

Stellaris® LM3S811 Evaluation Board

User's Manual



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Revision History

This table provides a summary of the document revisions.

Date	Revision	Description
September 2006	00	Initial release of doc to customers.
December 2006	01	Changed value in Table B-1 for Pad 11.
January 2009	02	Changed value in Table 3-1 for User Push Switch Input.
August 2009	03	Changed branding from Luminary Micro to Texas Instruments.
September 2009	04	Changed display and display interface information.
January 2010	05	Added Code Composer Studio™ to list of support toolchains.

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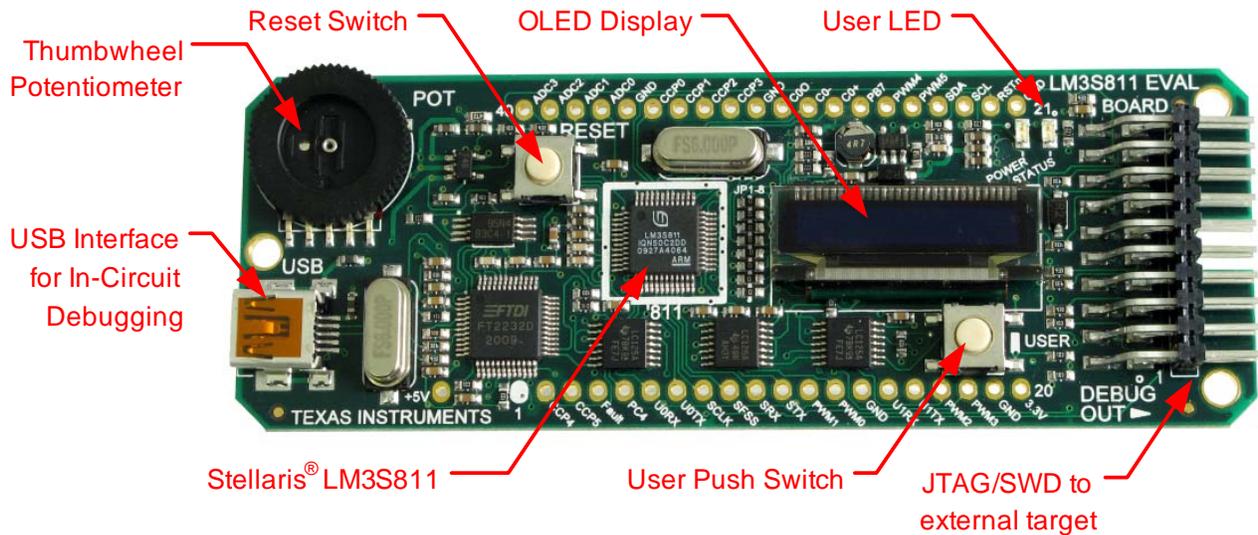
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Stellaris® LM3S811 Evaluation Board

The Stellaris® LM3S811 Evaluation Board is both a compact and versatile evaluation platform for the Stellaris LM3S811 ARM® Cortex™-M3-based microcontroller, and an In-Circuit Debug Interface (ICDI) for any Stellaris microcontroller-based target board. The EVB allows users to evaluate, prototype, and create application-specific designs.

Figure 1-1. Evaluation Board Layout



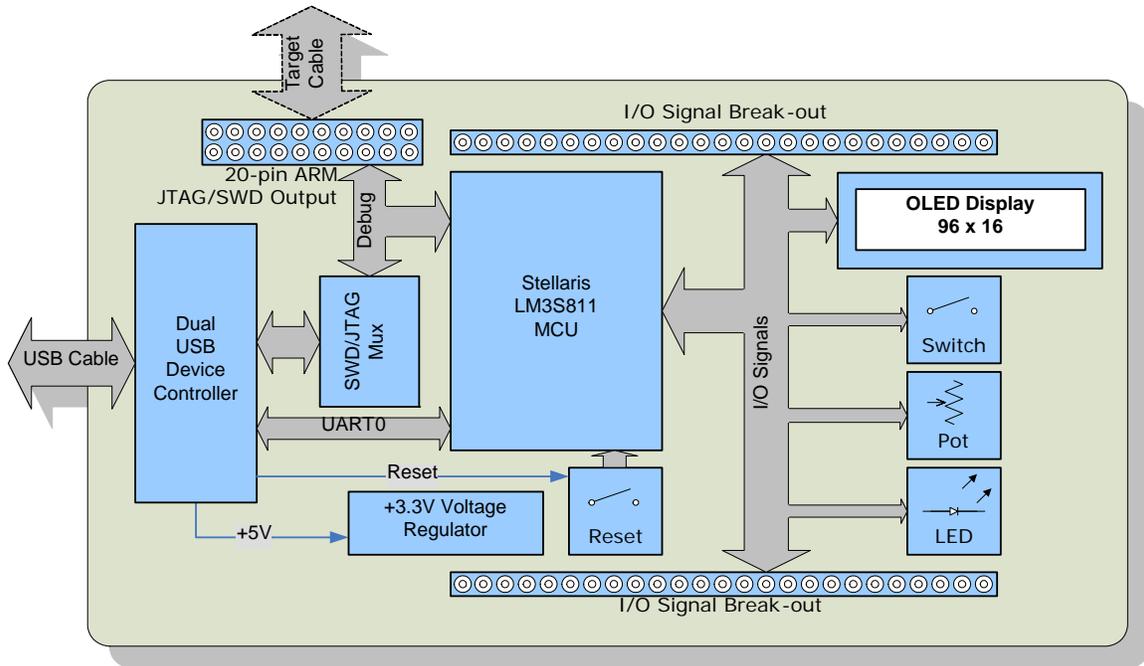
Features

The Stellaris® LM3S811 Evaluation Board includes the following features:

- Stellaris® LM3S811 microcontroller
- OLED graphics display with 96 x 16 pixel resolution
- User-programmable pushbutton and LED
- Reset pushbutton and power indicator LED
- Thumbwheel potentiometer for driving an Analog-to-Digital Converter (ADC) input
- Standard ARM® 20-pin JTAG debug connector for use as an In-Circuit Debug Interface (ICDI)
- I/O signal break-out pads for hardware prototyping
- UART0 accessible through a USB Virtual COM Port (VCP)
- USB interface for all communication and power

Block Diagram

Figure 1-2. LM3S811 Evaluation Board Block Diagram



Evaluation Kit Contents

The evaluation kit contains everything needed to develop and run applications for Stellaris microcontrollers including:

- LM3S811 Evaluation Board (EVB)
- USB cable
- 20-pin JTAG/SWD target cable
- CD containing:
 - A supported version of one of the following (including a toolchain-specific Quickstart guide):
 - Keil™ RealView® Microcontroller Development Kit (MDK-ARM)
 - IAR Embedded Workbench
 - Code Sourcery GCC development tools
 - Code Red Technologies development tools
 - Texas Instruments' Code Composer Studio™ IDE
 - Complete documentation
 - Quickstart application source code
 - Stellaris® Firmware Development Package with example source code

Evaluation Board Specifications

- Board supply voltage: 4.37–5.25 Vdc from USB connector
- Board supply current: 80 mA typ (fully active, CPU at 50 MHz)
- Break-out power output: 3.3 Vdc (100 mA max)
- Dimensions: 3.90" x 1.40" x 0.30" (LxWxH)
- RoHS status: Compliant

System Requirements

- Microsoft Windows 2000, XP, or 2003
- 128 MB of RAM (512 MB recommended)
- 100 MB of available hard-disk space
- 1024 x 768 minimum screen resolution
- CD-ROM drive
- USB port

Supported Devices

In-Circuit Debug Interface (ICDI) mode presently supports all Stellaris® Family devices.

Features of the LM3S811 Microcontroller

- 32-bit ARM® Cortex™-M3 v7M architecture optimized for small-footprint embedded applications
 - Thumb®-compatible Thumb-2-only instruction set processor core for high code density
 - 50-MHz operation
 - Hardware-division and single-cycle-multiplication
 - Integrated Nested Vectored Interrupt Controller (NVIC) providing deterministic interrupt handling
 - 27 interrupt channels with eight priority levels
- 64 KB single-cycle flash with two forms of flash protection on a 2-KB block basis
- 8 KB single-cycle SRAM
- Three timers, each of which can be configured: as a single 32-bit timer, as a dual 16-bit timer with capture and simple PWM modes, or to initiate an ADC event
- Real-Time Clock (RTC) capability
- Separate watchdog clock with an enable
- Programmable interrupt generation logic with interrupt masking
- Lock register protection from runaway software
- Reset generation logic with an enable/disable Synchronous Serial Interface (SSI)
- Programmable interface operation for Freescale SPI, National Semiconductor MICROWIRE™, or Texas Instruments synchronous serial
 - Master or slave operation

- Two fully programmable 16C550-type UARTs
 - Separate 16x8 transmit (TX) and 16x12 receive (RX) FIFOs to reduce CPU interrupt service loading
 - Programmable baud-rate generator
- Analog-to-Digital Converter (ADC)
 - Single- and differential-input configurations
 - Four 10-bit channels (inputs) when used as single ended inputs
 - Sample rate of 500 thousand samples/second
- I2C Bus with Master and slave receive and transmit operation with transmission speed up to 100 Kbps in Standard mode and 400 Kbps in Fast mode
- Six motion-control PWM outputs
- 1 to 32 GPIOs, depending on user configuration
- On-chip Linear Drop-Out (LDO) voltage regulator
- 3.3-V supply brownout detection and reporting via interrupt or reset
- On-chip temperature sensor
- 48-pin RoHS-compliant LQFP
- Industrial operating temperature

CHAPTER 2

Getting Started

The *Stellaris LM3S811 Evaluation Kit Quickstart* provides step-by-step instructions for getting started with your Stellaris LM3S811 Evaluation Kit. For your convenience these instructions are summarized below.

Powering the Board

The Stellaris LM3S811 Evaluation Board (EVB) is configured for immediate use. To power the EVB, use the USB cable supplied in the kit. Connect the mini-b (smaller) end of the USB cable to the connector labeled “USB” on the EVB. Connect the other end (Type A) to a free USB port on your host PC. The USB interface is capable of sourcing up to 500 mA for each attached device, which is sufficient for the evaluation board. If connecting the board through a USB hub, it must be a powered hub.

When you plug in the EVB for the first time, Windows starts the Found New Hardware Wizard. The *Stellaris LM3S811 Evaluation Kit Quickstart Guide* steps through the process of installing drivers for the Stellaris LM3S811 Evaluation Board.

Installing the Drivers

The Stellaris LM3S811 Evaluation Board requires several hardware drivers. All drivers are located in the \Tools\Ftdi directory on the Software and Documentation CD. Each time Windows requests a driver for this device, point it to the Software and Documentation CD.

Driver Installation

When the Found New Hardware Wizard starts, Windows asks if it can connect to Windows Update to search for software. Select “No, not this time,” and then click Next.

The Found New Hardware Wizard then asks you from where to install the software. Select “Install from a list or specific location (Advanced)” and click Next.

Make sure the Documentation and Software CD that came with the evaluation kit is in your CD-ROM drive. Select “Search for the best driver in these locations,” and check the “Search removable media (floppy, CD-ROM...)” option. Click Next.

A warning pops up during the Hardware Installation; click Continue Anyway.

Windows now finishes installing the drivers for “Stellaris Evaluation Board A.” When the driver install is finished, a window appears. Click Finish to close the dialog box.

Completing Driver Installation

You have just installed the drivers for “Stellaris Evaluation Board A”. The USB device built into the EVB is a composite USB device. After you click Finish, a new Found New Hardware Wizard window appears asking to install drivers for another device. This is for the “Stellaris Evaluation Board B” part of the composite USB device. Follow the same instructions as above to install the drivers for this device.

The Found New Hardware Wizard appears one last time. This is to install the drivers for the “Stellaris Virtual COM Port”. Again, follow the same instructions above to install the drivers for this device.

Now all of the hardware drivers for the LM3S811 Evaluation Board have been installed. These drivers give the debugger access to the JTAG interface and the host PC access to the Virtual COM Port.

Running the Quickstart Application

The quickstart application is a game in which you navigate a ship through an endless tunnel. Use the potentiometer (POT) to move the ship up and down, and the user pushbutton (USER) to fire a missile to destroy obstacles in the tunnel. Score accumulates for survival and destroying obstacles. The game lasts for only one ship; the score displays at the end of the game.

Since the OLED display on the evaluation board has burn-in characteristics similar to a CRT, the application also contains a screen saver. The screen saver only becomes active if two minutes have passed without the user pushbutton being pressed while waiting to start the game (i.e., the screen saver never appears during game play). An implementation of the Game of Life is run with a field of random data as the seed value.

After two minutes of running the screen saver, the display turns off and the user LED blinks. Exit either mode of screen saver (Game of Life or blank display) by pressing the user pushbutton (USER). Press the button again to start the game.

While the game is being played, a running tally of the score is output through UART0 of the LM3S811. UART0 is connected to the FTDI's second serial channel. This serial channel is available to Windows as a Virtual COM Port. To view the score, open up a terminal application such as HyperTerminal. Connect using COM#, where # is the number Windows has assigned the Virtual COM Port. Set the serial connection to a baud rate of 115200, 8 data bits, no parity, 1 stop bit, and no flow control.

Important: The quickstart application will not run if one or more jumpers are removed.

Hardware Description

This chapter provides the hardware description for the LM3S811 microcontroller including the peripherals included in the evaluation kit.

LM3S811 Microcontroller

Device Overview

The heart of the EVB is a Stellaris LM3S811 ARM® Cortex™-M3-based microcontroller. The LM3S811 offers 64 KB flash memory, 50-MHz operation, a 4-channel ADC, and a wide range of peripherals. Refer to the LM3S811 data sheet (order number DS-LM3S811) for complete device details.

The LM3S811 microcontroller is factory programmed with a quickstart demo program. The quickstart program resides in the LM3S811 on-chip flash memory and runs each time power is applied, unless ICDI mode is in use, or the quickstart has been replaced with a user program.

Clocking

A single external 6.0-MHz crystal drives the LM3S811 microcontroller. All required internal clocks are generated automatically within the device. The LM3S811 microcontroller is designed to run the ARM Cortex core at 50 MHz on this evaluation board.

Reset

The LM3S811 microcontroller shares its external reset input with the OLED display. Reset is asserted (Active Low) under any one of the following conditions:

- Power-on reset (duration set by resistor R1 and capacitor C2)
- Reset switch SW2 is held down
- In ICDI mode
- By the USB device controller (U2 FT2232), when instructed by the debugger

The Keil RVMDK debugger does not support external reset. Instead, the target device is reset using JTAG operations. In ICDI mode, the reset push-switch has no effect.

Power Supply

The LM3S811 is powered from a +3.3-V supply rail that is common to all devices on the EVB. A low-dropout (LDO) regulator regulates +5 V power from the USB cable to +3.3 V. +3.3 V at up to 100 mA is available for powering external circuits at break-out pin 20.

Debugging

Stellaris microcontrollers support programming and debugging using either JTAG or SWD. JTAG uses the TCK, TMS, TDI, and TDO signals. SWD requires fewer signals—SWCLK, SWDIO, and SWO. The debugger determines which debug protocol is used. For example, Keil RVMDK tools support only JTAG debugging.

JTAG/SWD signals are multiplexed with GPIO functions inside the Stellaris microcontroller. Do not configure JTAG/SWD pins (including PB7/TRST) as GPIO. Doing this prevents in-circuit programming and debugging.

USB Device Controller Functions

Device Overview

An FT2232 device from Future Technology Devices International Ltd manages USB-to-serial conversion. The FT2232 is factory configured to implement a JTAG/SWD port (synchronous serial) on channel A and a Virtual COM Port (VCP) on channel B. This feature allows two simultaneous communications links between the host computer and the target device using a single USB cable. Separate Windows drivers for each function are provided on the Documentation and Software CD.

A small serial EEPROM holds the FT2232 configuration data. The EEPROM is not accessible by the LM3S811 microcontroller.

For full details on FT2232 operation, go to www.ftdichip.com.

USB to JTAG/SWD

The FT2232 USB device performs JTAG/SWD serial operations under the control of the debugger. Two 74LV125 hex buffers multiplex SWD and JTAG functions and provide direction control for the bi-directional data line when working in SWD mode.

Virtual COM Port

The Virtual COM Port (VCP) allows Windows applications (such as HyperTerminal) to communicate with UART0 on the LM3S811 over USB. Once the FT2232 VCP driver is installed, Windows assigns a COM port number to the VCP channel.

For more information, see Using the Virtual COM Port on page 21.

Organic LED Display

The EVB features an Organic LED (OLED) graphics display with 96 x 16 pixel resolution. OLED is a new technology that offers many advantages over LCD display technology.

Features

- RiT RGS08096016BW001 series display
- 96 columns by 16 rows
- 1 bit/pixel monochrome
- High-contrast (typ. 2000:1)
- Excellent brightness (100 cd/m²)
- Fast response

Control Interface

The OLED display has a built-in controller IC (SSD1300) with synchronous serial and I²C interfaces. I²C is used on the EVB as it only requires two microcontroller pins. The OLED display has a fixed I²C address of 0x3d. The Stellaris driver library (DriverLib) (included on the Documentation and Software CD) contains complete drivers with source-code for the OLED display.

Note that the SSD1300's I²C bus implementation is not 100% compliant with the I²C specification. Designers should refer to the SSD1300 datasheet before connecting other I²C devices to the bus.

Power Supply

A +10 V supply is needed to bias the OLED display. In addition, a boost converter has been added to the board. This supply is dedicated to the OLED display and should not be used to power other devices.

Design Guidelines

The OLED display has a lifetime of about 10,000 hours. It is also prone to degradation due to burn-in, similar to CRT and plasma displays. The quickstart application includes both a screen-saver and a power-down mode to extend display life. These factors should be considered when developing EVB applications that use the OLED display.

When using the EVB as an In-Circuit Debug Interface (ICDI), the OLED display is held in reset to reduce power consumption and eliminate display wear-out.

Further Reference

For additional information on the RGS08096016BW001 OLED display, see the www.rtidisplay.com web site..

Full details on the SSD1300 controller are available from the Solomon Systech, Ltd., web site: www.solomon-systech.com.

Other Peripherals

Thumbwheel Potentiometer

A thumbwheel potentiometer connects to Channel 0 of the Analog-to-Digital Converter (ADC). A padding resistor (R7) sets the voltage range to 0 to 3.0 V. This corresponds with the full-scale range of the LM3S811's 10-bit ADC. The ADC input voltage increases with clockwise potentiometer rotation.

User LED

A user LED (D1) is provided for general use. The LED is connected to PC5/CCP1, allowing the option of either GPIO or PWM control (brightness control). Refer to the Quickstart Application source code for an example of PWM control.

User Pushbutton

A user pushbutton (SW2) is provided for general use. The switch interfaces to PC4 of the LM3S811.

Bypassing Peripherals

The EVB's on-board peripheral circuits require eight GPIO lines, leaving up to 24 GPIO lines immediately available for connection to external circuits. If all GPIO lines are needed, then the on-board hardware can be bypassed. The EVB is populated with eight 0-ohm resistor jumpers, which can be removed to isolate on-board hardware.

Important: The quickstart application will not run if one or more jumpers are removed.

Table 3-1. Isolating On-Board Hardware

MCU Pin	EVB Function	To Isolate, Remove...
Pin 33 PB2/I2CSCL	I2C SCL to Display	JP1
Pin 34 PB3/I2CSDA	I2C SDA to Display	JP2
Pin 17 PA0/U0Rx	VCP Receive	JP3
Pin 18 PA1/U0Tx	VCP Transmit	JP4
Pin 1 ADC0	ADC Input from Thumbwheel Potentiometer	JP5
Pin 14 GPIO PC4	User Push Switch Input	JP6
Pin 29 GPIO PC5	User LED output	JP7
Pin 48 GPIO PD7	OLED Power Enable	JP8

Interfacing to the EVB

An array of accessible I/O signals makes it easy to interface the EVB to external circuits. All LM3S811 I/O lines (except those with JTAG functions) are brought out to 0.1" pitch pads. For quick reference, silk-screened labels on the PCB show primary pin functions.

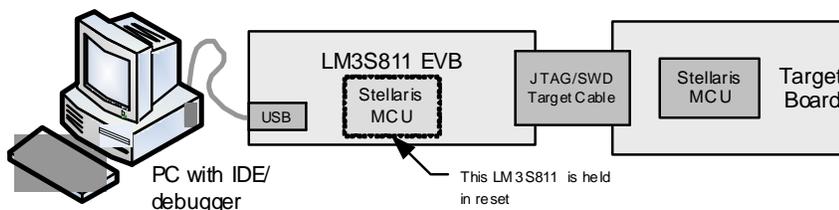
Table B-1 on page 32 has a complete list of I/O signals as well as recommended connectors.

Most LM3S811 I/O signals are +5-V tolerant. 5-V tolerant pins will not be damaged when connected to 5-V logic circuits. It is recommended that datasheets be checked for compatibility when mixing logic types. Refer to the LM3S811 datasheet for detailed electrical specifications.

Using the In-Circuit Debugger Interface

The Stellaris LM3S811 Evaluation Kit can operate as an In-Circuit Debugger Interface (ICDI). ICDI acts as a USB to the JTAG/SWD adaptor, allowing debugging of any external target board that uses a Stellaris microcontroller.

Figure 3-1. ICD Interface Mode



The debug interface operates in either Serial-Wire Debug (SWD) or full JTAG mode, depending on the configuration in the debugger IDE.

The Keil RVMDK does not distinguish between normal Evaluation Board mode and ICDI mode. The only requirement is that the correct Stellaris device is selected in the project configuration.

ICDI Features

ICDI includes the following features:

- Standard ARM® 20-pin JTAG debug connector
- USB 2.0 full speed interface allows JTAG/SWD debug
- Compatible with leading ARM Integrated Development Environment (IDE) packages including Keil RVMDK.

Enabling ICDI Mode

ICDI mode is enabled when the 20-pin JTAG/SWD target cable is connected to an external target. In this mode, the on-EVB LM3S811 microcontroller and OLED display are held in reset. Applications can not be executed in the on-EVB microcontroller when the EVB is connected as an ICDI device.

ARM Target Cable

The evaluation kit includes a 3-inch target cable for connecting the EVB to an external target. Cables up to 8-inch long can be used if required.

Target cable pin assignments are compatible with the ARM 20-pin standard (see Table B-3 on page 34). The target board must have GND connections on even pins from 4 through 20, otherwise the ICDI is not enabled when the target is connected. In this case, there will be conflict between the JTAG/SWD signals on the LM3S811 evaluation board and the external Stellaris device.

When using the kit as an evaluation board, do not make connections to the debug out connector.

Starting ICDI

With the USB cable removed, connect the EVB to a Stellaris microcontroller-based target board using the 20-pin JTAG/SWD target cable included in the Stellaris LM3S811 Evaluation Kit.

The red stripe on the cable should match pin 1 on both the EVB debug out connector and the target. When inserted correctly, the polarizing tab on the connector fits into the slot on the EVB PCB, so that the ribbon cable exits away from you.

Apply power to the target device, and then connect the USB cable to the LM3S811 Evaluation Board. The OLED display should not show any information. If it does display an image, then check the target JTAG/SWD connections to ensure the on-EVB LM3S811 microcontroller is being held in reset.

The Keil RVMDK is now be able to program and debug the target Stellaris microcontroller.

Communications

This chapter describes available communication for the LM3S811 microcontroller through the Virtual COM Port and the Windows application, HyperTerminal.

Using the Virtual COM Port

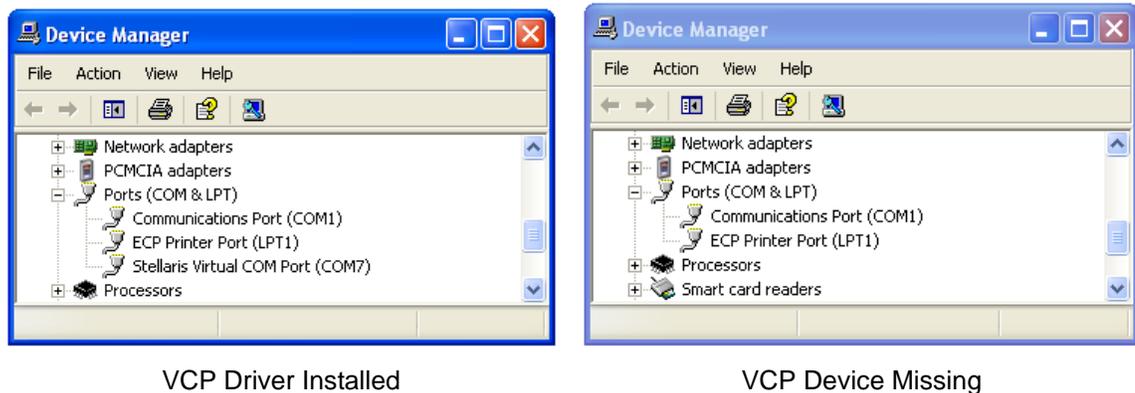
The Virtual COM Port (VCP) is a convenient way for Windows applications to communicate with UART0 on the LM3S811 microcontroller over USB. It offers all the capabilities of a standard RS232 interface without an additional cable.

Confirming Driver Installation

The VCP device driver is normally installed as part of the quickstart process. Confirm that the VCP device driver is installed by doing the following.

1. Connect the EVB to a PC using the USB cable supplied in the evaluation kit.
2. Open the Windows Device Manager, by either holding down the Windows Key and pressing the Pause/Break key, or, from the Start Menu, selecting Control Panel and then clicking on the System Icon.
3. Select the Hardware Tab, and click the Device Manager button.
4. In Device Manager, scroll down until you see Ports (COM & LPT). Click to expand this item. You should see a device called Stellaris Virtual COM Port (COM).

Figure 4-1. Check VCP Driver Installation



The Windows operating system assigns the COM Port number automatically. It may change if the EVB is reconnected.

If Device Manager does not show the Stellaris Virtual COM Port device, or if there is a question mark by the device, it will be necessary to install or reinstall the device driver.

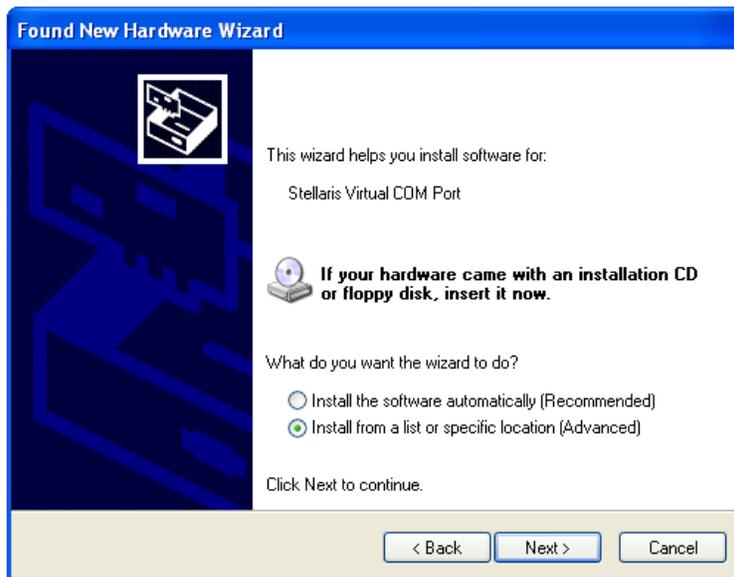
Installing the VCP Device Driver

When the EVB is first connected to a USB port, Windows automatically starts a driver installation wizard. The following steps guide you through the installation wizard.

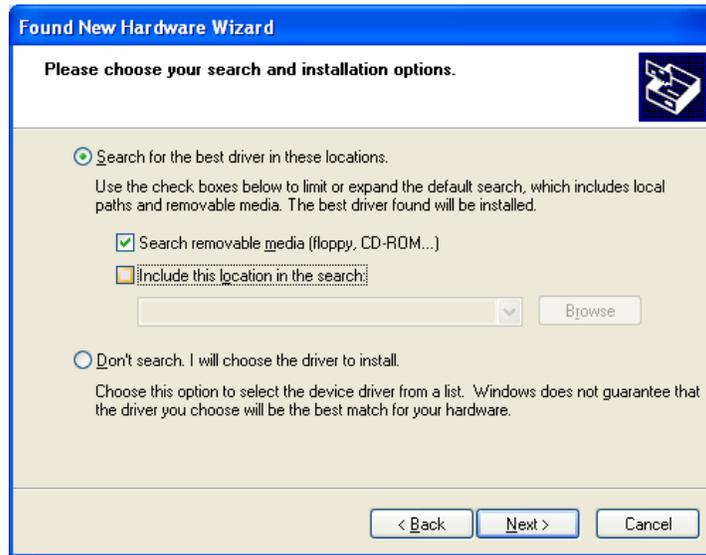
1. Connect the EVB to an available USB port using the USB cable supplied in the kit. In the Found New Hardware Wizard window, select “No, not this time” and click Next.



2. Select “Install from a list or specific location (Advanced)” and click Next.



3. Insert the Stellaris® LM3S811 Evaluation Kit Documentation and Software CD in the CD-ROM drive. Select “Search removable media (floppy, DR-ROM...)” and click Next.



4. Windows locates the driver on the Documentation and Software CD and start installing the driver. A warning dialog like the one below pops up. Click Continue Anyway.



5. VCP drivers are now installed. Click Finish.



You may want to use Device Manager to identify the COM Port assignment.

Now that drivers are installed, Windows automatically assign a COM port to the LM3S811 Evaluation Board each time it is connected.

About HyperTerminal

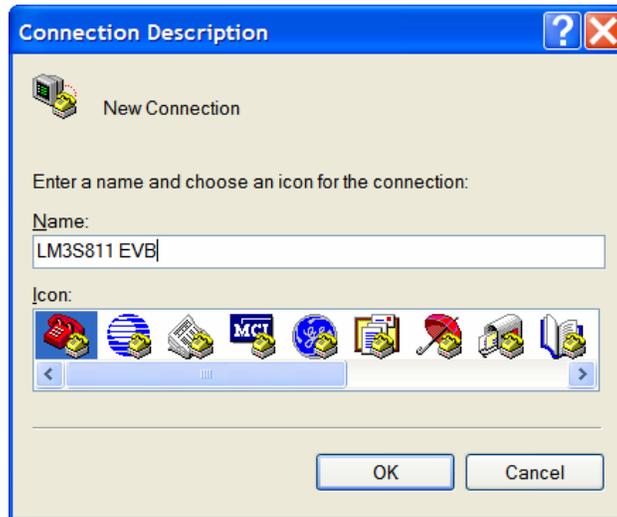
HyperTerminal is an ASCII terminal emulator that is included with Windows. It provides an easy way to transfer ASCII data to and from the LM3S811 Evaluation Board using the Virtual COM port feature.

The quickstart application sends a running tally of the game score through UART0 of the LM3S811.

Starting HyperTerminal

1. From the Windows XP Start menu, select:
Start > All Programs > Accessories > Communications > HyperTerminal
2. HyperTerminal asks for a name and icon to associate with the terminal profile you are about to create. Neither the name nor the icon selection is critical.

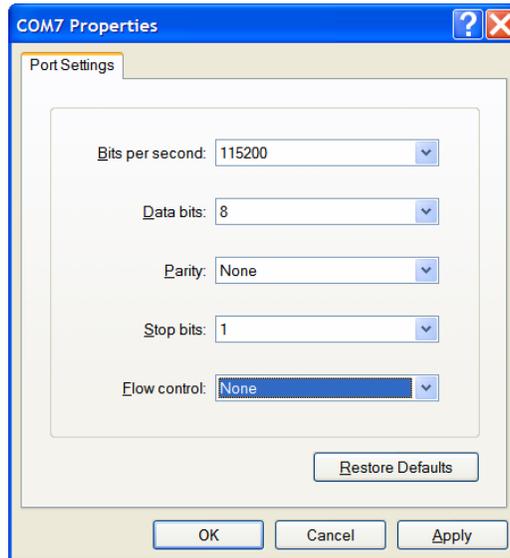
- Click OK to continue.



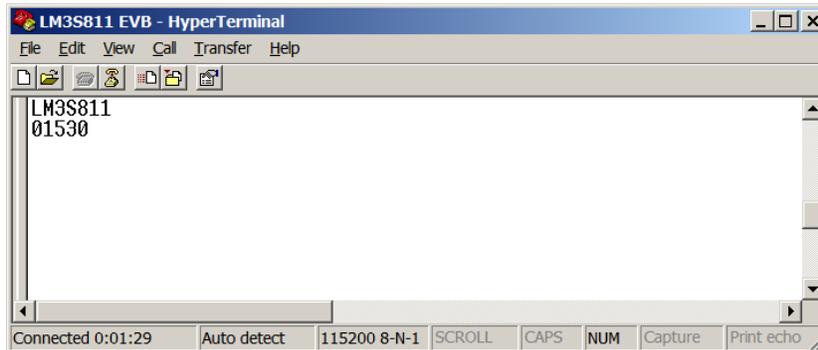
- Select the COM port assigned to the LM3S811 Evaluation Board. In the example below, it is COM7. Click OK.



5. Use the Properties dialog box to set the Port Settings. The quickstart application sends data at 115200 baud, 8 data bits, no parity, 1 stop bit, and no flow-control. Click OK.



6. HyperTerminal now starts. When the quickstart game is played, score data is visible in the terminal window. Save the terminal settings when exiting HyperTerminal.



A P P E N D I X A

Schematics

Schematics for the Stellaris LM3S811 Evaluation Board follow.

Figure A-1. LM3S811 Microcontroller (sheet 1 of 3)

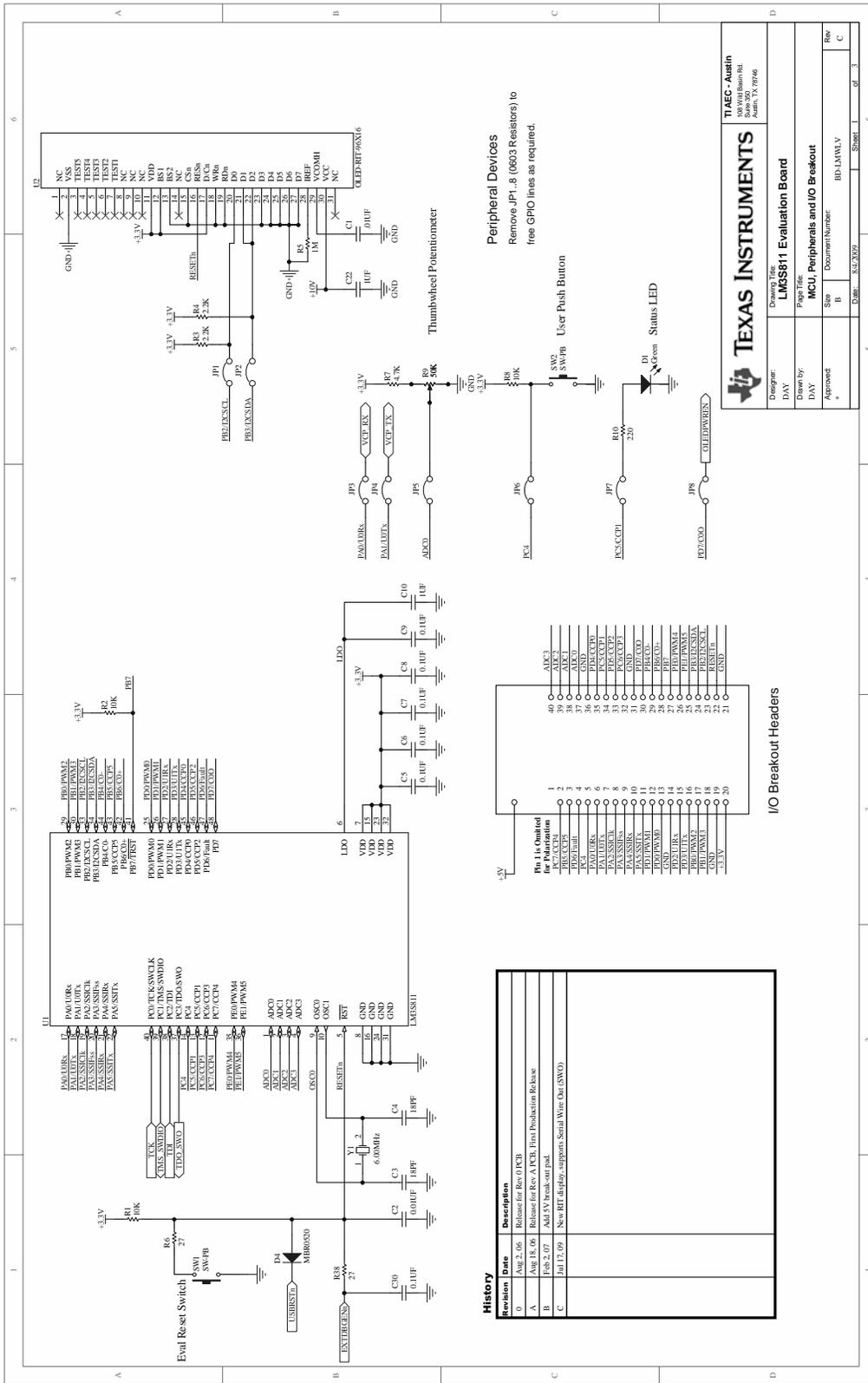
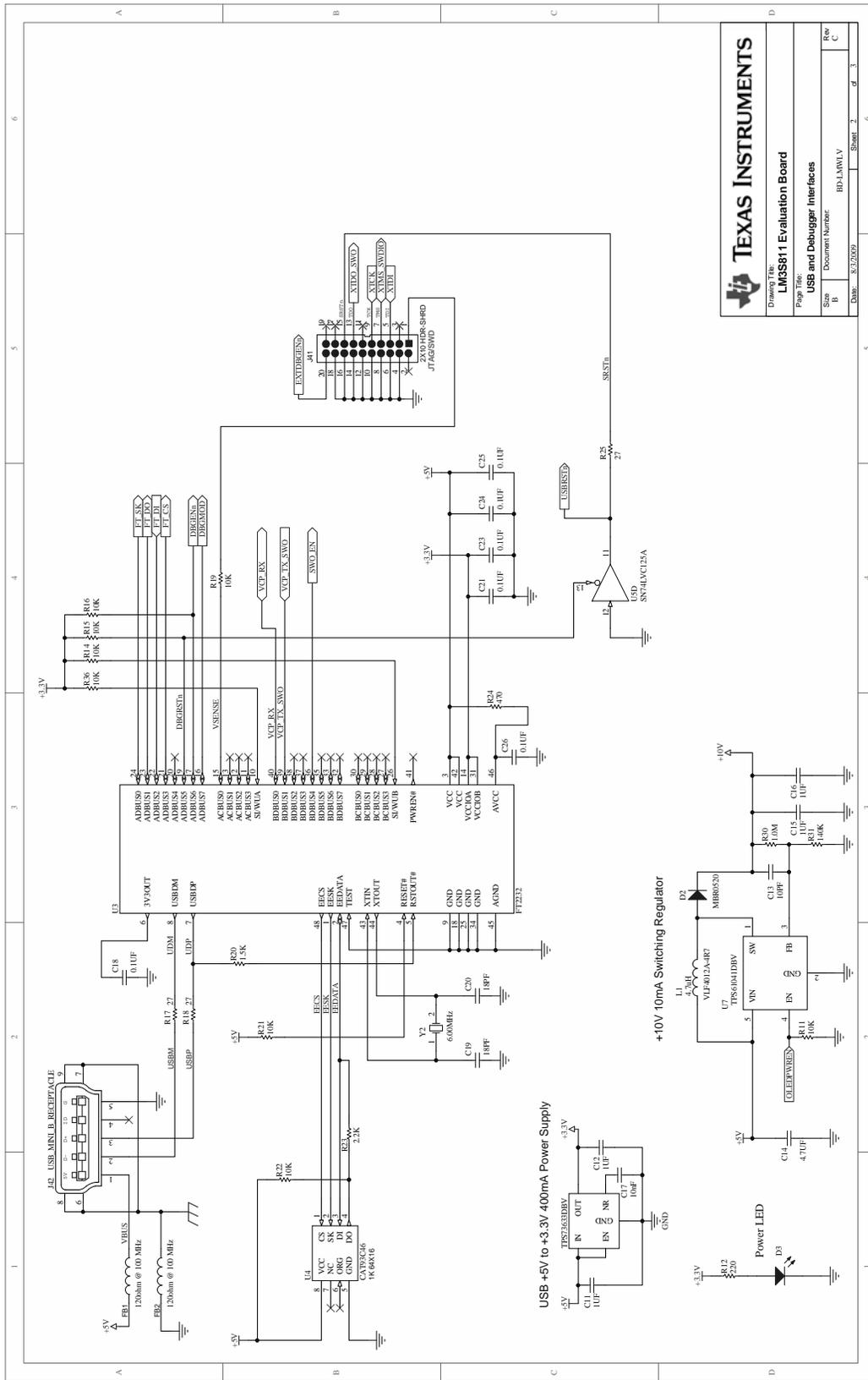
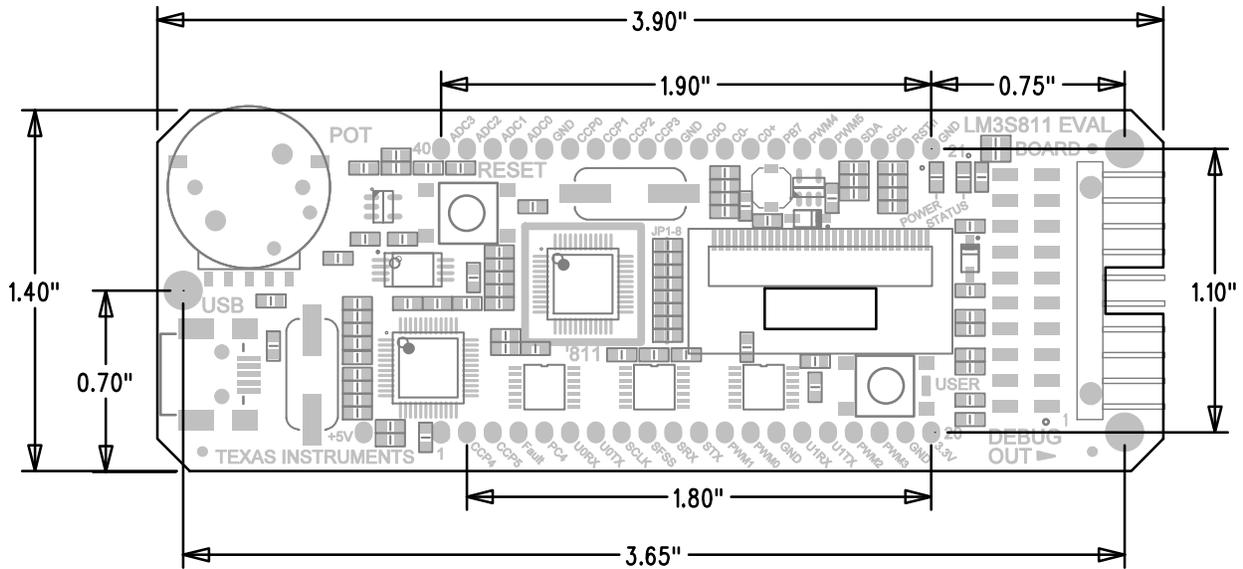


Figure A-2. LM3S811 Microcontroller (sheet 2 of 3)



Evaluation Board Dimensions

Figure B-2. Evaluation Board Dimensions



I/O Breakout Pads and Recommended Connectors

The LM3S811 EVB has 32 I/O pads, 6 power pads, and a reset signal, for a total of 39 pads. Connection can be made by soldering wires directly to these pads, or by using 0.1" pitch headers and sockets.

Table B-1. I/O Breakout Pads

Pad No.	Description	Pad No.	Description
1	BLANK	40	ADC3
2	PC7/CCP4	39	ADC2
3	PB5/CCP5	38	ADC1
4	PD6/Fault	37	ADC0 ^a
5	PC4 ^a	36	GND
6	PA0/U0Rx ^a	35	PD4/CCP0
7	PA1/U0Tx ^a	34	PC5/CCP1
8	PA2/SSICik	33	PD5/CCP2
9	PA3/SSIFss	32	PC6/CCP3
10	PA4/SSIRx	31	GND
11	PA5/SSITx	30	PD7/C00 ^a
12	PD1/PWM1	29	PB4/C0-

Table B-1. I/O Breakout Pads (Continued)

Pad No.	Description	Pad No.	Description
13	PD0/PWM0	28	PB6/C0+
14	GND	27	PB7 ^b
15	PD2/U1Rx	26	PE0/PWM4
16	PD3/U1Tx	25	PE1/PWM5
17	PB0/PWM2	24	PB3/I2CSDA ^a
18	PB1/PWM3	23	PB2/I2CSCL ^a
19	GND	22	$\overline{\text{RESET}}$
20	+3.3V	21	GND

a. Indicates an I/O line that is used by EVB hardware.

b. PB7 should not be used as a GPIO.

Table B-2. Recommended Connectors

Pins 2-20 (19 way)	Socket	Sullins PPPC191LFBN-RC	Digikey S7052-ND
	Pin Header	Sullins PTC19SAAN	Digikey S1012-19-ND
Pins 21-40 (20 way)	Socket	Sullins PPPC201LFBN-RC	Digikey S7053-ND
	Pin Header	Sullins PTC20SAAN	Digikey S1012-20-ND

ARM Target Pinout

In ICDI mode, the Stellaris LM3S811 Evaluation Kit supports ARM's standard 20-pin JTAG/SWD configuration. The same pin configuration can be used for debugging over Serial Wire Debug (SWD) and JTAG interfaces. The debugger software, running on the PC, determines which interface protocol is used.

The Stellaris target board should have a 2x10 0.1" pin header with signals as indicated in Table B-3.

Table B-3. 20-Pin JTAG/SWD Configuration

Function	Pin	Pin	Function
nc	1	2	nc
nc	3	4	GND
TDI	5	6	GND
TMS	7	8	GND
TCK	9	10	GND
nc	11	12	GND
TDO	13	14	GND
$\overline{\text{RST}}$	15	16	GND
nc	17	18	GND
nc	19	20	GND

ICDI does not control the $\overline{\text{TRST}}$ (test reset) signal. This reset function is implemented as a command over JTAG/SWD, so this signal is not necessary.

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