Intel® Platform Controller Hub EG20T

USB Client Driver for Windows* Programmer's Guide

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Date	Revision	Description
March 2011	002	Updated OS support in Section 2.0, “Operating System (OS) Support” on page 6 Updated Section 4.1, “Features” on page 8 Updated Table 1, “Supported IOCTLs” on page 8 Updated Section 4.7, “Supporting USB Data Transfer” on page 9 Updated Section 5.0, “Programming Guide” on page 12
September 2010	001	Initial release

1.0 Introduction

This document provides the programming details of the USB Client driver for Windows*. This includes information about the interfaces exposed by the driver and how to use those interfaces to drive the USB hardware.

2.0 Operating System (OS) Support

The USB Client driver is supported by the following operating systems:

No	OS	Notes
1	Microsoft Windows XP*	Service Pack 3
2	Windows Embedded Standard*	2009
3	Windows Embedded POSReady*	2009
4	Microsoft Window 7*	
5	Windows Embedded Standard 7*	

3.0 Dependencies

This driver is only dependent upon appropriate OS driver installation. Also, this driver is not dependent upon any other software delivered.

4.0 USB Client Driver API Details

This section provides information about the interfaces exposed by the USB Client driver. The current implementation of the driver's interfaces are exposed through Input/Output Controls (IOCTLs), which can be called from the application (user mode) using the DeviceIoControl Win32 API (refer to the MSDN documentation for more details on this API). The following sections provide information about the IOCTLs and how to use them to configure the USB hardware to work properly.

4.1 Features

The USB Client driver supports:

- High-speed (480 MHz) and full-speed (12 MHz).
- Control transfer, bulk transfer, and interrupt transfer modes. It does not support isochronous transfer mode
- 4 IN and 4 OUT physical endpoints.
- User-configurable endpoint information (set at initialization).
- All the standard device requests.

  Requests other than those listed below, are responded to automatically by hardware.
  - — GET_DESCRIPTOR is responded by software.
  - — SET_DESCRIPTOR is not supported (returns STALL).
  - — SYNC_FRAME is not supported (returns STALL).
  - — Extension of class requests is possible.
  - — Extension of vendor requests is possible.
- DMA in all endpoint.
- Hot Plug.

4.2 Interface Details

Table 1 lists IOCTLs supported by the driver.

Table 1. Supported IOCTLs

No	IOCTL	Remarks
1	IOCTL_SET_USB_DESCRIPTORS	Set the USB descriptor configuration information
2	IOCTL_USB_GET_CONFIG_NUMBER	Get a configured number after USB enumeration.

4.3 IOCTL Usage Details

This section assumes a single client model where there is a single application-level program configuring the USB Client interface and initiating I/O operations. The following file contains the details of the IOCTLs and data structures used.

- ioh_udc_ioctls.h – contains IOCTL definitions

4.3.1 IOCTL_SET_USB_DESCRIPTORS

This IOCTL is called to configure the USB Client controller with the descriptor information, such as device descriptor, configuration descriptor and interface descriptor.

4.3.2 IOCTL_USB_GET_CONFIG_NUMBER

This IOCTL is called to get a configuration number. When this USB client does not connect to the host, this request gets zero. After this USB client connects to the host and the emulation completes, this gets the configured number, which was set by SET_CONFIGURATION of USB standard request.

4.4 Structures and Enumerations

The USB Client driver does not define structures or enumerations for the API. The structures and enumerations are defined by Windows* Driver Development Kit.

4.5 Error Handling

Since the IOCTL command is implemented using Windows* API, the return value of the call is dependent on and defined by the OS. In Windows*, the return value will be a nonzero value. If the error is detected within or outside the driver, an appropriate system defined value will be returned by the driver.

4.6 Inter-IOCTL dependencies

There are no inter-IOCTL dependencies. Once this driver has been loaded successfully, the IOCTLs above can be used in any order.

4.7 Supporting USB Data Transfer

Four transfer types are defined with USB specification. This section describes the USB data transfer supported by the USB Client driver.

- Control transfer
- Bulk transfer
- Interrupt transfer

4.7.1 Control Transfer

The USB Client driver responds to all USB standard requests. An application does not have to handle Control Transfer.

Note: The USB Client driver does not support SET_DESCRIPTOR and SET_INTERFACE of the USB standard request. The driver responds normally to the request but it does not process the request. The USB Client driver does not support USB class requests and USB vendor requests.

4.7.2 Bulk Transfer

For Bulk OUT transfer, the USB client controller receives data from the host. An application should read data from USB client controller, using the ReadFile function of the Win32 API.

For Bulk IN transfer, an application should write data to the USB client controller, using the WriteFile function of the Win32 API. The USB client controller sends data to a host.

4.7.2.1 ReadFile for Bulk Out

This is the syntax of ReadFile Win32 API.

```
BOOL WINAPI ReadFile(
  __in          HANDLE hFile,
  __out         LPVOID lpBuffer,
  __in          DWORD nNumberOfBytesToRead,
  __out_opt     LPDWORD lpNumberOfBytesRead,
  __inout_opt   LPOVERLAPPED lpOverlapped
);
```

For the USB Client driver, the parameters are specified as follows:

hFile [in]	A handle to the endpoint of the USB client. The hFile parameter must be created with read access by the CreateFile function.
lpBuffer [out]	A pointer to the buffer that receives the data read from the USB client controller.
nNumberOfBytesToRead [in]	The maximum number of bytes to be read. An application can read data 32,768 bytes per read from the USB client driver. This number should be a multiple of the maximum packet size of this endpoint.
lpNumberOfBytesRead [out]	A pointer to the variable that receives the number of bytes read. This should be used to know the number of received data from the USB client controller.

When the ReadFile function is used with the USB client controller, it returns when one of the following conditions occur:

- The number of bytes requested is read.
- After a short packet is received, the end data of a short packet is read.
- An error occurs.

4.7.2.2 WriteFile for Bulk In

This is the syntax of WriteFile Win32 API.

```
BOOL WINAPI WriteFile(
  __in          HANDLE hFile,
  __in          LPCVOID lpBuffer,
  __in          DWORD nNumberOfBytesToWrite,
  __out_opt     LPDWORD lpNumberOfBytesWritten,
  __inout_opt   LPOVERLAPPED lpOverlapped
);
```

For the USB Client driver, the parameters are specified as follows:

Parameter	Description
hFile [in]	A handle to the endpoint of the USB client. The hFile parameter must be created with the write access by the CreateFile function.
lpBuffer [in]	A pointer to the buffer containing the data to be written to the USB client.
nNumberOfBytesToWrite [in]	The number of bytes to be written to the file or device. A value of zero should not be specify to this variable. Write operations are limited to 32,768 bytes per write.

When the **WriteFile** function is used with the USB client controller, it returns when one of the following conditions occur:

- The number of bytes requested is written.
- An error occurs.

4.7.3 Interrupt Transfer

For Interrupt OUT or IN transfer, an application should use the **ReadFile** or **WriteFile** function of the Win32 API as well as Bulk OUT or IN transfer. For more detail, see the Section 4.7.2.1 and Section 4.7.2.2.

4.7.4 Isochronous Transfer

The USB Client driver does not support isochronous transfer.

5.0 Programming Guide

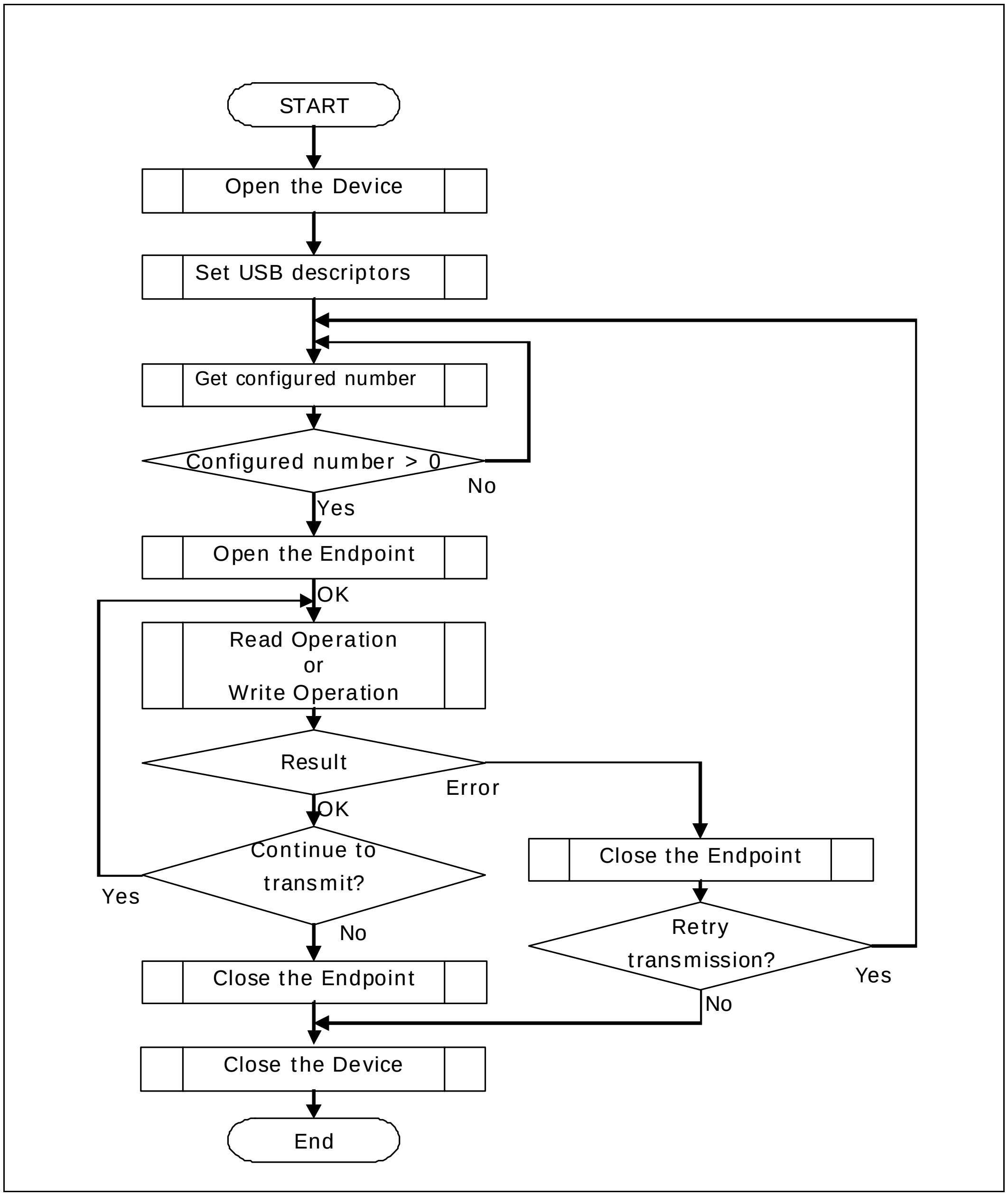
This section describes the basic procedure for using the USB Client driver from a user mode application. All operations are through the IOCTLs exposed by the USB Client driver. Refer to Section 4.3 for details on the IOCTLs. The steps involved in accessing the USB client driver from the user mode application are described below:

- Open the device
- Set USB descriptors
- Get configured number
- Open the endpoint
- Read or write data
- Close the endpoint
- Close the device

5.1 Basic Flow

The basic flow to use this driver from a user mode application is to open the device, set USB descriptors, get configured number, open the endpoints, read/write data, close the endpoints, and close the devicei.

Figure 1. Basic Flow



5.2 Opening the Device

The USB client is opened using **CreateFile** Win32 API. To get the device name, refer to Section 5.2.1.

```
/* Open the USB client driver */

GetDevicePath((LPGUID)&GUID_DEVINTERFACE_IOHUSBD,DevicePath));
```

```
hDevice = CreateFile(DevicePath, GENERIC_WRITE,FILE_SHARE_WRITE,

NULL,OPEN_EXISTING,0,NULL);
```

5.2.1 Using GUID Interface Exposed by the Driver

A device interface class is a way of exporting device and driver functionality to other system components, including other drivers, as well as user-mode applications. A driver can register a device interface class, and then enable an instance of the class for each device object to which user-mode I/O requests might be sent. The Intel® PCH EG20T USB Client driver registers the following interface.

No	Interface Name
1	GUID_DEVINTERFACE_IOHUSBD

This is defined in ioh_udc_ioctls.h.

Device interfaces are available to both kernel-mode components and user-mode applications. User-mode code can use **SetupDi**Xxx functions to find out about registered, enabled device interfaces.

Please refer to the following site to get the details about SetupDiXxx functions.

http://msdn.microsoft.com/en-us/library/ff549791.aspx

5.3 Setting USB Client Configuratation

IOCTL_USB_SET_DESCRIPTORS is used to initialize and configure the settings for the USB client.

DeviceIoControl Win32 API is used for sending information to the USB Client driver.

```
USB_DESCRIPTOR usbDescriptor ={0};

/* Fill this descriptor with desired data */


DWORD dwSize = 0;


DeviceIoControl(hDevice,

IOCTL_SET_USB_DESCRIPTORS,

&usbDescriptor,

sizeof(usbDescriptor),

NULL,

0,

&dwSize,

NULL);
```

5.3.1 Filling USB Descriptors

Define a descriptor structure as follows:

- USB_DEVICE_DESCRIPTOR is defined for High-Speed connection.
- USB_DEVICE_QUALIFIER_DESCRIPTOR is defined for Full-Speed connection.
- Two USB_CONFIGURATION_DESCRIPTOR are defined, each for HS connection and FS connection.
- Only one USB_INTERFACE_DESCRIPTOR is defined in the USB_CONFIGURATION_DESCRIPTOR.
- Six USB_ENDPOINT_DESCRIPTOR are able to be defined in the USB_CONFIGURATION_DESCRIPTOR.

```
#pragma pack(1)

typedef struct _USB_DESCRIPTORS_EXAMPLE {

  USB_DEVICE_DESCRIPTOR usbDeviceDesc;

  USB_DEVICE_QUALIFIER_DESCRIPTOR usbDeviceQualDesc;


  struct _HighSpeedConfig1 {

    USB_CONFIGURATION_DESCRIPTOR usbConfigDesc;

    USB_INTERFACE_DESCRIPTOR usbInterfaceDesc;

    USB_ENDPOINT_DESCRIPTOR usbEndPointDesc1;

    USB_ENDPOINT_DESCRIPTOR usbEndPointDesc2;

  } HSConfig;


  struct _FullSpeedConfigg1 {

    USB_CONFIGURATION_DESCRIPTOR usbOSpConfigDesc;

    USB_INTERFACE_DESCRIPTOR usbInterfaceDesc;

    USB_ENDPOINT_DESCRIPTOR usbEndPointDesc1;

    USB_ENDPOINT_DESCRIPTOR usbEndPointDesc2;

  } FSConfig;


  struct _UsbStringDescriptor1 {

    BYTE    bLength;

    BYTE    bDescriptorType;

    WORD    String[USB_STRING_SIZE1];

  } usbStringDesc1;


  struct _UsbStringDescriptor2 {
```

```
    BYTE    bLength;
    BYTE    bDescriptorType;
    WORD    String[USB_STRING_SIZE2];
  } usbStringDesc2;

  struct _UsbStringDescriptor3 {
    BYTE   bLength;
    BYTE   bDescriptorType;
    WORD   String[USB_STRING_SIZE3];
  } usbStringDesc3;
} USB_DESCRIPTORS_EXAMPLE, *USB_DESCRIPTORS_EXAMPLE;
#pragma pack()
```

Note: This structure must not include any excessive space. Therefore, this must be defined using '#pragma pack (1)'.

Fill USB_DEVICE_DESCRIPTOR and USB_DEVICE_QUALIFIER_DESCRIPTOR as follows:

```
/* Filling Device Descriptor */
pUSBDesc->usbDeviceDesc.bLength =
               sizeof(USB_DEVICE_DESCRIPTOR);
pUSBDesc->usbDeviceDesc.bDescriptorType=
               USB_DEVICE_DESCRIPTOR_TYPE;
pUSBDesc->usbDeviceDesc.bcdUSB= 0x0200;
pUSBDesc->usbDeviceDesc.bDeviceClass= 0;
pUSBDesc->usbDeviceDesc.bDeviceSubClass = 0;
pUSBDesc->usbDeviceDesc.bDeviceProtocol = 0;
pUSBDesc->usbDeviceDesc.bMaxPacketSize0 = 0x40;
pUSBDesc->usbDeviceDesc.idVendor= 0x****;
pUSBDesc->usbDeviceDesc.idProduct= 0x****;
pUSBDesc->usbDeviceDesc.bcdDevice= 0x001;
pUSBDesc->usbDeviceDesc.iManufacturer= 1;
pUSBDesc->usbDeviceDesc.iProduct= 2;
pUSBDesc->usbDeviceDesc.iSerialNumber= 0;
pUSBDesc->usbDeviceDesc.bNumConfigurations= 1;

/* Filling Device QualifierDescriptor */
```

```
pUSBDesc->usbDeviceQualDesc.bLength =
                sizeof(USB_DEVICE_QUALIFIER_DESCRIPTOR);
pUSBDesc->usbDeviceQualDesc.bDescriptorType =
                USB_DEVICE_QUALIFIER_DESCRIPTOR_TYPE;
pUSBDesc->usbDeviceQualDesc.bcdUSB= 0x0200;
pUSBDesc->usbDeviceQualDesc.bDeviceClass= 0;
pUSBDesc->usbDeviceQualDesc.bDeviceSubClass = 0;
pUSBDesc->usbDeviceQualDesc.bDeviceProtocol = 0;
pUSBDesc->usbDeviceQualDesc.bMaxPacketSize0 = 0x40;
pUSBDesc->usbDeviceQualDesc.bReserved= 0;
pUSBDesc->usbDeviceQualDesc.bNumConfigurations= 1;
```

Fill USB_CONFIGURATION_DESCRIPTOR for High-Speed connection as follows:

- EP1 OUT is used as a Bulk Out transfer endpoint.
- EP1 IN is used as a Bulk In transfer endpoint.

```
/* Filling Configuration  Descriptor */
pUSBDesc->HSConfig.usbConfigDesc.bLength =
                sizeof(USB_CONFIGURATION_DESCRIPTOR);
pUSBDesc->HSConfig.usbConfigDesc.bDescriptorType =
                USB_CONFIGURATION_DESCRIPTOR_TYPE;
pUSBDesc->HSConfig.usbConfigDesc.wTotalLength=
                sizeof(USB_CONFIGURATION_DESCRIPTOR)
                + sizeof(USB_INTERFACE_DESCRIPTOR)
                + sizeof(USB_ENDPOINT_DESCRIPTOR) * 2;
pUSBDesc->HSConfig.usbConfigDesc.bNumInterfaces= 1;
pUSBDesc->HSConfig.usbConfigDesc.bConfigurationValue = 1;
pUSBDesc->HSConfig.usbConfigDesc.iConfiguration= 0;
pUSBDesc->HSConfig.usbConfigDesc.bmAttributes= 0xc0;
pUSBDesc->HSConfig.usbConfigDesc.MaxPower= 1;

/* Filling Interface  Descriptor */
pUSBDesc->HSConfig.usbInterfaceDesc.bLength=
                sizeof(USB_INTERFACE_DESCRIPTOR);
pUSBDesc->HSConfig.usbInterfaceDesc.bDescriptorType=
                USB_INTERFACE_DESCRIPTOR_TYPE;
```

```
pUSBDesc->HSConfig.usbInterfaceDesc.bInterfaceNumber = 0x0;
pUSBDesc->HSConfig.usbInterfaceDesc.bAlternateSetting= 0x0;
pUSBDesc->HSConfig.usbInterfaceDesc.bNumEndpoints= 0x2;
pUSBDesc->HSConfig.usbInterfaceDesc.bInterfaceClass= 0xff;
pUSBDesc->HSConfig.usbInterfaceDesc.bInterfaceSubClass= 0xff;
pUSBDesc->HSConfig.usbInterfaceDesc.bInterfaceProtocol= 0xff;
pUSBDesc->HSConfig.usbInterfaceDesc.iInterface= 0x0;

/* Filling Endpoint  Descriptor - 1 */
pUSBDesc->FSConfig.usbEndPointDesc1.bLength=
               sizeof(USB_ENDPOINT_DESCRIPTOR);
pUSBDesc->FSConfig.usbEndPointDesc1.bDescriptorType=
               USB_ENDPOINT_DESCRIPTOR_TYPE;
pUSBDesc->FSConfig.usbEndPointDesc1.bEndpointAddress = 0x01;
pUSBDesc->FSConfig.usbEndPointDesc1.bmAttributes = 0x2;
pUSBDesc->FSConfig.usbEndPointDesc1.wMaxPacketSize= 0x200;
pUSBDesc->FSConfig.usbEndPointDesc1.bInterval= 0x0;

/* Filling Endpoint  Descriptor - 2 */
pUSBDesc->FSConfig.usbEndPointDesc2.bLength=
               sizeof(USB_ENDPOINT_DESCRIPTOR);
pUSBDesc->FSConfig.usbEndPointDesc2.bDescriptorType=
               USB_ENDPOINT_DESCRIPTOR_TYPE;
pUSBDesc->FSConfig.usbEndPointDesc2.bEndpointAddress = 0x81;
pUSBDesc->FSConfig.usbEndPointDesc2.bmAttributes = 0x2;
pUSBDesc->FSConfig.usbEndPointDesc2.wMaxPacketSize= 0x200;
pUSBDesc->FSConfig.usbEndPointDesc2.bInterval= 0x0;
```

Fill USB_CONFIGURATION_DESCRIPTOR for Full-Speed connection as follows:

- EP1 OUT is used as a Bulk Out transfer endpoint.
- EP1 IN is used as a Bulk In transfer endpoint.

/* Filling Configuration Descriptor */

```
pUSBDesc->HSConfig.usbConfigDesc.bLength =
               sizeof(USB_CONFIGURATION_DESCRIPTOR);
pUSBDesc->HSConfig.usbConfigDesc.bDescriptorType =
```

```
                USB_OTHER_SPEED_CONFIGURATION_DESCRIPTOR_TYPE;
pUSBDesc->HSConfig.usbConfigDesc.wTotalLength=
                sizeof(USB_CONFIGURATION_DESCRIPTOR)
                + sizeof(USB_INTERFACE_DESCRIPTOR)
                + sizeof(USB_ENDPOINT_DESCRIPTOR) * 2;
pUSBDesc->HSConfig.usbConfigDesc.bNumInterfaces= 1;
pUSBDesc->HSConfig.usbConfigDesc.bConfigurationValue = 1;
pUSBDesc->HSConfig.usbConfigDesc.iConfiguration= 0;
pUSBDesc->HSConfig.usbConfigDesc.bmAttributes= 0xc0;
pUSBDesc->HSConfig.usbConfigDesc.MaxPower= 1;

/* Filling Interface  Descriptor */
pUSBDesc->HSConfig.usbInterfaceDesc.bLength=
                sizeof(USB_INTERFACE_DESCRIPTOR);
pUSBDesc->HSConfig.usbInterfaceDesc.bDescriptorType=
                USB_INTERFACE_DESCRIPTOR_TYPE;
pUSBDesc->HSConfig.usbInterfaceDesc.bInterfaceNumber = 0x0;
pUSBDesc->HSConfig.usbInterfaceDesc.bAlternateSetting= 0x0;
pUSBDesc->HSConfig.usbInterfaceDesc.bNumEndpoints= 0x2;
pUSBDesc->HSConfig.usbInterfaceDesc.bInterfaceClass= 0xff;
pUSBDesc->HSConfig.usbInterfaceDesc.bInterfaceSubClass= 0xff;
pUSBDesc->HSConfig.usbInterfaceDesc.bInterfaceProtocol= 0xff;
pUSBDesc->HSConfig.usbInterfaceDesc.iInterface= 0x0;

/* Filling Endpoint  Descriptor - 1 */
pUSBDesc->FSConfig.usbEndPointDesc1.bLength=
                sizeof(USB_ENDPOINT_DESCRIPTOR);
pUSBDesc->FSConfig.usbEndPointDesc1.bDescriptorType=
                USB_ENDPOINT_DESCRIPTOR_TYPE;
pUSBDesc->FSConfig.usbEndPointDesc1.bEndpointAddress = 0x01;
pUSBDesc->FSConfig.usbEndPointDesc1.bmAttributes = 0x2;
pUSBDesc->FSConfig.usbEndPointDesc1.wMaxPacketSize= 0x40;
pUSBDesc->FSConfig.usbEndPointDesc1.bInterval= 0x0;
```

```
/* Filling Endpoint  Descriptor - 2 */
pUSBDesc->FSConfig.usbEndPointDesc2.bLength=
               sizeof(USB_ENDPOINT_DESCRIPTOR);
pUSBDesc->FSConfig.usbEndPointDesc2.bDescriptorType=
               USB_ENDPOINT_DESCRIPTOR_TYPE;
pUSBDesc->FSConfig.usbEndPointDesc2.bEndpointAddress = 0x81;
pUSBDesc->FSConfig.usbEndPointDesc2.bmAttributes = 0x2;
pUSBDesc->FSConfig.usbEndPointDesc2.wMaxPacketSize= 0x40;
pUSBDesc->FSConfig.usbEndPointDesc2.bInterval= 0x0;
```

Fill USB_STRING_DESCRIPTOR_TYPE for High-Speed connection as follows:

```
/* Filling String  Descriptor - 0 */
pUSBDesc->usbStringDesc1.bLength= 4;
pUSBDesc->usbStringDesc1.bDescriptorType=
               USB_STRING_DESCRIPTOR_TYPE;
pUSBDesc->usbStringDesc1.String[0] = 0x0409;

/* Filling String  Descriptor - 1 */
pUSBDesc->usbStringDesc2.bLength= 26;
pUSBDesc->usbStringDesc2.bDescriptorType=
               USB_STRING_DESCRIPTOR_TYPE;
pUSBDesc->usbStringDesc2.String[0] = 'M';
pUSBDesc->usbStringDesc2.String[1] = 'a';
pUSBDesc->usbStringDesc2.String[2] = 'n';
pUSBDesc->usbStringDesc2.String[3] = 'u';
pUSBDesc->usbStringDesc2.String[4] = 'f';
pUSBDesc->usbStringDesc2.String[5] = 'a';
pUSBDesc->usbStringDesc2.String[6] = 'c';
pUSBDesc->usbStringDesc2.String[7] = 't';
pUSBDesc->usbStringDesc2.String[8] = 'u';
pUSBDesc->usbStringDesc2.String[9] = 'r';
pUSBDesc->usbStringDesc2.String[10] = 'e';
pUSBDesc->usbStringDesc2.String[11] = '.';

/* Filling String  Descriptor - 2 */
```

```
pUSBDesc->usbStringDesc3.bLength= 18

pUSBDesc->usbStringDesc3.bDescriptorType=

               USB_STRING_DESCRIPTOR_TYPE;

pUSBDesc->usbStringDesc3.String[0] = 'P';

pUSBDesc->usbStringDesc3.String[1] = 'r';

pUSBDesc->usbStringDesc3.String[2] = 'o';

pUSBDesc->usbStringDesc3.String[3] = 'd';

pUSBDesc->usbStringDesc3.String[4] = 'u';

pUSBDesc->usbStringDesc3.String[5] = 'c';

pUSBDesc->usbStringDesc3.String[6] = 't';

pUSBDesc->usbStringDesc3.String[7] = '.';
```

Note: The bLength of each string descriptor structure should be same as the size of itself structure.

5.4 Getting Configured Number

IOCTL_USB_GET_CONFIG_NUMBER is used to get the a configured number from USB Client.

DeviceIoControl Win32 API is used for sending information to the USB Client driver.

```
DWORD nConfigNum;

DWORD dwSize;


DeviceIoControl(hDevice,

                   IOCTL_USB_GET_CONFIG_NUMBER,

                   &nConfigNum,

                   sizeof(DWORD), /* This should be 4(bytes). */

                   NULL,

                   0,

                   &dwSize,

                   NULL);
```

When nConfigNum is not zero, it is available to open each endpoint, except EP0.

5.5 Opening the Endpoint

The endpoint of the USB client is opened using **CreateFile** Win32 API. To get the endpoint name, refer to 5.7.1.

```
PCHAR pEndpoitPathName;
```

```
HANDLE hEndpoint;


/* Get a file path name. */

pEndpoitPathName =
"\\?\pci#ven_8086&dev_8808&subsys_00000000&rev_01#5&1b6ba73f&0&1400b8#{66fde0f3-
69eb-427f-a91a-e3ce4c13b36a}\2";


/* Open the endpoint. */

hEndpoint = CreateFile(pEndpoitPathName,

                      GENERIC_WRITE | GENERIC_READ,

                      FILE_SHARE_WRITE | FILE_SHARE_READ,

                      NULL,

                      OPEN_EXISTING,

                      0,

                      NULL);
```

5.5.1 Getting Endpoint Path Name

To open the endpoint for Bulk/Interrupt transfer, an endpoint path name is required. An endpoint path name is generated by adding an endpoint path number to the device path name. Refer to Section 5.2 on how to identify device path name. Table 2 shows endpoint path numbers to endpoint address.

Table 2. Endpoint Path Number

Endpoint Path Number	Endpoint Address	Endpoint Name	Endpoint Direction	Note
0	0x00	EP0	OUT	For only control transfer. These are not used for Bulk/ Interrupt transfer.
1	0x80	EP0	IN	
2	0x01	EP1	OUT	-
3	0x81	EP1	IN	-
4	0x02	EP2	OUT	-
5	0x82	EP2	IN	-
6	0x03	EP3	OUT	-
7	0x83	EP3	IN	-

An endpoint address is defined as *bEndpointAddress* of an endpoint descriptor's member.

Example:

When the dvice was opened the following device path name was used.

DevicePathName =
"\\?\pci#ven_8086&dev_8808&subsys_00000000&rev_01#5&1b6ba73f&0&1400b8#{66fde0f3-69eb-427f-a91a-e3ce4c13b36a}";

To open the **EP1 OUT**, The following endpoint path name is used.

EndpointPathNumer = 2;

EndpointPassName =
"\\?\pci#ven_8086&dev_8808&subsys_00000000&rev_01#5&1b6ba73f&0&1400b8#{66fde0f3-69eb-427f-a91a-e3ce4c13b36a}\2";

To open the **EP1 IN**, The following endpoint path name is used.

EndpointPathNumber = 3;

EndpointPassName =
"\\?\pci#ven_8086&dev_8808&subsys_00000000&rev_01#5&1b6ba73f&0&1400b8#{66fde0f3-69eb-427f-a91a-e3ce4c13b36a}\3";

5.6 Reading Data

ReadFile is used for read operations for Bulk/Interrupt Out transfer.

```
HANDLE hEndpoint;
ULONG nBytesRead;
PBYTE pBuffer;
DWORD dwResult;
ULONG nBytesResult;

/* Set maximum transfer size. */
nByteRead = 2048;

/* Allocate memory. */
pBuffer = (PBYTE)malloc(nByteRead);

/* Request a read transfer. */
dwResult = ReadFile(hEndpoint,
                   pBuffer,
                   nBytesRead,
                   &nBytesResult,
                   NULL);

/* Process the read data. */
```

Note: *nBytesRead* should be equal or larger than the data size that the host sends to the client, and should be a multiple of MAX_PACKET_SIZE of the target endpoint.

5.7 Writing Data

WriteFile is used for read operations for Bulk/Interrupt IN transfer.

```
HANDLE hEndpoint;
ULONG nBytesWrite;
PBYTE pBuffer;
DWORD dwResult;
ULONG nBytesResult;

/* Set transfer size. */
nBytesWrute = 2000;

/* Allocate memory. */
pBuffer = (PBYTE)malloc(nBytesWrite);

/* Prepare write data */

/* Request a write transfer. */
dwResult = WriteFile(hEndpoint,
                   pBuffer,
                   nBytesRead,
                   &nBytesResult,
                   NULL);
```

5.8 Closing the Endpoint

Once all the operations related to the USB client driver are completed, the endpoint handle must be freed by calling the **CloseHandle** Win32 API.

```
CloseHandle(hEndpoint);
```

5.9 Closing the Device

Once all the operations related to the USB Client driver are completed, the device handle must be freed by calling the **CloseHandle** Win32 API.

```
CloseHandle(hDevice);
```