ToolStick Virtual Tools User's Guide

Relevant Devices

All Silicon Labs MCUs.

1. Introduction

The ToolStick development platform consists of a ToolStick Base Adapter and a ToolStick Daughter card. The ToolStick Virtual Tools application provides a set of tools for the PC that can be controlled via the UART serial interface of the ToolStick Base Adapter. The ToolStick Virtual Tools application includes the following components:

- ToolStick Terminal
- ToolStick Virtual LCD
- ToolStick Virtual Oscilloscope

Figure 1 shows a system block diagram of the ToolStick platform and the communication path between the ToolStick Virtual Tools application and the MCU firmware.

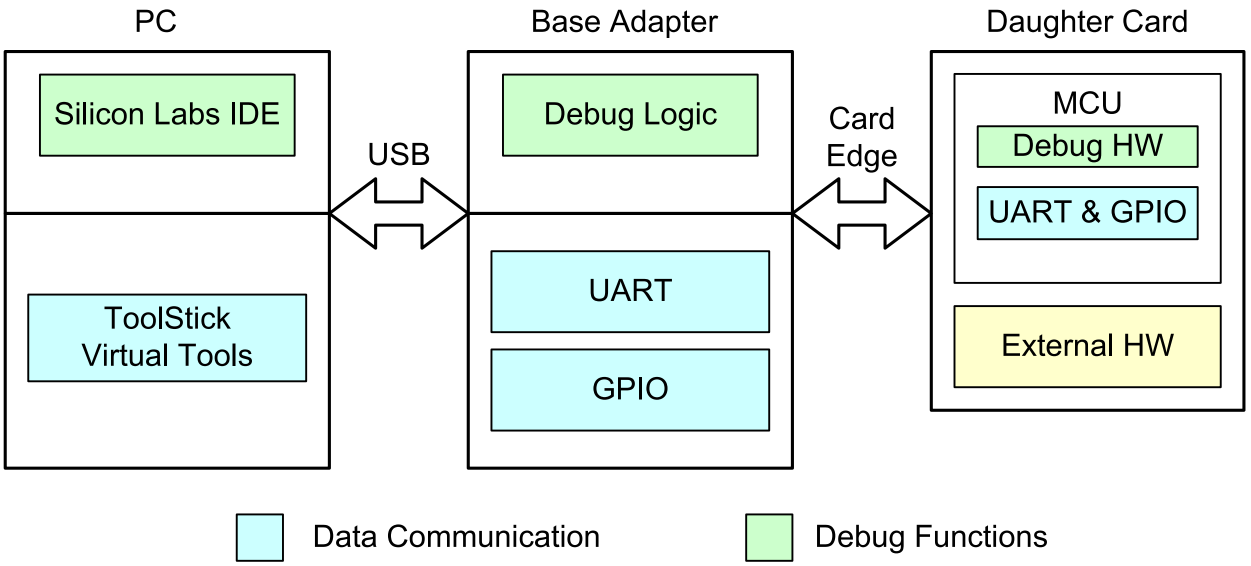

Figure 1. ToolStick Development Platform Block Diagram

2. Getting Started

The ToolStick Virtual Tools installer can be downloaded from www.silabs.com/mcuniversity. This installer includes the following components:

- ToolStick Virtual Tools
- Documentation
- PCB files
- ToolStick Virtual Tools interface libraries
- Code examples

Figure 2 shows the ToolStick Virtual Tools launch window from which each of the individual tools can be launched.

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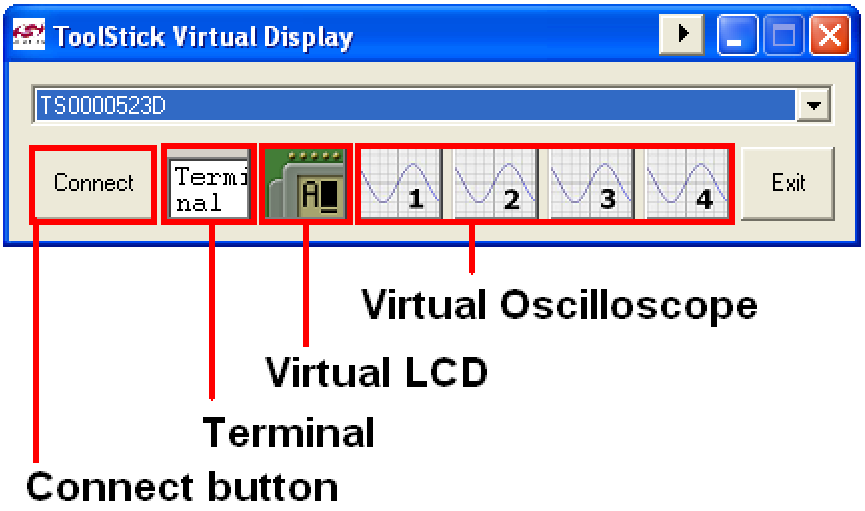


Figure 2. ToolStick Virtual Tools

2.1. System Requirements

ToolStick Virtual Tools requirements consist of the following:

- Pentium class host PC running Windows 2000 or newer.
- One available USB port.
- 64 MB RAM and 40 MB free HD space recommended.

2.2. Software Installation

Download the ToolStick Virtual Tools installer from www.silabs.com/mcuniversity. Launch the installer, and follow the prompts to complete the installation. The ToolStick Virtual Tools are installed to the following default location: *C:\SiLabs\MCU\ToolStick\UniversityDC\VirtualTools\*.

If you plan to build and download code to the target MCU on the daughter card, you will need the Silicon Laboratories Integrated Development Environment (IDE). This IDE integrates a source-code editor, a source-level debugger, and an in-system Flash programmer. It is also available for download from the above website (www.silabs.com/mcuniversity). See the ToolStick University Daughter Card User’s Guide included with the ToolStick Virtual Tools for instructions on using the IDE. This document would be installed by default at *C:\SiLabs\MCU\ToolStick\UniversityDC\Documentation\.*

Note: The ToolStick Base Adapter uses a USB connection to the PC, but does not require any external device drivers to be installed. This is because the base adapter conforms to the USB Human Interface Device (HID) class, for which the device drivers are supplied with the Windows OS (Windows 2000 or newer).

3. ToolStick Virtual Tools Interface Libraries

The following set of device interface functions implement an Application Programming Interface (API) on the target MCU. Using these functions simplifies code development when interfacing with the ToolStick Virtual Tools. The API is provided in the form of precompiled libraries compiled under the Keil (TS_vInterface_Keil.LIB) and SDCC (TS_vInterface_SDCC.LIB) toolsets. All functions in the interface library are declared in the header file, TS_vInterface.h. In order to make use of these libraries, device firmware must be developed using one of these toolsets, with the appropriate library included in the build. The available interface functions are:

`SilabsInit020()`	- Initializes the C8051F020 MCU for use with the Virtual Tools
`TerminalWrite()`	- Writes a byte to the ToolStick Terminal
`TerminalRead()`	- Reads a byte from the ToolStick Terminal
`LCD_ControlWrite()`	- Writes a control byte to the Virtual LCD
`LCD_ControlRead()`	- Reads a control byte from the Virtual LCD
`LCD_DataWrite()`	- Writes a data byte to the Virtual LCD
`LCD_DataRead()`	- Reads a data byte from the Virtual LCD
`ScopeClearBuffer()`	- Clears the Virtual Oscilloscope data buffer
`ScopeSampleWrite()`	- Writes a sample value to a Virtual Oscilloscope channel
`Lib_VersionRead()`	- Returns the ToolStick Virtual Tools interface library version

Each of these functions is described in detail in the following sections. The interface libraries are included in the ToolStick Virtual Tools installer and are installed to the following default location: *C:\SiLabs\MCU\ToolStick\UniversityDC\Interface_Libraries\*. See "Appendix A—ToolStick Virtual Tools Interface Library Details" on page 10 for more details about the interface libraries.

3.1. SilabsInit020

Description: This function initializes the C8051F020 MCU for use with the ToolStick Virtual Tools. The MCU system clock is configured to use the external 22.1184 MHz crystal present on the ToolStick University daughter card. The crystal is required for proper UART communication. The UART is configured for a baud rate of 230400 bps with a data format of 8-N-1 (8 data bits, No parity, 1 stop bit). Timer 1 is used as the baud rate generator. The Port I/O crossbar is enabled. The port pin, P0.0 (TX), is configured as a push-pull output, and the port pin, P0.1 (RX), is configured as a digital input.

Supported Devices: C8051F020

Prototype: `void SilabsInit020 (void)`

Parameters: None.

Return Value: None.

3.2. Lib_VersionRead

Description: This function reads a version number of the ToolStick Virtual Tools interface library.

Supported Devices: All Silicon Labs MCUs. See Appendix A.

Prototype: `uint8_t Lib_VersionRead (void)`

Parameters: None.

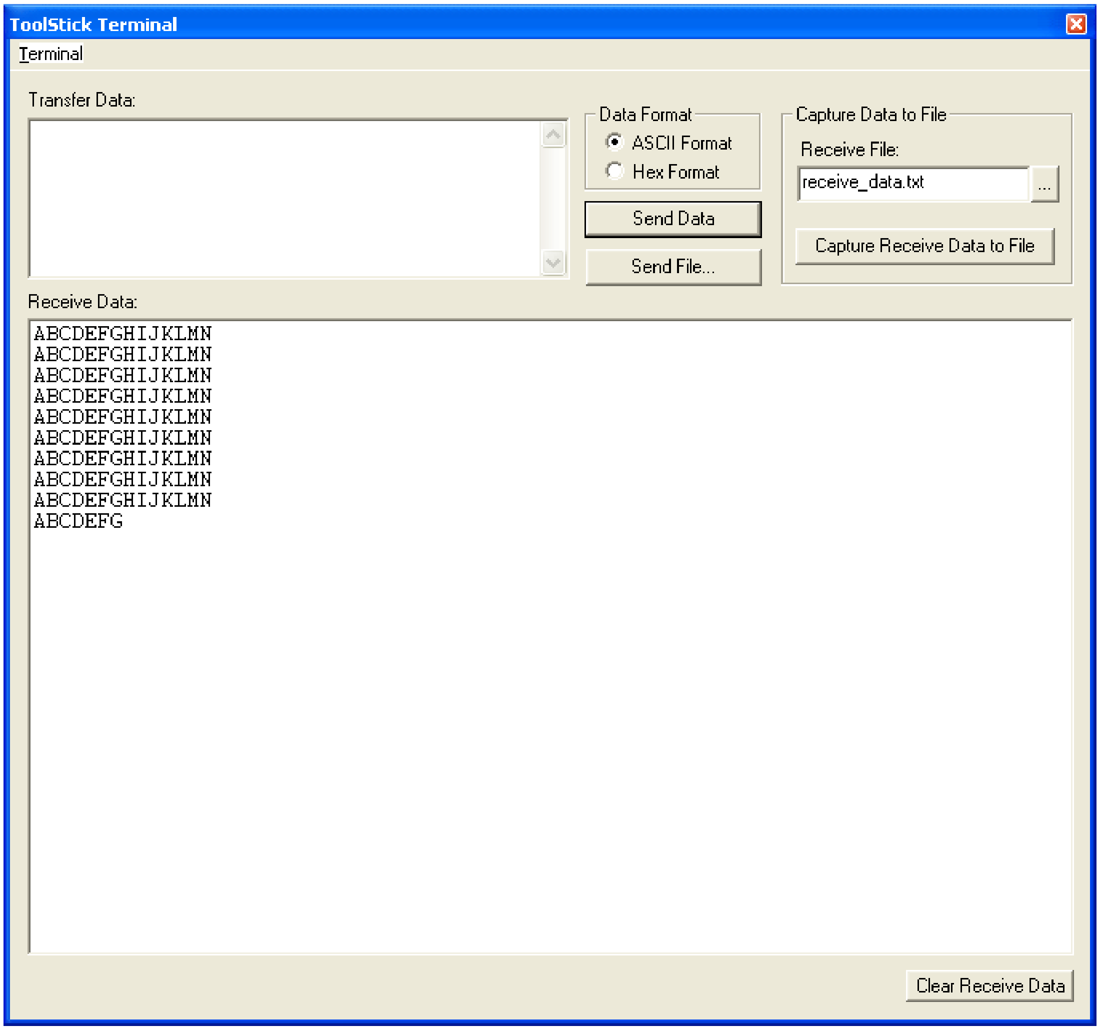
Return Value: Returns an unsigned 8-bit value indicating the library version.

4. ToolStick Terminal

The ToolStick Terminal program provides the standard terminal interface to the target microcontroller's UART. However, instead of requiring the usual RS-232 and COM port connection, the ToolStick Terminal uses the USB interface of the ToolStick Base Adapter to provide the same functionality. In addition to the standard terminal functions (send file, receive file), two GPIO pins on the target microcontroller can be controlled using the Terminal for RTS/CTS handshaking. The **UniDC_VirtualTools_Demo** example code included with the ToolStick Virtual Tools installer illustrates the use of this application. See "7. Library Files, Header Files, and Code Examples" on page 9 to locate this example.

Note: The ToolStick Terminal application integrated within the ToolStick Virtual Tools application differs from the standalone ToolStick Terminal application available from www.silabs.com/toolstick. In the case of the Terminal in Virtual Tools, the baud rate is fixed at 230400 bps and is set up for RTS/CTS handshaking. These two options cannot be changed for any of the ToolStick Virtual Tools applications.

The following sections describe the two Terminal interface functions included in the ToolStick Virtual Tools Interface Library. Figure 3 shows the ToolStick Terminal application.



● ASCII Format
○ Hex Format

Receive File: receive_data.txt

```
ABCDEFGHIJKLMN
ABCDEFGHIJKLMN
ABCDEFGHIJKLMN
ABCDEFGHIJKLMN
ABCDEFGHIJKLMN
ABCDEFGHIJKLMN
ABCDEFGHIJKLMN
ABCDEFGHIJKLMN
ABCDEFGHIJKLMN
ABCDEFG
```

Figure 3. ToolStick Terminal Application

4.1. TerminalRead

Description: This function reads a byte from the ToolStick Terminal.

Supported Devices: All Silicon Labs MCUs. See Appendix A.

Prototype: `uint8_t TerminalRead (void)`

Parameters: None.

Return Value: Returns an unsigned 8-bit value read from the ToolStick Terminal.

4.2. TerminalWrite

Description: This function writes a byte to the ToolStick Terminal.

Supported Devices: All Silicon Labs MCUs.
See " Appendix A—ToolStick Virtual Tools Interface Library Details" on page 10.

Prototype: `void TerminalWrite (uint8_t SendChar)`

Parameters: **1.** SendChar—8-bit value to be sent to the ToolStick Terminal

Return Value: None.

5. ToolStick Virtual LCD

The ToolStick Virtual LCD (Liquid Crystal Display) offers a virtual LCD with a serial interface on the PC. This enables learning how to interface with a serial LCD without the additional hardware cost of an actual LCD. Figure 4 shows the Virtual LCD as it appears on the PC. The following sections describe the four Virtual LCD interface functions included in the ToolStick Virtual Tools Interface Library

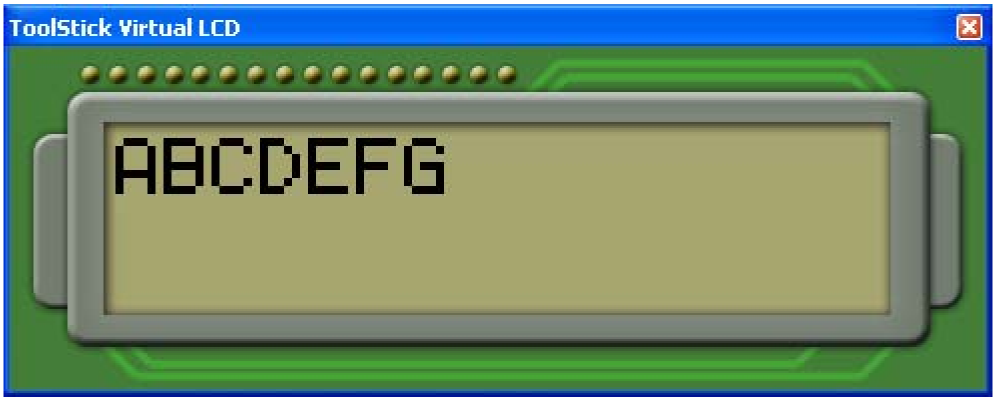


Figure 4. ToolStick Virtual LCD Application

5.1. LCD_ControlRead

Description: This function reads a control byte from the Virtual LCD.

Supported Devices: All Silicon Labs MCUs.
See " Appendix A—ToolStick Virtual Tools Interface Library Details" on page 10.

Prototype: `uint8_t LCD_ControlRead (void)`

Parameters: None.

Return Value: Returns an unsigned 8-bit value read from the Virtual LCD.

5.2. LCD_ControlWrite

Description: This function writes a control byte to the Virtual LCD. The control commands that can be sent to the Virtual LCD are listed in Table 1.

Supported Devices: All Silicon Labs MCUs.
See " Appendix A—ToolStick Virtual Tools Interface Library Details" on page 10.

Prototype: `void LCD_ControlWrite (uint8_t SendChar)`

Parameters: **1.** SendChar—8-bit value to be sent to the Virtual LCD.

Return Value: None.

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Table 1. LCD Control Commands

SendChar Value	Description
0x0C	Display ON, Cursor OFF
0x01	Clear LCD
0x06	Entry mode increment without shift

5.3. LCD_DataRead

Description: This function reads a data byte from the Virtual LCD.

Supported Devices: All Silicon Labs MCUs.
See " Appendix A—ToolStick Virtual Tools Interface Library Details" on page 10.

Prototype: `uint8_t LCD_DataRead (void)`

Parameters: None.

Return Value: Returns an unsigned 8-bit value read from the Virtual LCD.

5.4. LCD_DataWrite

Description: This function writes a data byte to the Virtual LCD.

Supported Devices: All Silicon Labs MCUs.
See " Appendix A—ToolStick Virtual Tools Interface Library Details" on page 10.

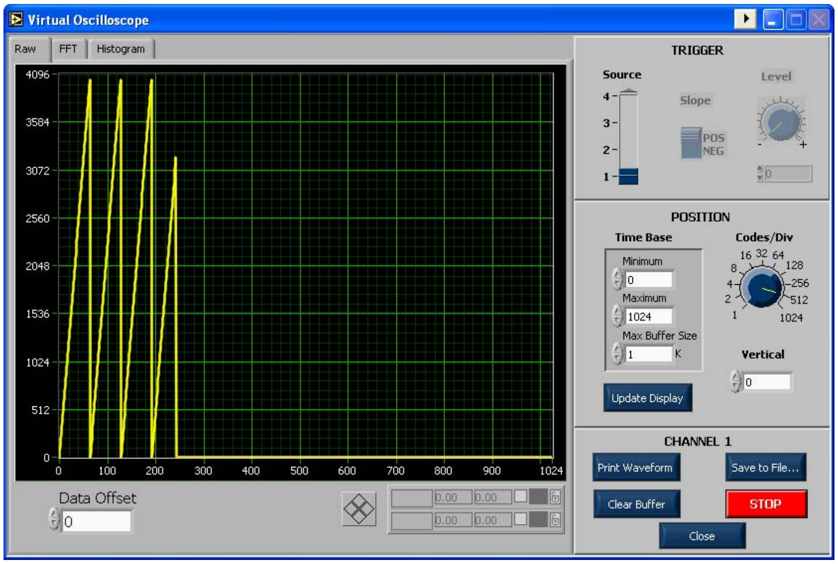
Supported Devices: void LCD_DataWrite (uint8_t SendChar)

Parameters: **1.** SendChar—8-bit value to be sent to the Virtual LCD.

Return Value: None.

6. ToolStick Virtual Oscilloscope

The ToolStick Virtual Oscilloscope application allows the PC to be used as an oscilloscope by sending data points to be plotted through the target MCU's UART interface via the ToolStick Base Adapter. Data, such as analog measurements from the MCU, can be sent to the virtual oscilloscope to be plotted. The virtual oscilloscope has four channels and can plot data up to 12-bits wide. The 12-bit data is ORed with the 4-bit channel number and sent to the PC as a 16-bit number. The following sections describe the two Virtual Oscilloscope interface functions included in the ToolStick Virtual Tools interface library. Figure 5 shows the ToolStick Virtual Oscilloscope application.



Data Offset 0

Level 0

Minimum 0

Maximum 1024

Max Buffer Size 1 K

Vertical 0

0.00 0.00

0.00 0.00

Figure 5. ToolStick Virtual Oscilloscope Application

6.1. ScopeClearBuffer

Description: This function clears the data in its buffer for the specified channel of the Virtual Oscilloscope.

Supported Devices: All Silicon Labs MCUs.
See " Appendix A—ToolStick Virtual Tools Interface Library Details" on page 10.

Supported Devices: void ScopeClearBuffer (uint8_t ChannelMask)

Parameters: **1.** ChannelMask—8-bit value of the channel whose buffer needs to be cleared. Valid values are between 0 and 3.

Return Value: None.

6.2. ScopeSampleWrite

Description: This function writes a sample value to the specified channel of the Virtual Oscilloscope.

Supported Devices: All Silicon Labs MCUs.
See " Appendix A—ToolStick Virtual Tools Interface Library Details" on page 10.

Supported Devices: void ScopeSampleWrite (uint8_t Channel, uint8_t sendValueMSB, uint8_t sendValueLSB)

1. Channel—8-bit value of the channel whose buffer needs to be cleared. Valid values are between 0 and 3.
2. sendValueMSB—8-bit value that holds the most significant 4 bits of the 12-bit sample value.
3. sendValueLSB—8-bit value that holds the least significant 8 bits of the 12-bit sample value.

Return Value: None.

7. Library Files, Header Files, and Code Examples

The ToolStick Virtual Tools interface library (for SDCC and Keil toolsets), SFR definition header files for the C8051F020 MCU, and code examples are included in the ToolStick Virtual Tools installer. This can be downloaded and installed from www.silabs.com/mcuniversity. The files are installed at the following default location: *C:\SiLabs\MCU\ToolStick\UniversityDC\Firmware\*. The examples included are **UniDC_SimpleDemo**, **UniDC_FeaturesDemo**, and **UniDC_VirtualTools_Demo**. Open the *.wsp project from the Silicon Labs IDE using the **Project→Open Project** menu option, and follow the instructions listed at the top of the C source file to try these examples.

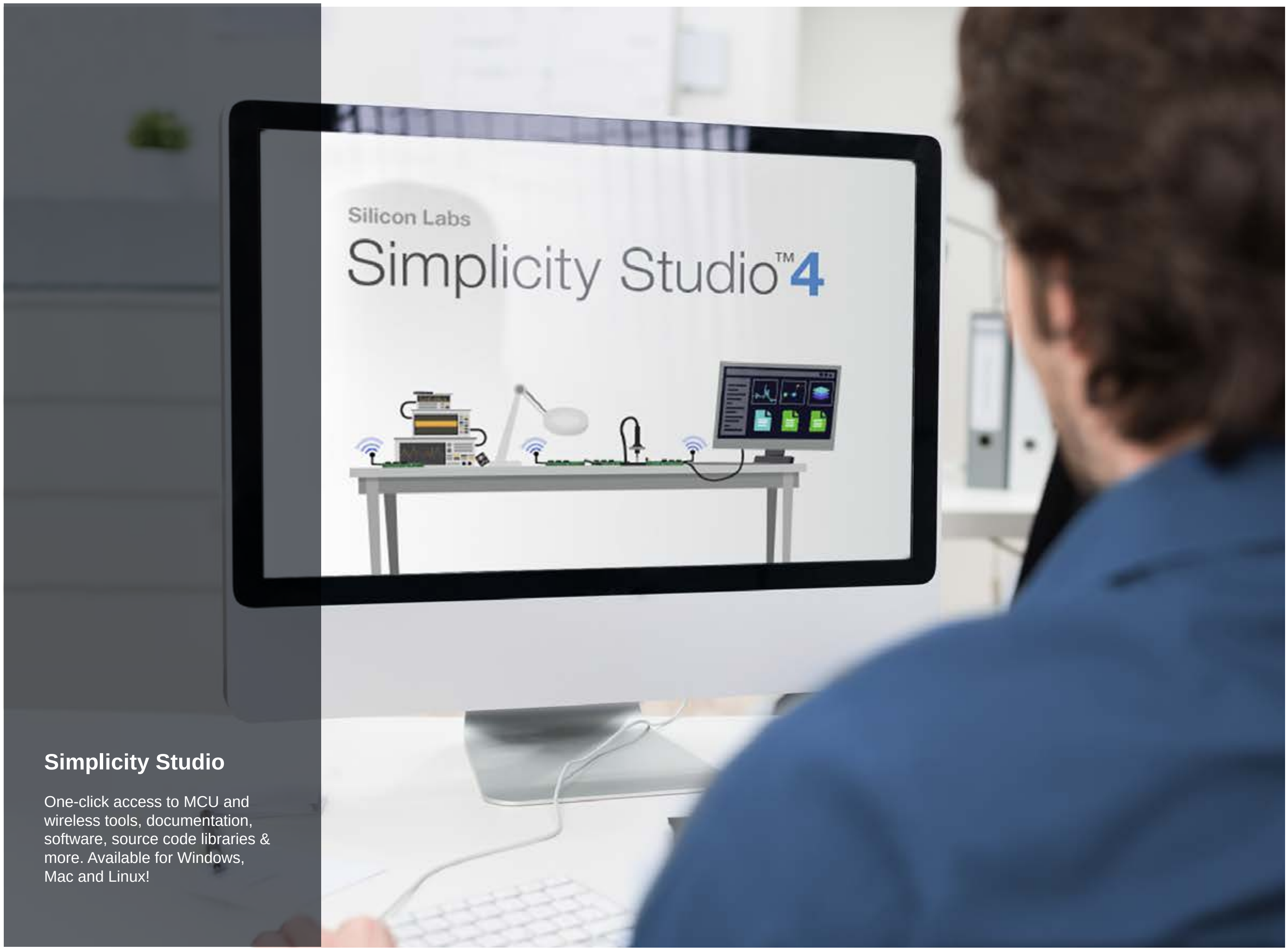
Appendix A—ToolStick Virtual Tools Interface Library Details

All the three ToolStick Virtual Tools applications share the same UART channel for data transfer. In order to distinguish between the data going to the different ToolStick Virtual Tools applications, an escape character should be added before the actual data byte indicating for which ToolStick Virtual Tools application the data is intended. The ToolStick Virtual Tools interface library functions automatically add the appropriate escape character; so, there is no need to add these extra characters when using those functions. As an alternative to the interface functions, the ToolStick Virtual Tools can be accessed directly by adding the appropriate escape character before the UART data. A list of escape characters and descriptions is included in Table 2.

Table 2. ToolStick Virtual Tools Escape Characters

Value	Description
0x01	Prefix before sending a character to be written to the Terminal.
0x02	Prefix before trying to read a character from the Terminal.
0x17	Prefix before sending a control character to be written to the Virtual LCD.
0x18	Prefix before trying to read a control character from the Virtual LCD.
0x19	Prefix before trying to read a data byte from the Virtual LCD.
0x20 - 0x7F	Values in this range are meant for the virtual LCD and can be sent without any escape character prefix.
0x80	This is the mask for any Virtual Oscilloscope control characters. The most significant bit should be set for all these characters.
0x07	Channel 8 is used to send Virtual Oscilloscope commands.
0x01	Virtual Oscilloscope command to clear a channel buffer. For this command, the first character sent should be 0xF1 [0x80 | (0x07 << 4) | 0x01], and the next character sent should be the number of the channel whose buffer should be cleared.

Note: All the interface library functions (except the SilabsInit020 function) can be used with all Silicon Labs MCUs as long as the UART0 is set up for 230400 bps, 8-N-1. For devices with SFR Paging, the SFR page should be set to the UART0 page before calling any of the interface library functions. The only SFRs used by the interface functions (except the SilabsInit020 function) are SBUF0, TI0, and RI0, which are located at the same SFR locations in all Silicon Labs MCUs.



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