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Driving a Stepper Motor With a TM4C123 Microcontroller

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Design Resources

TIDM-TM4C123StepperMotor	Tool Folder Containing Design Files
TM4C123GH6PM	Product Folder
DRV8833	Product Folder
EK-TM4C123GXL	Tools Folder

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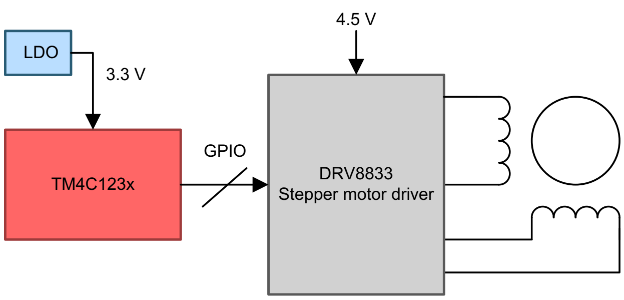
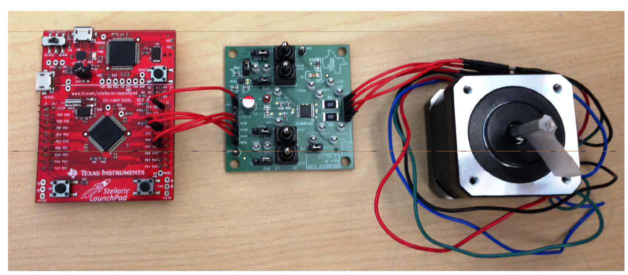
Design Features

- The TM4C123 Microcontroller (MCU) Uses Four GPIO Pins to Control the Output of the H-Bridge Drivers in DRV8833 Driven by a General-Purpose Timer.
- The TM4C123GXL LaunchPad™ Uses Buttons to Control the Direction, Speed, Starting, and Stopping of the Stepper Motor.
- The Stepper Motor can be Driven in Full Step and Half Step Modes.
- The Software is Designed to Work With an EK-TM4C123GXL LaunchPad and DRV8833 EVM.

Featured Applications

- Industrial Applications
- Speed Control Applications
- Precision Motor Control





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1 System Description

This system example shows how to control a stepper motor with the TM4C123 high-performance MCU and DRV8833 motor driver. The direction, speed, starting, and stopping of stepper motor can be controlled by buttons on the EK-TM4C123GXL LaunchPad. This example uses a general-purpose timer to control 4 GPIO pins to generate the PWM signals for driving the motor.

1.1 TM4C123GH6PM MCU

The TM4C123GH6PM microcontroller is targeted for industrial applications including the following: remote monitoring, electronic point-of-sale machines, test equipment, measurement equipment, network appliances, switches, factory automation, HVAC, building control, gaming equipment, motion control, transportation, and security.

The TM4C123GH6PM MCU has up to 43 GPIOs with programmable control for GPIO interrupts, pad configuration, and pin muxing. The MCU is integrated with six 32-bit general-purpose timers (up to twelve 16-bit), eight UARTs, four synchronous serial interface (SSI) modules, four inter-integrated circuit (I2C) modules, two 12-bit analog-to-digital converters (ADC) with 12 analog input channels and a sample rate of one million samples per second, eight pulse width modulation (PWM) generator blocks, and two quadrature encoder interface (QEI) modules. The universal serial bus (USB) controller supports the USB OTG/Host/Device modes. The ARM® PrimeCell 32-channel configurable µDMA controller is also integrated to provide a method to offload data transfer tasks from the Cortex-M4® processor and to more efficiently use the processor and the bus bandwidth.

See Figure 1 for a high-level overview of the TM4C123GH6PM MCU.

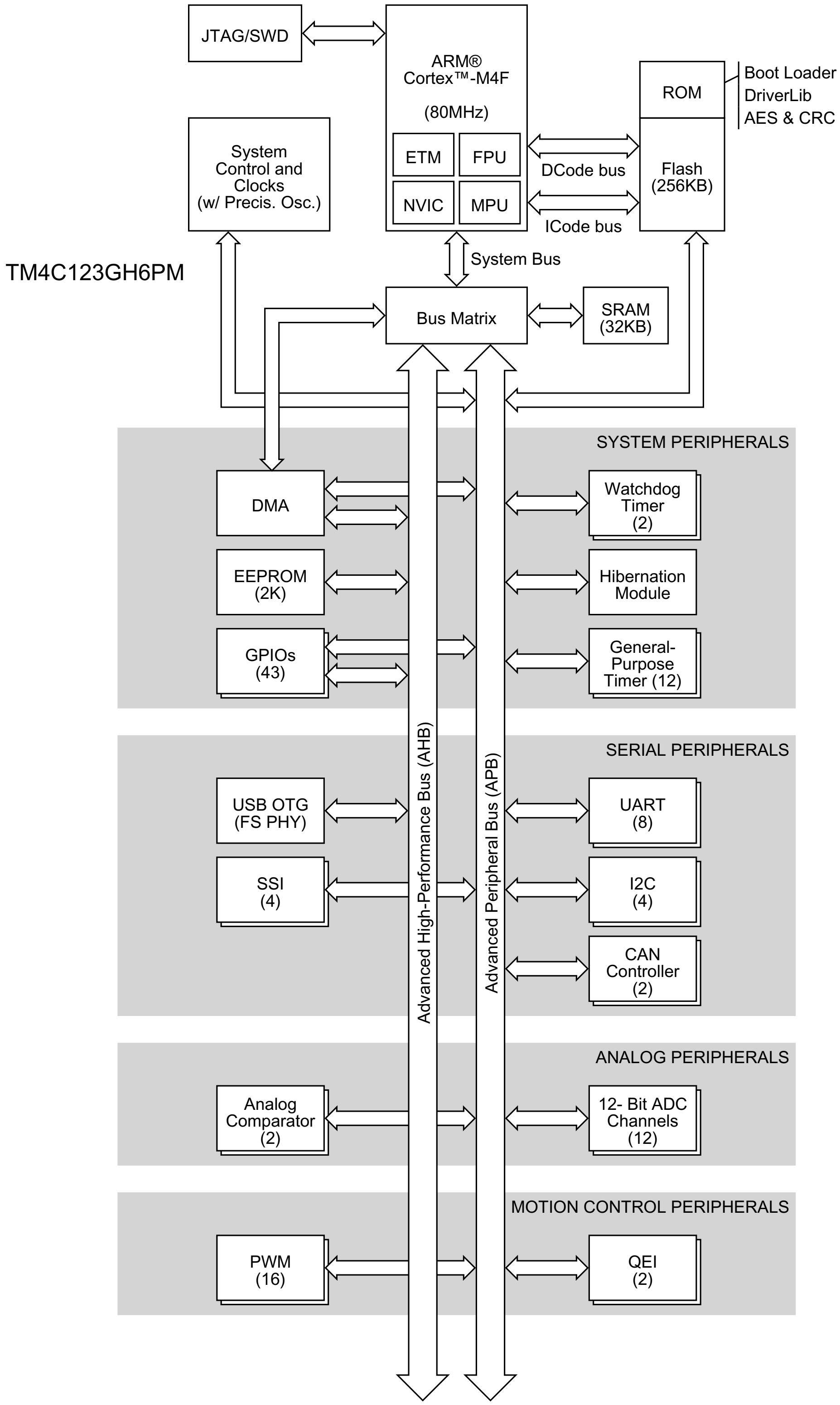

Figure 1. TM4C123GH6PM MCU High-Level Block Diagram

1.2 DRV8833 Stepper Motor Driver

The DRV8833 device has two H-bridge drivers to drive a bipolar stepper motor, two DC brush motors, or other inductive loads. Aimed at driving 3.3-V and 5-V motors, this stepper driver has integrated field-effect transistors (FETs) to support up to 1.5 A (rms) with a low-power sleep mode to conserve power for battery-powered applications. This device offers internal shutdown functions with a fault output pin that provide for overcurrent protection, short-circuit protection, undervoltage lockout, and overtemperature. See Figure 2 for an overview of the block diagram of the DRV8833 stepper motor drive.

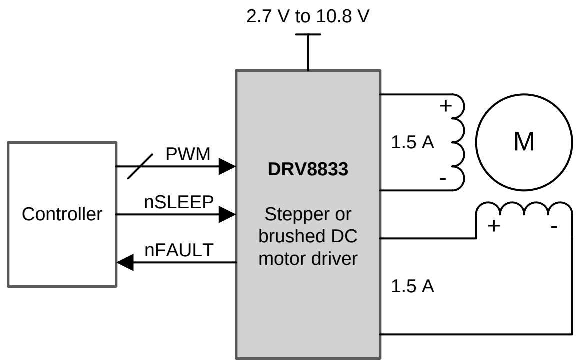

Figure 2. DRV833 Functional Block Diagram

2 Getting Started Hardware

The hardware used in this example is the EK-TM4C123GXL LaunchPad and the DRV8833 motor driver. The EK-TM4C123GXL LaunchPad board is connected to the DRV8833 motor driver EVM board through the connectors on the EK-TM4C123GXL. Table 1 lists the signal mapping.

Table 1. TM4C123/DRV833 Interface Signals

TM4C123GXL-Connected LaunchPad	DRV8833
PC4	AIN1
PC5	AIN2
PC6	BIN2
PC7	BIN1
GND	GND

The block diagram in Figure 3 shows the TM4C123/DRV8833 interface.TM4C123 controls the output of DRV8833.

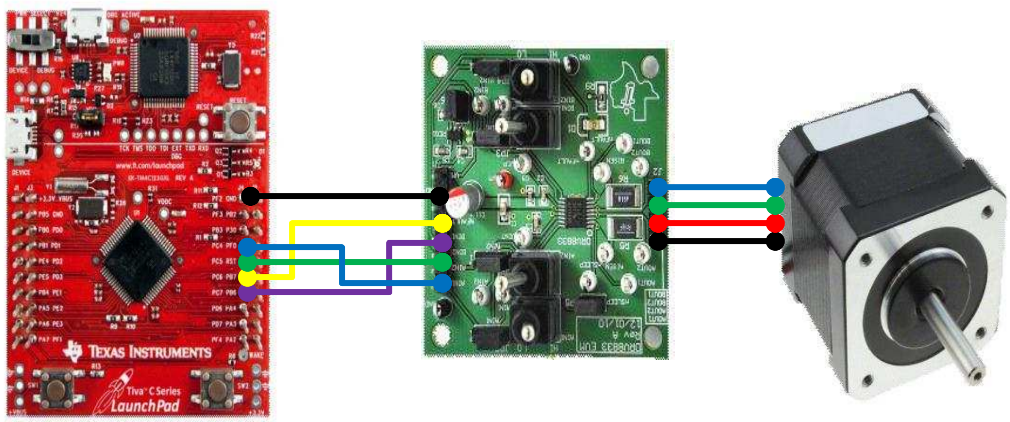

Figure 3. General Setup for Stepper Motor Drive

The following TM4C123 peripherals are also enabled in the system.

- Timer 0 interrupt to drive motor
- Timer 1 interrupt to sample button states
- GPIO input pins PF0 and PF4 to sample the button states
- GPIO input pin PB5 to enable full or half step mode

3 Getting Started Software

Figure 4 shows the architecture of the TM4C123 software. The TI TivaWare™ library controls the hardware on TM4C123. This design has two timers. One timer drives the motor and interrupts the CPU at predetermined intervals. In the timer interrupt service routine (ISR), the CPU changes the states of the four GPIO pins to drive the motor.

The second timer reads the status of the buttons on the LaunchPad at regular intervals. The CPU checks how long the button is pressed. If SW1 is pressed briefly, this command starts or stops the motor. If SW1 is held down, this command increases the rotation speed. If SW2 is pressed briefly, this command changes the direction of the rotation. If SW2 is held down, this command decreases the rotation speed. Changing the period of the timer that drives the motor controls the rotation speed.

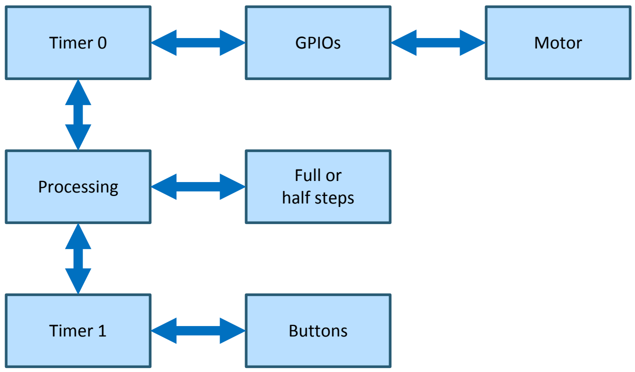

Figure 4. TM4C123 Software Architecture Block Diagram

TI developed the software as an extension of TivaWare examples. The demonstration has additional files (buttons.c) containing APIs for controlling the peripherals. The stepper_motor.c file contains the stepper motor control. The software is provided in a zip file.

4 Installing the Demo

To rebuild the demo, install the following TI tools and software packages.

- Code Composer Studio™ (CCS) v6.0.1 or above
- TivaWare v2.1.0.12573 or above
- Stepper motor control software provided in the zip file

Figure 5 shows where to place the extracted directory.

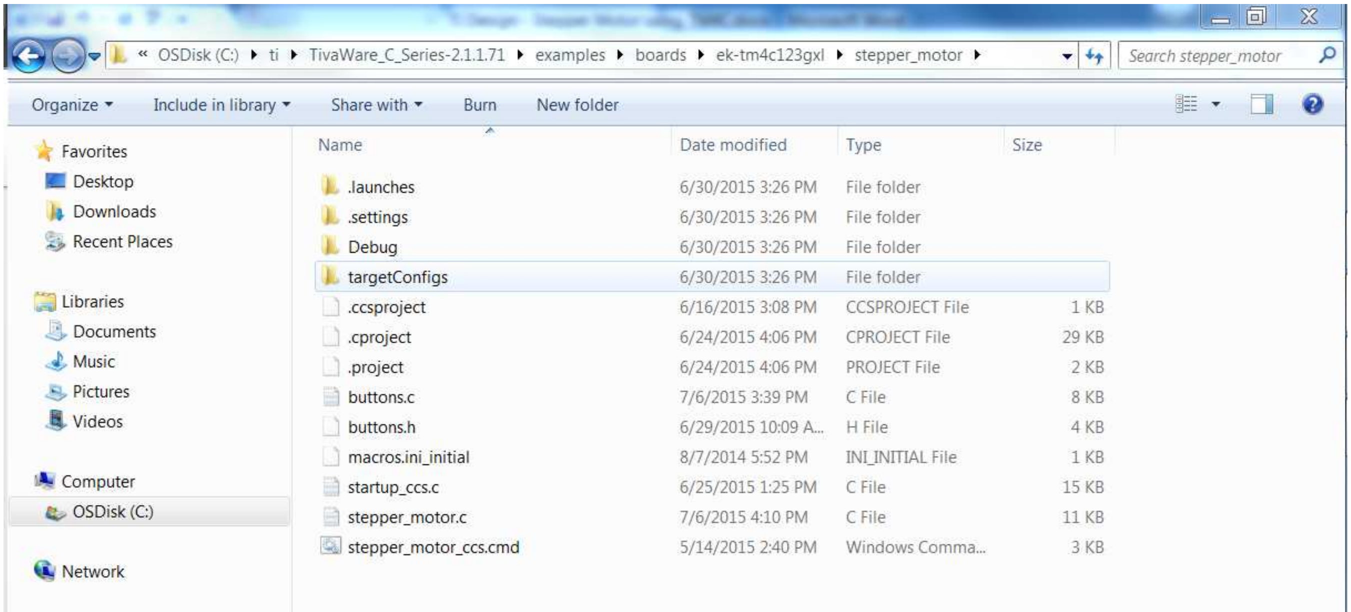

Figure 5. Placement of the Extracted Directories

Figure 6 shows the project directory.

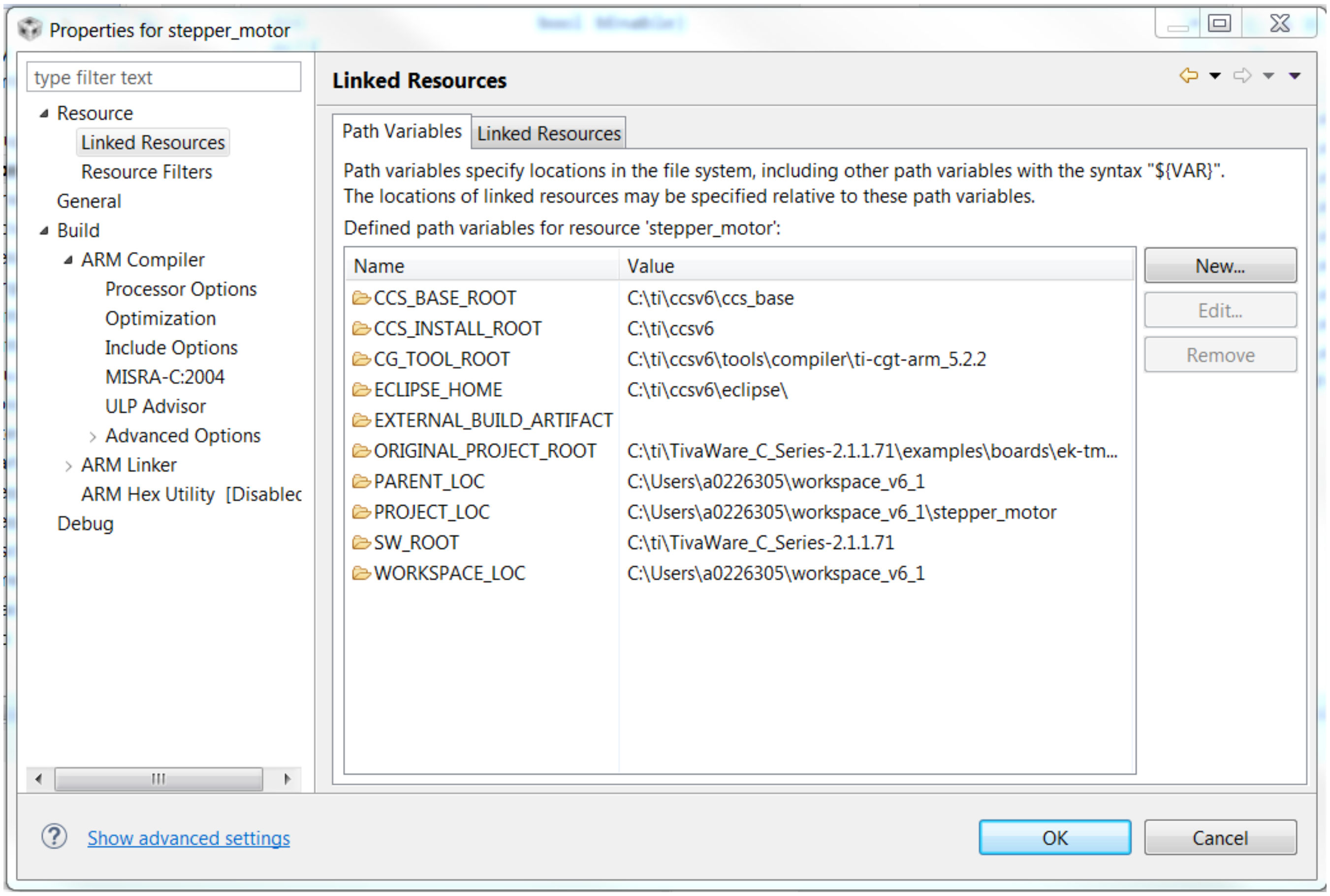

Figure 6. The Content of stepper_motor Directory

Figure 7 shows the linked path for compiling the project. Install the software in the default location to ensure the paths match Figure 7. If you fail to install the software in the default location, the linked paths must be modified to match the actual installation.

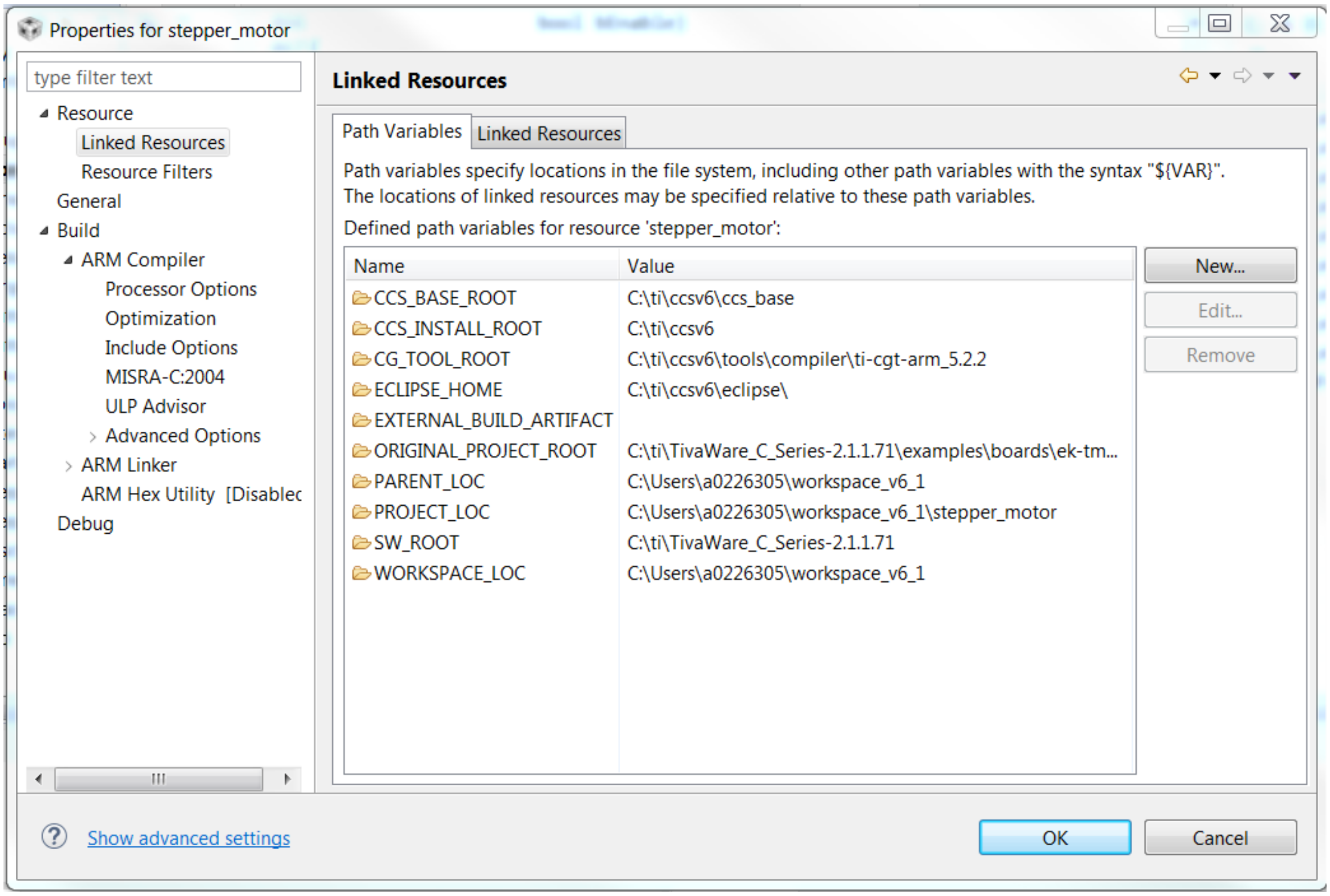

Figure 7. The Linked Paths of the Project.

5 Executing the Demonstration

The LaunchPad buttons control the state and speed of the motor. Pressing button SW1 once turns the motor on or off. Pressing and holding SW1 increases the speed of the motor until SW1 is released or until the motor reaches the maximum speed. Pressing button SW2 changes the direction of the motor. Pressing and holding SW2 decreases the speed of the motor until SW2 is released or until minimum speed is reached.

The CPU loading increases with higher rotation speed because the timer interrupts are generated more frequently at a higher rotation speed. This is a fraction of CPU capability. The real minimum and maximum rotation speed is determined by the characteristics of the motor. The developers chose the minimum and maximum rotation speed limit to demonstrate the change in the rotation speed.

6 Resources

To download the software files and resource files for this reference design, visit the following website: http://www.ti.com/tool/TIDM-TM4C123StepperMotor.

7 References

1. TivaWare for C Series
2. EK-TM4C1293GXL LaunchPad
3. DRV8833C Stepper Motor Driver

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