AN1815
APPLICATION NOTE

USB Device Disconnect-On-Demand with uPSD32xx

The uPSD32xx family, from ST, consists of Flash programmable system devices with a 8032 Microcontroller Core. Of these, the uPSD3234A-40 and uPSD3254A-40 are notable for having a complete implementation of the USB hardware directly on the chip. This USB hardware complies with the Universal Serial Bus Specification Revision 1.1, and has a low-speed (1.5Mbit/s) device capability. Up to 8 bytes can be transmitted or received in one packet. The typical sustainable bus throughput is up to 6 KBytes per second on USB1.1, up to 11 KBytes per second with certain types of USB2.0 host.

There are times, such as to force a reset, when a physical USB device would be physically disconnected, and then reconnected. This application note presents a possible way of emulating, on demand by software, a disconnect of an embedded USB device, within the uPSD32xx, without needing to add any active components.

USB DEVICE CONNECT AND DISCONNECT SIGNALLING

When no function is attached to the downstream port of the host or hub, its pull-down resistors cause both D+ and D- to be pulled below the single-ended low threshold of the host or hub port. This creates an SE0 state on the downstream port.

A connect condition is detected when the hub detects that one of the data lines is pulled, for more than 2.5µs, above its V_{IH} threshold (2.0V, according to Universal Serial Bus Specification Revision 1.1). Figure 1 depicts this for a low-speed USB device, and Figure 2 for a full-speed one.

Figure 1. Low-speed Device Connect Detection

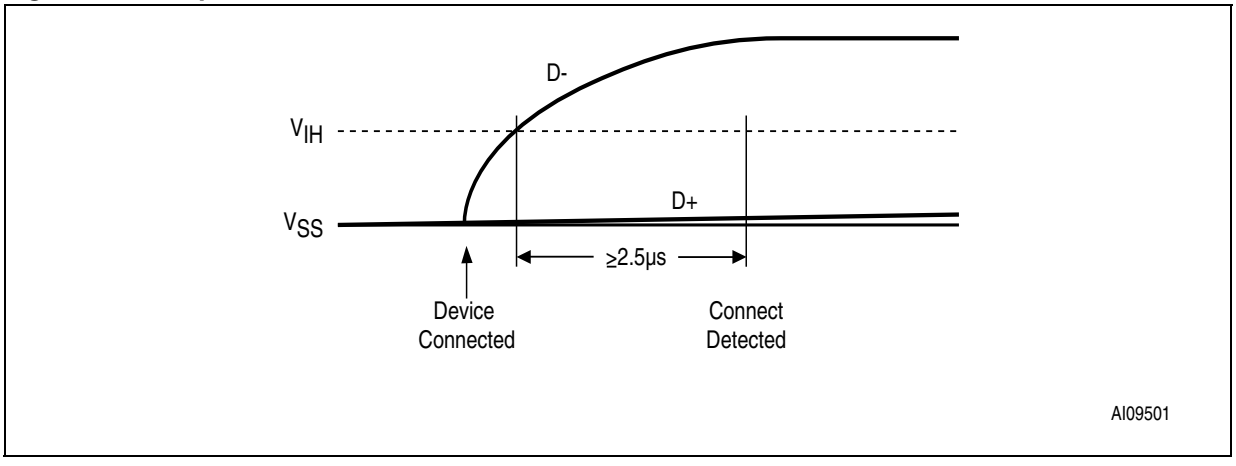


TABLE OF CONTENTS

USB DEVICE CONNECT AND DISCONNECT SIGNALLING 1

Figure 1. Low-speed Device Connect Detection. 1
Figure 2. Full-speed Device Connect Detection 3
Figure 3. Disconnect Detection. 3

TYPICAL USB CONNECTION CIRCUIT 4

Figure 4. Typical USB Connection Circuit in 5V Systems (uPSD32xx) 4

HARDWARE MODIFICATION FOR NEW DESIGNS 5

Figure 5. Possible Hardware Modification Recommended for the New Designs (minimal solution) 5
Figure 6. Possible Hardware Modification Recommended for the New Designs (optimal solution) . 6

HOW TO MAKE AN EASY HARDWARE MODIFICATION IN ALREADY EXISTING DESIGNS 7

Figure 7. Easy Hardware Modification for already Existing Equipment (such as DK3200) 7

DISCONNECT-ON-DEMAND FEATURE AND DK32XX DEVELOPMENT KITS 8

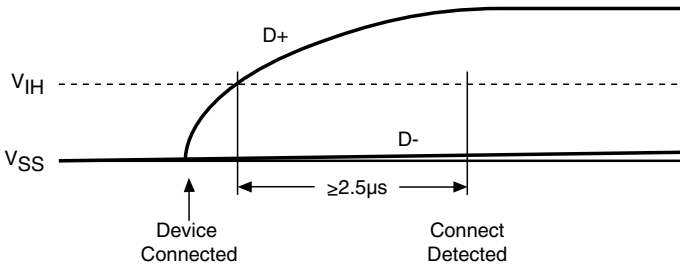
Figure 8. Modification of DK3200 Development Kit 8

AN EXAMPLE OF THE SOFTWARE SIDE OF THE SOLUTION 9

REVISION HISTORY 10

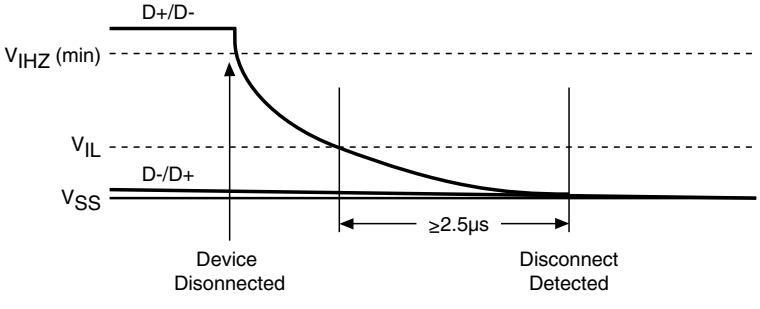
Table 1. Document Revision History 10

Figure 2. Full-speed Device Connect Detection



A disconnect condition is indicated if the host or hub is not driving the data lines on a downstream port, persisting for more than 2.5µs. This is depicted in Figure 3.

Figure 3. Disconnect Detection

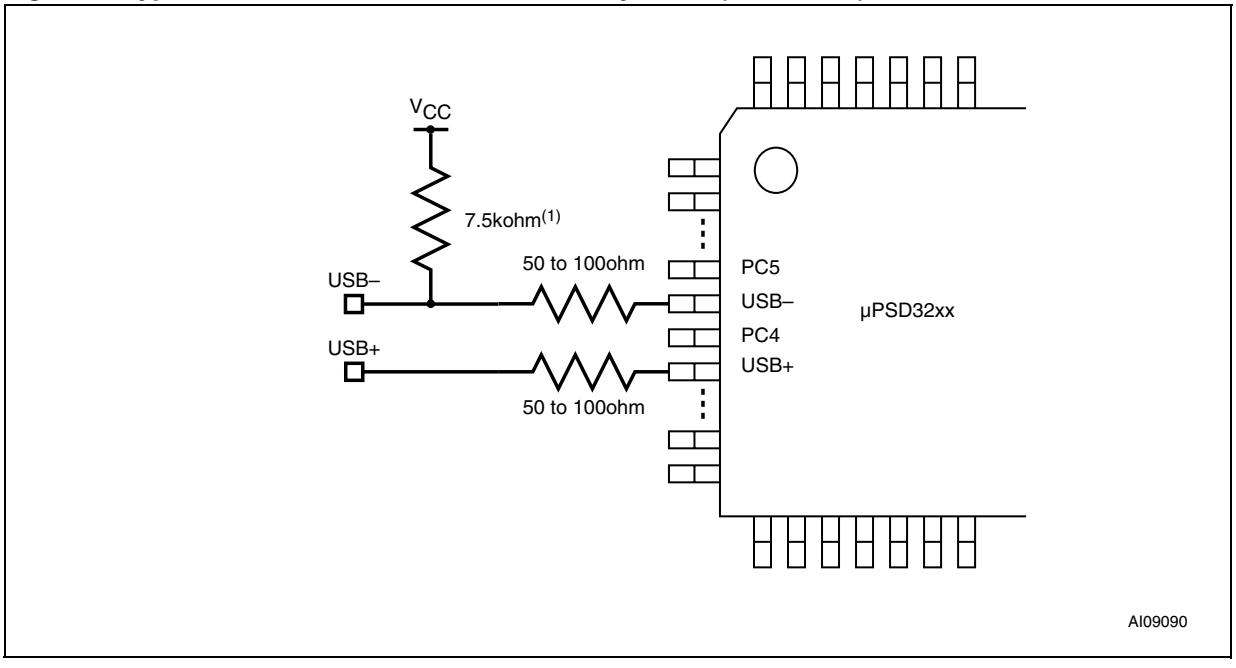


Hubs may optionally determine the speed of the attached device by sampling the state of the bus, immediately before driving SE0 to indicate a reset condition to the device. Alternatively, the hub may float the bus, after driving a reset, and perform another bus state evaluation after 2.5µs.

TYPICAL USB CONNECTION CIRCUIT

Figure 4 shows a typical USB circuit that is generally used in uPSD32x4A systems (for a 5V power supply only).

Figure 4. Typical USB Connection Circuit in 5V Systems (uPSD32xx)



HARDWARE MODIFICATION FOR NEW DESIGNS

The following modification, with on-demand disconnect capability using only one add-on resistor, can be implemented in all new designs. The USB disconnect is physically performed by a suitable port pin. The recommended port pin is PC4 because of its position near the USB pins, and its good electrical capabilities. This pin is typically only used in extended 6-wire JTAG In-System-Configuration signalling, and so is free for this new use in most designs.

As shown in Figure 4, pull-up was usually achieved using two resistors. In the normal function state, the PC4 port is configured as an input pin and the JTAG TERRn signal is inactive. Because of the voltage divider, when the USB- signal is low during a USB communication, PC4 (also TERRn) is still near the midpoint of the supply voltage (2.5V when V_{CC}=5V). This voltage level is interpreted as a logic '1'.

According to the last USB engineering change notice, and new host design versions availability, the previous solution with a 7.5kΩ pull-up signalling resistor, for 5V systems, is no longer recommended. Because the host pull-down resistor used to be defined as "15kΩ ± 5%", but is now defined as "14.25 to 24.80kΩ", the voltage at USB- can exceed 3.6V (V_{TERM}). So, now, a third resistor should be added to reach the Thevenin resistance (no less than 900Ω, but typically 1.5kΩ). The open-circuit voltage of the pull-up resistor must not exceed V_{BUS}, and this alternative must produce an idle voltage V_{IHZ} on D- of between 2.7 and 3.6V when terminated by a pull-down resistor (to ground) at the host. Figure 5 shows a possible solution.

Figure 5. Possible Hardware Modification Recommended for the New Designs (minimal solution)

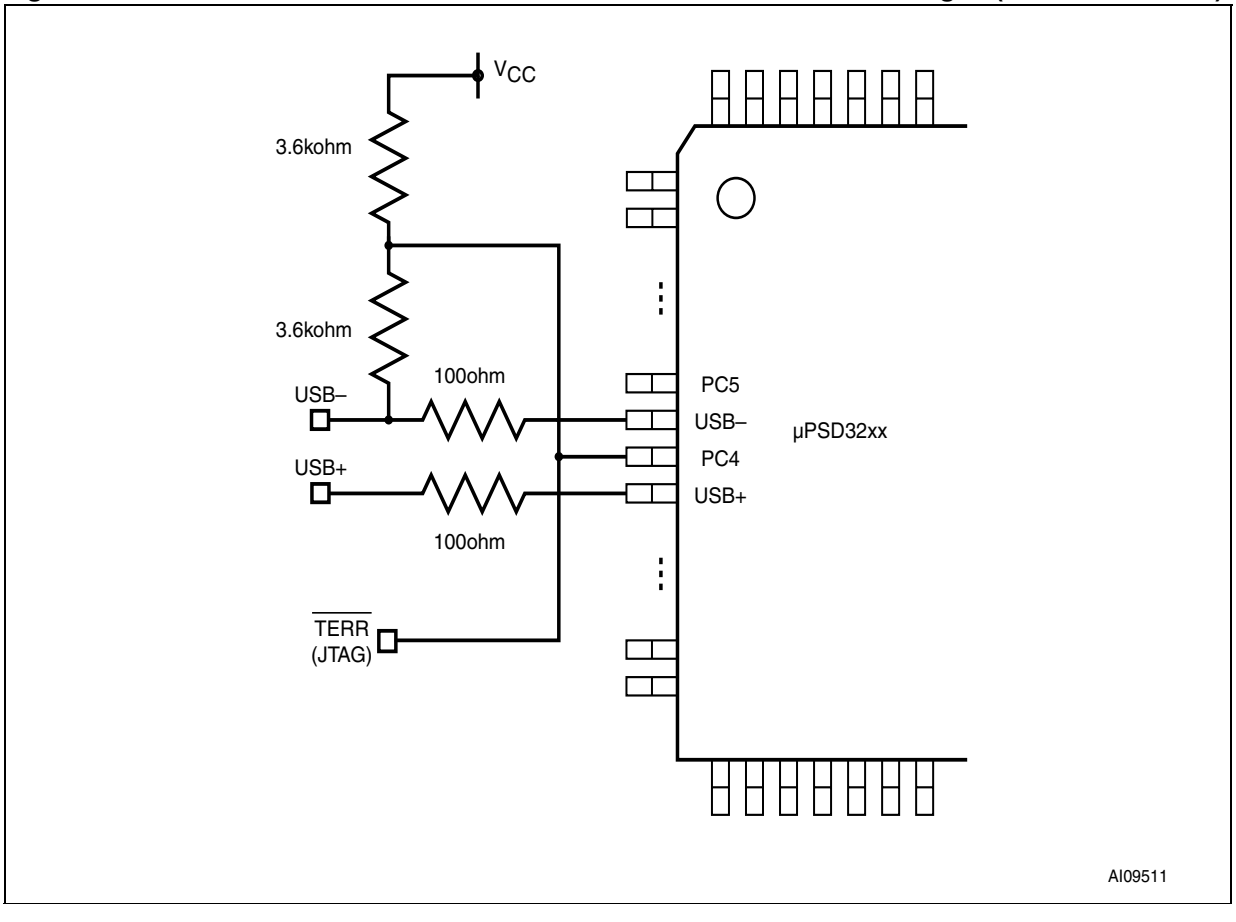
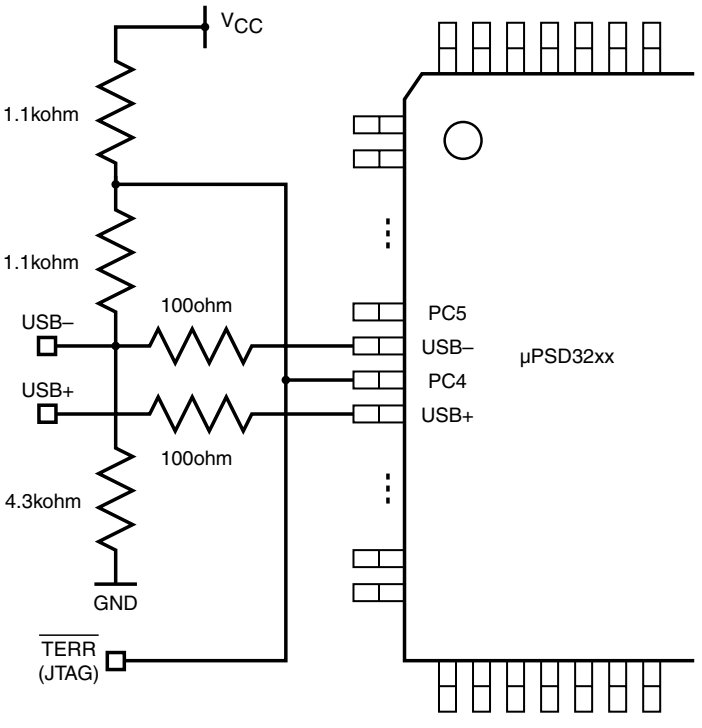


Figure 6. Possible Hardware Modification Recommended for the New Designs (optimal solution)

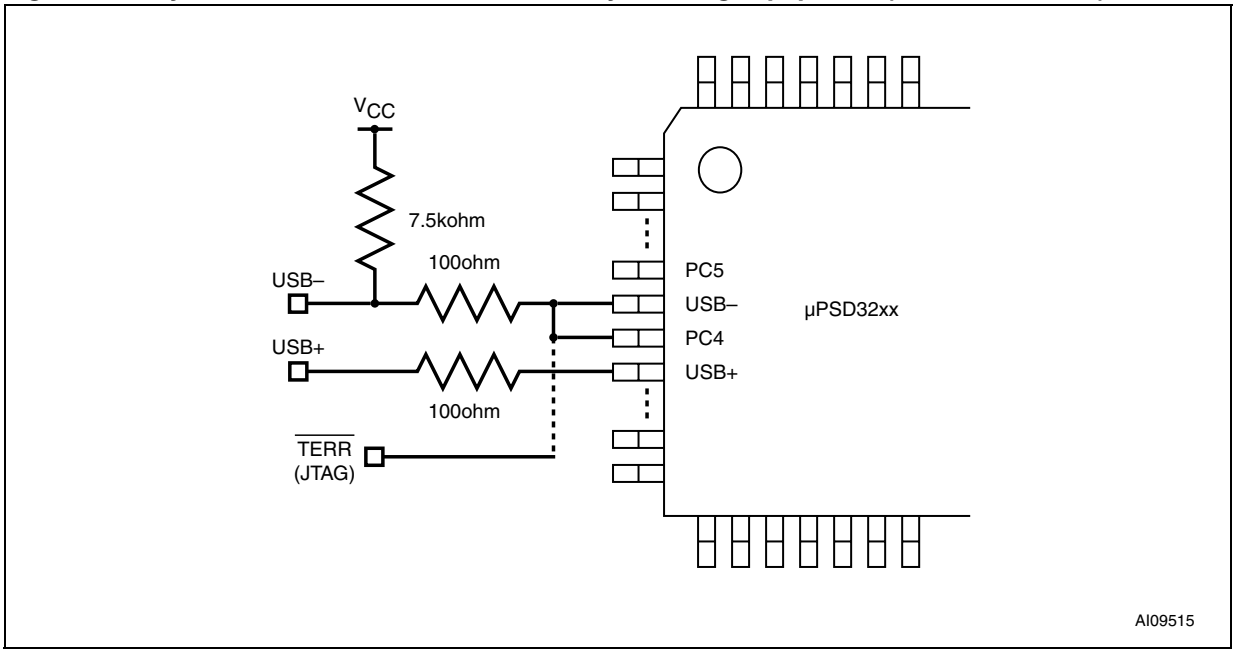


HOW TO MAKE AN EASY HARDWARE MODIFICATION IN ALREADY EXISTING DESIGNS

The USB Disconnect-On-Demand feature can be also implemented in already existing equipment. Figure 7 shows the principle very graphically. The chosen port pin (PC4 because of its proximity to the USB pins) can be directly connected to USB- pin on uPSD. The two 100Ω resistors must be present.

Note: Because of PC4 port as TERRn signal usage, an error can be signalled when programming the uPSD via JTAG. Therefore the basic 4-wire JTAG In-System-Configuration scheme (or USB cable unplugged) would have to be used to avoid possible false errors caused by a communication on USB (USB-signal).

Figure 7. Easy Hardware Modification for already Existing Equipment (such as DK3200)

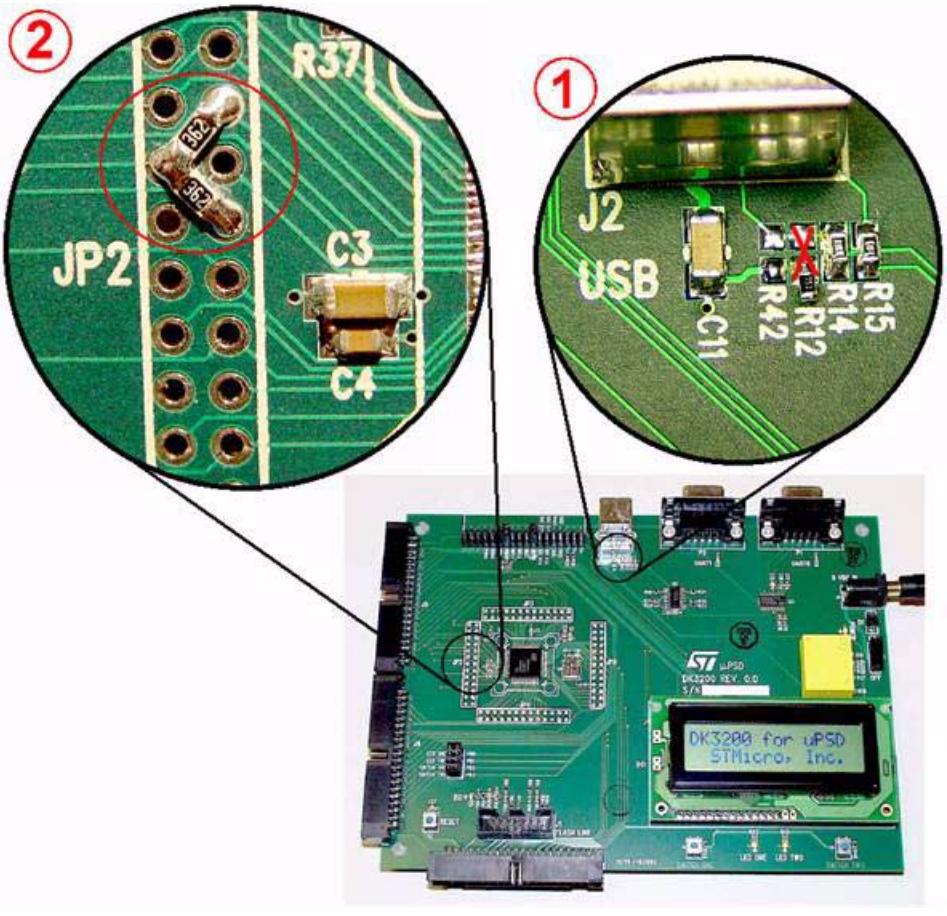


DISCONNECT-ON-DEMAND FEATURE AND DK32XX DEVELOPMENT KITS

The uPSD development kit, DK3200, has no USB Disconnect-On-Demand feature. Figure 8 shows how the feature can be fully implemented. The first step is to remove R12; the second step is to solder in two 3.6kΩ SMD0805 type resistors.

Other development kits for uPSD32xx (like the DK3210M Multimedia kit) have the full USB Disconnect-On-Demand feature already implemented.

Figure 8. Modification of DK3200 Development Kit



AN EXAMPLE OF THE SOFTWARE SIDE OF THE SOLUTION

The following lines present a possible solution of the software side. The following steps have to be performed:

- USB Disconnect:
  - Disable USB hardware
  - Pull down USB- line
  - Wait for detection by USB host (typically after 10ms)
- USB Connect:
  - Release USB- line (pull-up resistor activated)
  - Enable USB hardware
  - Initialize USB software (drivers)

This can be implemented in the C programming language as follows:

```
void USB_Reconnect(void)
{
// USB Disconnect
UADR = 0;                              // disable USB hardware
UIEN = 0;                              // disable USB interrupts
uPSD_xreg.DATAOUT_C &= 0xEF;           // set port PC4 to log.0
uPSD_xreg.DRIVE_C |= 0x10;             // set PC4 to have Open Drain pin drive
uPSD_xreg.DIRECTION_C |= 0x10;         // set PC4 as output

// WAIT 1 sec. or wait for key release (KeyUp) event
// An example: Switch ONE on DK3200 kit
// while ((uPSD_xreg.DATAIN_B & 0x04)==0) {};

// USB Connect
uPSD_xreg.DIRECTION_C &= 0xEF;         // set PC4 as input
uPSD_xreg.DRIVE_C &= 0xEF;             // set PC4 as input

UsbInitialize();                       // Initialize USB hardware/software
}
```

The *USB_Reconnect* routine can also be optionally executed after CPU reset (or as a modified *UsbInitialize* routine).

REVISION HISTORY

Table 1. Document Revision History

Date	Version	Revision Details
27-May-2004	1.0	First Issue
20-Aug-2004	2.0	Document put in new template, and µ changed to u.

If you have any questions or suggestions concerning the matters raised in this document, please send them to the following electronic mail addresses:

ask.memory@st.com (*for general enquiries*)

Please remember to include your name, company, location, telephone number and fax number.