdichip.com
Web Site URL http://www.ftdichip.com

Branch Office – Shanghai, China

Future Technology Devices International Limited (China)
Room 408, 317 Xianxia Road,
ChangNing District,
ShangHai, China

Tel: +86 (21) 62351596
Fax: +86(21) 62351595

E-Mail (Sales): cn.sales@ftdichip.com
E-Mail (Support): cn.support@ftdichip.com
E-Mail (General Enquiries): cn.admin1@ftdichip.com
Web Site URL: http://www.ftdichip.com

Distributor and Sales Representatives

Please visit the Sales Network page of the FTDI Web site for the contact details of our distributor(s) and sales representative(s) in your country.

Appendix A – Revision History

Revision History

Draft	Initial Draft	December, 2008
1.0	Initial Release	21st January, 2008
1.1	Added missing commands	18th March 2009
1.2	Updated JTAG state machine Updated US Office support email	2nd October, 2009