Application Report
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MSC12xx Serial Programming Board

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ABSTRACT

The MSC12xx series of microcontrollers consists of microsystem products containing analog-to-digital converters (ADCs) and digital-to-analog converters (DACs) with embedded flash memory. The flash memory ranges in size from 4K to 32K and can be used for both code development as well as applications. Some applications commonly require programming the flash one time only; in such cases, it may be possible to use high-speed parallel programmers. Other applications require the flash to be updated. The serial programming function of the MSC12xx products can be used to program the flash for development, system applications and updates. A high-speed serial programming board can be constructed for this purpose without the need for installing unnecessary interface components on every system board. This application report discusses building and using a proven serial programmer as well as circuit design descriptions sufficient for the user to build his or her own programming board. TI does not sell or build any version of this board.

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- Single device programming for any MSC12xx product
- RS-232 or high-speed USB serial communication
- Hot switching of target systems
- Possible download speed of 921.6K baud with USB
- Status and reload features when using the TI Downloader software

2 Overview

Some applications may only require a single programming of the flash on a MSC12xx device. This is often done using parallel programmers prior to PCB assembly. There are times, however, when applications may need updating in the flash. This may occur as a program change, a bug fix, or during application development. The MSC12xx Serial Programmer described in this application report allows a simple means of updating the target device while allowing the target system to have minimal components for communication. This is achieved by placing the necessary communication hardware on the MSC12xx Serial Programmer. A ribbon cable can then be used to connect the programmer to the target system. In this way, a single programmer can be used to program many target devices without the cost of having each target system built with the necessary communication components. Figure 1 shows a block diagram of the MSC12xx Serial Programmer.

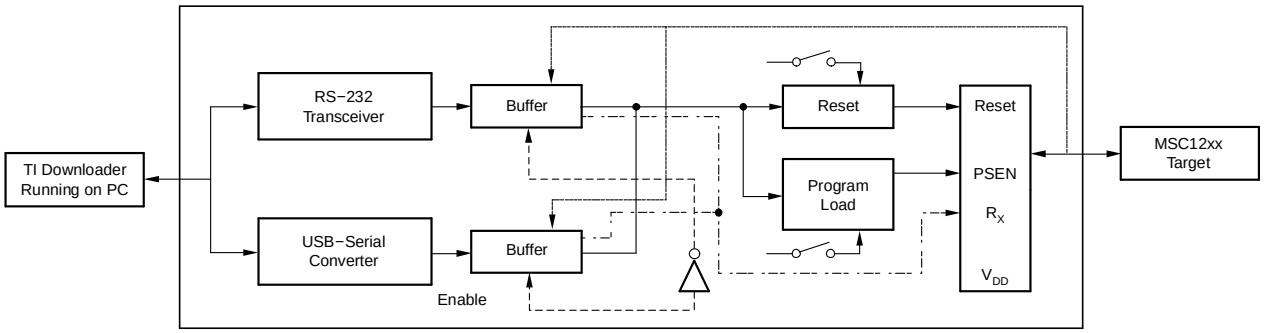


Figure 1. Block Diagram

The programmer consists of both a RS-232 DB-9 and a USB type B connector for serial communication from a PC or terminal device. You can enable the mode of communication that best suits your needs. The programmer converts the incoming signals to logic levels and buffers the output. Serial data moves to and from the target device through a switch to a header. A cable connects the header on the programmer to the target system.

When using RS-232, an external power supply must be connected to the programmer. If USB is used, power can be supplied from the USB interface device.

The programming header to the target device contains $+V_{DD}$ and GND. This allows for the option of powering the target from the programming board, or vice-versa. Signals also going to the header include $\overline{\text{PSEN}}$, RESET, R_XD and T_XD. A switch is available to disconnect the power and signal lines to the target device while leaving the programmer in a powered state.

The serial flash programming mode is initiated when $\overline{\text{PSEN}}$ is logic low (0) and ALE is logic high (1) when reset has completed. This is accomplished by using handshake signals from the communication terminal to derive the reset and program load functions. Communication with the device occurs via serial port 0 using port pins P3.0(R_XD) and P3.1(T_XD).

Timing for $\overline{\text{PSEN}}$ and RESET are determined by preset values of supervisor devices connected to the RTS and DTR handshake signals. The output of the supervisors are connected through the switch to the programming header.

A number of commands can be communicated to the device such as Flash Erase, Flash Read and Flash Write. Download format is Intel hex. (For additional information, see Application Note SBAA076, available for download at www.ti.com.)

The TI Downloader program is the easiest way to communicate with and download the desired program to the target device. However, any terminal device and program can be used. (See Application Note SBAA089A, available at www.ti.com.) One of the advantages of the TI Downloader is the ability to use the setup, status and programming capabilities built into the software. This software also allows for flexible user configuration. The TI Downloader software runs on any Microsoft Windows®-equipped PC; however, in order to use the USB functions, you will need a PC that is using Microsoft Windows98SE® or higher.

3 Hardware

3.1 Settings and Configuration

The serial programming board setup is quite simple. There are only three critical jumper settings. 5V must be supplied either from USB or from an external adapter. JMP1 allows this selection. When pins 2 and 3 are shorted, 5V comes from the external supply through U1. When pins 1 and 2 are shorted, 5V comes from the USB connection.

JMP2 selects the voltage level for V_{DD}. When pins 1 and 2 are shorted, V_{DD} is 3.3V. When pins 2 and 3 are shorted, V_{DD} is 5V.

JMP4 selects which serial device is communicating. When JMP4 is installed, the USB serial device is active. When JMP4 is removed, the RS-232 device is active.

The target device is connected to the programmer through J4. SW3 controls whether the serial programming board is powering the target device and outputting controls signals to it.

3.2 Power Supply

The power supply requirement for the entire system is quite small; it can easily operate from an inexpensive AC/DC wall plug adapter. The adapter should have an output between 6V and 10V with current of at least 100ma (J2.) The programmer can also be powered directly from the USB supply (J1.) The connector for J2 is 2.5mm with a male center conductor. The orientation of the plug should have the center conductor as *plus* (+) and the outer conductor as *minus* (–). When using USB as a power source, USB provides 5V. Noise from the PC is reduced by the filtering of L1, L2 and CF1.

Two REG113 400mA LDO regulators are used. U1 is a 5V regulator that primarily regulates an external AC/DC wall plug adapter to 5V. The target MSC can be operated from either a 5V or 3.3V supply. Power can be supplied to the target through pin 1 of J4. The 3.3V supply is regulated from U2. U2 can receive a voltage input from either the USB 5V source or from U1. The input for U1 is made via JMP1.

To select the voltage V_{DD} for the target device, use JMP2 to select either 3.3V or 5V. Even though the MSC can be programmed using either voltage, the TUSB3410VF is a 3.3V-only part. For this reason, buffers are used with 5V tolerant inputs. This allows the buffers to be used as level shifters.

Two green LEDs are lit when proper voltage is applied. D2 indicates the presence of 5V, and D3 indicates 3.3V.

3.3 RS-232 Communication

RS-232 communication is accomplished by using a DB-9 cable with a male connector plugged into J3. The configuration on the programming board allows the use of a pin-to-pin, straight-through cable. The other end of the cable is plugged into a PC or some type of terminal that can be used to communicate with the target device. It is recommended to use a PC that can run the TI Downloader program. Communication with the target is established using a transceiver (U7) to translate RS-232 levels to the programming board logic levels. The transceiver is buffered through a tri-state buffer U4. The buffer is enabled by removing the jumper from JMP4. This allows pull-up resistor R9 to disable the buffers from the USB device, and enable the buffers for the RS-232 transceiver by inverting the logic from the high to low state through the single gate inverter U6.

The transceiver used is a MAX3243 (U7.) Only one half of the transceiver pair is needed for communication. The FORCEON and $\overline{\text{FORCEOFF}}$ lines are configured so that the transceiver is in the **always-on** condition when JMP4 is not installed. When JMP4 is installed, the buffers for U7 are disabled and the transceiver is forced off by pulling pin 22, the $\overline{\text{FORCEOFF}}$ pin of U7, low.

Transmit data from the PC or terminal device is translated to the proper logic levels then buffered through the tri-state buffer connecting to the target device as RX through J4 pin 3. TX data from the target device follows a reverse path through J4 pin 5 to the transceiver that translates the signal to RS-232 levels. This is the receive data to the PC or terminal device.

Control signals for resetting or programming the target device follow control signals through the control lines RTS and DTR. These signals are also buffered to the target device. DTR controls the Reset and RTS controls $\overline{\text{PSEN}}$ for program load.

3.4 USB Communication

For USB communication, the proper drivers must be loaded in the PC to match the operating system being used. See Section 5 for more information regarding the installation of the drivers for the operating system.

The TUSB3410 (U3) is a USB-to-serial converter. Once the USB type B male end cable has been connected to the serial programming board (J1,) and the opposite end of the cable plugged into the computer's USB port, the computer will recognize the programming board as a USB serial device. It will appear to the PC that U3 is a COM device. The number assigned to U3 will depend on the total number of COM devices in the PC and the how the operating system defines new COM ports.

If JMP4 is installed, the buffers (U4) will be disabled for the RS-232 transceiver (U7) while the buffers (U5) for U3 will be enabled. This allows the USB serial device to communicate with the MSC12xx device. Communication is similar to the RS-232 device. Transmit data from the PC is buffered through the tri-state buffer (U5), and connects to the target device as RX through J4 pin 3. TX data from the target device follows a reverse path through J4 pin 5 to the USB to serial converter (U3.) This is the receive data to the PC.

Control signals for resetting or programming the target device follow control signals through the control lines RTS and DTR. These signals are also buffered to the target device. DTR controls the Reset and RTS controls $\overline{\text{PSEN}}$ for program load.

3.5 Reset and $\overline{\text{PSEN}}$ Control

As was previously stated, RTS and DTR control the target device to either reset the device or place it in the program load mode. The RTS and DTR signals follow the handshake lines of the communication mode chosen through JMP4. Each control line connects to a 0.1µF series capacitor that allows the circuit to act in a one-shot mode. The timing is based upon the 100KΩ resistor that is pulled high to +3.3V. At the junction of the capacitor and resistor is an open drain buffer. The open drain buffers allow push-button switches to be placed in parallel for manual operation of the reset (SW1) and program load (SW2) functions. Both control lines are designed this way.

From this point on the circuit differs for each control signal. The pulse created from DTR going low pulls the open drain buffer low (U8), driving pin 3 of U10 low. This is the reset pin of a TPS3837 supervisor device. When pin 3 goes low, the output pin 4 goes high resetting the target device at J4 pin 9. The time duration for the reset pulse is based independently of the input pulse. This is configured by pulling pin 1 low. This sets an internal timing threshold within U10 and maintains a consistent reset pulse of 10ms.

To set the device into program load, $\overline{\text{PSEN}}$ needs to remain low while Reset goes high and then low. $\overline{\text{PSEN}}$ is connected to U11 so that when the $\overline{\text{MR}}$ pin (3) goes low, the output pin (4) also goes low through the open drain circuit. Current is limited by R14 which is connected to J4 pin 7. This device, TPS3838, has a different timing than the Reset device. The threshold pin is tied high through resistor R12, creating a pulse of 200ms. A capacitor is also placed in parallel with the threshold pin (1) of U11. This allows the device to have a short duration pulse at power up, so that when power is first applied to the circuitry the target device will go into reset mode instead of programming mode

There is a diode (D5) connected between the outputs of the open drain buffers (U8 and U9.) The orientation of the diode allows the reset function to have no effect on the $\overline{\text{PSEN}}$ line. However, the program load function will activate both the RESET function and the $\overline{\text{PSEN}}$ function by pulling pin 3 low for both U10 and U11.

SW1 and SW2 allow for manual operation of the reset and program load functions.

For more detailed information on the required timing for RESET and $\overline{\text{PSEN}}$ for program loading, see the product data sheet for the specific device of interest.

4 Usage

4.1 TI Downloader

The TI Downloader software allows communication between the PC and the target device via the programming board. The software will utilize the DTR and RTS signals to either reset the device or set the device into serial programming mode. The software will also allow the PC to act as a terminal device for loading the Intel hex files into the MSC12xx flash memory.

4.2 Installation

The easiest way to install and set up the TI Downloader software is by using the MSC products CD-ROM. This CD-ROM comes will all MSC12xx evaluation modules. The drivers can also be downloaded from the TI website at www.ti.com by searching for ***MSC1210***. On the product page, look under *Related Software*. If using the CD-ROM, select the checkbox for **TI Downloader** and press the *Install Checked Items* button (see Figure 2).

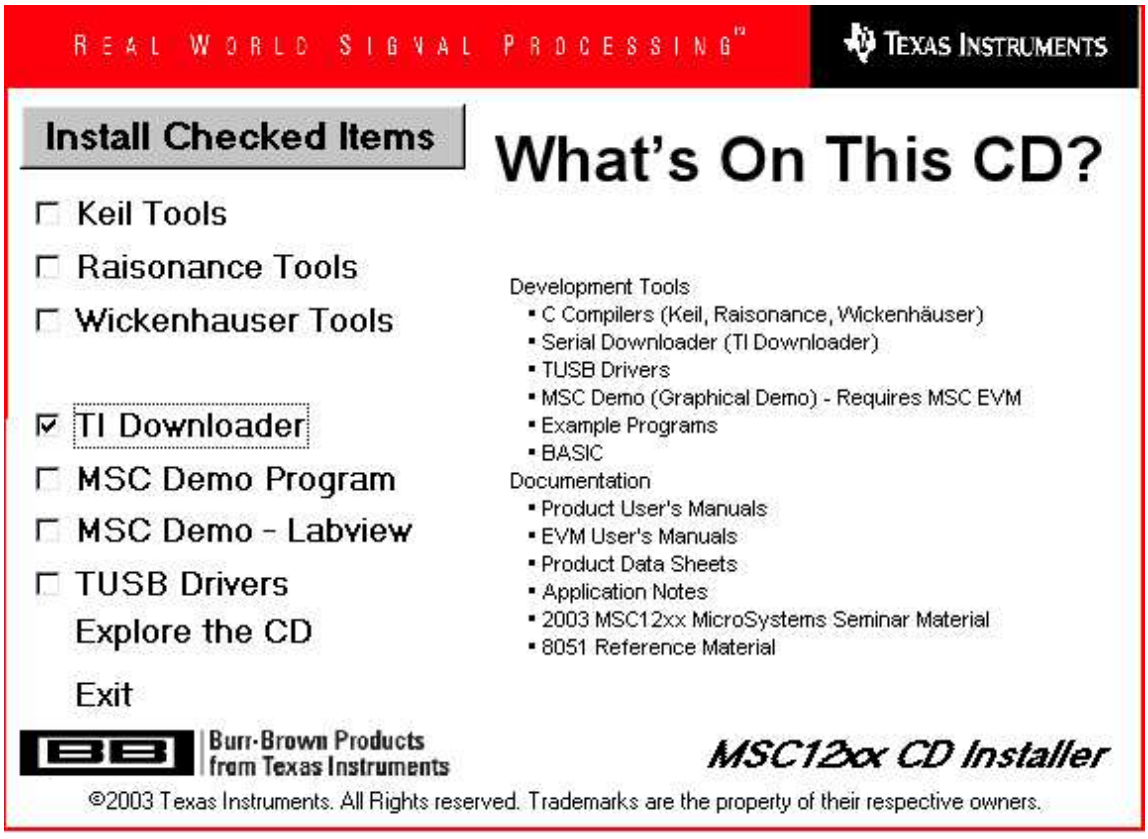


Figure 2. TI Downloader Installation Screen

Follow the setup prompts. The installation of the program defaults to the Windows directory. The shortcut to the TI Downloader program defaults to the Texas Instruments group.

4.3 Usage

Shortcuts to the TI Downloader program may include command line arguments in the form of:

- download.exe [/Ffilename] [/Xfrequency] [/Pport] [/Bbaud] [/H] [/Tbaud] [/S] [/D]

A list of the available operands is found in Table 1. Each operand should immediately follow the switch character with no spaces. As an example, the shortcut may appear as:

- download.exe /FHelloWorld.hex /B9600 /P1

If the filename, crystal frequency or port are not included, then a pop-up box will appear to prompt for the necessary information.

Table 1. TI Downloader Shortcut Operands

OPERATOR	DESCRIPTION
/Ffilename	Hex filename to be loaded.
/Xfrequency	Crystal frequency operating on MSC12xx target device.
/Pport	Number of the PC COM port being used.
/Bbaud	Defaults to value computed from crystal used unless standard baud is given.
/H	Erases configuration bytes.
/Tbaud	Opens a terminal window at the download baud rate or the specified baud rate.
/S	Skips the downloading and immediately opens a terminal window.
/D	Debug operating mode.
/Esize	Erases a given number of kilobytes of program memory. This has no effect on Y2, Y3 or Y4 devices.
/M	Manual reset mode where the program waits for confirmation before downloading program file.

If the /F or /X command line operators are missing, the TI Downloader program will wait for input on a screen similar to that shown in Figure 3. A separate box will pop up, prompting the user for the filename. To use the drop-down menu for baud rate selection, the appropriate checkboxes must be selected for opening the terminal screen or setting the download baud rate. The same is true for limiting the flash erase. To enter a flash erase value, the checkbox must be selected for limiting the flash erase. There are additional checkboxes for erasing the hardware configuration and for skipping the file download altogether.

Faster downloads can occur when the /B option is selected because it determines the actual internal clock frequency and sets the timer register. When autobaud is not used, the communication speed can be much faster.

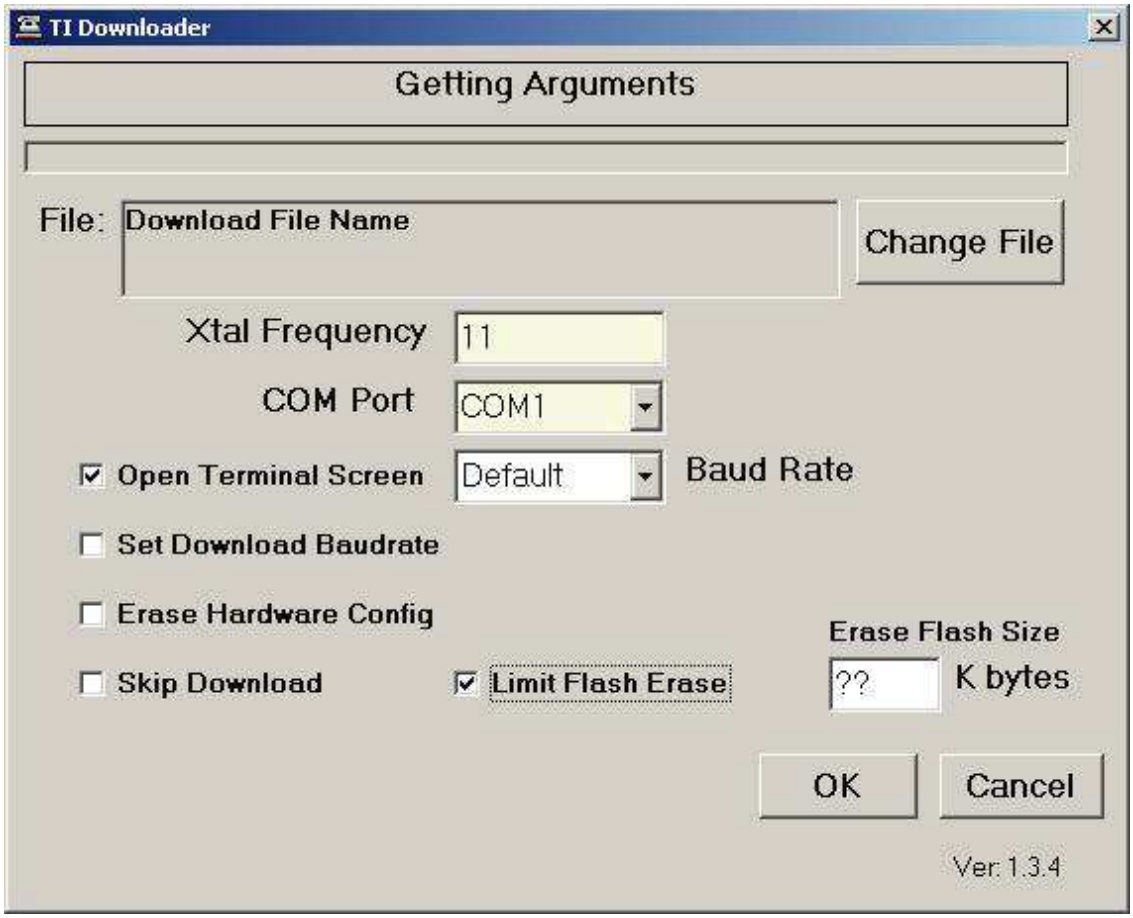


Figure 3. TI Downloader Start-up Screen

Once the file download process begins, a progress and status bar will appear at the top of the display window. If the download completes successfully and either the /T option was selected or the open terminal screen option was selected, then a terminal window will open. There are a number of icon options at the top of the window, as shown in Figure 4. Table 2 lists the icons as they appear from left to right in the terminal window.

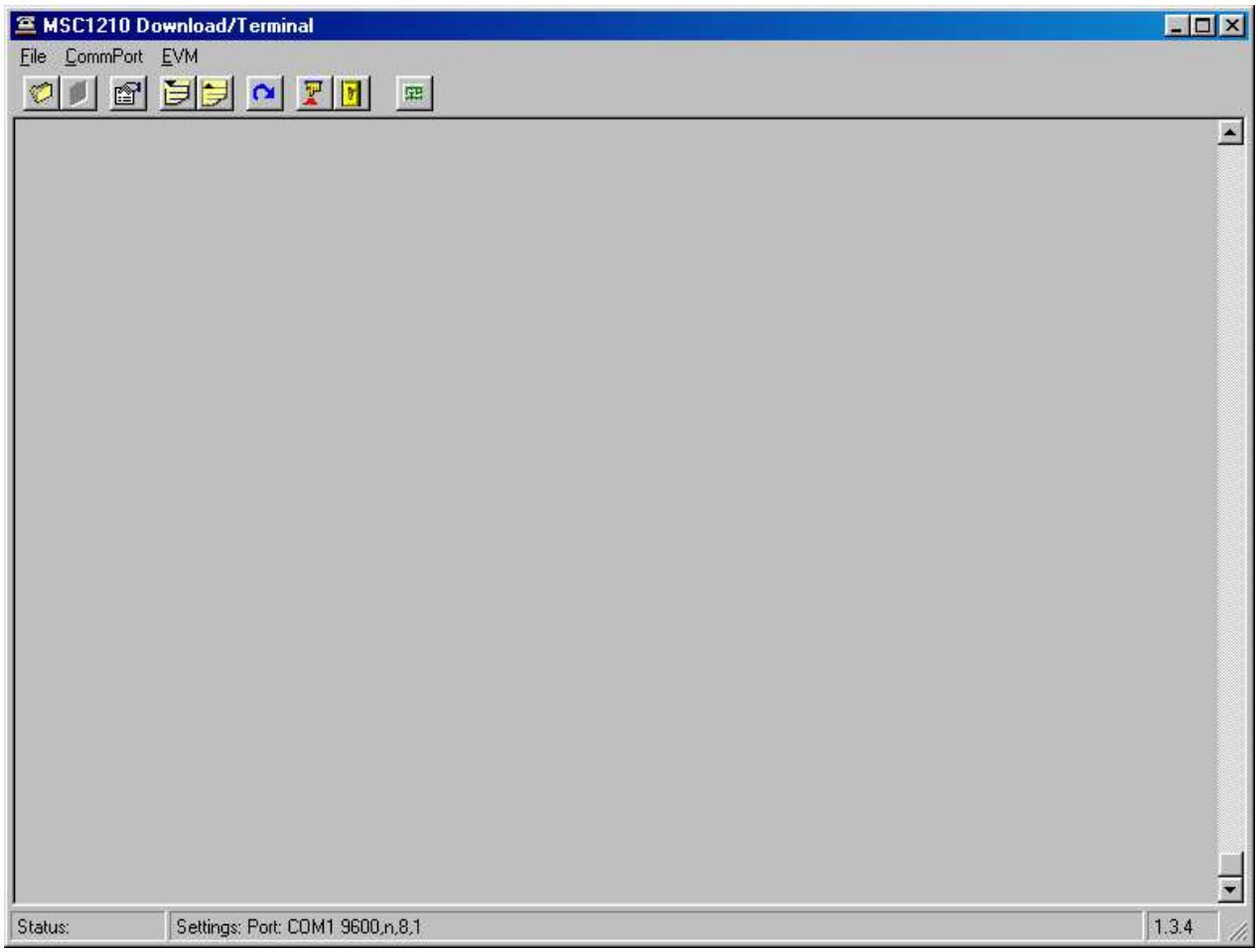


Figure 4. Terminal Window

One icon of particular interest is the one for reloading the hex file (see the sixth bullet in Table 2). When using the serial programming board, this icon will allow the repeated operation of loading the program. This is useful when changing target devices so that there is no need to restart the TI Downloader program each time. It is also helpful when using a compiler that only generates a new hex file but does not call the downloader.

Table 2. TI Downloader Terminal Command Icons

ICON	DESCRIPTION
 Open Log File	Opens a file to record terminal activity as a log file.
 Close Log File	Discontinues terminal logging and closes the log file.
 Properties	Change the COM port, or operating properties.
 Load Basic File	Used to retrieve a file and send it to the COM port. Starts with NEW command.
 Save Basic File	Issues the LIST command and copies the result to a file.
 Reload Hex file	Resends the hex file previously sent to the MSC12xx device.
 Reset	Resets the MSC12xx device by toggling the DTR signal.
 Power Cycle	Cycles the power for MSC1210-DAQ-EVM. It has no effect on the MSC12xx Serial Programmer.
 Clear Screen	Clears the display on the terminal window.

5 USB Driver

5.1 Installation and Setup

The easiest way to install and set up the USB driver is by using the MSC products CD-ROM. This CD-ROM comes with all MSC12xx evaluation modules. The drivers can also be downloaded from the TI website at www.ti.com by searching for ***TUSBWINCVP***.

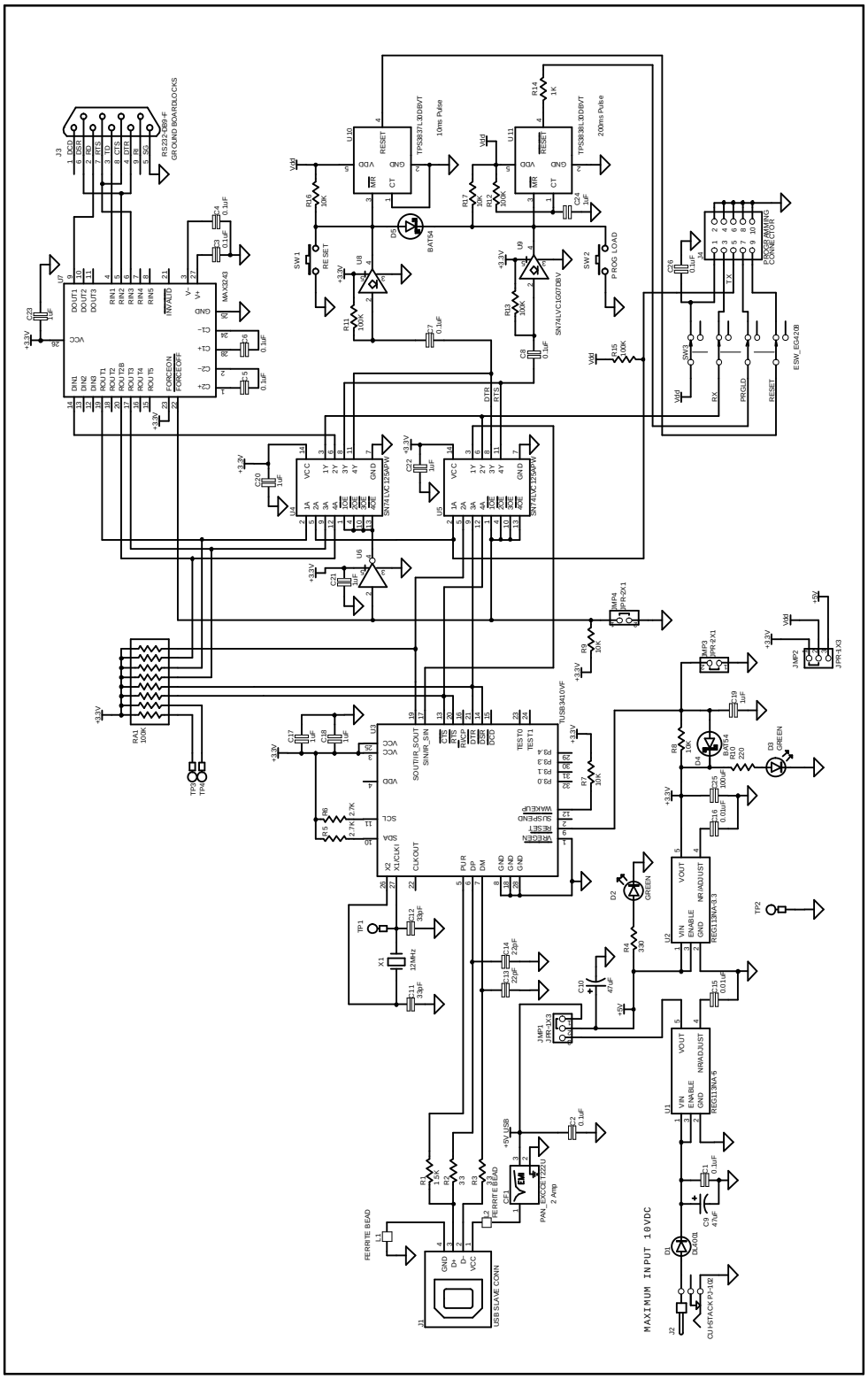
If using the CD-ROM, select the checkbox for **TUSB Drivers** and press the *Install Checked Items* button (see Figure 5.)

Figure 5. TUSB Driver Installation Screen

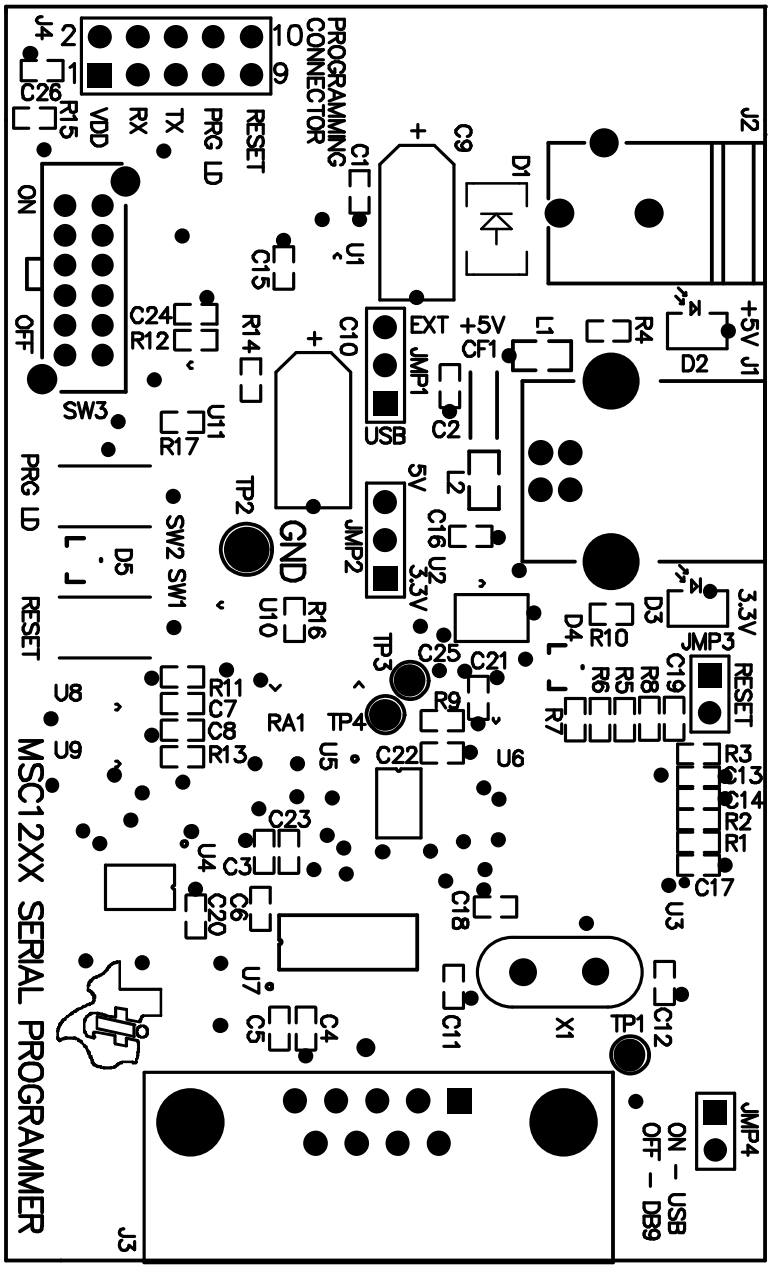
6 References

- *MSC1210 In-Application Flash Programming* (SBAA087)
- *Building and Using the MSC1210 Versatile Programmer* (SBAA093)
- *TUSB3410 Data Sheet* (SLLS519)
- *TUSB3410UART EVM User's Guide* (SLLU043)
- *MAX3243 Data Sheet* (SLLS350)
- *MSC1210: Precision ADC with 8051 Microcontroller and Flash Memory Data Sheet* (SBAS203F)
- *MSC1200: Precision ADC and DAC with 8051 Microcontroller and Flash Memory Data Sheet* (SBAS289E)

Appendix A MSC12xx Serial Programming Board Schematic



Appendix B Silk Screen



Appendix C Bill of Materials

Table C-1. MSC12xx Bill of Materials

ITEM NO.	QTY	VALUE	REF. DES.	DESCRIPTION	VENDOR	MFG. PART NUMBER
1	2	33	R2, R3	1/10W 5% Chip Resistor	Panasonic	ERJ-3GEYJ330V
2	1	220	R10	1/10W 5% Chip Resistor	Panasonic	ERJ-3GEYJ221V
3	1	330	R4	1/10W 5% Chip Resistor	Panasonic	ERJ-3GEYJ331V
4	1	1k	R14	1/10W 5% Chip Resistor	Panasonic	ERJ-3GEYJ102V
5	1	1.5k	R1	1/10W 5% Chip Resistor	Panasonic	ERJ-3GEYJ152V
6	2	2.7k	R5, R6	1/10W 5% Chip Resistor	Panasonic	ERJ-3GEYJ272V
7	5	10K	R7-R9, R16, R17	1/10W 5% Chip Resistor	Panasonic	ERJ-3GEYJ103V
8	4	100K	R11-R13, R15	1/10W 5% Chip Resistor	Panasonic	ERJ-3GEYJ104V
9	1	100K	RA1	1/16W 5% Chip Resistor Array	CTS Corporation	742C163104JTR
10	2	22pF	C13, C14	50V Ceramic Chip Capacitor, ±5%, NPO	TDK	C1608C0G1H220J
11	2	33pF	C11, C12	50V Ceramic Chip Capacitor, ±5%, NPO	TDK	C1608C0G1H330J
12	2	0.01µF	C15, C16	50V Ceramic Chip Capacitor, ±10%, X7R	TDK	C1608X7R1H103K
13	9	0.1µF	C1-C8, C26	25V Ceramic Chip Capacitor, ±10%, X7R	TDK	C1608X7R1E104K
14	8	1µF	C17-C24	6.3V Ceramic Chip Capacitor, ±10%, X5R	TDK	C1608X5R0J105K
15	1	100µF	C25	6.3V Ceramic Chip Capacitor, ±20%, X5R	TDK	C3225X5R0J107M
16	2	47µF	C9, C10	16V Tantalum Chip Capacitor, ±10%	Kemet	T491D476K016AS
17	1		CF1	50V, 2200pF EMI Filter	Panasonic	EXC-CET222U
18	1		D1	50V, 1A Diode	Micro Commercial Corp.	DL4001
19	2		D4, D5	30µV, 200mA Schottky Diode	Fairchild Semiconductor	BAT54
20	2		D2, D3	Green LED	Lumex	SML-LX0603GW-TR
21	2		L1, L2	Ferrite Bead Core	Panasonic	EXC-ML20A390U
22	1	12MHz	X1	Quartz Crystal	Citizen	HC49US12.000MABJ
23	1		U1	5V, 400mA LDO Regulator	Texas Instruments	REG113NA-5
24	1		U2	3.3V, 400mA LDO Regulator	Texas Instruments	REG113NA-3.3
25	1		U3	USB/Serial Converter	Texas Instruments	TUSB3410VF
26	2		U4, U5	Quad Bus Buffer with Tri-State Enable	Texas Instruments	SN74LVC125APW
27	1		U6	Single IC Converter	Texas Instruments	SN74LVC1G04DBVR
28	1		U7	RS-232 Transceiver	Texas Instruments	MAX3243CPWR

Table C-1. MSC12xx Bill of Materials (continued)

ITEM NO.	QTY	VALUE	REF. DES.	DESCRIPTION	VENDOR	MFG. PART NUMBER
29	2		U8, U9	Single Gate, Open Drain Buffer	Texas Instruments	SN74LVC1G07DBVT
30	1		U10	Supervisory Circuit, Reset High	Texas Instruments	TPS3837L30DBVT
31	1		U11	Supervisory Circuit, Reset Low	Texas Instruments	TPS3838L30DBVT
32	1		J1	USB Type **B** Socket	Mill-Max	897-30-004-90-000000
33	1		J2	2.5mm Power Jack	CUI Inc.	PJ-102B
34	1		J3	DB9 Right Angle Female Connector	AMP/Tyco Electronics	747844-4
35	1		J4	5-Position, Dual Row Header, 0.1in Spacing	Samtec	TSW-105-07-L-D
36	2		JMP1, JMP2	3-Position Jumper, 0.1in Spacing	Samtec	TSW-103-07-L-S
Not Installed	1		JMP3	2-Position Jumper, 0.1in Spacing	Samtec	TSW-102-07-L-S
37	1		JMP4	2-Position Jumper, 0.1in Spacing	Samtec	TSW-102-07-L-S
38	2		SW1, SW2	Normally Open Pushbutton Switch	Panasonic	EVQ-PJU04K
39	1		SW3	4 PDT Right-Angle Switch	E-Switch	EG4208
40	2		TP2	Large Loop Test Point Terminal	Keystone Electronics	5011
Not Installed	3		TP1, TP3, TP4	Miniature Test Point Terminal	Keystone Electronics	5000
41	3		N/A	Shorting Jumper	Samtec	SNT-100-BK-TH
42	4		N/A	Rubber Feet, Adhesive Backed	3M Bumpon	SJ-5003

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