AVR328: USB Generic HID Implementation

8-bit AVR® Microcontrollers

Application Note

Features

- **Supported by all Microsoft® O/S from Windows® 98SE and later**
- **Simple PC Interface with Read/Write Functions**
- **Up to 64Kbytes/s Full Duplex Transfer**
- **Runs on any AVR® USB microcontroller**

1. Introduction

The aim of this document is to describe how to start and implement a USB application based on the HID class to transfer data between a PC and user equipment.

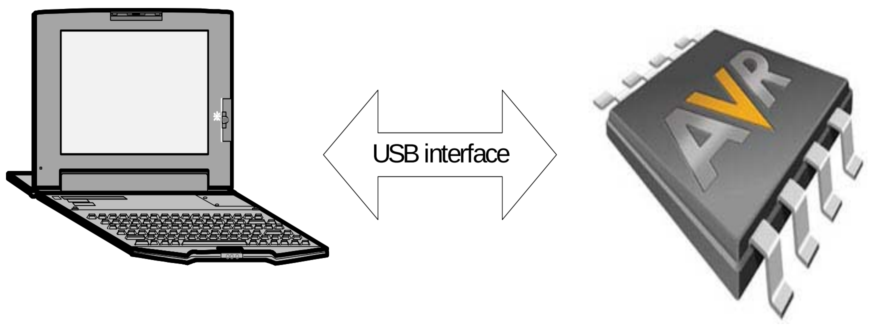
2. Description

The USB interface becomes very complex when the user data does not fit with USB standard classes (Mass Storage, Audio, Video...). Specific drivers must be developed, requiring a significant amount of development time.

Atmel has developed a solution to save time and development efforts. This solution is based on HID class. It ensures a full duplex transfer between the device and the PC (up to 64Kbytes/s). Adding to the data exchange, this application allows the user to upgrade firmware without any hardware setup.

The HID class is supported by all Microsoft O/S from Windows 98SE and later. It is also supported by most other O/S running on PCs (at time of publication).

A familiarity with the USB firmware architecture (Doc 7603, Included in the USB CD-ROM & Atmel website) and the HID specification (http://www.usb.org/developers/hidpage) is assumed.



Rev. 7599A–AVR–01/06

3. Hardware Requirements

The generic HID application requires the following hardware:

1. AVR USB evaluation board (STK525)
2. AT90USB microcontroller
3. USB cable (Standard A to Mini B)
4. PC running on Windows (98SE, ME, 2000, XP) with USB 1.1 or 2.0 host

4. Software Requirement

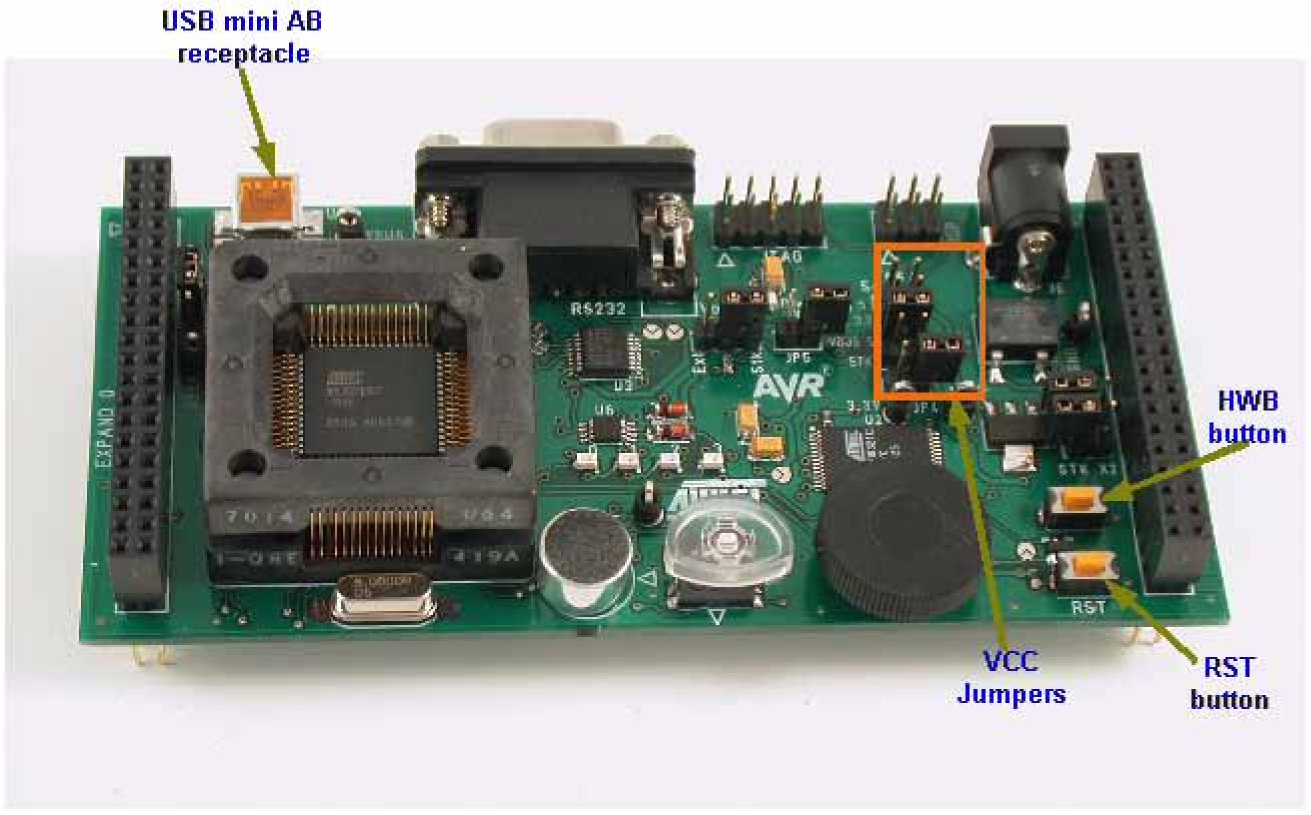
The software needed for this application include:

1. FLIP software (Device Firmware Upgrade tool)
2. usb_hid_generic.a90 (included in USB CD-ROM)
3. usb_hid_generic.exe (included in USB CD-ROM)

5. STK525 Default Settings

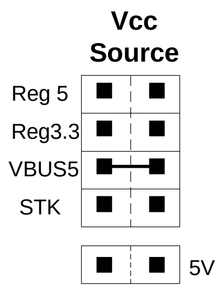
The STK525 board must be configured as below:

Figure 5-1. STK525 Board



All the jumpers should be open, only the Vcc Source jumper VBUS5 should be set as below:

Figure 5-2. Vcc Jumpers



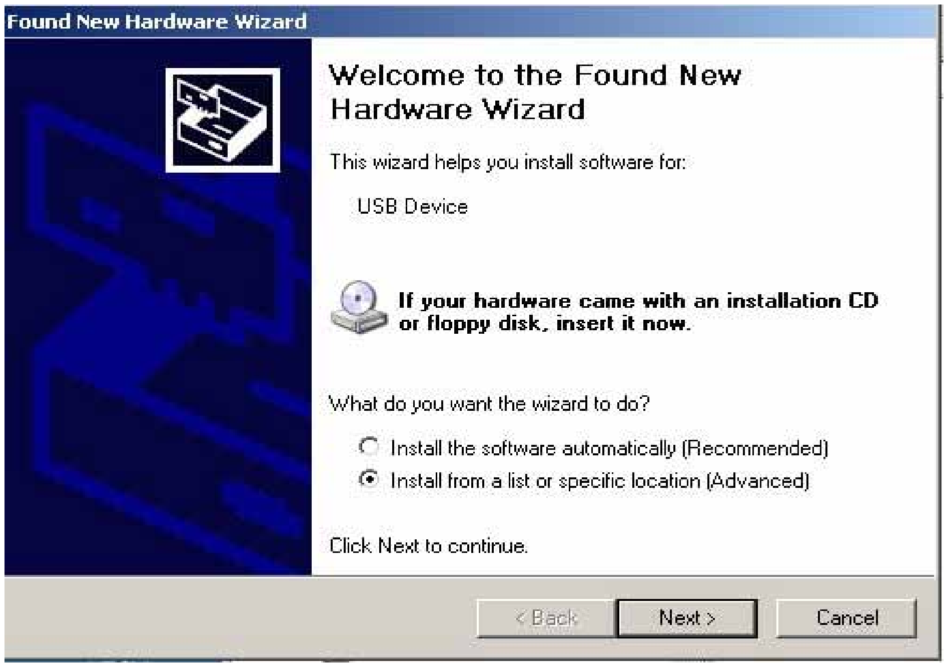
6. Device Firmware Upgrade

The first thing to do before starting the demo is to load the hex file into the on-chip flash memory of the microcontroller. The “Flip” software is the tool used to upgrade the firmware (available freely in the USB CD-ROM or Atmel website).

The following steps should be completed to allow the device starting DFU mode, and load the hex file:

1. Install Flip software (Flip version 3.0 or above is required).
2. Connect the STK525 board to the PC using the USB cable (Standard A to Mini B).
3. Push the HWB (Hardware Bootloader) button
4. Push the RST (Reset) button
5. Release the RST button
6. Release the HWB button
7. If your hardware conditions explained above are correct, a new device detection wizard will be displayed. Please follow the instructions (the INF file is located in the USB subdirectory from Flip installation: “install path:\ATMEL\FLIP\FLIPx.x.x\usb”).

Figure 6-1. New Device Detection Wizard



Found New Hardware Wizard

Welcome to the Found New Hardware Wizard

This wizard helps you install software for:

USB Device

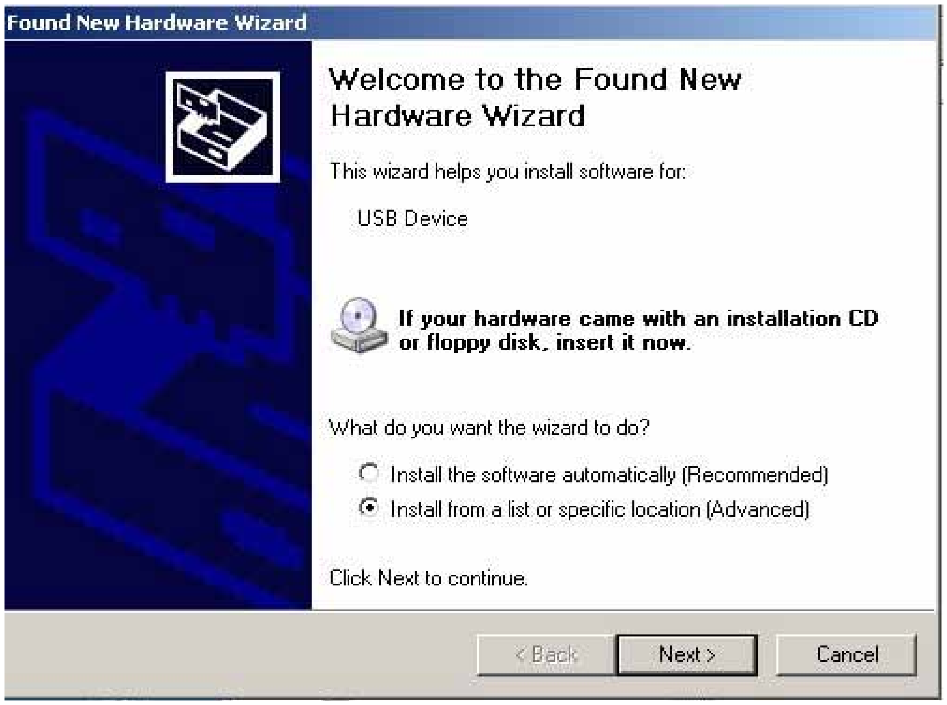
If your hardware came with an installation CD or floppy disk, insert it now.

What do you want the wizard to do?

- ○ Install the software automatically (Recommended)
- ● Install from a list or specific location (Advanced)

Click Next to continue.

Figure 6-2. Driver Location



Found New Hardware Wizard

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This wizard helps you install software for:

USB Device

If your hardware came with an installation CD or floppy disk, insert it now.

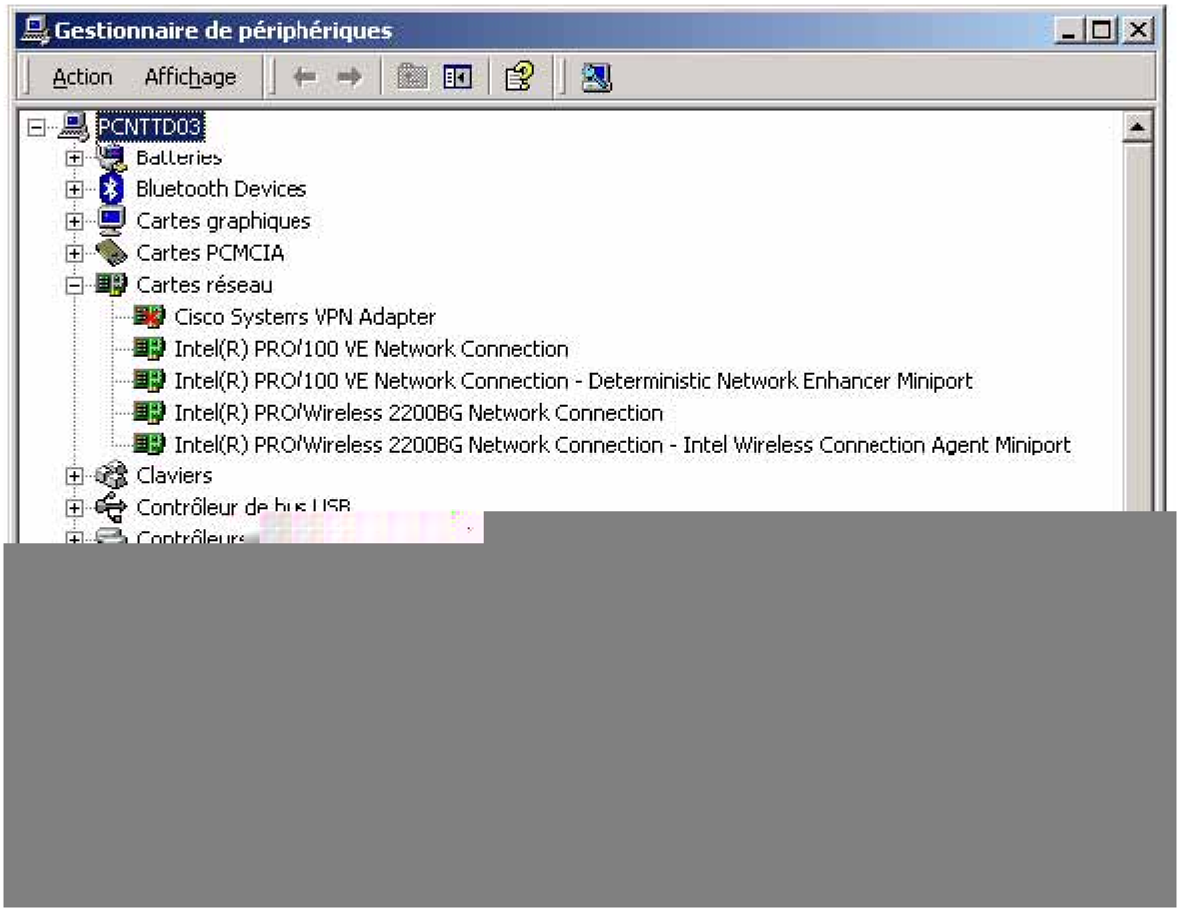
What do you want the wizard to do?

- ○ Install the software automatically (Recommended)
- ● Install from a list or specific location (Advanced)

Click Next to continue.

8. Check the Device Manager Figure 6-3. and you should see the same icon (jungo icon) as shown in the figure below. If not, repeat step 2.

Figure 6-3. Device Manager



Gestionnaire de périphériques

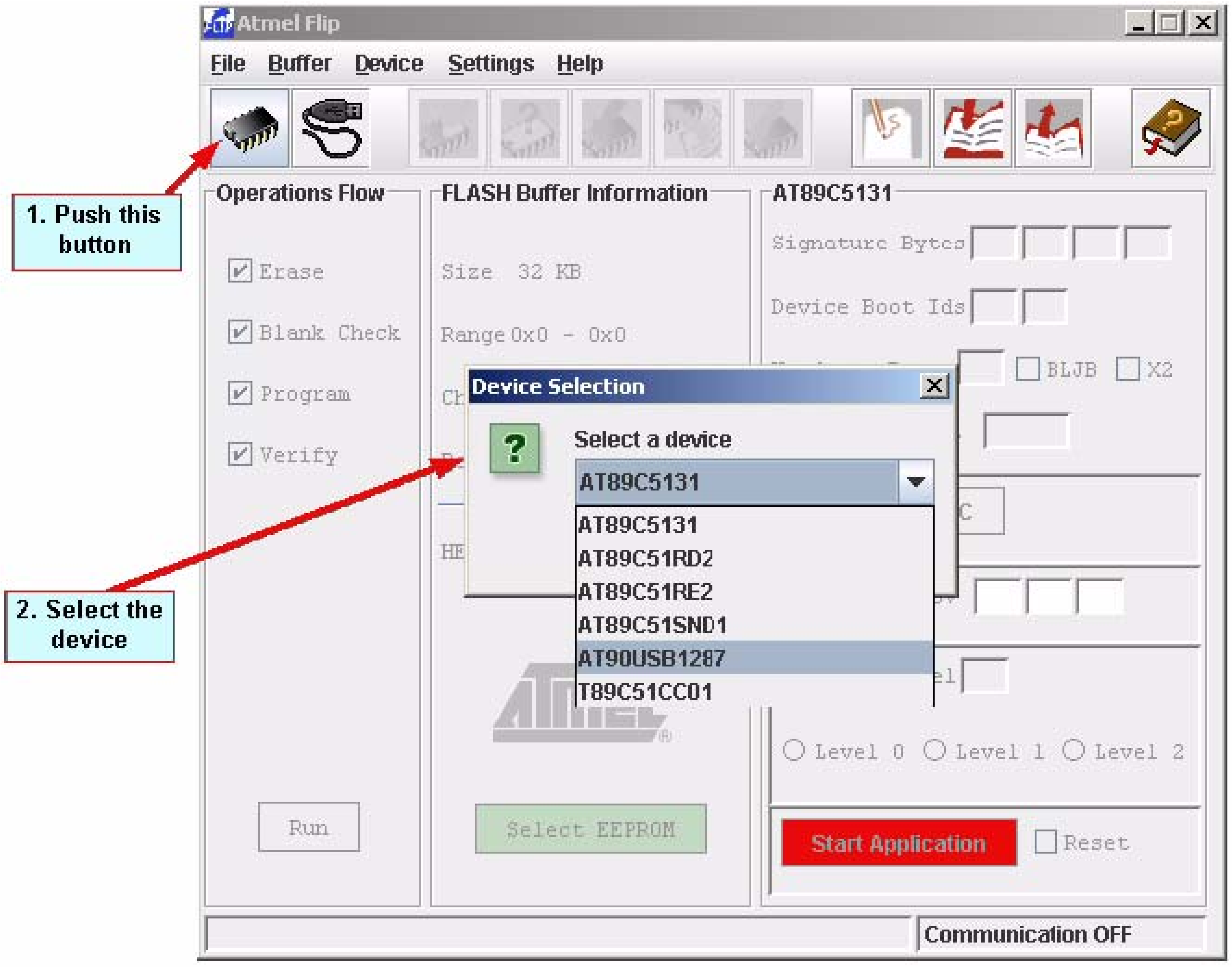
Action Affichage

- PCNTTD03
  - Batteries
  - Bluetooth Devices
  - Cartes graphiques
  - Cartes PCMCIA
  - Cartes réseau
    - Cisco Systems VPN Adapter
    - Intel(R) PRO/100 VE Network Connection
    - Intel(R) PRO/100 VE Network Connection - Deterministic Network Enhancer Miniport
    - Intel(R) PRO/Wireless 2200BG Network Connection
    - Intel(R) PRO/Wireless 2200BG Network Connection - Intel Wireless Connection Agent Miniport
  - Claviers
  - Contrôleur de bus USB
  - Contrôleurs

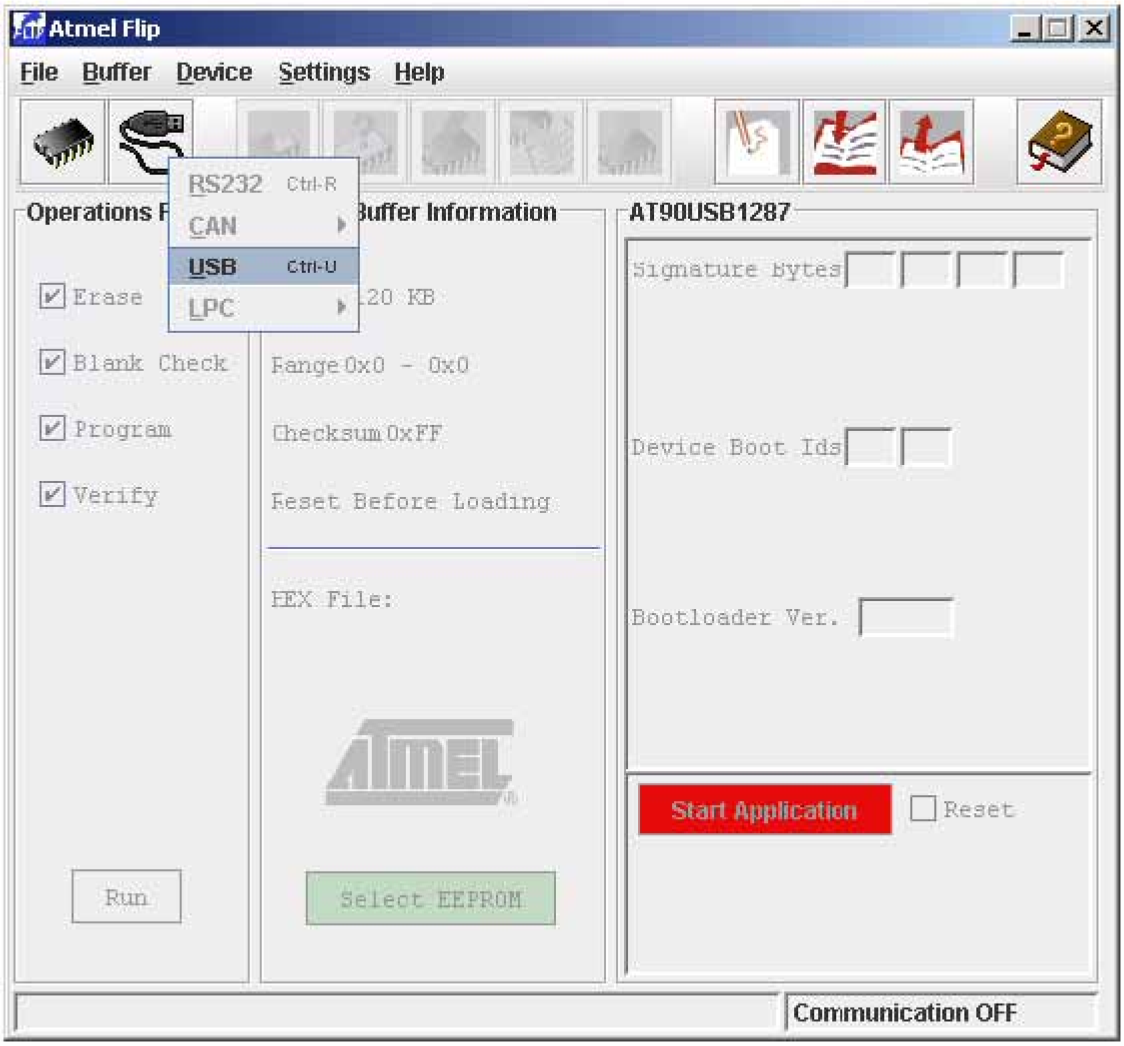
Once your device is in DFU mode, launch the Flip software and follow the instructions explained below, Figure 6-4.

1. Select AT90USB device

Figure 6-4. Device Selection

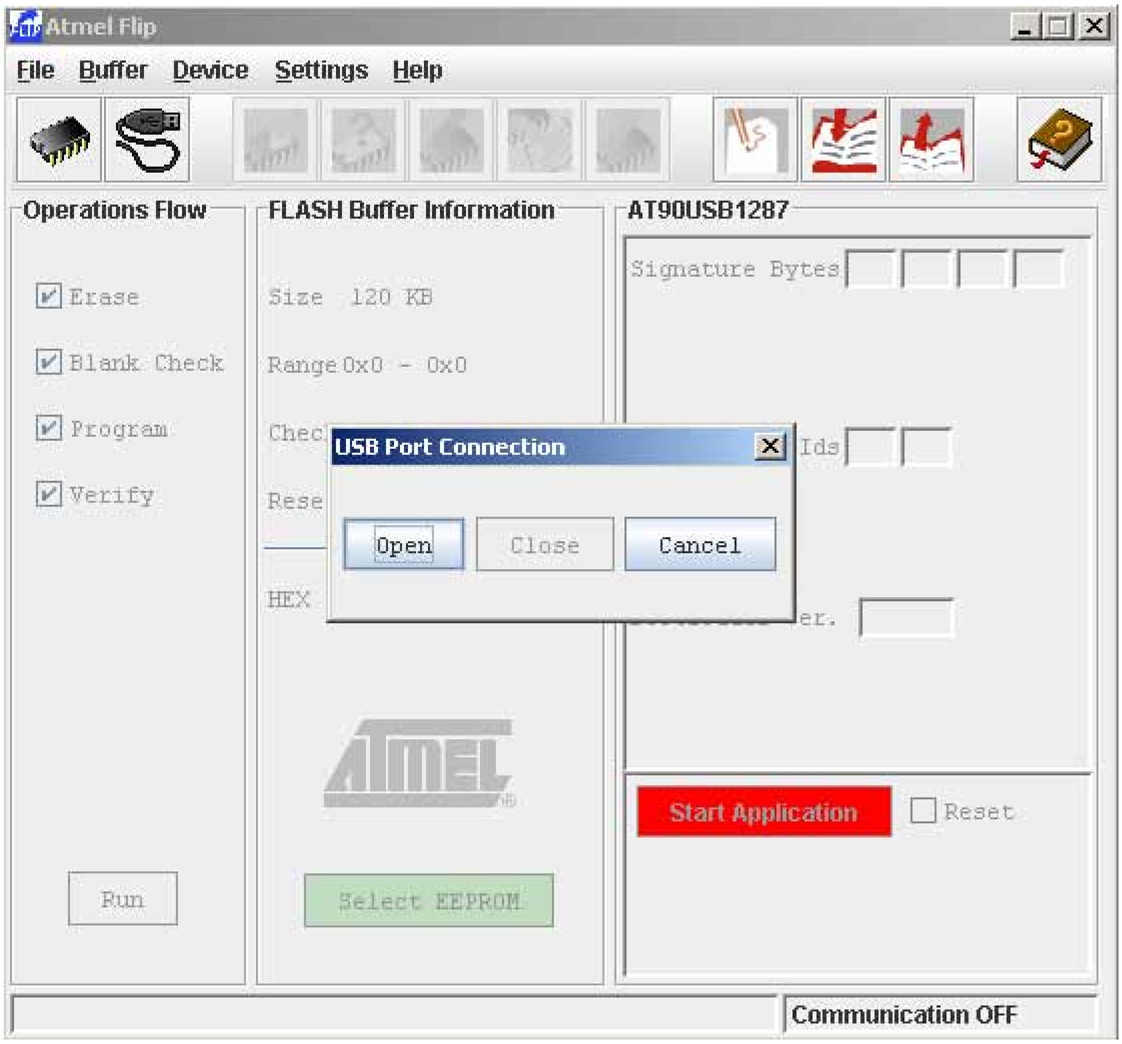


2. Select the USB as communication mode
   a. USB Communication Mode



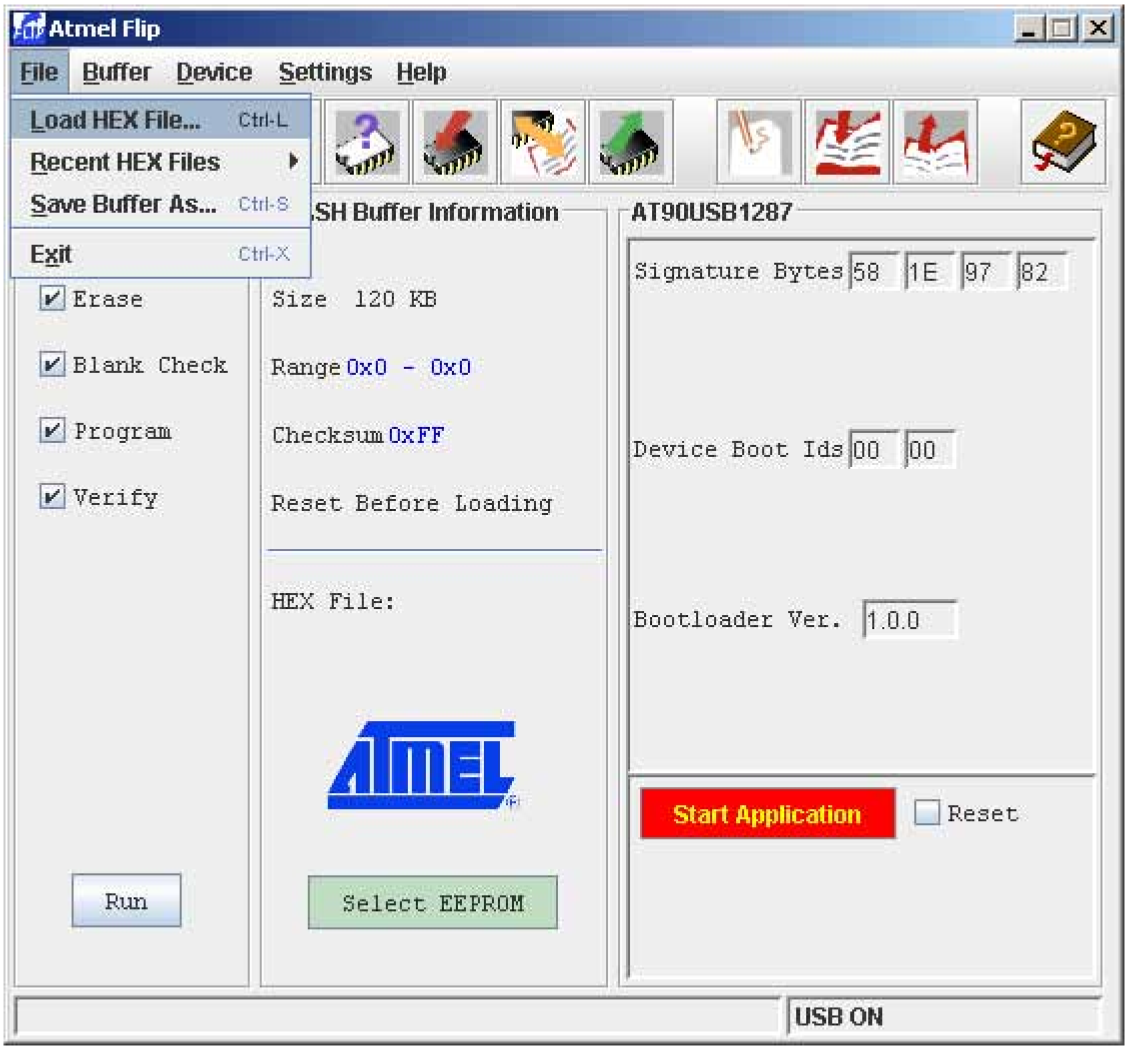
3. Open the communication

Figure 6-5. Open the USB Communication



4. Choose the HEX file to load (the HEX file is including in USB CD-ROM: usb_hid_generic.a90

Figure 6-6. HEX File to Load



Erase ✓
Blank Check ✓
Program ✓
Verify ✓

SH Buffer Information

Size 120 KB

Range 0x0 - 0x0

Checksum 0xFF

Reset Before Loading

HEX File:

AT90USB1287

Signature Bytes 58 1E 97 82

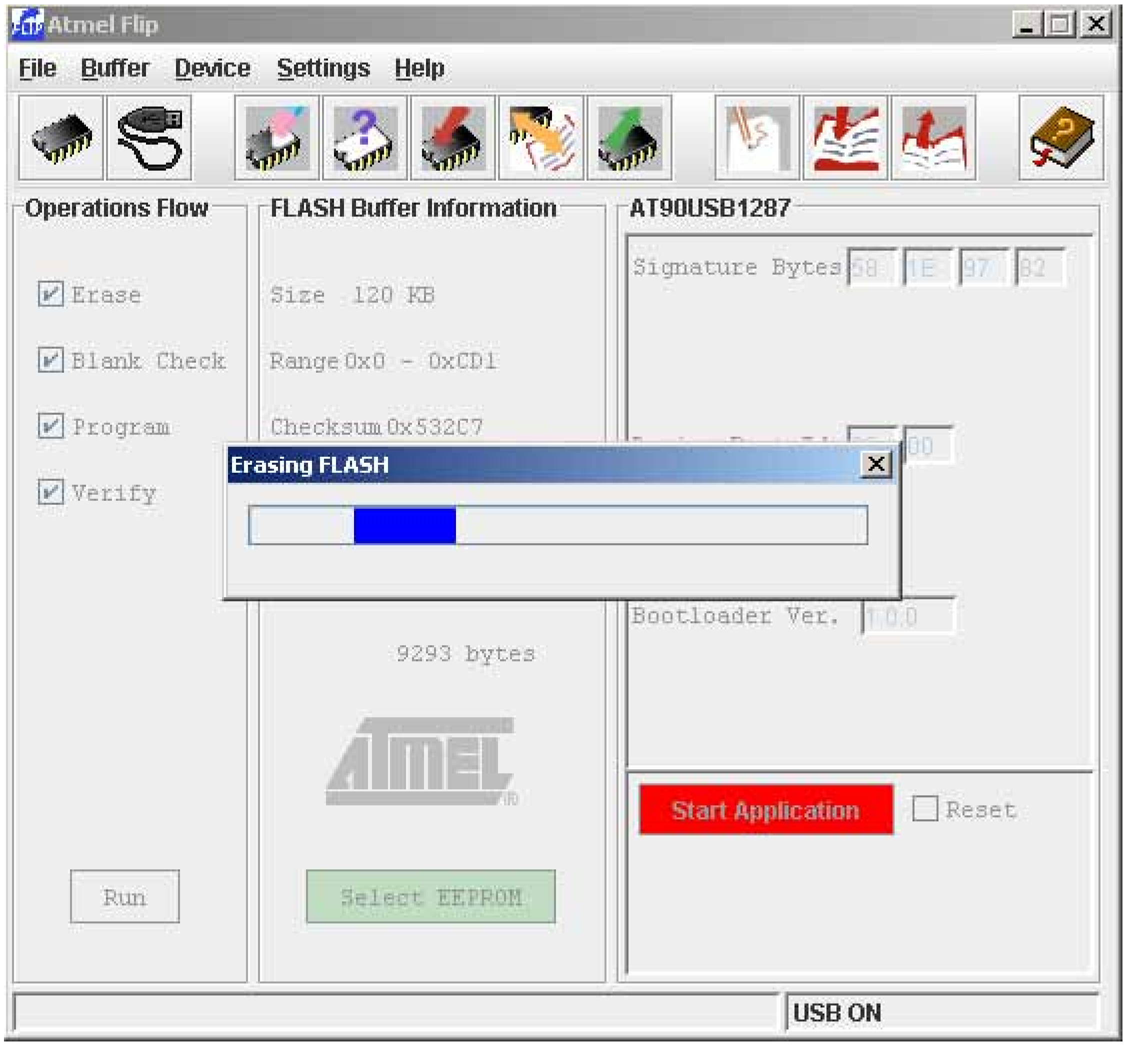
Device Boot Ids 00 00

Bootloader Ver. 1.0.0

Reset ☐

5. Load the HEX file (*Check Erase, Blank Check, Program* and *Verify*, then Push *Run* button)

Figure 6-7. HEX File Loading



Operations Flow

☑ Erase
☑ Blank Check
☑ Program
☑ Verify

FLASH Buffer Information

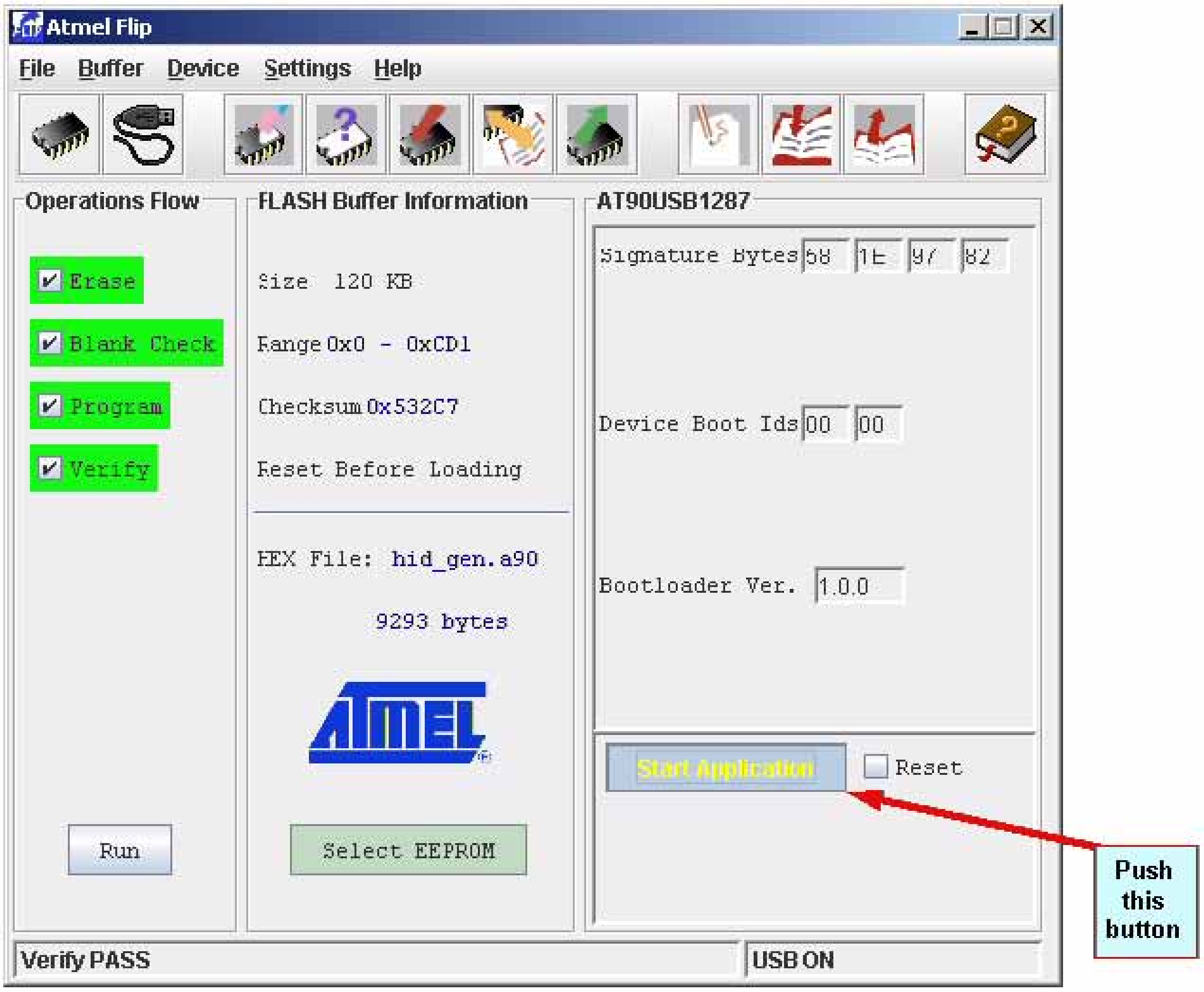
Size 120 KB
Range 0x0 - 0xCD1
Checksum 0x532C7
9293 bytes

AT90USB1287

Signature Bytes 58 1E 97 82
Bootloader Ver. 1.0.0

6. Start the application

Figure 6-8. Start Application



Size 120 KB

Range 0x0 - 0xCD1

Checksum 0x532C7

Reset Before Loading

HEX File: hid_gen.a90

9293 bytes

Signature Bytes 58 1E 97 82

Device Boot Ids 00 00

Bootloader Ver. 1.0.0

Verify PASS

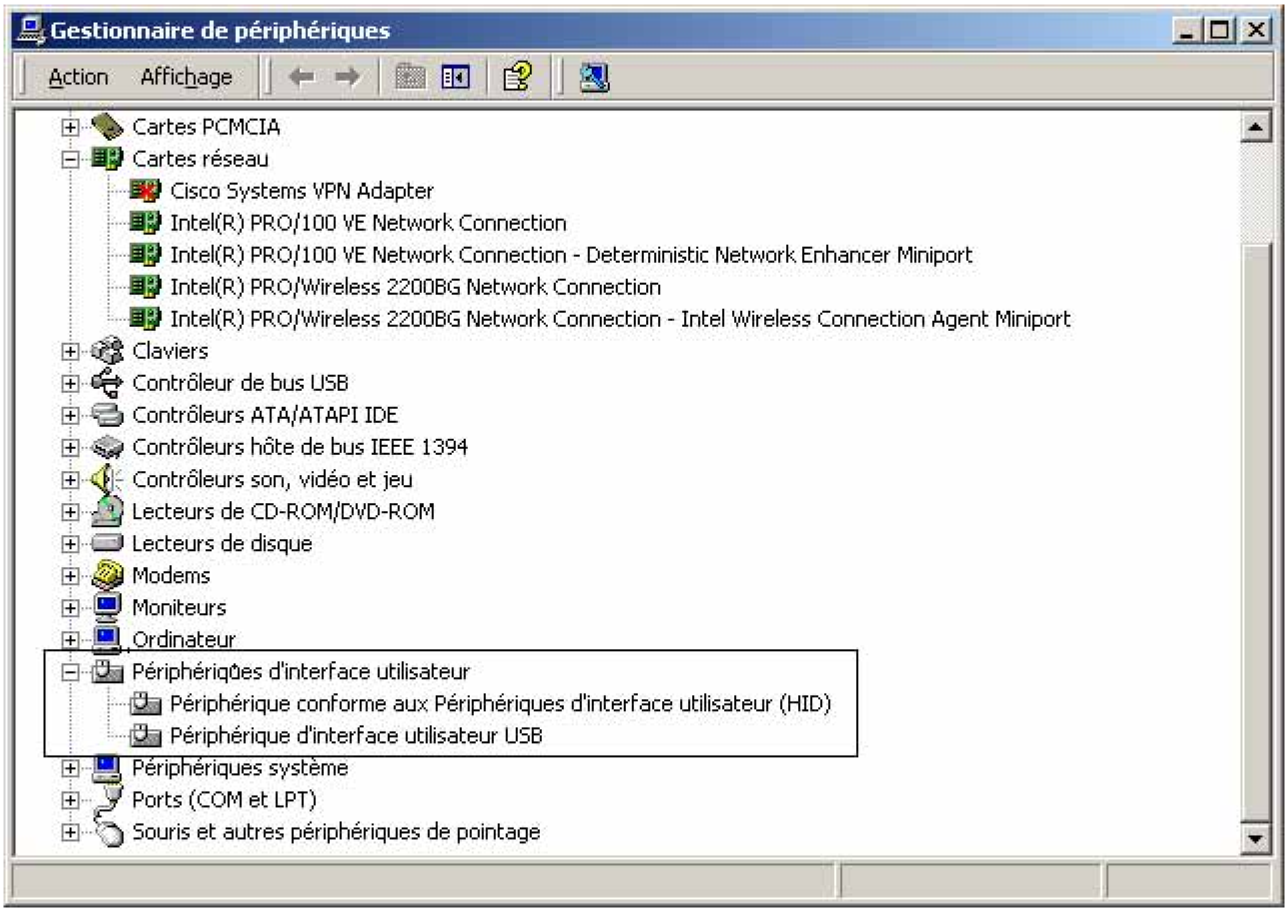
USB ON

Note: The AT90USB bootloader will detach and jump into the user application when “Start Application” button is pressed.

7. Quick Start

Once your device is programmed with *usb_hid_generic.a90* file, you can start the generic HID demo. Check that your device has enumerated as HID device (see Figure 7-1.), then launch the PC application (see Figure 7-3.) and start exchanging data between the PC and the STK525 (see Figure 7-2.).

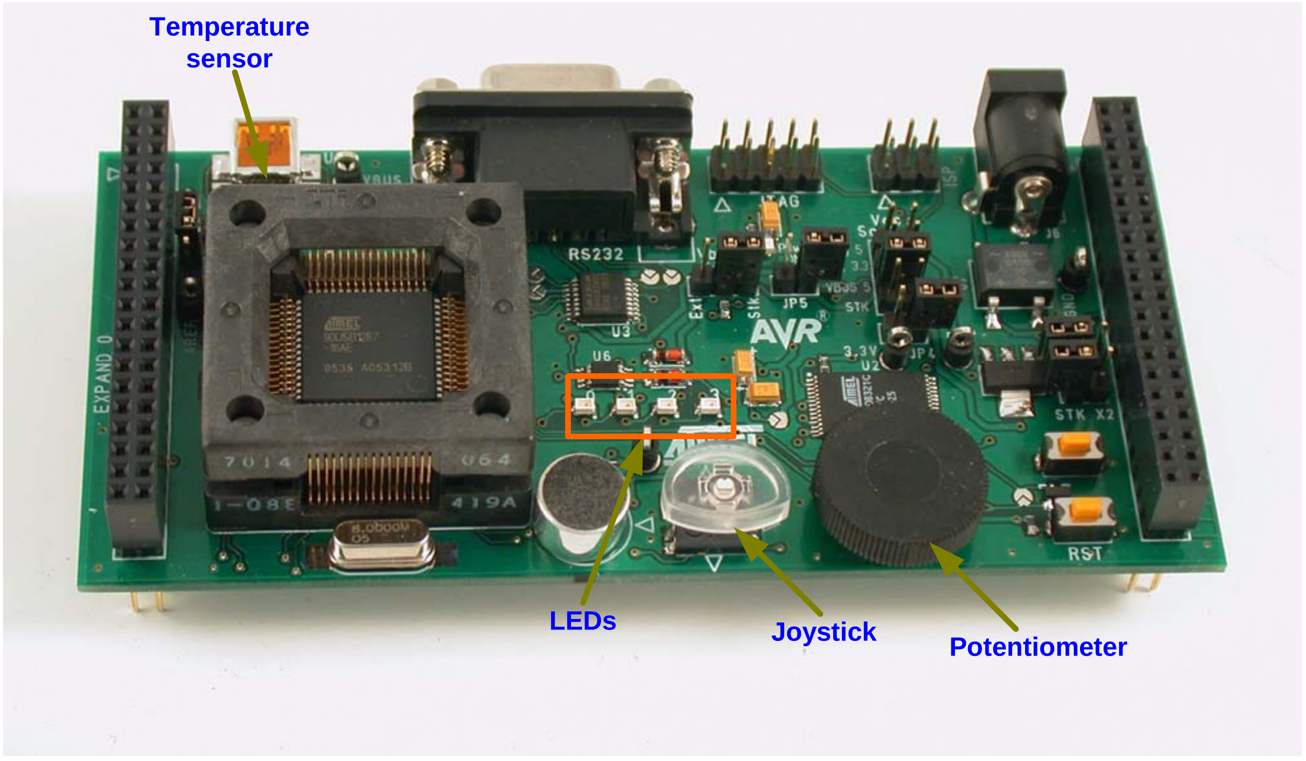
Figure 7-1. HID Enumeration



```
+ Cartes PCMCIA
- Cartes réseau
    Cisco Systems VPN Adapter
    Intel(R) PRO/100 VE Network Connection
    Intel(R) PRO/100 VE Network Connection - Deterministic Network Enhancer Miniport
    Intel(R) PRO/Wireless 2200BG Network Connection
    Intel(R) PRO/Wireless 2200BG Network Connection - Intel Wireless Connection Agent Miniport
+ Claviers
+ Contrôleur de bus USB
+ Contrôleurs ATA/ATAPI IDE
+ Contrôleurs hôte de bus IEEE 1394
+ Contrôleurs son, vidéo et jeu
+ Lecteurs de CD-ROM/DVD-ROM
+ Lecteurs de disque
+ Modems
+ Moniteurs
+ Ordinateur
- Périphériqûes d'interface utilisateur
    Périphérique conforme aux Périphériques d'interface utilisateur (HID)
    Périphérique d'interface utilisateur USB
+ Périphériques système
+ Ports (COM et LPT)
+ Souris et autres périphériques de pointage
```

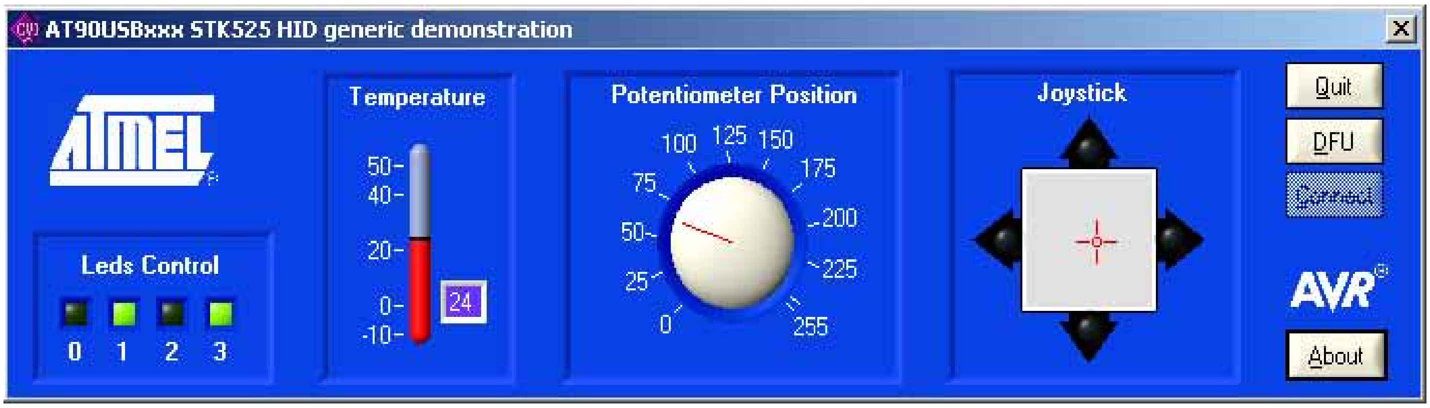
The figure below shows the Hardware used by the demo:

Figure 7-2. Hardware generic HID



The figure below shows the GUI used by the PC application

Figure 7-3. GUI generic HID



To move the pointer in one direction (up, down, left, right..), you have to push the joystick in the same direction.

The potentiometer controls the potentiometer, which displays on the screen an 8-bit coded value.

The temperature value is given by the temperature sensor.

To turn on/off the Leds, you have to click on the Leds Control buttons on the PC display.

Click on the DFU button to put the device in DFU mode, then use Flip softaware to upgrade your device (no hardware conditions needed).

8. Application Overview

The generic HID application is a simple data exchange between a PC and the device.

The USB data exchange for this application is based on two interrupt endpoints (one IN and one OUT) which contain the HID reports for the device application.

The PC asks the device if there is new data available each *P* time (polling interval time), the device will send the data if it is available, otherwise it will send a NAK (No Acknowledge) to tell the PC that there is no data available. The data package sent from the device to the PC is called report IN.

To send data to the device, the PC checks if there is new data available for the application each *P* time (polling interval time). Once data is available, the PC sends it to the device. This data package is called report OUT.

The report IN and the report OUT have the structures below:

Figure 8-1. Report IN structure

Bytes 4 to 7	Byte 3	Byte 2	Byte 1	Byte 0
Reserved	Temperature value	Potentiometer value	Joystick value	LEDs value

- LEDs value: This byte contains the current state (ON/OFF) of the LEDs.
- joystick value: This byte contains the joystick state (Active/Inactive) and the direction of the pointer.
- Potentiometer value: This byte contains the potentiometer value.
- Temperature value: This byte contains the temperature sensor value.

Figure 8-2. Report OUT structure

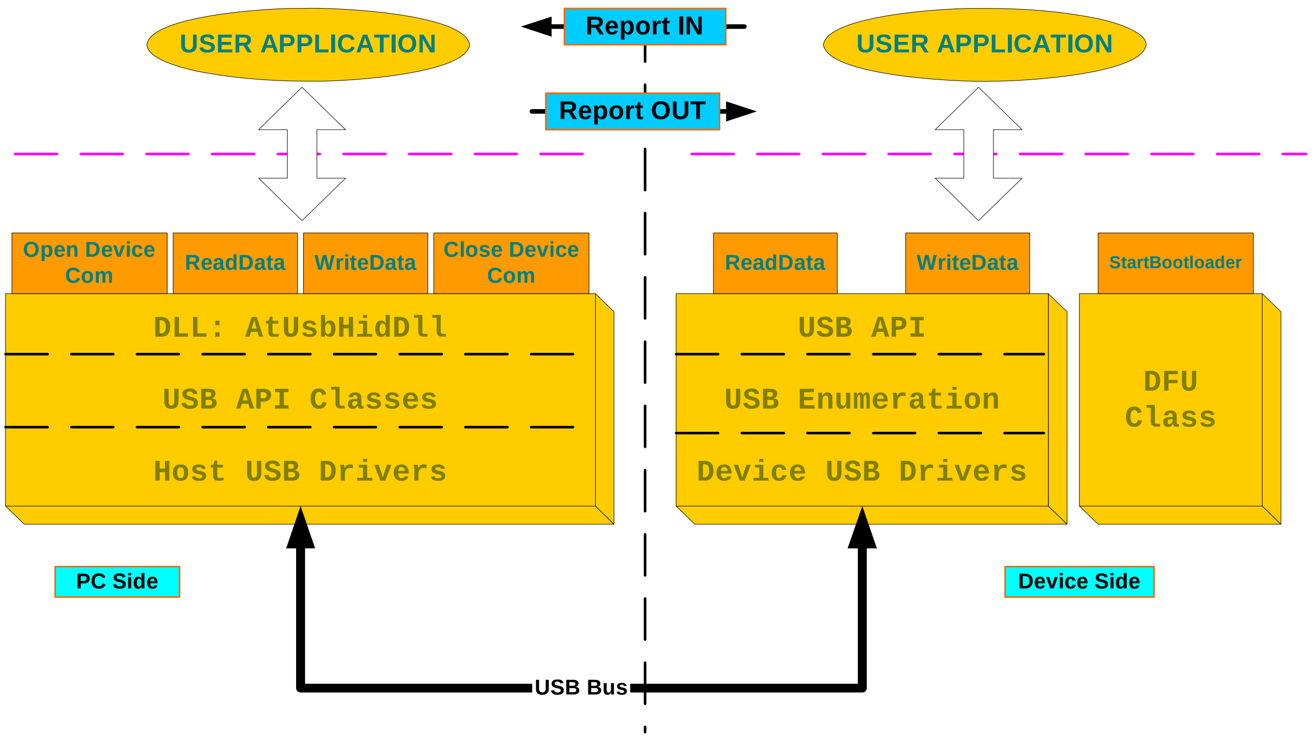
Bytes 5 to 7	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0
Reserved	DFU value		Reserved	Reserved	LEDs value

LEDs value: This byte contains the new state of the LEDs.

DFU value: The values of these two bytes (byte 3: 0x55, byte 4: 0xAA) are used to put the device in DFU mode

Note: In this application we use 8 bytes for the report IN/OUT size. This size can be changed by the user. There is no maximum value of the report size, but a maximum of 64 bytes can be sent a time (see Section "Firmware", page 16).

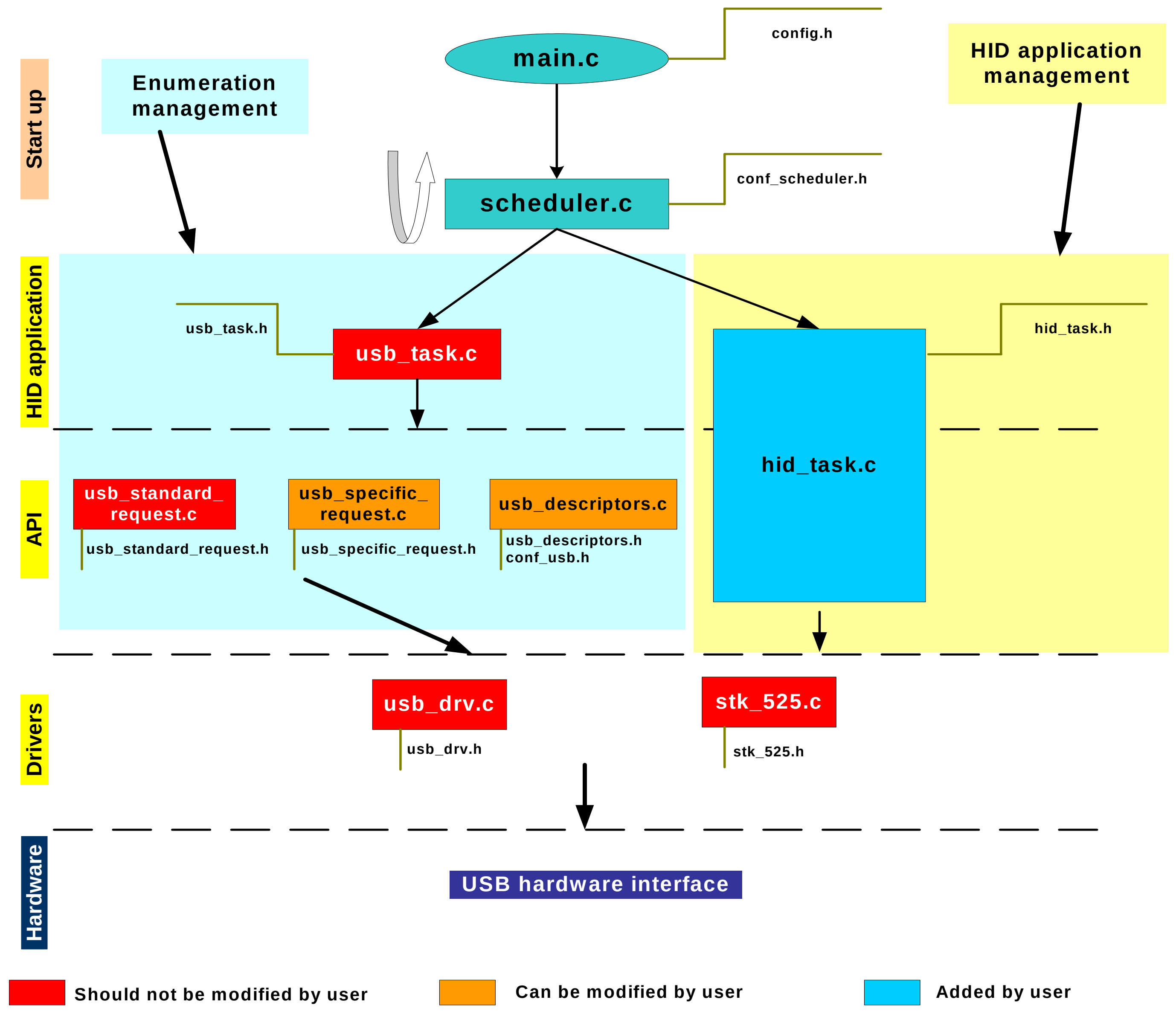
Figure 8-3. Application Overview



9. Firmware

As explained in the USB Firmware Architecture document (Doc 7603, included in the USB CD-ROM) all USB firmware packages are based on the same architecture (please refer to this document for more details).

Figure 9-1. Generic HID Firmware Architecture



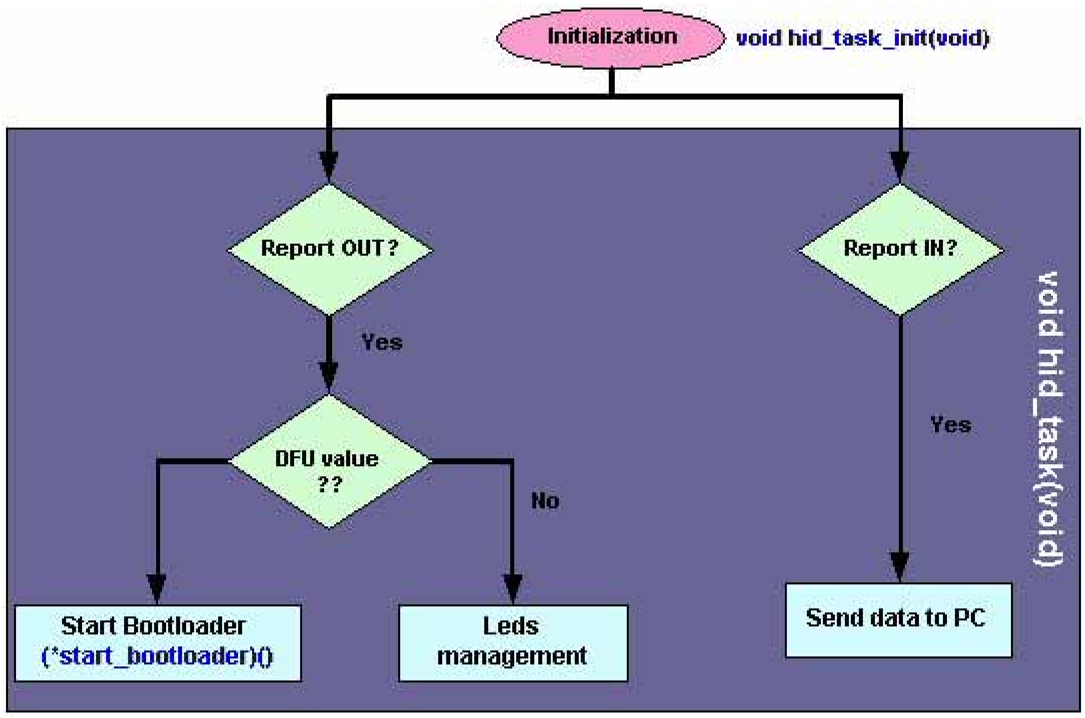
This section is dedicated to the HID module only. The customization of the files described hereafter allow the user to build his own Generic HID Application:

- hid_task.c
- usb_descriptor.h

9.1 hid_task.c

This file contains the functions to initialize the device, manage the data transfer with the PC, and start the bootloader when the user wants to upgrade his firmware.

Figure 9-2. Generic HID Application



9.1.1 hid_task_init

This function performs the initialization of the device parameters and hardware resources (joystick, potentiometer...).

9.1.2 (*start_bootloader)

This function pointer allows the launch of the bootloader.

9.1.3 hid_task

This function manages the data transfer, and the launch of the bootloader, once the DFU command is sent by the PC.

9.2 stk_525.c.

This file contains all the routines to manage the STK525 board resources (Joystick, potentiometer, Temperature sensor, LEDs...). The user should not modify this file when using the STK525 board. Otherwise he have to build his own hadware management file.

9.3 Report length modification

As mentioned in Application Overview section, the user can modify the report IN/OUT length.

The report IN and report OUT lengths are defined in the file *usb_descriptor.h:*

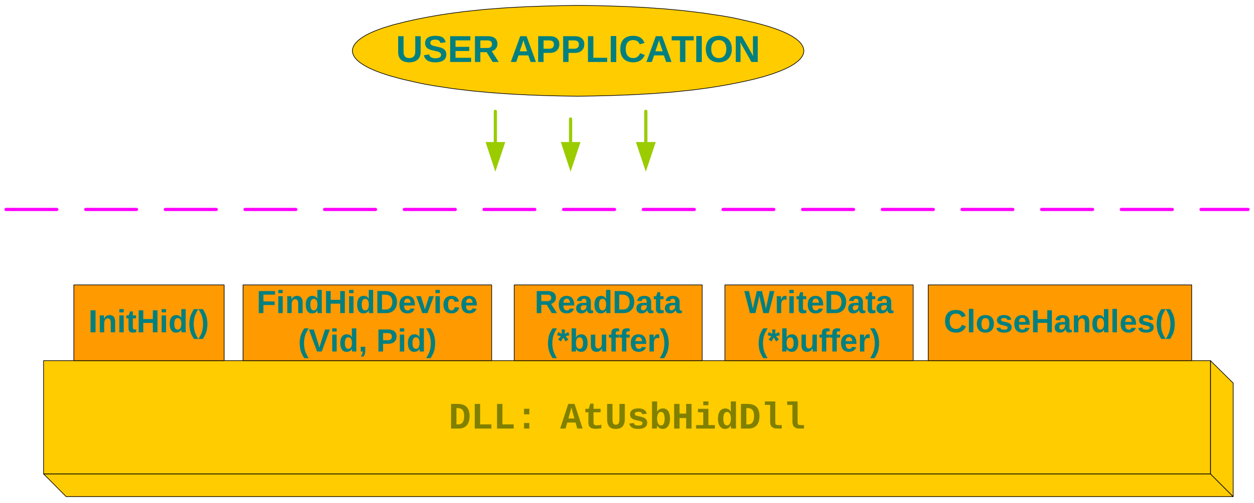
```
#define LENGTH_OF_REPORT_IN 8
#define LENGTH_OF_REPORT_OUT 8
```

10. PC Software

As shown in the Figure 8-3, the Generic HID application requires a software package. This package contains a DLL (Dynamic Link Library) and a user application.

The DLL allows the user to interface with the host USB drivers and avoid a heavy development. This DLL contains five functions explained below:

Figure 10-1. HID DLL



10.0.1 InitHid

This function initializes all the application parameters. It should be called before any USB transfer.

Parameters: none.

10.0.2 FindHidDevice

This function returns true and creates the handle if the right device is found (the VID & PID are correct). Otherwise, it returns false.

Parameters: VID: The vendor ID of the device

PID: The Product ID of the device.

10.0.3 ReadData

This function ensures the reading of data sent by the device and saves it on the buffer.

Parameters:*buffer: Pointer of the buffer on which data will be saved

10.0.4 WriteData

This function ensures the sending of data from the PC to the device. It also ensures the sending of the DFU command.

Parameters:*buffer: Pointer of data buffer.

10.0.5 CloseHandles

This function closes all the handles and the threads. It should be called when you close the application.

Parameters : none.

10.0.6 Limitation

Do not unplug the device when the PC application is running (close the application before).

11. Related Documents

AVR USB Datasheet (doc 7593)

USB Firmware Architecture (doc 7603)

USB HID class specification (doc 7602)

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