

C8051F540 DEVELOPMENT KIT USER'S GUIDE

1. Relevant Devices

The C8051F540 Development Kit is intended as a development platform for the microcontrollers in the C8051F54x MCU family.

- The target board included in this kit is provided with a pre-soldered **C8051F540** MCU (QFN32 package) and a **C8051F542** (QFN24 package).
- Code developed on the C8051F540 can be easily ported to the other members of this MCU family.
- Refer to the C8051F54x data sheet for the differences between the members of this MCU family.

2. Kit Contents

The C8051F540 Development Kit contains the following items:

- C8051F540 Target Board
- C8051Fxxx Development Kit Quick-Start Guide
- AC to DC Power Adapter
- USB Debug Adapter (USB to Debug Interface)
- Two USB Cables

3. Hardware Setup

Refer to Figure 1 for a diagram of the hardware configuration.

1. Connect the USB Debug Adapter to the **DEBUG A** 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. Verify that shorting blocks are installed on the target board as shown in Figure 5 on page 7.
4. Connect the other end of the USB cable to a USB Port on the PC.
5. Connect the ac/dc power adapter to power jack P1 on the target board.

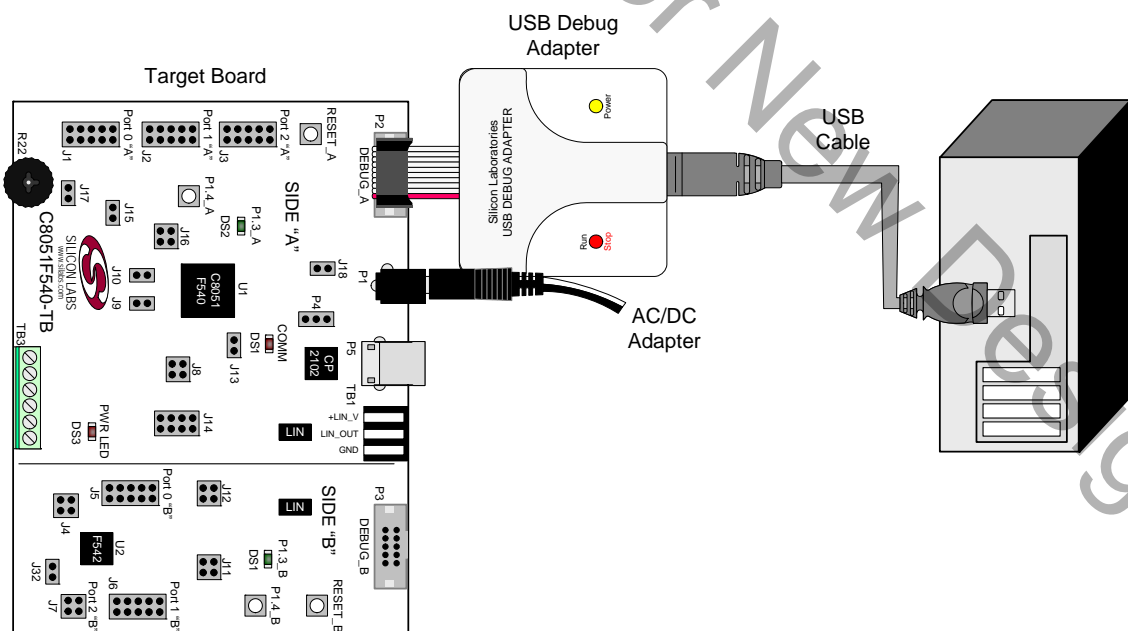


Figure 1. Hardware Setup using a USB Debug Adapter

Notes:

- Use the **Reset** icon in the IDE to reset the target when connected during a debug session.
- 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.

4. Software Setup

Simplicity Studio greatly reduces development time and complexity with Silicon Labs EFM32 and 8051 MCU products by providing a high-powered IDE, tools for hardware configuration, and links to helpful resources, all in one place.

Once Simplicity Studio is installed, the application itself can be used to install additional software and documentation components to aid in the development and evaluation process.

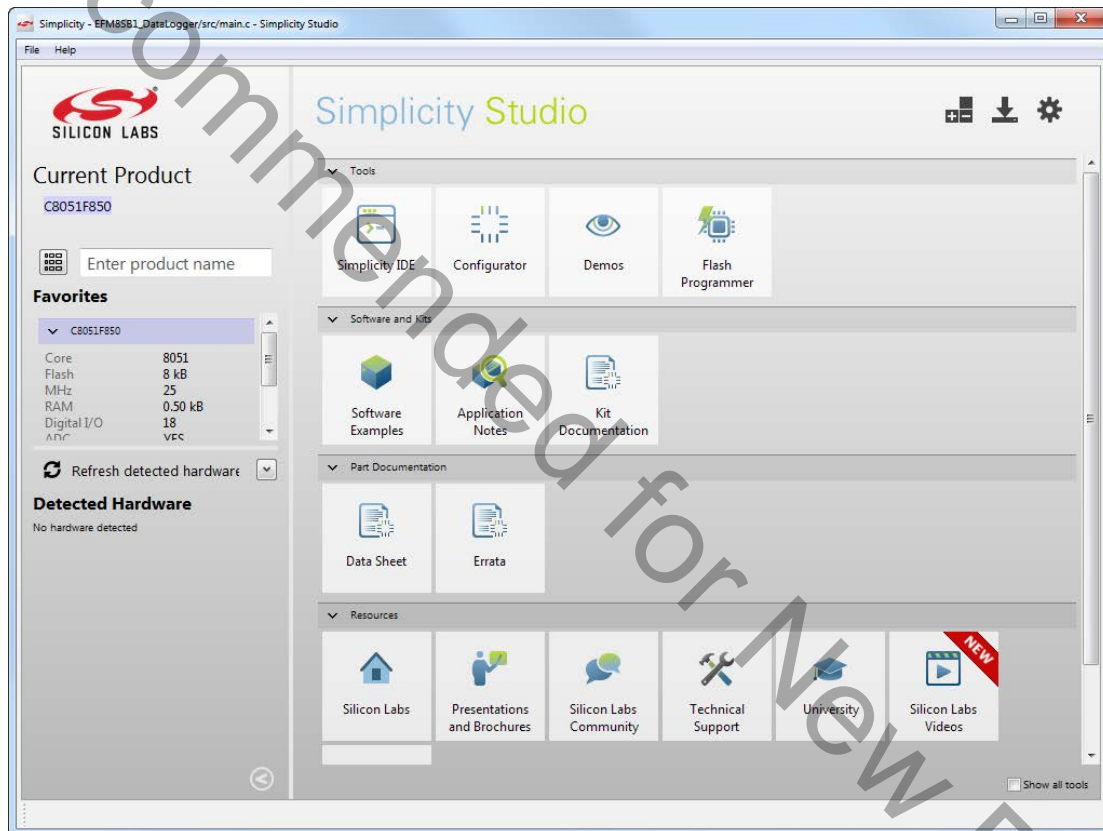


Figure 2. Simplicity Studio

The following Simplicity Studio components are required for the C8051F540 Development Kit:

- 8051 Products Part Support
- Simplicity Developer Platform

Download and install Simplicity Studio from www.silabs.com/8bit-software or www.silabs.com/simplicity-studio. Once installed, run Simplicity Studio by selecting **Start**→**Silicon Labs**→**Simplicity Studio**→**Simplicity Studio** from the start menu or clicking the **Simplicity Studio** shortcut on the desktop. Follow the instructions to install the software, and click **Simplicity IDE** to launch the IDE.

The first time the project creation wizard runs, the **Setup Environment** wizard will guide the user through the process of configuring the build tools and SDK selection.

In the **Part Selection** step of the wizard, select from the list of installed parts only the parts to use during

development. Choosing parts and families in this step affects the displayed or filtered parts in the later device selection menus. Choose the C8051F54x family by checking the **C8051F54x** check box. Modify the part selection at any time by accessing the **Part Management** dialog from the **Window→Preferences→Simplicity Studio→Part Management** menu item.

Simplicity Studio can detect if certain toolchains are not activated. If the **Licensing Helper** is displayed after completing the **Setup Environment** wizard, follow the instructions to activate the toolchain.

4.1. Running Blinky

Each project has its own source files, target configuration, SDK configuration, and build configurations such as the **Debug** and **Release** build configurations. The IDE can be used to manage multiple projects in a collection called a workspace. Workspace settings are applied globally to all projects within the workspace. This can include settings such as key bindings, window preferences, and code style and formatting options. Project actions, such as build and debug are context sensitive. For example, the user must select a project in the **Project Explorer** view in order to build that project.

To create a project based on the Blinky example:

1. Click the **Software Examples** tile from the Simplicity Studio home screen.
2. In the **Kit** drop-down, select **C8051F540 Development Kit**, in the **Part** drop-down, select **C8051F540**, and in the **SDK** drop-down, select the desired SDK. Click **Next**.
3. Select **Example** and click **Next**.
4. Under **C8051F540 Development Kit**, select **F54x Blinky**, click **Next**, and click **Finish**.
5. Click on the project in the **Project Explorer** and click **Build**, the hammer icon in the top bar. Alternatively, go to **Project→Build Project**.
6. Click **Debug** to download the project to the hardware and start a debug session.
7. Press the **Resume** button to start the code running. The LED should blink.



8. Press the **Suspend** button to stop the code.



9. Press the **Reset the device** button to reset the target MCU.



10. Press the **Disconnect** button to return to the development perspective.



4.2. Simplicity Studio Help

Simplicity Studio includes detailed help information and device documentation within the tool. The help contains descriptions for each dialog window. To view the documentation for a dialog, click the question mark icon in the window:



This will open a pane specific to the dialog with additional details.

The documentation within the tool can also be viewed by going to **Help→Help Contents** or **Help→Search**.

4.3. CP210x USB to UART VCP Driver Installation

The Target Board includes a Silicon Labs CP210x USB-to-UART Bridge Controller. Device drivers for the CP210x need to be installed before the PC software can communicate with the MCU through the UART interface.

1. After opening Simplicity Studio for the first time, a dialog will prompt to install the CP210x drivers. Click **Yes**. The drivers can also be installed at any time by going to **Help**→**Install Drivers**→**CP210x VCP USB Drivers**.
2. Accept the license agreement and follow the steps to install the driver on the system. The installer will let you know when your system is up to date. The driver files included in this installation have been certified by Microsoft.
3. To complete the installation process, connect the included USB cable between the host computer and the USB connector (P5) on the Target Board. Windows will automatically finish the driver installation. Information windows will pop up from the taskbar to show the installation progress.
4. If needed, the driver files can be uninstalled by selecting **Windows Driver Package—Silicon Laboratories...** option in the **Programs and Features** window.

4.4. Configuration Wizard 2

The Configuration Wizard 2 is a code generation tool for all of the Silicon Laboratories devices. Code is generated through the use of dialog boxes for each of the device's peripherals.

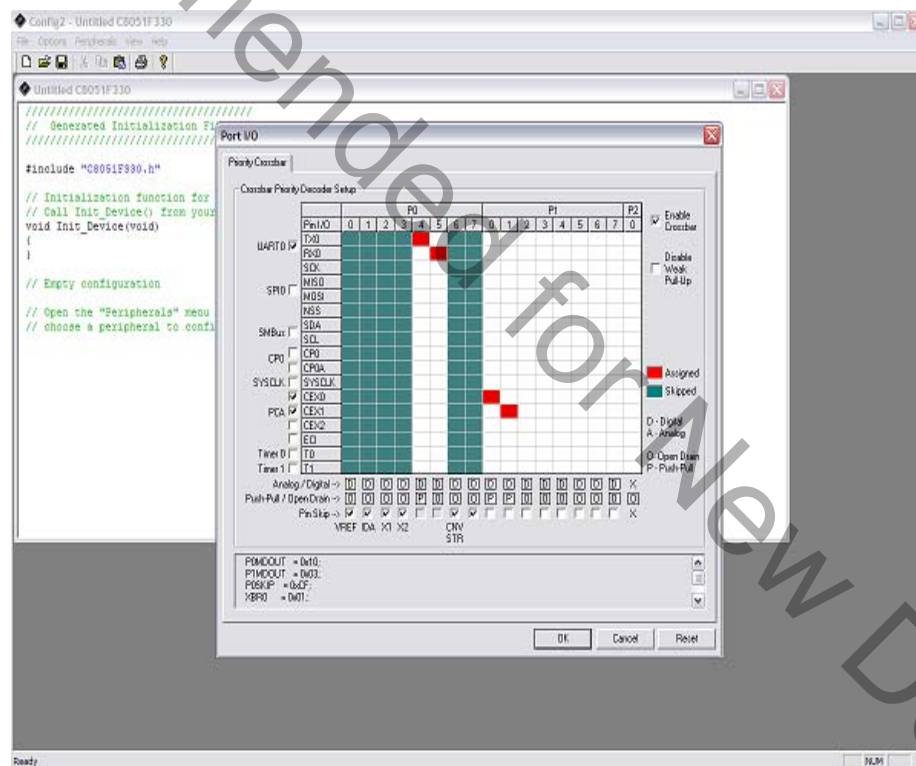


Figure 3. Configuration Wizard 2 Utility

The Configuration Wizard 2 utility helps accelerate development by automatically generating initialization source code to configure and enable the on-chip resources needed by most design projects. In just a few steps, the wizard creates complete startup code for a specific Silicon Laboratories MCU. The program is configurable to provide the output in C or assembly. For more information, please refer to the Configuration Wizard 2 help available under the **Help** menu in Configuration Wizard 2.

For more information, please refer to the Configuration Wizard 2 documentation. The documentation and software are available from the Downloads webpage (www.silabs.com/mcudownloads).

5. Target Board

The C8051F540 Development Kit includes a target board with a **C8051F540** (Side A) and **C8051F542** (Side B) 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 4 for the locations of the various I/O connectors. Figure 5 on page 7 shows the factory default shorting block positions. A summary of the signal names and headers is provided in Table 9 on page 13.

P4	Header to choose between +5V from Debug Adapter (P2) or +5V from on-board regulator (U4)
J18	Connect V_HIGH node from TB1 LIN header to +5V regulator input for board power
P1	Power connector (accepts input from 7 to 15 VDC unregulated power adapter)
P5	USB connector (connects to PC for serial communication)
TB1	Shared LIN Connector for Side A and B MCUs for external nodes
J1-J3	Side A: Port 0 through Port 2 headers
J8	Side A: Connects +5V net to VIO and VREGIN of the MCU
J9, J10	Side A: External crystal enable connectors
J13	Side A: Connects decoupling capacitors C28 and C29 for MCU VREF (P0.0)
J15	Side A: Connects VIO to VIO_A_SRC which powers the R22 potentiometer, the <u>RST_A</u> pin pull-up, and P1.4_A Switch pull-up.
J16	Side A: Connects P1.3_A LED and P1.4_A Switch to MCU port pins
J17	Side A: Connects MCU to two separate transceivers (UART(U3), and LIN(T2))
J20	Side A: Connects R27 potentiometer to port pin 1.2
P2	Side A: DEBUG connector for Debug Adapter interface
TB3	Side A: Power supply terminal block
J4	Side B: Connects +5V net to VIO and VREGIN of the MCU
J5-7	Side B: Port 0 through Port 2 headers
J11	Side B: Connects P1.3_B LED and P1.4_B Switch to MCU port pins
J12	Side B: Connects MCU to LIN transceiver (T1)
J19	Side B: Connects decoupling capacitors C41 and C42 for MCU VREF (P0.0)
P3	Side B: DEBUG connector for Debug Adapter interface



5.1. Target Board Shorting Blocks: Factory Defaults

The C8051F540 Target Board comes from the factory with pre-installed shorting blocks on many headers. Figure 5 shows the positions of the factory default shorting blocks.

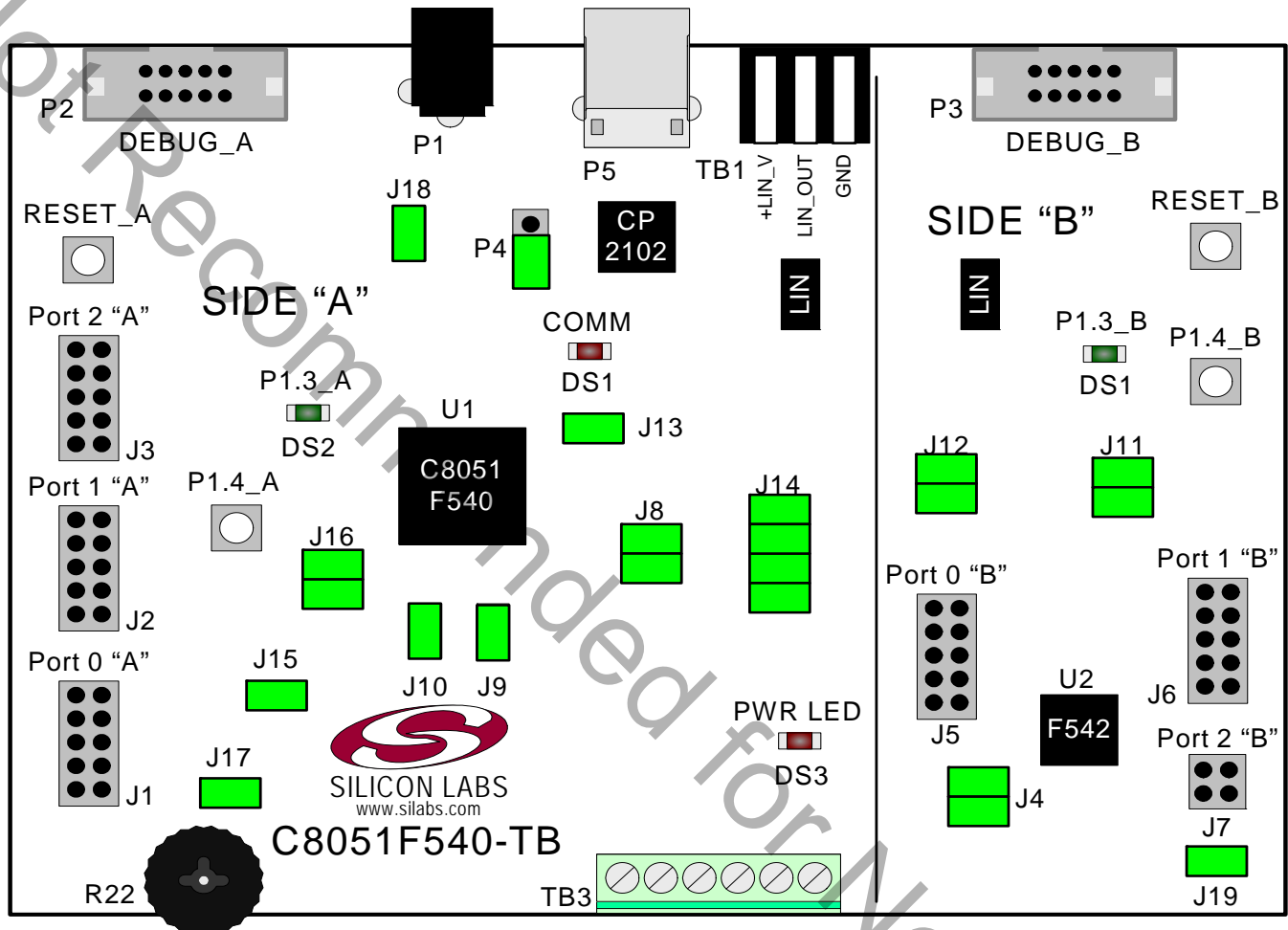


Figure 5. C8051F540 Target Board Shorting Blocks: Factory Defaults

5.2. Target Board Power Options and Current Measurement (J4, J8, J24, P1, TB1)

The MCUs on the C8051F540 Target Board are powered from a +5 V net. The +5 V net is connected to the headers J8 (Side A) and J4 (Side B). Shorting blocks can be put on each header to connect the +5 V net to the VREGIN and VIO pins on the two MCUs. With the shorting blocks removed, a source meter can be used across the headers to measure the current consumption of the MCU.

The +5 V net on the target board has three possible sources:

1. 12 V dc power using the ac to dc power adapter (P1)
2. 5 V dc USB VBUS power from PC via the USB Debug Adapter (DEBUG_A)
3. 12 V dc power from the LIN external header (TB1)

5.2.1. Using the AC to DC Power Adapter as the Target Board Power Source (P1, P4)

The default configuration of the target board uses the ac to dc power adapter as the source. The 12 V from the adapter is regulated to +5 V using an LDO regulator (U4). The output of the regulator is connected to the +5 V net of the target board through the P4 header. A shorting block should be installed on pins P4[2–3] for this purpose. The +5 V net powers the MCUs.

5.2.2. Using the USB Debug Adapter as the Target Board Power Source (P4)

The target board can use +5 V provided by the USB Debug Adapter. To enable this source, a shorting block should be installed on pins P4[1-2]. With this shorting block, the output of the LDO regulator (U4) is disconnected from the +5 V net of the target board, and the SER_PWR node is connected to +5 V.

Note: The USB Debug Adapter does not provide the necessary peak power for the CAN transceivers to operate. One of the 12 V dc sources is recommended for CAN transceiver operation.

5.2.3. Using an External +12V LIN Source as the Target Board Power Source (P4, TB1)

The two 12 V power sources (LIN and ac to dc power adapter) are ORed together using reverse-biased diodes (Z1 and Z2) and connected to the input of the LDO regulator (U6). The output of the regulator is connected to the +5 V net of the target board through the P4 header. A shorting block should be installed on pins P4[2-3] for this purpose. The +5 V net powers the MCUs directly.

5.3. System Clock Sources (J9, J10)

5.3.1. Internal Oscillators

The C8051F540 and C8051F542 devices installed on the target board feature a factory-calibrated, programmable high-frequency internal oscillator (24 MHz base frequency, $\pm 0.5\%$), which is enabled as the system clock source on reset. After reset, the internal oscillator operates at a frequency of 187.5 kHz by default but may be configured by software to operate at other frequencies. The on-chip crystal is accurate for LIN master communications and in many applications an external oscillator is not required. However, if you wish to operate the C8051F540 device (Side A) at a frequency not available with the internal oscillator, an external crystal may be used. Refer to the C8051F54x data sheet for more information on configuring the system clock source.

5.3.2. External Oscillator Options

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 Ω resistor at R2 and install capacitors at C7 and C8 using values appropriate for the crystal you select. If you wish to operate the external oscillator in capacitor or RC mode, options to install a capacitor or an RC network are also available on the target board. R2, R3, C7, and C8 are located on the back side of the board, near the Side A MCU. Populate C7 for capacitor mode, and populate R3 and C7 for RC mode. Refer to the C8051F54x data sheet for more information on the use of external oscillators.

5.4. Switches and LEDs (J11, J16)

Two push-button switches are provided on the target board for each MCU. Switch RESET_A is connected to the $\overline{\text{RST}}$ pin of the C8051F540. Switch RESET_B is connected to the $\overline{\text{RST}}$ pin of the C8051F542. Pressing RESET_A puts the C8051F540 device into its hardware-reset state, and similarly for RESET_B and the C8051F542 MCU. Switches P1.4_A and P1.4_B are connected to the MCU's general purpose I/O (GPIO) pins through headers. Pressing either one of these switches generates a logic low signal on the port pin. Remove the shorting block from the header to disconnect these switches from the port pins. See Table 1 for the port pins and headers corresponding to each switch.

Four LEDs are provided on the target board to serve as indicators. The red LED labeled PWR indicates presence of power to the target board. The second red LED labeled COMM indicates if the CP2102 USB-to-UART bridge is recognized by the PC. The green LED on Side A is labeled with port pin name and is connected to a C8051F580 GPIO pin through a header. Remove the shorting block from the header to disconnect the LED from the port pin. Similarly, a second green LED on Side B is connected to the C8051F542 through another header. See Table 1 for the port pins and headers corresponding to each LED.

Table 1. Target Board I/O Descriptions

Description	I/O	Header(s)
RESET_A	Reset (Side A)	none
RESET_B	Reset (Side B)	none
P1.4_A Switch	P1.4 (Side A)	J16[1–2]
P1.4_B Switch	P1.4 (Side B)	J11[1–2]
P1.3_A LED	P1.3 (Side A)	J16[3–4]
P1.3_B LED	P1.3 (Side B)	J11[3–4]
Red LED (PWR)	Power	none
Red LED (COMM)	COMM Active	none

5.5. Target Board Debug Interfaces (P2 and P3)

The debug connectors P2 (DEBUG_A) and P3 (DEBUG_B) provide access to the debug (C2) pins of the C8051F540 and C8051F542. The debug connectors are used to connect the Serial Adapter or the USB Debug Adapter to the target board for in-circuit debugging and Flash programming. Table 2 shows the DEBUG pin definitions.

Table 2. DEBUG Connector Pin Descriptions

Side A - C8051F540		Side B - C8051F542	
Pin #	Description	Pin #	Description
1	Not Connected	1	Not Connected
2, 3, 9	GND (Ground)	2, 3, 9	GND (Ground)
4	P2.1_C2D_A	4	P2.1_C2D_B
5	$\overline{\text{RST_A}}$ (Reset)	5	$\overline{\text{RST_B}}$ (Reset)
6	P2.1	6	P2.1_B
7	$\overline{\text{RST/C2CK_A}}$	7	$\overline{\text{RST/C2CK_B}}$
8	Not Connected	8	Not Connected
10	USB Power (+5VDC from P2)	10	Not Connected

5.6. Serial Interface (P5, J14)

A USB-to-UART bridge device (U3) and USB connector (P5) are provided on the target board to facilitate serial connections to UART0 of the C8051F540 (Side A). The Silicon Labs CP2102 USB-to-UART bridge provides data connectivity between the C8051F540 and the PC via a USB port. The TX and RX signals of UART0 may be connected to the CP2102 by installing shorting blocks on header J14. The shorting block positions for connecting each of these signals to the CP2102 are listed in Table 3. To use this interface, the USB-to-UART device drivers should be installed as described in Section 4.3. "CP210x USB to UART VCP Driver Installation," on page 4.

Table 3. Serial Interface Header (J14) Description

Header Pins	UART0 Pin Description
J14[3–4]	UART_TX (P0.4_A)
J14[1–2]	UART_RX (P0.5_A)

5.7. LIN Interface and Network (J12, J14, TB1)

Both MCUs on the target board are connected to LIN transceivers through headers. These headers assume that the MCU's crossbars are configured to put the LIN TX and RX pins on port pins P1.0 and P1.1 respectively. See the C8051F54x data sheet for crossbar configuration. The C8051F540 (Side A) is connected to the T1 transceiver through the J14 header and the C8051F542 (Side B) is connected to the T2 transceiver through the J12 header. The two LIN transceivers are connected to each other and form a LIN network. Other external devices can be connected to the LIN network through the TB1 interface. The TB1 interface also provides the option for connecting an external power source so that all LIN transceivers can use the same source voltage. This source voltage can also be used to power the target board. If an external voltage source is not provided, the LIN transceivers use the 12 V provided through the P1 power adapter connector. See Section 5.2. for more power option details. The shorting block positions for connecting the MCUs to the LIN transceivers are listed in Table 4. The pin connections for the external LIN devices are listed in Table 5.

Table 4. LIN Interface Headers (J12 and J14) Description

Header Pins	LIN0 Pin Description
J14[5–6]	LIN_TX (P1.0_A)
J14[7–8]	LIN_RX (P1.1_A)
J12[3–3]	LIN_TX (P1.0_B)
J12[1–2]	LIN_RX (P1.1_B)

Table 5. TB1 External LIN Interface Header Description

Pin #	Pin Description
1	GND
2	LIN_OUT
3	+LIN_V

5.8. Port I/O Connectors (J1-J3 and J5-J7)

Each of the parallel ports of the C8051F540 (Side A) and C8051F542 (Side B) has its own 10-pin header connector. Each connector provides a pin for the corresponding port pins 0–7, +5 V VIO, and digital ground. The same pin-out is used for all of the port connectors.

Table 6. Port I/O Connector Pin Description

Pin #	Pin Description
1	Pn.0
2	Pn.1
3	Pn.2
4	Pn.3
5	Pn.4
6	Pn.5
7	Pn.6
8	Pn.7
9	+5V (VIO)
10	GND (Ground)

Port 2 on the C8051F542 (Side B) MCU has only two pins and has a reduced header.

Table 7. Port I/O Connector Pin Description (J7)

Pin #	Pin Description
1	Pn.0
2	Pn.1
3	+5V (VIO)
4	GND (Ground)

5.9. Voltage Reference (VREF) Connectors (J13 and J19)

The VREF connectors can be used to connect the VREF pin from the MCU (P0.0) to external 0.1 μ F and 4.7 μ F decoupling capacitors. The C8051F540 (Side A) device is connected to the capacitors through the J13 header and the C8051F542 (Side B) device connects to its own set of capacitors through J19.

5.10. Potentiometer (J17)

The C8051F540 (Side A) device has the option to connect port pin P1.2 to a 10K linear potentiometer. The potentiometer is connected through the J17 header. The potentiometer can be used for testing the analog-to-digital (ADC) converter of the MCU.

5.11. Power Supply I/O (Side A) (TB3)

All of the C8051F540 target device's supply pins are connected to the TB3 terminal block. Refer to Table 8 for the TB3 terminal block connections.

Table 8. TB3 Terminal Block Pin Descriptions

Pin #	Description
1	VIO_A
2	VREGIN_A
3	VDD_A
4	VDDA_A
5	GNDA_A
6	GND

5.12. Alternate Power Supply Headers (J15, J18)

The C8051F540 Target Board includes two headers that allow for alternate power sources and power measurement. Header J15 connects the VIO voltage supplied to the Side A MCU to other peripherals on the board, such as the P1.4_SW push-button switch pull-up, and the R17 potentiometer source. To enable current measurement, the shorting block on J15 can be removed so that the VIO_A node only powers the VIO pin on the MCU. Another voltage source will need to be applied to the VIO_SRC node to power the other peripherals.

Header J18 connects the P4 power-adaptor supply to the V_HIGH node, which is used as the power source for the LIN transceivers (T1, T2). The shorting block on header J18 can be removed to force the LIN transceivers to use the voltage supply externally supplied on the +LIN_V pin on the TB1 header.

5.13. C2 Pin Sharing

On the C8051F540 (Side A), the debug pins C2CK and C2D are shared with the pins $\overline{\text{RST}}$ and P2.1, respectively. On the C8051F542 (Side B), the debug pins C2CK and C2D are shared with the pins $\overline{\text{RST}}$ and P2.1, respectively. The target board includes the resistors necessary to enable pin sharing which allow the pin-shared pins ($\overline{\text{RST}}$ and P3.0) to be used normally while simultaneously debugging the device. See Application Note "AN124: Pin Sharing Techniques for the C2 Interface" at www.silabs.com for more information regarding pin sharing.

5.14. Target Board Pin Assignment Summary

Some GPIO pins of the C8051F540 MCU can have an alternate fixed function. For example, pin 30 on the C8051F540 MCU is designated P0.4, and can be used as a GPIO pin. Also, if the UART0 peripheral on the MCU is enabled using the crossbar registers, the TX signal is routed to this pin. This is shown in the "Alternate Fixed Function" column. The "Target Board Function" column shows that this pin is used as TX on the C8051F540 Target Board. The "Relevant Headers" column shows that this signal is routed to pin 6 of the J14 header and pin 6 of the J1 header. More details can be found in the C8051F54x data sheet. Some of the GPIO pins of the C8051F540 have been used for various functions on the target board. Table 9 summarizes the C8051F540 MCU (Side A) pin assignments on the target board, and also shows the various headers associated with each signal.

Table 9. C8051F540 Target Board Pin Assignments and Headers

MCU Pin Name	Pin#	Primary Function	Alternate Fixed Function	Target Board Function	Relevant Headers
P0.0	8	P0.0	VREF	VREF	J1[1], J13[1]
P0.1	1	P0.1	CNVSTR	CNVSTR	J1[2]
P0.2	32	P0.2	XTAL1	XTAL1	J1[3]*, J9[2]
P0.3	31	P0.3	XTAL2	XTAL2	J1[4]*, J10[2]
P0.4	30	P0.4	UART_TX	TX_MCU	J1[5], J14[6]
P0.5	29	P0.5	UART_RX	RX_MCU	J1[6], J14[8]
P0.6	28	P0.6			J1[7]
P0.7	27	P0.7			J1[8]
P1.0	26	P1.0		LIN_TX	J2[1], J14[4]
P1.1	25	P1.1		LIN_RX	J2[2], J14[2]
P1.2	24	P1.2		POTENTIOMETER	J2[3], J17[2]
P1.3	23	P1.3		LED	J2[4], J16[1]
P1.4	22	P1.4		SWITCH	J2[5], J16[3]
P1.5	21	P1.5		GPIO	J2[6]
P1.6	20	P1.6		GPIO	J2[7]
P1.7	19	P1.7		GPIO	J2[8]
P2.0	18	P2.0		GPIO	J3[1]
P2.1	17	P2.1		GPIO	J3[2]
P2.2	16	P2.2		GPIO	J3[3]
P2.3	15	P2.3		GPIO	J3[4]
P2.4	14	P2.4		GPIO	J3[5]
P2.5	13	P2.5		GPIO	J3[6]
P2.6	12	P2.6		GPIO	J3[7]
P2.7	11	P2.7		GPIO	J3[8]

Table 9. C8051F540 Target Board Pin Assignments and Headers (Continued)

MCU Pin Name	Pin#	Primary Function	Alternate Fixed Function	Target Board Function	Relevant Headers
P3.0	9	P3.0		C2D	Test Point near P2
$\overline{\text{RST}}/\text{C2CK}$	12	$\overline{\text{RST}}$	C2CK	$\overline{\text{RST}}/\text{C2CK}$	P2[7], P2[5]*
VIO	2	VIO		VIO	J8[1], J15[2], TB3[1] J1-J3[2]
VREGIN	3	VREGIN		VREGIN	J8[3], TB3[2]
VDD	4	VDD		VDD	TB3[3]
VDDA	5	VDDA		VDDA	TB3[4]
GND	6	GND		GND	J1-J3[1], TB3[6]
GNDA	7	GNDA		VDD	TB3[5]
*Note: Headers denoted by this symbol are not directly connected to the MCU pin; the connection might be via one or more headers and/or pin-sharing resistor(s). See board schematic for details.					

6. Schematics

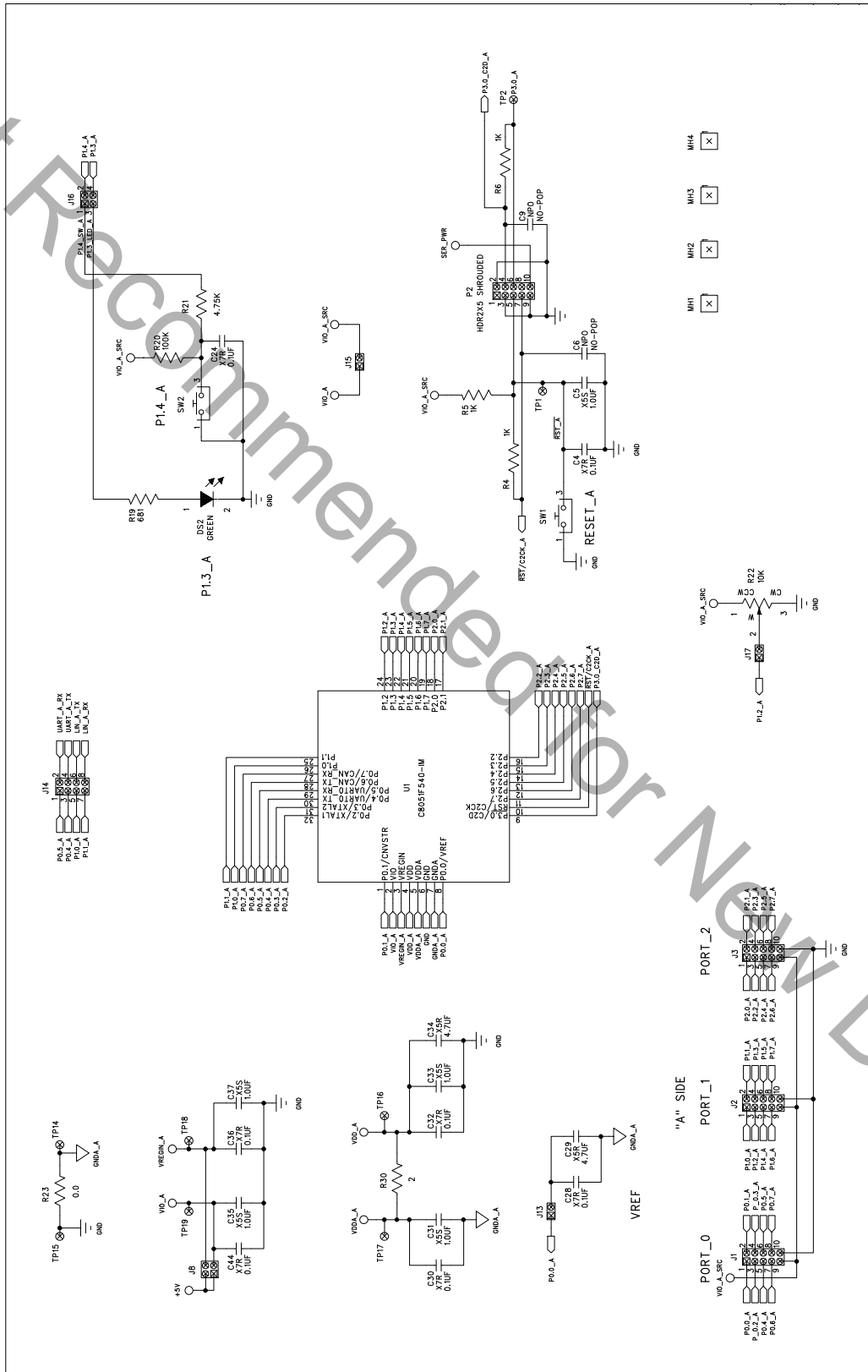


Figure 6. C8051F540 Target Board Schematic (Page 1 of 4)



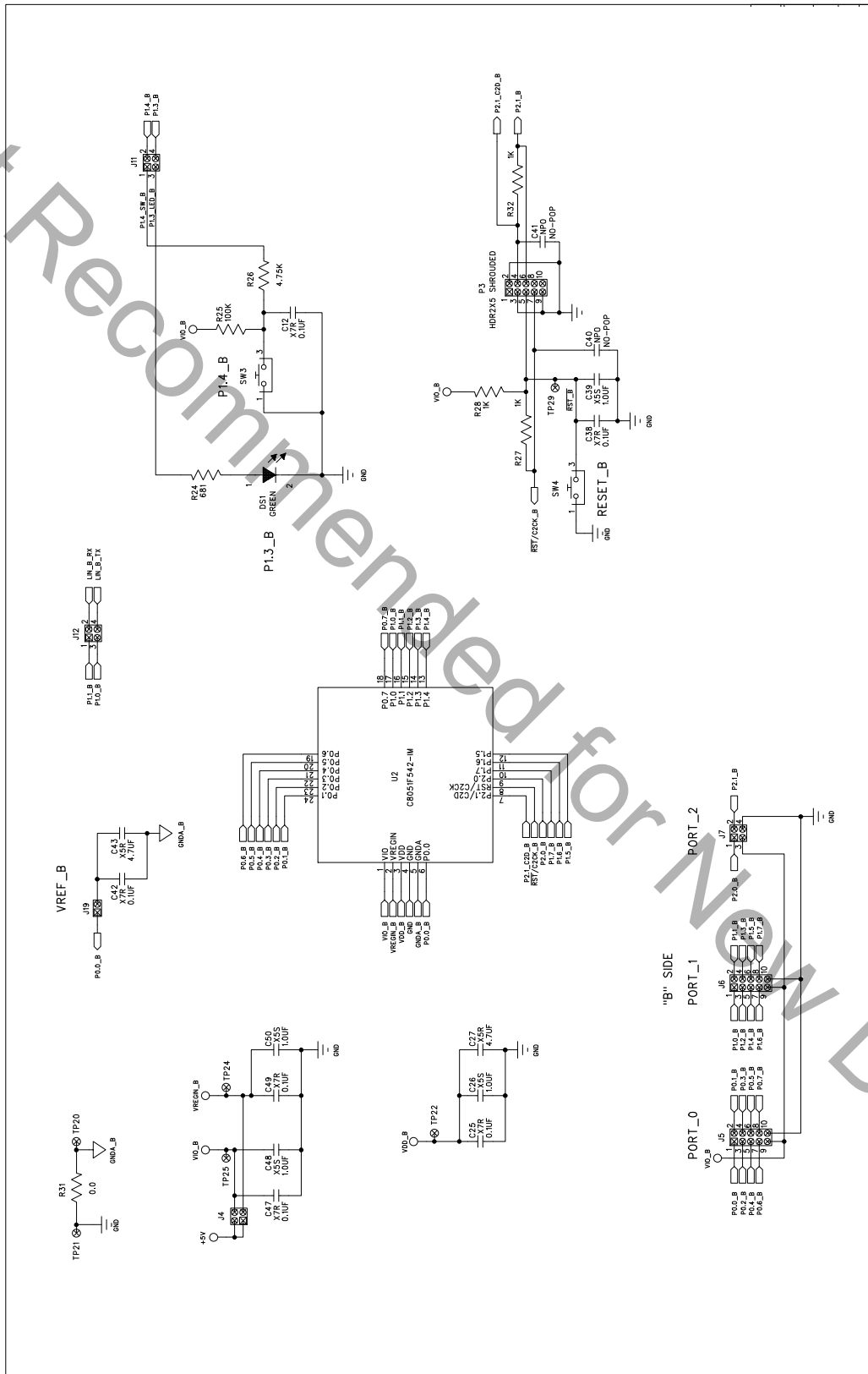


Figure 8. C8051F540 Target Board Schematic (Page 3 of 4)

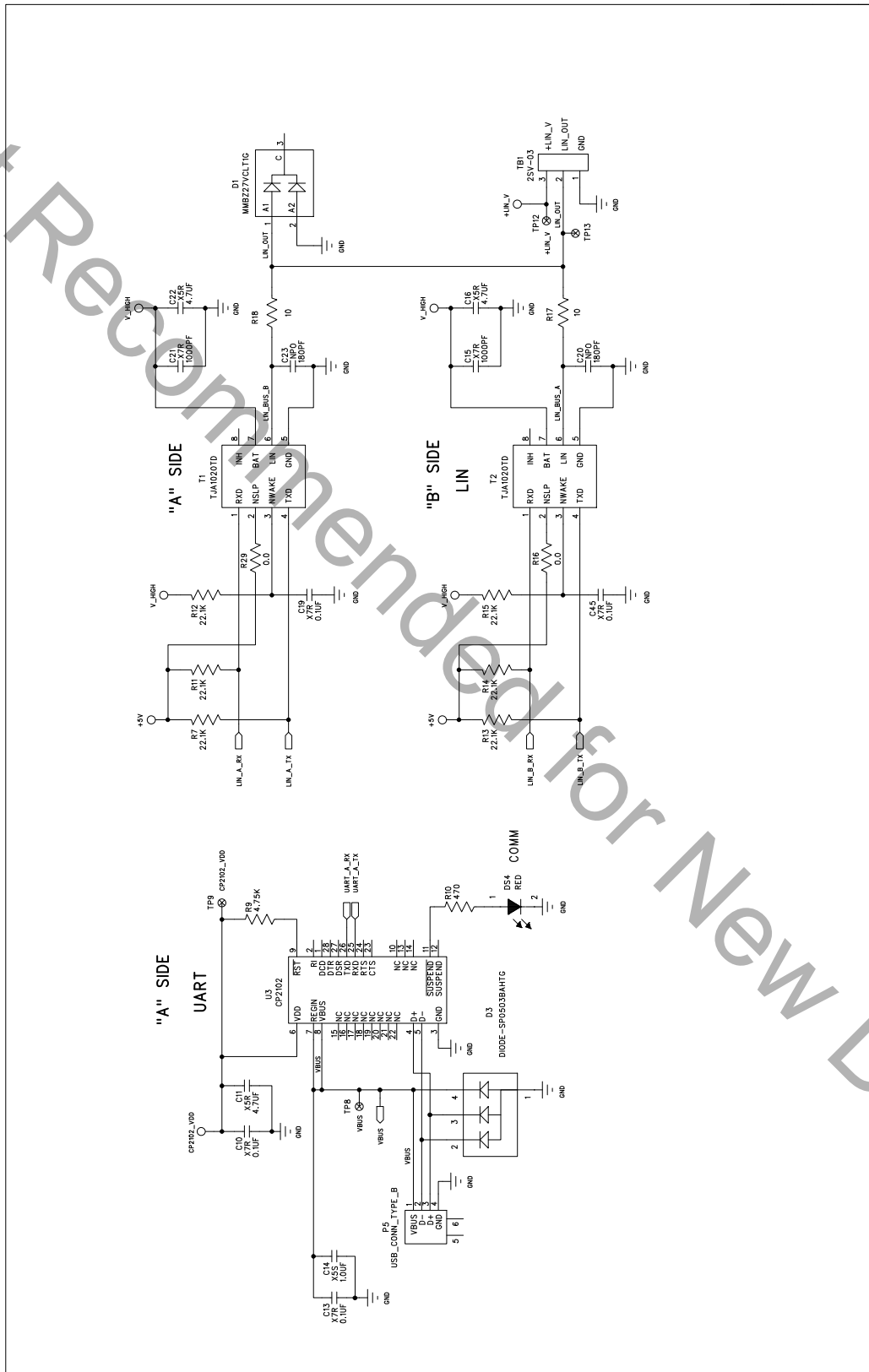


Figure 9. C8051F540 Target Board Schematic (Page 4 of 4)

DOCUMENT CHANGE LIST

Revision 0.1 to Revision 0.2

- Updated 4. "Software Setup," on page 2.

Not Recommended for New Designs

Simplicity Studio

One-click access to MCU and wireless tools, documentation, software, source code libraries & more. Available for Windows, Mac and Linux!



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