



SILICON LABORATORIES

# C8051F32x-DK

## C8051F32X DEVELOPMENT KIT USER'S GUIDE

### 1. Kit Contents

The C8051F32x Development Kit contains the following items:

- C8051F320 Target Board
- C8051Fxxx Development Kit Quick-Start Guide
- Silicon Laboratories IDE and Product Information CD-ROM. CD content includes:
  - Silicon Laboratories Integrated Development Environment (IDE)
  - Keil 8051 Development Tools (macro assembler, linker, evaluation 'C' compiler)
  - Source code examples and register definition files
  - Documentation
  - C8051F32x Development Kit User's Guide (this document)
- AC to DC Power Adapter
- USB Debug Adapter (USB to Debug Interface)
- USB Cable

### 2. Hardware Setup using a USB Debug Adapter

The target board is connected to a PC running the Silicon Laboratories IDE via the USB Debug Adapter as shown in Figure 1.

1. Connect the USB Debug Adapter to the DEBUG connector on the target board with the 10-pin ribbon cable.
2. Connect one end of the USB cable to the USB connector on the USB Debug Adapter.
3. Connect the other end of the USB cable to a USB Port on the PC.
4. Connect the ac/dc power adapter to power jack P1 on the target board.

#### Notes:

- Use the Reset button in the IDE to reset the target when connected using a USB Debug Adapter.
- Remove power from the target board and the USB Debug Adapter before connecting or disconnecting the ribbon cable from the target board. Connecting or disconnecting the cable when the devices have power can damage the device and/or the USB Debug Adapter.

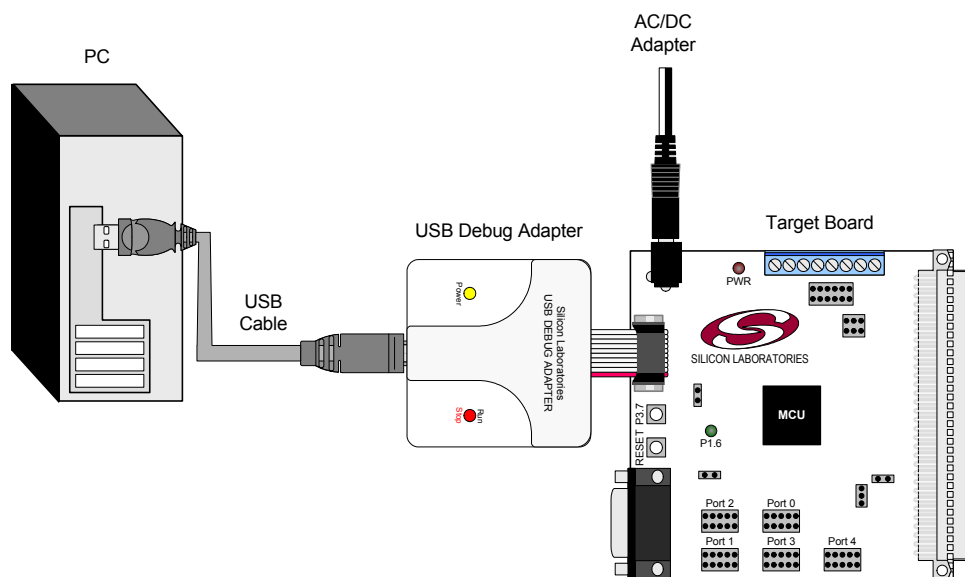


Figure 1. Hardware Setup using a USB Debug Adapter

## 3. Software Setup

The included CD-ROM contains the Silicon Laboratories Integrated Development Environment (IDE), Keil software 8051 tools and additional documentation. Insert the CD-ROM into your PC's CD-ROM drive. An installer will automatically launch, allowing you to install the IDE software or read documentation by clicking buttons on the Installation Panel. If the installer does not automatically start when you insert the CD-ROM, run *autorun.exe* found in the root directory of the CD-ROM. Refer to the *readme.txt* file on the CD-ROM for the latest information regarding known IDE problems and restrictions.

## 4. Silicon Laboratories Integrated Development Environment

The Silicon Laboratories IDE integrates a source-code editor, source-level debugger and in-system Flash programmer. The use of third-party compilers and assemblers is also supported. This development kit includes the Keil Software A51 macro assembler, BL51 linker and evaluation version C51 'C' compiler. These tools can be used from within the Silicon Laboratories IDE.

### 4.1. System Requirements

The Silicon Laboratories IDE requirements:

- Pentium-class host PC running Microsoft Windows 98SE or later.
- One available COM or USB port.
- 64 MB RAM and 40 MB free HD space recommended.

### 4.2. Assembler and Linker

A full-version Keil A51 macro assembler and BL51 banking linker are included with the development kit and are installed during IDE installation. The complete assembler and linker reference manual can be found under the **Help** menu in the IDE or in the "*SiLabs\MCU\hlp*" directory (A51.pdf).

### 4.3. Evaluation C51 'C' Compiler

An evaluation version of the Keil C51 'C' compiler is included with the development kit and is installed during IDE installation. The evaluation version of the C51 compiler is the same as the full professional version except code size is limited to 4 kB and the floating point library is not included. The C51 compiler reference manual can be found under the **Help** menu in the IDE or in the "*SiLabs\MCU\hlp*" directory (C51.pdf).

### 4.4. Using the Keil Software 8051 Tools with the Silicon Laboratories IDE

To perform source-level debugging with the IDE, you must configure the Keil 8051 tools to generate an absolute object file in the OMF-51 format with object extensions and debug records enabled. You may build the OMF-51 absolute object file by calling the Keil 8051 tools at the command line (e.g. batch file or make file) or by using the project manager built into the IDE. The default configuration when using the Silicon Laboratories IDE project manager enables object extension and debug record generation. Refer to Applications Note "**AN104: Integrating Keil 8051 Tools Into the Silicon Labs IDE**" in the "*SiLabs\MCU\Documentation\Appnotes*" directory on the CD-ROM for additional information on using the Keil 8051 tools with the Silicon Laboratories IDE.

To build an absolute object file using the Silicon Laboratories IDE project manager, you must first create a project. A project consists of a set of files, IDE configuration, debug views, and a target build configuration (list of files and tool configurations used as input to the assembler, compiler, and linker when building an output object file).

The following sections illustrate the steps necessary to manually create a project with one or more source files, build a program and download the program to the target in preparation for debugging. (The IDE will automatically create a single-file project using the currently open and active source file if you select **Build/Make Project** before a project is defined.)

## 4.4.1. Creating a New Project

1. Select **Project**→**New Project** to open a new project and reset all configuration settings to default.
2. Select **File**→**New File** to open an editor window. Create your source file(s) and save the file(s) with a recognized extension, such as .c, .h, or .asm, to enable color syntax highlighting.
3. Right-click on “New Project” in the **Project Window**. Select **Add files to project**. Select files in the file browser and click Open. Continue adding files until all project files have been added.
4. For each of the files in the **Project Window** that you want assembled, compiled and linked into the target build, right-click on the file name and select **Add file to build**. Each file will be assembled or compiled as appropriate (based on file extension) and linked into the build of the absolute object file.

**Note:** If a project contains a large number of files, the “Group” feature of the IDE can be used to organize. Right-click on “New Project” in the **Project Window**. Select **Add Groups to project**. Add pre-defined groups or add customized groups. Right-click on the group name and choose **Add file to group**. Select files to be added. Continue adding files until all project files have been added.

## 4.4.2. Building and Downloading the Program for Debugging

1. Once all source files have been added to the target build, build the project by clicking on the **Build/Make Project** button in the toolbar or selecting **Project**→**Build/Make Project** from the menu.

**Note:** After the project has been built the first time, the **Build/Make Project** command will only build the files that have been changed since the previous build. To rebuild all files and project dependencies, click on the **Rebuild All** button in the toolbar or select **Project**→**Rebuild All** from the menu.

2. Before connecting to the target device, several connection options may need to be set. Open the **Connection Options** window by selecting **Options**→**Connection Options...** in the IDE menu. First, select the appropriate adapter in the “Serial Adapter” section. Next, the correct “Debug Interface” must be selected. C8051F32x family devices use the Silicon Labs 2-wire (C2) debug interface. Once all the selections are made, click the OK button to close the window.
3. Click the **Connect** button in the toolbar or select **Debug**→**Connect** from the menu to connect to the device.
4. Download the project to the target by clicking the **Download Code** button in the toolbar.

**Note:** To enable automatic downloading if the program build is successful select **Enable automatic connect/download after build** in the **Project**→**Target Build Configuration** dialog. If errors occur during the build process, the IDE will not attempt the download.

5. Save the project when finished with the debug session to preserve the current target build configuration, editor settings and the location of all open debug views. To save the project, select **Project**→**Save Project As...** from the menu. Create a new name for the project and click on **Save**.

## 5. Example Source Code

Example source code and register definition files are provided in the “*SiLabs\MCU\Examples\C8051F32x*” directory during IDE installation. These files may be used as a template for code development. Example applications include a blinking LED example which configures the green LED on the target board to blink at a fixed rate. A Universal Serial Bus (USB) application example is also included with the C8051F32x development kit.

### 5.1. Register Definition Files

Register definition files *C8051F320.inc* and *C8051F320.h* define all SFR registers and bit-addressable control/status bits. They are installed into the “*SiLabs\MCU\Examples\C8051F32x*” directory during IDE installation. The register and bit names are identical to those used in the C8051F32x datasheet. Both register definition files are also installed in the default search path used by the Keil Software 8051 tools. Therefore, when using the Keil 8051 tools included with the development kit (A51, C51), it is not necessary to copy a register definition file to each project's file directory.

### 5.2. Blinking LED Example

The example source files *blink.asm* and *blink.c* show examples of several basic C8051F32x functions. These include; disabling the watchdog timer (WDT), configuring the Port I/O crossbar, configuring a timer for an interrupt routine, initializing the system clock, and configuring a GPIO port. When compiled/assembled and linked this program flashes the green LED on the C8051F320 target board about five times a second using the interrupt handler with a C8051F320 timer.

### 5.3. Universal Serial Bus (USB) Application Example

The included USB application example requires Windows 98SE/2000/XP operating system. This example consists of three parts, firmware running on the C8051F320 device, a USB device driver running on the host PC, and a host application. The host application communicates with the C8051F320 via USB, allowing the user to view and to change the state of several I/O peripherals on the C8051F320 target board. The example files can be found in the “*SiLabs\MCU\Examples\C8051F32x\C\USB\_INT*” directory. Located in this directory is the project file for the firmware, the USB driver files, and the host application executable. In addition, three subdirectories are provided that contain the source code for each part of the example application; Host Application Source, Driver Source, and Firmware. Use the following instructions to set up the example USB firmware, install the USB driver, and then run the example host application.

After the target board is connected to the host computer via USB, the example application enumerates and sends data between the target and the host application using Endpoint 0, 1, and 2. The Endpoint 0 packets are control packets as defined in Chapter 9 of the Universal Serial Bus Specification, version 2.0. Endpoints 1 and 2 are used for data IN and OUT, respectively. These data packets consist of 8 bytes used to denote the current status of the buttons, LEDs, Potentiometer, and logic levels of various port pins on the target board. Accessing the USB core (i.e., accessing the USB registers and moving data to and from the Endpoint FIFOs on the target board) is documented in Silicon Laboratories' C8051F32x datasheet.

## 5.3.1. Setting-up the Firmware

1. Set up the hardware on the C8051F320 target board according to the instructions in Section 2.
2. Create a project using the following steps.
  - a. Open the Silicon Laboratories IDE.
  - b. Click on the **Project**→**Open Project...** option in the IDE menus.
  - c. Answer **No** to the following message:  
Not all project windows can be restored if not connected.  
Do you want to connect now?
  - d. Select the *USB\_Int.wsp* project, located by default in the *SiLabs\MCU\Examples\C8051F32x\C\USB\_INT* directory, and click the **Open** button.
  - e. Click the **Build/Make Project** button in the IDE toolbar.
  - f. The project should now be compiled and linked successfully, with no errors.
  - g. Connect to the device by clicking the **Connect** button on the IDE toolbar.
  - h. Download the project to the target by clicking the **Download Code** button in the IDE toolbar.
3. Begin program execution on the target by either of the following methods:
  - a. Click the **Go** button in the IDE toolbar.
  - b. Disconnect the IDE from the device by pressing the **Disconnect** button on the toolbar. Next, press the **Reset** button on the C8051F320 target board.

## 5.3.2. Installing the USB Driver

1. Connect the USB cable between the host computer and the C8051F320 target board, as shown in Figure 1. See Figure 2 on page 6 for the location of the USB connector.
2. At this point, Windows should notify you it has found new hardware and prompt you with a **Found New Hardware** wizard. Press the **Next** button.
3. Select **Search for a suitable driver for my device (recommended)** and press the **Next** button.
4. Select **Specify a location** under “Optional search locations:” and press the **Next** button.
5. Press the **Browse** button to locate the *SiLabsInt.inf* driver installation file, located by default in the “*SiLabs\MCU\Examples\C8051F320\C\USB\_INT*” directory. Once this file is selected press the **OK** button.
6. Verify that the correct path and filename are shown and press the **Next** button.
7. Press the **Finish** button.

## 5.3.3. Running the Host Application

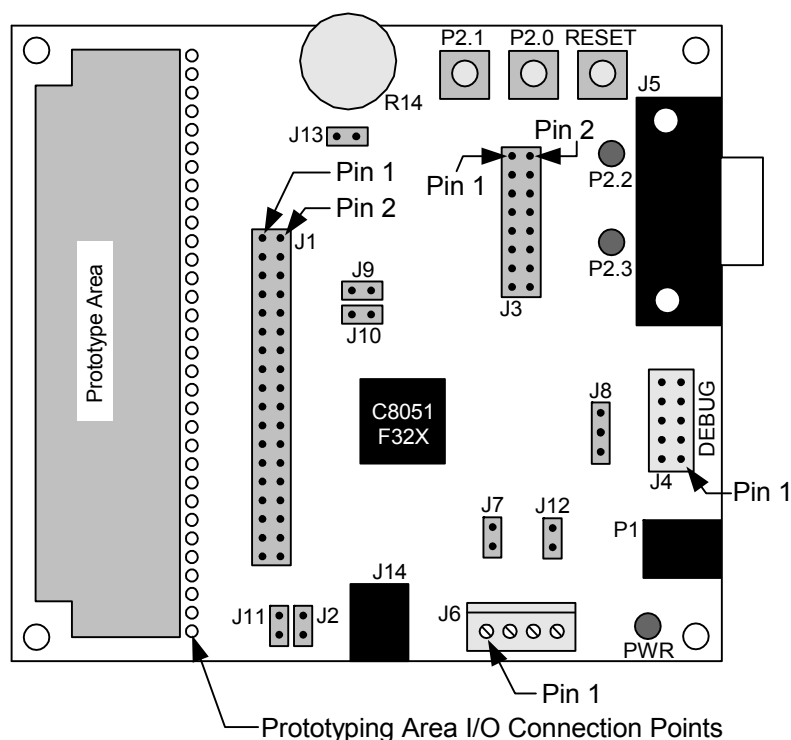
1. Once firmware has been downloaded to the target board and the driver has been installed successfully, run the *USBTest.exe* example application located by default in the “*SiLabs\MCU\Examples\C8051F320\C\USB\_INT*” directory.
2. The *USBTest* application will display the status of the potentiometer, the temperature sensor, the two switches, and the lower four bits of Port 0.
3. The application also includes check boxes for turning on the two LEDs and changing the logic levels on the lower four bits of Port 1.
4. If any of the application functions do not operate correctly, verify shorting blocks are installed at the following positions: J3[1-2] (P2.0 Switch), J3[3-4] (P2.1 Switch), J3[5-6] (P2.2 LED), J3[7-8] (P2.3 LED), J9 (P0.2), J10 (P0.3) and J13 (P1.7 Potentiometer).
5. See Figure 2 on page 6 for the location of headers, LEDs, switches, and potentiometer.

**Note:** The C8051F320 target board has the ability to be powered through the USB cable. To enable the USB powered mode, move the shorting block located at header J2 to header J11.

## 6. Target Board

The C8051F32x Development Kit includes a target board with a C8051F320 device pre-installed for evaluation and preliminary software development. Numerous input/output (I/O) connections are provided to facilitate prototyping using the target board. Refer to Figure 2 for the locations of the various I/O connectors.

- P1 Power connector (accepts input from 7 to 15 VDC unregulated power adapter)
- J1 36-pin Expansion I/O connector
- J2 Power Target Board from power adapter
- J3 Port I/O Configuration Connector
- J4 DEBUG connector for Debug Adapter interface
- J5 DB-9 connector for UART0 RS232 interface
- J6 Analog I/O terminal block
- J7 Low pass filter connector
- J8 USB Debug Adapter target board power connector
- J9, J10 External crystal enable connectors
- J11 Power Target Board from USB
- J12 Connects external capacitance to P0.7
- J13 Connects R14 Potentiometer to P1.7
- J14 USB connector for USB interface



**Figure 2. C8051F320 Target Board**

## 6.1. System Clock Sources

The C8051F320 device installed on the target board features a calibrated programmable internal oscillator which is enabled as the system clock source on reset. After reset, the internal oscillator operates at a frequency of 1.5 MHz ( $\pm 1.5\%$ ) by default but may be configured by software to operate at other frequencies. Therefore, in many applications an external oscillator is not required. However, if you wish to operate the C8051F320 device at a frequency not available with the internal oscillator, an external crystal may be used. Refer to the C8051F32x datasheet for more information on configuring the system clock source.

The target board is designed to facilitate the installation of an external crystal. Remove shorting blocks at headers J9 and J10 and install the crystal at the pads marked Y1. Install a 10 M $\Omega$  resistor at R9 and install capacitors at C14 and C15 using values appropriate for the crystal you select. Refer to the C8051F32x datasheet for more information on the use of external oscillators.

## 6.2. Switches and LEDs

Three switches are provided on the target board. Switch SW1 is connected to the RESET pin of the C8051F320. Pressing SW1 puts the device into its hardware-reset state. Switch SW2 and SW3 are connected to the C8051F320's general purpose I/O (GPIO) pins through headers. Pressing SW2 or SW3 generates a logic low signal on the port pin. Remove the shorting blocks from the header to disconnect SW2 and SW3 from the port pins. The port pin signals are also routed to pins on the J1 I/O connector. See Table 1 for the port pins and headers corresponding to each switch.

Three LEDs are also provided on the target board. The red LED labeled PWR is used to indicate a power connection to the target board. The green LEDs labeled with port pin names are connected to the C8051F320's GPIO pins through headers. Remove the shorting blocks from the header to disconnect the LEDs from the port pin. The port pin signals are also routed to pins on the J1 I/O connector. See Table 1 for the port pins and headers corresponding to each LED.

Also included on the C8051F320 target board is a 10 K $\Omega$  Thumb-wheel Rotary Potentiometer, part number R14. The Potentiometer is connected to the C8051F320's GPIO pin through a header. Remove the shorting block from the header to disconnect the Potentiometer from the port pin. The port pin signal is also routed to a pin on the J1 I/O connector. See Table 1 for the port pin and header corresponding to the Potentiometer.

**Table 1. Target Board I/O Descriptions**

Description	I/O	Header
SW1	Reset	none
SW2	P2.0	J3[1–2]
SW3	P2.1	J3[3–4]
Green LED	P2.2	J3[5–6]
Green LED	P2.3	J3[7–8]
Red LED	PWR	none
Potentiometer	R14	J13

## 6.3. Universal Serial Bus (USB) Interface (J14)

A Universal Serial Bus (USB) connector (J14) is provided to facilitate connections to the USB interface on the C8051F320. Table 2 shows the J14 pin definitions.

**Table 2. USB Connector Pin Descriptions**

Pin #	Description
1	VBUS
2	D-
3	D+
4	GND (Ground)

## 6.4. Expansion I/O Connector (J1)

The 32-pin Expansion I/O connector J1 provides access to all signal pins of the C8051F320 device. Pins for +3 V, digital ground and the output of an on-board low-pass filter are also available. A small through-hole prototyping area is also provided. All I/O signals routed to connector J1 are also routed to through-hole connection points between J1 and the prototyping area (see Figure 2 on page 6). Each connection point is labeled indicating the signal available at the connection point. See Table 3 for a list of pin descriptions for J1.

**Table 3. J1 Pin Descriptions**

Pin #	Description	Pin #	Description	Pin #	Description
1	+3 VD (+3.3 VDC)	13	P1.2	25	P2.6
2	PWM Output	14	P1.3	26	P2.7
3	P0.0	15	P1.4	27	P3.0
4	P0.1	16	P1.5	28	/RST (Reset)
5	P0.2	17	P1.6	29	VREGIN
6	P0.3	18	P1.7	30	VDD
7	P0.4	19	P2.0	31	VBUS
8	P0.5	20	P2.1	32	GND (Ground)
9	P0.6	21	P2.2		
10	P0.7	22	P2.3		
11	P1.0	23	P2.4		
12	P1.1	24	P2.5		

## 6.5. USB Self-powered Configuration (J2, J11)

The C8051F320 target board can be configured as a self-powered USB device to take power from the USB cable instead of the ac/dc adapter connected at P1. To configure the target boards as a self-powered USB device, remove the shorting block from J2 and install on J11. (A shorting block should only be installed on J2 or J11, never both at the same time.) Install shorting blocks in the following manner:

J2(ON) & J11(OFF) → Target Board is powered from the ac/dc Adapter at P1.

J2(OFF) & J11(ON) → Target Board is powered from the USB connection

**Note:** When the C8051F320 target board is self-powered from the USB, the Serial Adapter is not powered from the target board. The Serial Adapter must be powered directly by connecting the ac/dc adapter to the Serial Adapters' dc power jack. Also, the RS232 Serial Interface (J5) cannot be used when powering the target board from the USB.



## 6.6. Target Board DEBUG Interface (J4)

The DEBUG connector (J4) provides access to the DEBUG (C2) pins of the C8051F320. It is used to connect the Serial Adapter or the USB Debug Adapter to the target board for in-circuit debugging and Flash programming. Table 4 shows the DEBUG pin definitions.

**Table 4. DEBUG Connector Pin Descriptions**

Pin #	Description
1	+3 VD (+3.3 VDC)
2, 3, 9	GND (Ground)
4	C2D
5	/RST (Reset)
6	P3.0
7	C2CK
8	Not Connected
10	USB Power

## 6.7. Serial Interface (J5)

A RS232 transceiver circuit and DB-9 (J5) connector are provided on the target board to facilitate serial connections to UART0 of the C8051F320. The TX, RX, RTS and CTS signals of UART0 may be connected to the DB-9 connector and transceiver by installing shorting blocks on header J3.

- J3[9-10] - Install shorting block to connect UART0 TX (P0.4) to transceiver.
- J3[11-12] - Install shorting block to connect UART0 RX (P0.5) to transceiver.
- J3[13-14] - Install shorting block to connect UART0 RTS (P2.6) to transceiver.
- J3[15-16] - Install shorting block to connect UART0 CTS (P2.7) to transceiver.

## 6.8. Analog I/O (J6)

Several of the C8051F320 target device's port pins are connected to the J6 terminal block. Refer to Table 5 for the J6 terminal block connections.

**Table 5. J6 Terminal Block Pin Descriptions**

Pin #	Description
1	P2.5 / AIN2.5
2	P2.4 / AIN2.4
3	GND (Ground)
4	P0.7 / Vref (Voltage Reference)

## 6.9. USB Debug Adapter Target Board Power Connector (J8)

The USB Debug Adapter includes a connection to provide power to the target board. This connection is routed from J4[10] to J8[1]. Place a shorting block at header J8[2-3] to power the board directly from an ac/dc power adapter. Place a shorting block at header J8[1-2] to power the board from the USB Debug Adapter. Please note that the second option is not supported with either the EC1 or EC2 Serial Adapters.

## 6.10. Low-pass Filter (J7)

The C8051F320 target board features a low-pass filter that may be connected to port pin P2.4. Install a shorting block on J7[1-2] to connect the P2.4 pin of the target device to the low-pass filter input. The output of the low-pass filter is routed to the PWM signal at J1[2]. The C8051F320 may be programmed to generate a PWM (Pulse-Width Modulated) waveform which is then input to the low-pass filter to implement a user-controlled PWM digital-to-analog converter. Refer to Applications Note **AN107 - Implementing 16-Bit PWM Using the PCA** in the "documentation" directory on the CD-ROM for a discussion on generating a programmable dc voltage level with a PWM waveform and low-pass filter.

## 7. Schematic

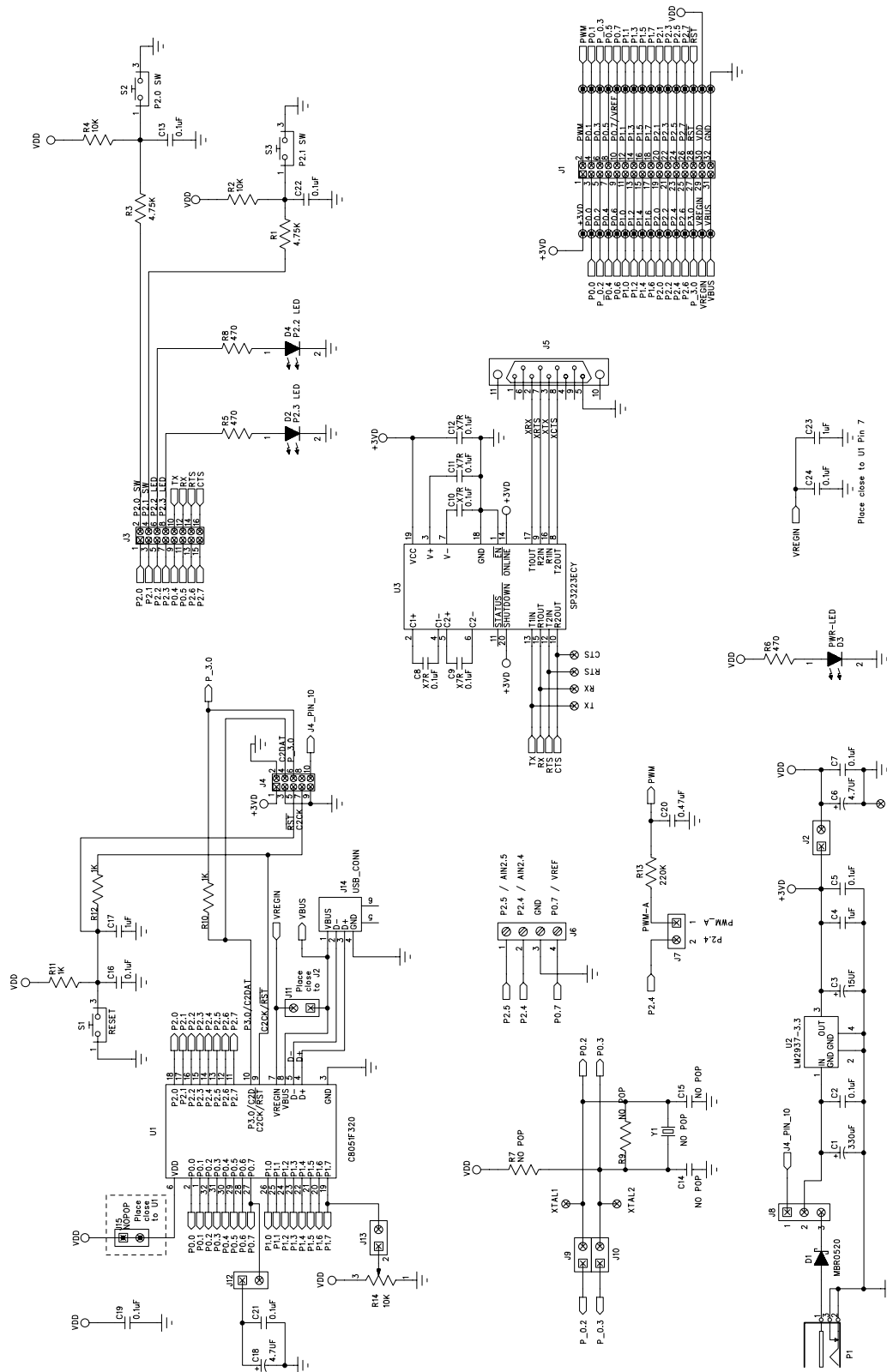


Figure 3. C8051F320 Target Board Schematic

## DOCUMENT CHANGE LIST

### Revision 0.6 to Revision 0.7

- Section 1, added USB Debug Adapter and USB Cable.
- Section 2, changed name from "Hardware Setup" to "Hardware Setup using an EC2 Serial Adapter".
- Section 2, added 2 Notes bullets.
- Section 2, removed Note from bottom of page.
- Added Section 3, "Hardware Setup using a USB Debug Adapter".
- Section 5.4.2, changed step 2 to include new instructions.
- Section 7, J4, changed "Serial Adapter" to "Debug Adapter".
- Target Board DEBUG Interface Section, added USB Debug Adapter.
- DEBUG Connector Pin Descriptions Table, changed pin 4 to C2D.
- Changed "jumper" to "header".
- EC2 Serial Adapter section, added EC2 to the section title, table title and figure title.
- EC2 Serial Adapter section, changed "JTAG" to "DEBUG".
- Added "USB Debug Adapter" section.
- Section 7, J8, changed "Serial Adapter" to "USB Debug Adapter"
- DEBUG Connector Pin Descriptions Table, changed pin 10 to USB Power
- USB Debug Adapter Target Board Power Connector (J8) Section, changed "Serial" to "USB Debug"

### Revision 0.7 to Revision 0.8

- Removed EC2 Serial Adapter from Kit Contents.
- Removed Section 2. Hardware Setup using an EC2 Serial Adapter. See RS232 Serial Adapter (EC2) User's Guide.
- Removed Section 8. EC2 Serial Adapter. See RS232 Serial Adapter (EC2) User's Guide.
- Removed Section 9. USB Debug Adapter. See USB Debug Adapter User's Guide.

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