Description of the Universal Serial Bus Human Interface Device interface to the Dicon FiberOptics Inc. Gen. 3 Fiberlamp (3 Channel)

USB Descriptors

The Gen. 3 Fiberlamp firmware will interface with the Lightmix v1.4 software through the Universal Serial Bus (USB). To simplify the installation of the the fiberlamp by the end user, the Fiberlamp will act as a Human Inteface Device (HID). The HID class standard is described in http://www.usb.org/developers/devclass_docs/HID1_11.pdf. The advantage of using the HID class is that it is not necessary to install device drivers (e.g. INF files) to run the device. Instead the moment the device is plugged in the USB bus, it communicates with the USB Host Controller (present in the host PC) to exactly describe its communication interface. This document describes the USB HID interface and the way the internal communication between host PC and Firmware is to take place.

USB Device Descriptor

The USB Device descriptor for the FiberLamp states that it is a full speed USB1.1 device, which is limited to 64 byte package length. The vendor ID is 0xC251, the product ID is 0x1302. The device ID is 0x0100. The manufacturer is "Dicon Fiberoptics", the product is "Dicon FiberLamp" and the serial number is "TEST00000000". There is only 1 configuration for the device.
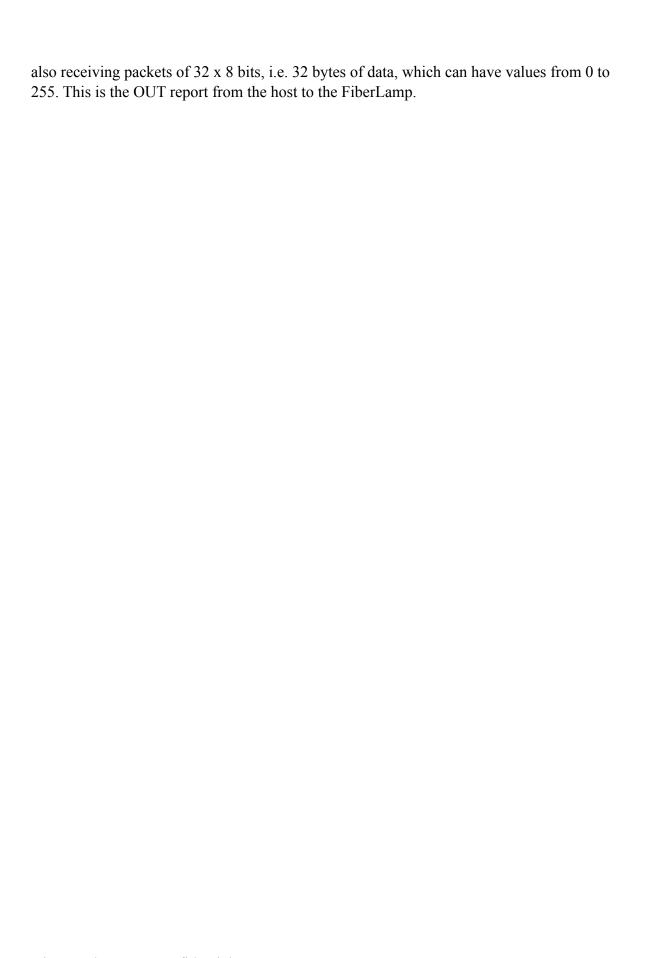
NOTE: Gener8 assigned a random Vendor ID. Vendor IDs (VIDs) are owned by the vendor company, i.e. Dicon Fiberoptics, Inc., and are assigned and maintained by the USB-IF (USB Implementers Forum) only. Email admin@usb.org for more information on USB-IF membership and obtaining a VID. Product IDs (PIDs) are assigned by each vendor as they see fit; the USB-IF recommends each vendor set up a coordinated allocation scheme for PIDs so different teams don't inadvertently choose the same PID for different products. Duplicate numbers may cause driver error.

USB Configuration Descriptor

The USB Configuration descriptor states that there is only 1 interface between the device and host named "HID". The FiberLamp is allowed to draw 100mA of power from the USB bus (although it is self powered). The FiberLamp is an HID class device with only 1 (IN) endpoint. It is compatible with the USB HID 1.00. There is only 1 descriptor for the interface, which is a "Report" descriptor. The IN endpoint (data from FiberLamp to host) is to be an interrupt type endpoint of maximum 64 bytes running at 32ms intervals.

USB Report Descriptor

The Report Descriptor states that this is a "Vendor Specific" type HID device which uses only "Vendor Usage case 1". The Fiberlamp will send a packet of 32 x 8 bits, i.e. 32 bytes of data, which can have values from 0 to 255 to the IN endpoint of the host. The Fiberlamp is

also receiving packets of 32 x 8 bits, i.e. 32 bytes of data, which can have values from 0 to 255. This is the OUT report from the host to the FiberLamp.

Description of communication protocol

Null Byte

The USB HID descriptor states that the FiberLamp will provide an IN report to the host every 32 milliseconds. If there is valid data to be communicated, the FiberLamp will put this data into the IN report. If there is no more valid data to Report the FiberLamp firmware will send null bytes, which are 0x1D values.

Generic Message Format

Each message send in the OUT report (from the host to the FiberLamp firmware) should have the following fomat:

Message Structure (n+1 bytes long)
Byte 00: Message Header Cookie, defined as 0xA9
Byte 01: Length Byte, i.e. number of bytes to follow (n-2)
Byte 02: Command, see below for allowed values
Byte 03..n-2: Data Payload
Byte n-1: Checksum
Byte n: Message End Cookie, defined as 0x5C

NOTE #1: The value in the length byte does not include the header cookie, the end cookie and the checksum.
NOTE #2: The data payload depends on the command and is optional.
NOTE #3: The checksum is the two's complement negative value of the sum of all bytes in the message, beginning at the length byte (byte 01) and ending at the last data byte (byte n-2). Thus the result of summing all bytes from the length byte through the checksum will be 0.

Generic Response Format

The Firmware will respond to each command in the IN report with a message of the following format:

Response Structure (n+1 bytes long)
Byte 00: Response Header Cookie, defined as 0xA9
Byte 01: Length Byte, i.e. number of bytes to follow (n-2)
Byte 02: Echo of the Command
Byte 03: Response Code (0 = No Error, >0 = error)
Byte 04..n-2: Data Payload
Byte n-1: Checksum
Byte n: Response End Cookie, defined as 0x5C

NOTE #1: The value in the length byte does not include the header cookie, the end cookie and the checksum.

NOTE #2: The data payload depends on the command and is optional.

NOTE #3: The checksum is the two's complement negative value of the sum of all bytes in the message, beginning at the length byte (byte 01) and ending at the last data byte (byte n-2). Thus the result of summing all bytes from the length byte through the checksum will be 0.

Variable message length versus fixed USB report size

The message and response lengths are variable, but each USB packet (both IN report and OUT report) has a fixed length of 32 bytes. The IN (from FiberLamp to host) and OUT (from host to FiberLamp) reports might have multiple messages or responses within a single packet. It is also possible that a single message or response spans multiple USB packets.

Firmware Response Codes and their meaning.

The Firmware Response Code will be one of the following values:

Firmware Response Description	Response Code
ERR_OK	0
ERR_UNKNOWN_COMMAND	1
ERR_PARAMETER_OUT_OF_RANGE	9
ERR_EEPROM_LENGTH	100
ERR_EEPROM_PAGE	101
ERR_EEPROM_ACCESS	102
ERR_EEPROM_COMM	103
ERR_SERIAL_TOO_LONG	104
ERR_CANNOT_ADD_STEP	106

The normal response to any allowed command is ERR_OK. If the command is not in the above list or it is not supported in the current firmware, the response will be ERR_UNKNOWN_COMMAND. The firmware does range checking on certain parameters. If any of the parameters is out of the acceptable range the response will be ERR_PARAMETER_OUT_OF_RANGE.

The EEPROM errors should never happen, since the access to EEPROM is controlled entirely by the firmware. For completeness we add that ERR_EEPROM_LENGTH means that more than 64 bytes are attempted to be written to the EEPROM. ERR_EEPROM_PAGE means that a write attempt is made across a 64 byte EEPROM page. ERR_EEPROM_ACCESS means that a write attempt is made into the EEPROM restricted area. ERR_EEPROM_COMM means there was a communication error during the Read or Write of the EEPROM.

The device serial number, which is stored in EEPROM is 32 bytes long. If an attempt is made to write a serial number longer than 32 bytes the ERR_SERIAL_TOO_LONG error results. Error ERR_CANNOT_ADD_STEP occurs when a step addition is attempted beyond the defined length of the playlist.

Firmware Commands

The following firmware command codes are currently defined:

Firmware Command Description	Command Number
MSG_SET_COLOR	1
MSG_START_SAVING_PLAYLIST	2
MSG_ADD_PLAYLIST_STEP	3
MSG_PLAY_PLAYLIST	4
MSG_GET_SERIAL_NUMBER	9
MSG_SET_SERIAL_NUMBER	10
MSG_GET_FW_TYPE	11
MSG_GET_FW_VERSION	12
MSG_SET_MAX_DUTY_CYCLE	13
MSG_OVERWRITE_PRESET_MODE	14
MSG_RESTORE_PRESET_MODE	15
MSG_GET_PLAYLIST_NR_STEPS	17
MSG_GET_PLAYLIST_STEP	18
MSG_GET_TEMPERATURE	19
MSG_SET_DMX_ADDRESS	20
MSG_GET_DMX_AVAILABLE	21
MSG_SET_DMX_AVAILABLE	22
MSG_GET_PRESET_MODE	23
MSG_PLAY_PRESET_MODE	24
MSG_SET_MAX_DUTY_CYCLE_PCNT	25
MSG_GET_DMX_MASTER	26
MSG_SET_DMX_MASTER	27

SET COLOR (command = 1)
Data Payload:
- Byte 03: Red Brightness Level [BL]: 0 to 255.
- Byte 04: Blue Brightness Level: 0 to 255.
- Byte 05: Green Brightness Level: 0 to 255.
- Byte 06: Blink Rate [BR]: 0 to 100. 0 equals constant on. Otherwise,
  Blink $_{on/off\ time}$ = (101 − blink rate) * 15ms. (Set both the ON time and the OFF time to be this number of ms. Total period is therefore twice this value.)

Function:
- Display the color defined by the RGB values and the specified blink rate indefinitely until a new command is received.

START SAVING PLAYLIST (command = 2)
Data Payload:
- Byte 03: Playlist Number: 0 to 4

- Byte 04 (MSByte).. Byte 07 (LSByte): 4 byte number of steps for this playlist. Current maximum is 768.

Function:
- Writes the number of steps to the EEPROM address reserved for this playlist number (0 is an allowed value, indicating an empty playlist. No steps are added after.)
- Keep the playlist number in memory for subsequent calls to the "ADD PLAYLIST STEPS" commands

ADD PLAYLIST STEP (command = 3)

Data Payload:
- Byte 03: Red brightness level: 0 to 255
- Byte 04: Green brightness level: 0 to 255
- Byte 05: Blue brightness level: 0 to 255
- Byte 06: Fade flag + Blink Rate [1 byte]: The MSB of this parameter defines whether this step will fade to the next color. Blink Rate is from 0 to 100, where
  Blink $_{on/off\ time}$ = (101 – blink rate) * 15ms
- Byte 07: Minutes 0 to 255.
- Byte 08 (MSByte) .. Byte 09 (LSByte): Milliseconds 0 to 60,000 (actually 65,535).

Function:
- Write the playlist step to the portion of EEPROM reserved for the playlist number set by the "START SAVING PLAYLIST" command.
- Increment step number; prepare to store next step in the address following this step.

PLAY PLAYLIST (command = 4)

Data Payload:
- Byte 03: Playlist number: 0 to 4

Function:
- Play the specified playlist

GET SERIAL NUMBER (command = 9)

Data Payload:
- NONE

Function:
- Read the serial number of the device from the EEPROM

Response Length:
- Variable, Byte 01 (Length Byte) value is 3 + Length of Serial Number

Response Payload:
- Byte 04.. Byte N: Characters of serial number

SET SERIAL NUMBER (command = 10)

Data Payload:
- Byte 03.. Byte N: Characters of serial number

Function:

- Set the serial number of the device in EEPROM

GET FIRMWARE TYPE (command = 11)
Data Payload:
- NONE

Function:
- Read the Firmware Type string from the EEPROM

Response Length:
- Variable, Byte 01 (Length Byte) value is 3 + Length of Firmware Type string

Response Payload:
- Byte 04.. Byte N: Characters of Firmware Type string

GET FIRMWARE Version (command = 12)
Data Payload:
- NONE

Function:
- Read the Firmware Type string from the EEPROM

Response Payload:
- Byte 04: Major Revision Number
- Byte 05: Minor Revision Number
- Byte 06: Major Patch Version
- Byte 07: Minor Patch Version

SET MAXIMUM DUTY CYCLE (command = 13) (Dicon use only)
Data Payload:
- Byte 03: Color: R = 0, G = 1, or B = 2
- Byte 04 (MSByte).. Byte 07 (LSByte): Established maximum duty cycle: 0 to 499,999.

Function:
- Set during calibration
- Store in EEPROM
- If not set, default is 80% of maximum (400,000)
- **ALL** actual PWM duty cycle is derived from applying this percentage to the brightness levels from LightMix, DMX interface, or preset modes.
- Actual PWM Duty Cycle = (BL / 255) * Max $_{calibrated}$

OVERWRITE PRESET MODE (command = 14)
Data Payload:
- Byte 03: Preset mode number: 1 to 7
- Byte 04: Red Brightness Level
- Byte 05: Green Brightness Level
- Byte 06: Green Brightness Level

- Byte 07: Blink Rate [BR]: 0 to 100. 0 equals constant on. Otherwise,
  Blink $_{on/off\ time}$ = (101 − blink rate) * 15ms. (Set both the ON time and the OFF time to be this number of ms. Total period is therefore twice this value.)

Function:
- Store new preset color in EEPROM
- If not set, show default colors (1:Red, 2:Green, 3:Blue, 4:Cyan, 5:Yellow, 6:Magenta, 7:White)

RESTORE PRESET MODE (command = 15)

Data Payload:
- Byte 03: Preset mode number: 1 to 8

Function
- Restore the preset mode to default color.

GET PLAYLIST STEPS (command = 17)

Data Payload:
- Byte 03: Playlist number: 0 to 4

Function:
- Returns number of steps for the specified playlist number

Response Payload:
- Byte 04(MSByte) .. Byte 07(LSByte): Number of steps.

GET PLAYLIST STEP (command = 18)

Data Payload:
- Byte 03: Playlist number: 0 to 4
- Byte 04(MSByte) .. Byte 07(LSByte): Step number: 0 to [number of steps] − 1

Response Payload:
- All parameters of the specified playlist step of the specified playlist.
- Byte 04: Red brightness level: 0 to 255
- Byte 05: Green brightness level: 0 to 255
- Byte 06: Blue brightness level: 0 to 255
- Byte 07: Fade flag + Blink Rate [1 byte]: The MSB of this parameter defines whether this step will fade to the next color. Blink Rate is from 0 to 100, where
  Blink $_{on/off\ time}$ = (101 − blink rate) * 15ms
- Byte 08: Minutes 0 to 255.
- Byte 09 (MSByte) .. Byte 10 (LSByte): Milliseconds 0 to 60,000 (actually 65,535).

GET TEMPERATURE (command = 19) (Dicon use only)

Data Payload:
- NONE

Function:
- Returns the current lamp temperature

Response Payload:

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- Byte 04: Temperature in Centigrade rounded to the nearest whole degree.

SET DMX BASE ADDRESS (command = 20)
Data Payload:
- Byte 03(MSByte) .. Byte 06(LSByte): 4 byte DMX Base address: 1 through 510
Function:
- Set DMX base address for the Fiberlamp channels
  - Red Channel is DMX base address
  - Green Channel is DMX base address + 1
  - Blue Channel is DMX Base address + 2
  - Blink Rate is NOT supported through DMX

GET DMX AVAILABLE (command = 21)
Data Payload:
- NONE
Function:
- Returns the DMX availability bit (1 = lamp responds to DMX, 0 = lamp does not respond to DMX)
Response Payload:
- Byte 04: DMX availability bit (1 = lamp responds to DMX, 0 = lamp does not respond to DMX)

SET DMX AVAILABLE (command = 22)
Data Payload:
- Byte 03: DMX Availability (0 = DMX NOT available, 1 = DMX available)
- Byte 04: 0x98
- Byte 05: 0x76
- Byte 06: 0x54
- Byte 07: 0x32
Function:
- Set the availability of DMX on the lamp

GET PRESET MODE (command = 23)
Data Payload:
- Byte 03: Preset number: 1 to 7
Response Payload:
- The color in the preset mode.
- Byte 04: Red brightness level: 0 to 255
- Byte 05: Green brightness level: 0 to 255
- Byte 06: Blue brightness level: 0 to 255

- Byte 07: Fade flag + Blink Rate [1 byte]: The MSB of this parameter defines whether this step will fade to the next color. Blink Rate is from 0 to 100, where

$$\text{Blink}_{\text{on/off time}} = (101 - \text{blink rate}) * 15\text{ms}$$

Function
- Retrieve the current saved color of the preset mode.

PLAY PRESET MODE (command = 24)

Data Payload:
- Byte 03: Preset number: 0 to 7

Function:
- Set the lamp color to one of the preset mode colors. Mode 0 is lamp OFF.

SET MAX DUTY CYCLE PERCENTAGE (command = 25)

Data Payload:
- Byte 03: Color: R = 0, G = 1, or B = 2
- Byte 04: max duty cycle percentage

Function:
- Sets the maximum duty cycle percentage for the specified color channel

GET DMX MASTER (command = 26)

Data Payload:
- None

Function:
- Returns if the device is configured to be DMX master

Response:
- Byte 04: 0 (DMX slave), 1 (DMX master)

SET DMX MASTER (command = 27)

Data Payload:
- Byte 03: 0 (DMX slave), 1 (DMX master)

Function:
- Sets the DMX master mode. This value is non-volatile. Device remains in same DMX master/slave configuration after power cycling.

Firmware Versions

Nov 5, 2007	0.1.0.0	GV	Original Release
Nov 8, 2007	0.1.0.1	GV	Do not wait for entire DMX packet before changing color
Nov 9, 2007	0.1.0.2	GV	Fix bug in not allowing high blink rates

Dec 4, 2007	0.1.1.0	GV	Blink OFF state is now completely OFF (disable PWM, GPIO = 0)
Dec 5, 2007	0.1.1.1	GV	Allow changing of preset mode 1 through USB communication
Dec. 11, 2007	0.1.2.0	GV	Only allow Max Duty Cycle <500,000. Certain USB commands do no longer stop the play list.
Dec 12, 2007	0.1.3.0	GV	Add DMX Availability support
Dec 13, 2007	0.1.3.1	GV	No longer use SHDN to cause blinky. Default max duty cycle is now 499,999.
Dec 14, 2007	0.1.4.0	GV	Add Get Preset Color and Play Preset Color.
Dec 14, 2007	0.1.4.1	GV	Button press no longer skips mode 0 (OFF)
Dec 21, 2007	1.0.0.0	GV	Declare version 1.0.0.0
Feb 18, 2009	2.0.9.0	TW	First version for Gen 3 board. 3 logical channels mapped to 4 physical channels. DMX master. Lamp off for temperature shutdown. 10KHz PWM.