USB Power Switch demonstrator kit

Introduction

The objective of this demonstrator is to display to the user the features and capabilities of the USB Power switches (ST204x and ST205x) developed by STMicroelectronics using a Windows® -based host software application and one of several USB low-speed microcontrollers from ST acting as a peripheral device. The host software and the ST7 source code provides a clear picture of the power switch capabilities. The USB communication between host and the device is done through a HID class based protocol developed specially for demonstration board applications .

The demonstration board incorporates microcontroller, programmable voltage regulator, Mosfets, switches and various resistive networks. The onboard regulator can be configured to supply various voltages by selecting appropriate resistance from the resistive network present at the adjust pin of the regulator. Different voltages and loads can be selected from the PC software as well as through switches present on the board. LEDs are provided on the board to indicate the various combinations of input voltage and load applied to the power switch. The board has an ICC connector to program the microcontroller Flash memory. An external 12V charge pump is also provided on the board to allow the user to perform In-Application Programming (IAP) of the microcontroller embedded Flash program memory. Any type of real load (e.g. USB speakers) can be powered from this board by plugging in the connector present on the board.

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Contents

List of figures

List of tables

1 Getting started

1.1 System requirements

In order to use the USB Power Switch Demonstrator with the Windows® operating system, a recent version of Windows, such as Windows 98, Windows 2000 or Windows XP must be installed on the PC.

The version of the Windows OS installed on your PC may be determined by clicking on the "System" icon in the Control Panel.

1.2 Package contents

The USB Evaluation Kit includes the following items:

● Hardware content
  – One USB Power Switch demonstration board
● Software content
  – PC executable software (USBPS_GUI) for using the demonstration board
  – PC executable software (DFUGUI) for upgrading firmware through USB using DFU feature.
  – ST7 firmware (C source code) for the ST72F62.
● Documentation
  – User Manual for using the Power Switch demonstrator kit.
  – ST7262 Datasheet.
 – USB power switches datasheets.
  – Usage document for using DFUGUI.

1.3 Software installation

Run the setup file to install USBPS_GUI and follow the on-screen prompts to complete the installation.

1.4 Hardware installation

Figure 1 shows a photograph of the demonstration board with all the components usable on this board. The schematic of the demonstration board is given in *Figure 7*.

Figure 1.   Power switch board layout
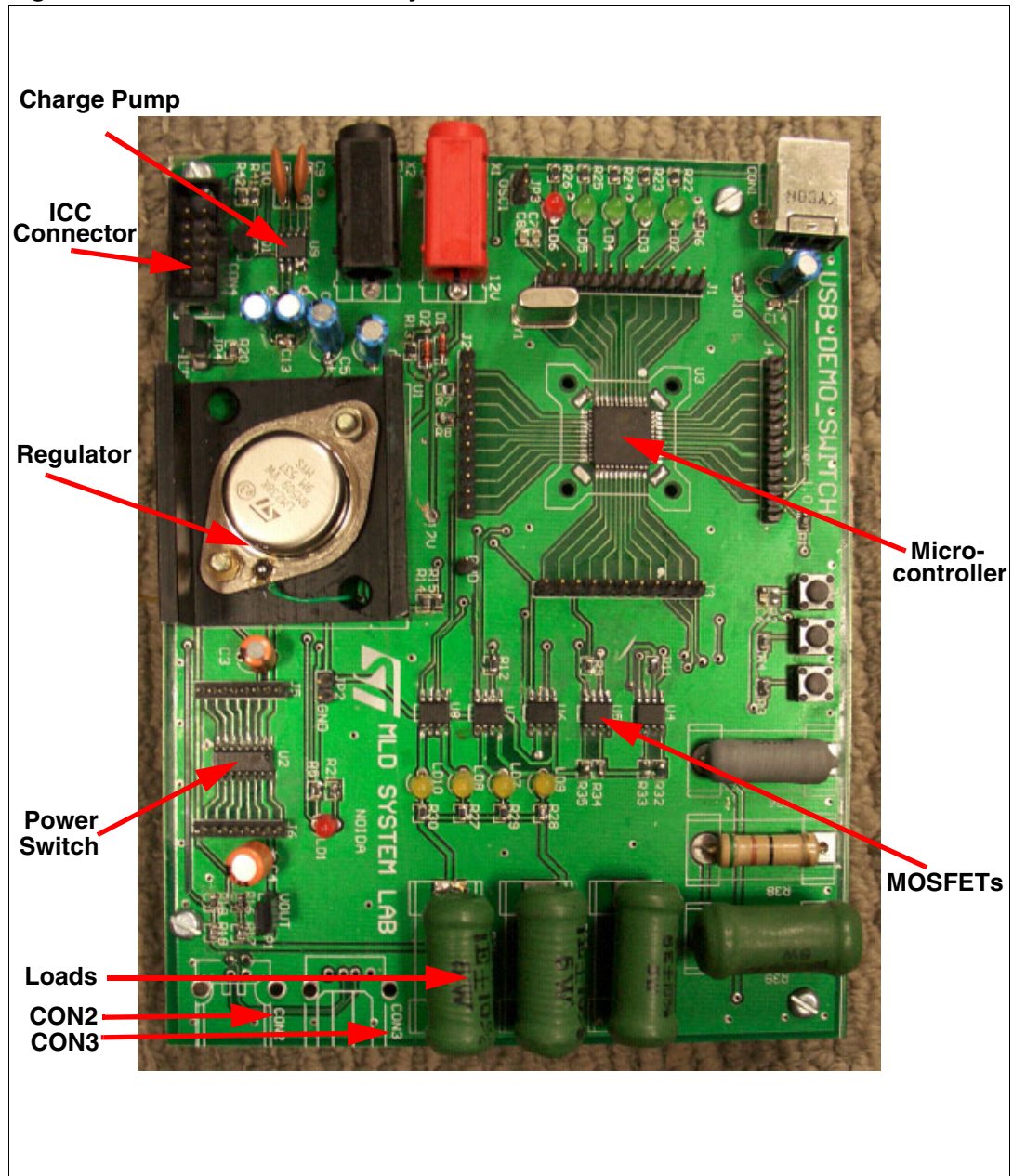
1.4.1   Power supply

The microcontroller is directly powered by the USB Connector (bus-powered). While the rest of the circuit needs a 10V/3A supply which has to be plugged in the connectors of the board after inserting the USB cable.

2 Running the USB power switch kit

2.1 Introduction

This USB Power Switch kit consists of two main parts: an USBPS_GUI running on PC and a Demonstration board. Communications between the PC and the ST7 board are done through different USB pipes:

–   Control IN and OUT during the enumeration with the bi-directional endpoint 0

–   Interrupt IN from endpoint 1 for data transferred from ST7 to PC.

–   Interrupt OUT to the endpoint 2 for the data transferred from PC to ST7.

Figure 2. Enumeration result
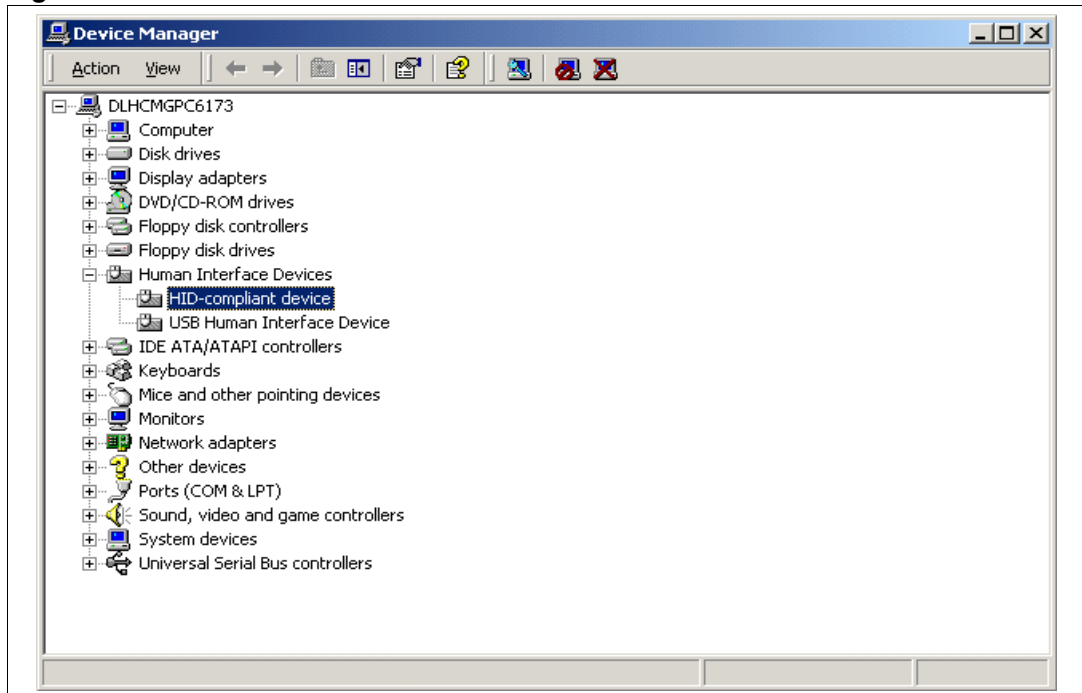
By starting the USBPS_GUI on the PC, you get a graphical interface (*Figure 3*) for controlling the demonstration board. This PC software is used to issue various commands and to control data transfers between the PC and the ST7 peripheral.

2.2 USBPS GUI description

2.2.1 Main window

The USBPS GUI enables the user to configure the parameters shown in *Figure 3*.

Figure 3. USBPS_GUI
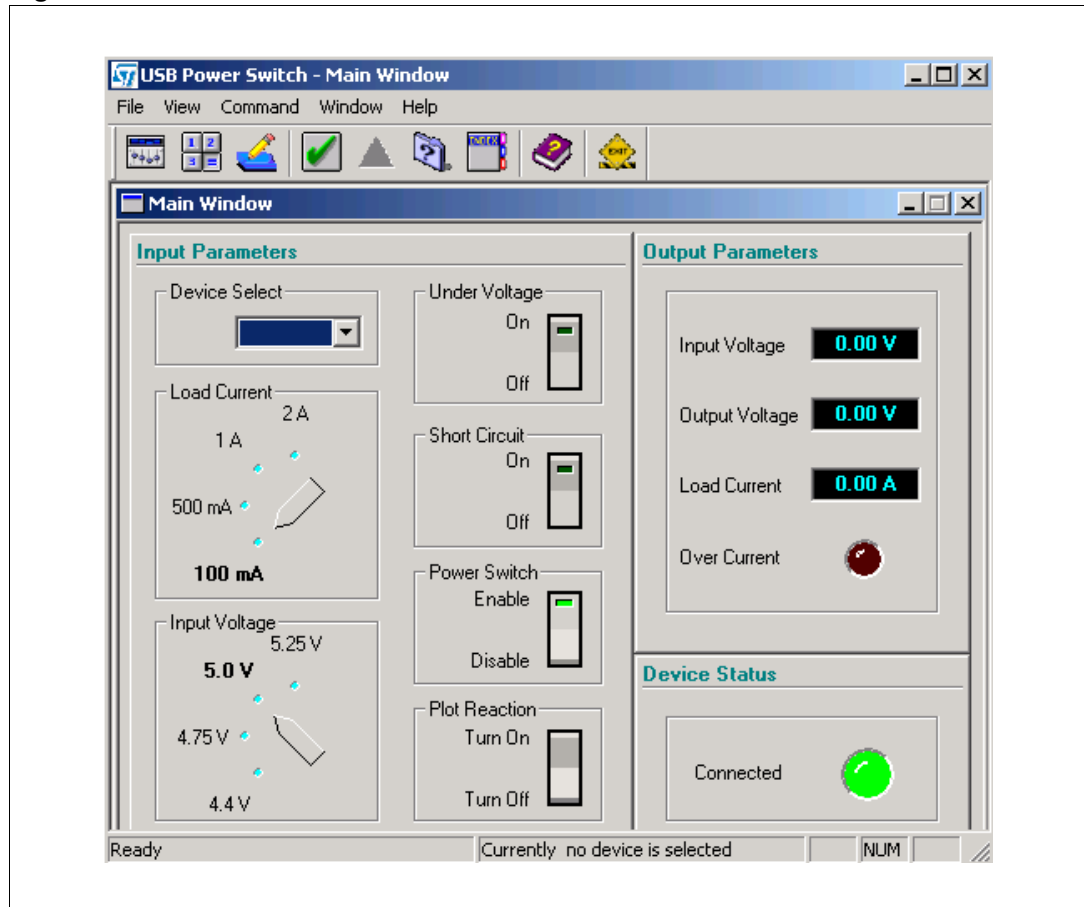
Input parameters

- Device Select: Click the drop-down menu to select the correct board from the list of available devices.

- Load current: Select the correct load to apply at the switch output: 100mA, 500mA, 1A or 2A. Larger loads can be applied by changing the load resistance R37 with the required load on the demonstration board.

- Input voltage: Select the correct input voltage for the switch: 4.4V, 4.75, 5.0V or 5.25V.

- Under Voltage: Select the under voltage protection. When ON, a 1.2V supply is applied at the switch input. At this input supply level, the Power Switch output will be zero, displaying the cut off capability of the Power Switch at low input voltages.

- Short Circuit: Select ON to enable a short-circuit at the Power Switch output. A graph of short circuit current versus time will be plotted in a separate window.

- Power Switch: Select Enable or Disable option on the GUI to control the voltage on the Enable pin of the Power Switch.

- Plot Reaction: Select Turn ON/OFF to display in a separate window the plotting of a graph of the output rise time and fall time, respectively, of the Power Switch.

Output parameters

- Input Voltage, Output Voltage and Load Current windows display the current parameter settings.
- Over Current: This LED is ON when a current larger than device rating is flowing through the device.

Device status

- Connected: This LED is ON when an HID device is connected to the Power Supply board via a USB cable.

2.2.2 Device Database window

The Device Database window (*Figure 4*) enables the user to register a new pin-compatible power switch device by entering the device name, maximum current range, short-circuit current and Enable signal polarity parameters.

Figure 4. Device database window
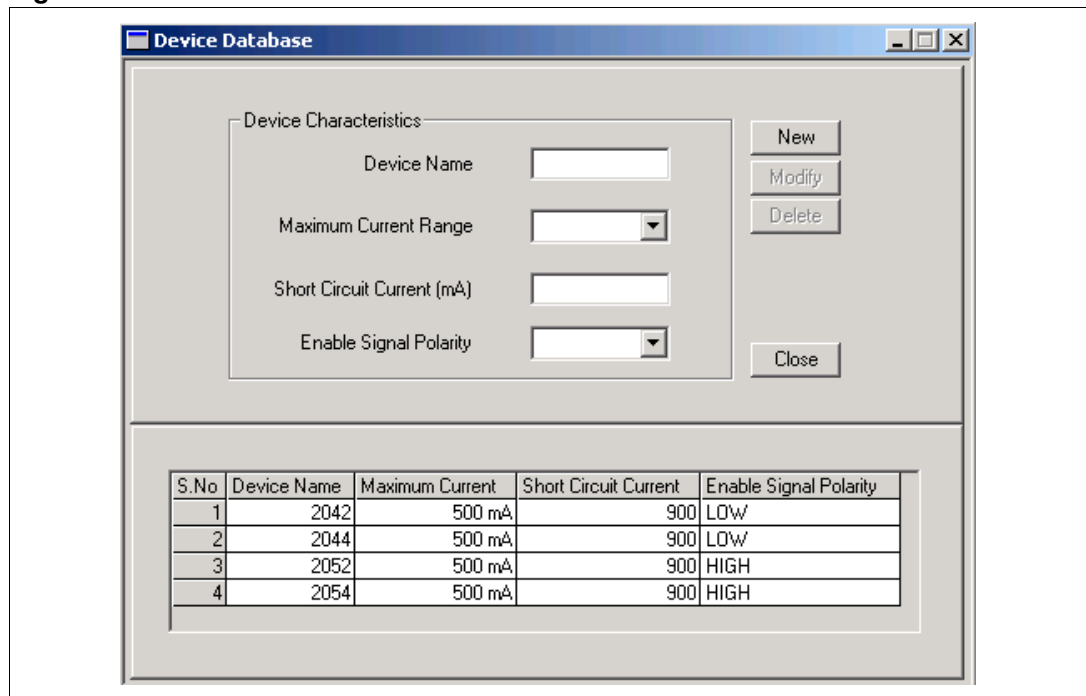
2.2.3 Sampling Information window

The Sampling Information window (*Figure 5*) enables the user to update the sampling time and number of samples parameters for short-circuits and to enable the display of graphs separately.
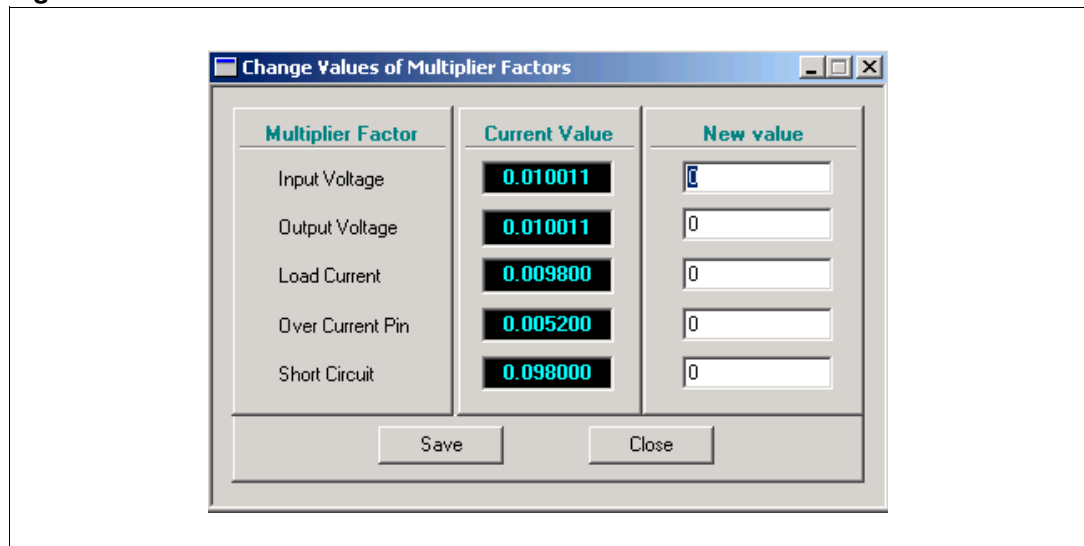
Figure 5.   Sampling information window
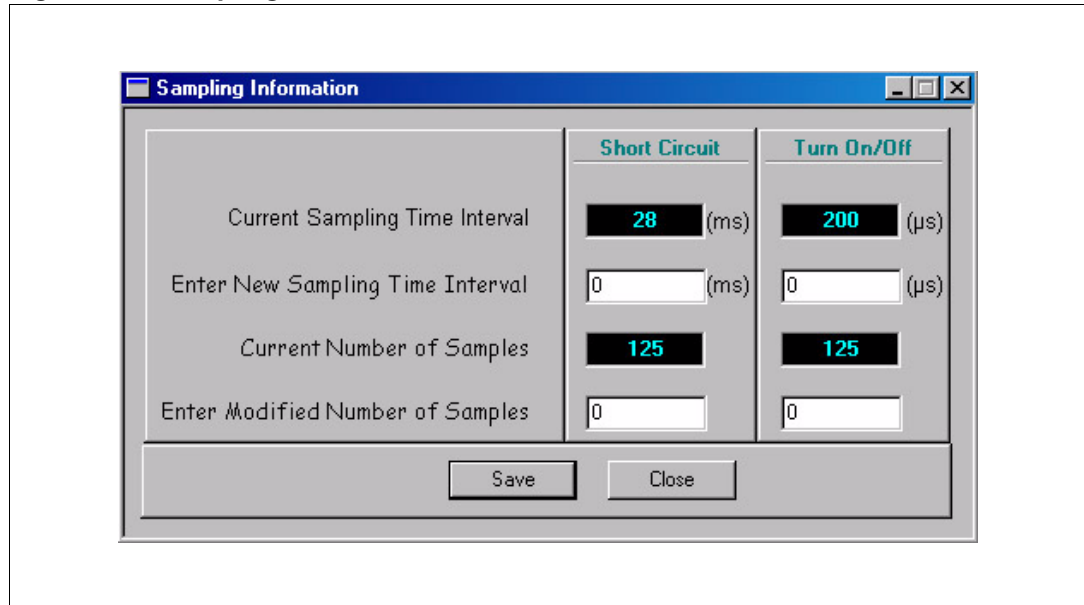
2.2.4 Calibration Values window

The Calibration Values window (*Figure 6*) is used for changing the multiplication factors used for calibrating the ADC values.

Figure 6.   Calibration Values window

2.3   Communication with the demonstration board

2.3.1   PC software control of the demonstration board

To use the USBPS GUI, select a particular device (i.e. Power Switch as on the demonstration board) from Device Select drop box. Selection of an incorrect Power Switch will lead to incorrect results.

Note: *If the correct device is not listed in the drop box, enter the required information in the Device Database window as described in Section 2.2.2: Device Database window.*

Use the various parameters described in *Section 2.2: USBPS GUI description* to look into the features of the USB Power Switch.

2.3.2   Manual control of the demonstration board

This Power Switch Demonstration board can also work without the PC software. Different voltages and loads can be selected using switch S2 & S3 respectively. Pressing S3 again and again will increment the voltage in the above mentioned steps and after 5.25V under voltage (i.e. 1.2V) is selected. After under voltage the next state is 4.4V. Similarly load at the output can be varied using S2. In default state of the board, 5V is present at Power Switch input and 100 mA load at the output.

2.3.3   Display of demonstration board state

Real time values of input voltage, output voltage of the Power Switch and its load current are incremented every second in the GUI display window. In case of over current through the switch, indication will be given on the GUI through over current LED.

2.4   Programming the MCU Flash memory

2.4.1   Programming through ICC

To program the MCU through ICC, plug in the ICC cable and put jumper JP4 in 2-3 position as described in *Table 1*. In the firmware two S19 files are available one for sector0 (0xF000-0xFFFF) and other for Sectors 1 and 2 (0xC000-0xEFFF). Program these files in the respective sectors. The board has been tested with the INDART kit.

2.4.2   Upgrading firmware through DFU

Device firmware upgrade (DFU) is used to reprogram Sectors 1 and 2 through USB cable without reprogramming Sector 0. Use the DFUGUI to upgrade Sectors 1 and 2. Refer to help manual of ST7 DFUGUI for a complete description.

2.4.3   Entering DFU mode

Press and hold the switch S3 and reset the board (by pressing S1). The board will now go into DFU mode. Now, Sectors 1 an 2 can be upgraded. To exit DFU mode, reset the board.

Table 1. **Jumper settings**

Jumper No.	Jumper Location	Jumper Setting
JP1	Connector between o/p of power switch and load.	This jumper should always be present on the board during normal operation. If reading of load current with multimeter is desired then only, jumper should be removed and ammeter should be inserted.
JP2	Connector between adjust pin of regulator and ground.	This jumper should not be present on the board else it will cause undervoltage situation. It is kept for future.
JP3	Connector between ICCLK pin and OSC1 pin of microcontroller	This jumper is useful only in ICC mode. Don't put this jumper ON if the crystal is present.
JP4	Connetor Between 12V input and Vpp pin of the microcontroller.	It's a 3 pin jumper and useful in ICC and DFU mode. Short its 2-3 pins in ICC mode and 1-2 pins in DFU mode. Through this jumper 12V is supplied to the Vpp pin of the MCU.

Table 2. **Switches configuration**

Switch No.	Switch Use
SW1	Reset
SW2	Load Switching
SW3	Input voltage switching & entry in DFU mode

Table 3. **LEDs configuration**

LED No	LED Color	Glowing Condition
LED1	Red	Over Current through Power Switch
LED2	Green	Presence of 4.4V at Power Switch input.
LED3	Green	Presence of 4.75V at Power Switch input.
LED4	Green	Presence of 5.0V at Power Switch input.
LED5	Green	Presence of 5.25V at Power Switch input.
LED6	Red	Under Voltage Condition
LED7	Yellow	400mA Load LED
LED8	Yellow	600mA Load LED
LED9	Yellow	100mA Load LED
LED10	Yellow	2A Load LED

2.5 Plugging of real load

Any type of USB real load can be powered from this board. First plug the USB cable into connector CON2 then plug the load into connector CON3.

2.6 Demonstration board schematic

Figure 7. Board schematic
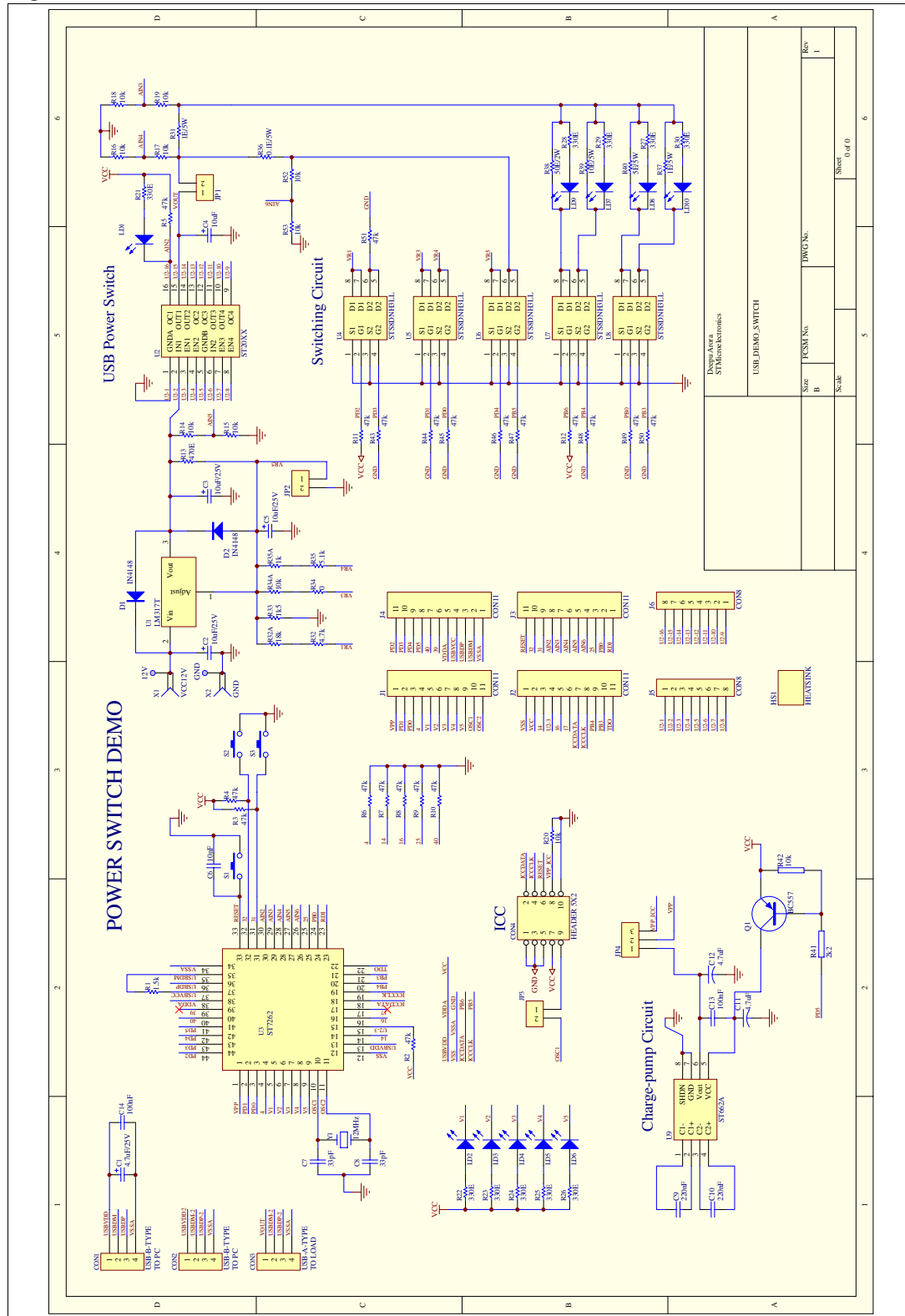
3 Bill of materials

Table 4. Bill of materials

Index	Qty	Reference	Value/Generic part number	Package	Manufacturer	Manifacturer's ordering code/orderable part number
1	1	R1	1.5K	SMD 0805	Any	
2	20	R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R43, R44, R45, R46, R47, R48, R49, R50, R51	47K	SMD 0805	Any	
3	1	R13	470E	SMD 0805	Any	
4	11	R14, R15, R16, R17, R18, R19, R20, R42, R52, R53, R34A	10K	SMD 0805	Any	
5	10	R21, R22, R23, R24, R25, R26, R27, R28, R29, R30	330E	SMD 0805	Any	
6	1	R35A	1K	SMD 0805	Any	
7	1	R33	1K5	SMD 0805	Any	
8	1	R32	4K7	SMD 0805	Any	
9	1	R35	5K1	SMD 0805	Any	
10	1	R32A	18K	SMD 0805	Any	
11	1	R34	0E	SMD 0805	Any	
12	1	R41	2K2	SMD 0805	Any	
13	1	R36	0.1E, 5W	Leaded	RS Components	RS199-6378
14	2	R31, R37	1E, 5W	Leaded	Any	
15	1	R40	5E ,5W	Leaded	Any	
16	1	R39	10E, 5W	Leaded	Any	
17	1	R38	50E, 2 W	Leaded	Any	
18	3	C1, C11, C12	4.7uF, 25V	RB-.2/.4	Any	
19	4	C2, C3, C4, C5	10uF, 25V	RB-.2/.4	Any	
20	1	C6	10nF	SMD 0805	Any	
21	2	C7, C8	33pF	SMD 0805	Any	
22	2	C9, C10	220nF	Leaded	Any	
23	2	C13, C14	100nF	SMD 0805	Any	
24	4	LD2, LD3, LD4, LD5		Thru Hole LED 3mm -Green	Any	

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Table 4. Bill of materials (continued)

Index	Qty	Reference	Value/Generic part number	Package	Manufacturer	Manifacturer's ordering code/orderable part number
25	4	LD7, LD8 ,LD9, LD10		Thru Hole LED 3mm -Yellow	Any	
26	2	LD1, LD6		Thru Hole LED 3mm -Red	Any	
27	1	U1	LM238	TO-3	ST	LM238K
28	1	U2	ST2042BDR, or ST2044BDR, or ST2052BDR, or ST2054BDR	SO-8 or SO-16	ST	ST2042BDR, or ST2044BDR, or ST2052BDR, or ST2054BDR
29	1	U3	ST72F621J4	TQFP-44	ST	ST72F621J4T1
30	5	U4, U5, U6, U7, U8	STS8DNH3LL	SO-8	ST	STS8DNH3LL
31	1	U9	ST662A	SO-8	ST	ST662ABD-TR
32	1	Q1	BC557 or BC558	TO-92A	Any	
33	2	D1, D2	IN4148	DO-35	Any	
34	3	S1, S2, S3		Push Button	Any	
35	2	CON1, CON2	USB-B-TYPE	USB-B	Kycon	KUSB-BS-1-N-BLK
36	1	CON3	USB-A-TYPE	USB-A	Kycon	KUSB-AS-1-N-BLK
37	1	CON4	HEADER 5X2	IDC-10B	Any	
38	1	Y1	12MHz Crystal	XTAL-3	Any	
39	1	HS1	Heat Sink	HS-TO3	Any	
40	1	X1	VCC12V	RS738-547	FARNELL	150-039
41	1	X2	GND	RS738-547	FARNELL	150-040
42	4	J1, J2, J3, J4	CON11	SIP-11	Any	
43	2	J5, J6	CON8	SIP-8	Any	
44	3	JP1, JP2, JP3	CON2	SIP-2	Any	

4 Revision history

Revision history

Date	Revision	Changes
19-May-2006	1	Initial release.

Please Read Carefully:

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