User's Guide
SLAU499–May 2013

MSPMATHLIB: An Optimized MSP430™ Library of Floating-Point Scalar Math Functions

MSPMATHLIB is an accelerated floating point math library for MSP430™ MCUs that delivers up to 26 times faster computation for the most commonly used math functions. The library seamlessly integrates with existing projects to replace the most common floating point math functions without any changes to the code.

Contents

1 Introduction

MSPMATHLIB includes the following twelve functions:

- Trigonometric: sin, cos, tan
- Inverse trigonometric: asin, acos, atan, atan2
- Exponential: exp, log
- Misc: sqrt, reciprocal, fmod

MSPMATHLIB enables users to run highly accurate floating point algorithms more efficiently without the need to convert to complicated fixed point code. This benefits math-intensive applications that are limited by performance or energy. New high-performance applications are now possible, and existing applications can run faster. Existing low-energy applications can now execute costly math calculations in a fraction of the time and increase time spent in low-power modes. The low-power performance enabled by MSPMATHLIB can benefit applications such as utility metering and applications involving sensors, a touch interface, or graphical computations.

The library is compliant with *IEEE Standard for Floating-Point Arithmetic* (IEEE Std 754) and includes support for finite, infinite, and not a number (NaN) for both input and output. All functions use rounding with ties to even (zero) and have the maximum possible accuracy for all input ranges. Due to the nature of the floating point format, some functions lose accuracy in certain ranges such as asin, acos, exp, and log. In these cases, the result is as accurate as possible. This accuracy is comparable to existing implementations.

Visit http://www.ti.com/tool/mspmathlib for product download and supported devices.

2 Benchmarks

The benchmarks that are shown in Section 2.1 and Section 2.2 were obtained using Code Composer Studio™ IDE version 5.3.0.00090, MSP430 compiler version 4.1.5, and small code and data models. Comparable results can be expected when running on IAR Embedded Workbench™ IDE.

2.1 Performance

Figure 1 shows the average CPU cycles needed to calculate a result for the existing MSP430 math implementations and for MSPMATHLIB. The number above each pair of bars is the factor by which the specified function is improved when using MSPMATHLIB.

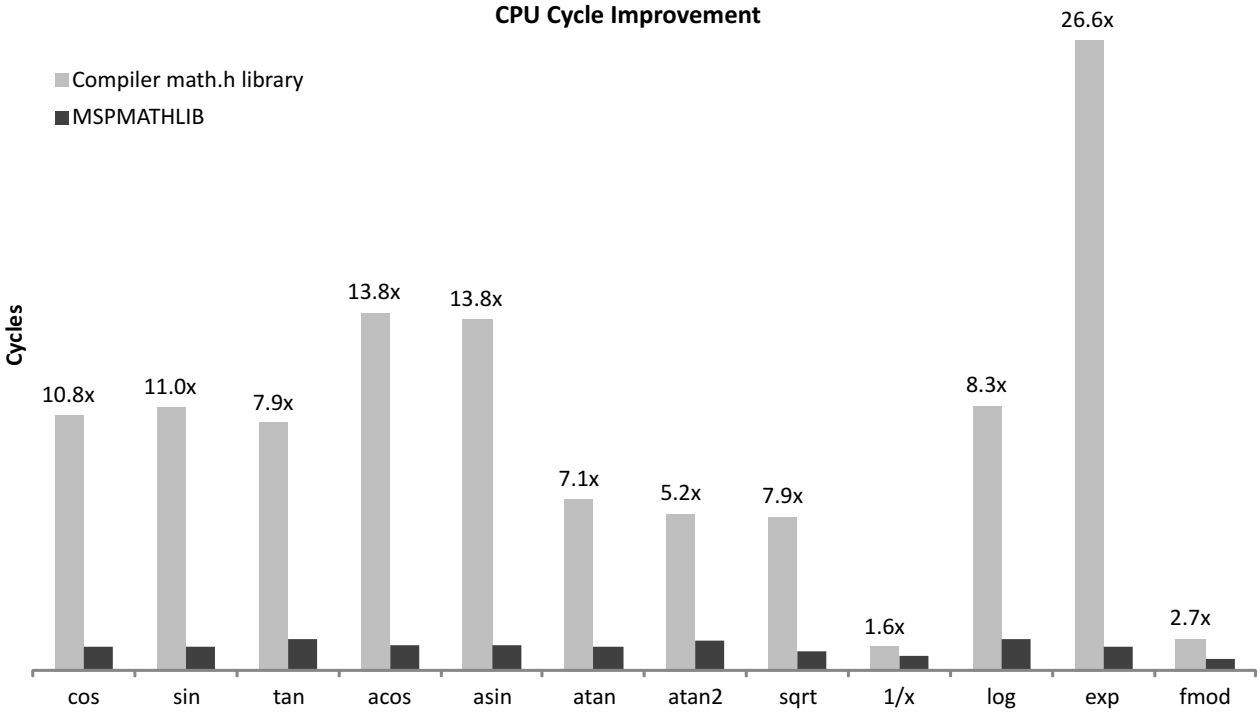

Figure 1. MSPMATHLIB Performance (Fewer Cycles is Better)

2.2 Accuracy Benchmarks

Table 1 shows the worst-case relative accuracy for common input ranges of the compiler libraries and MSPMATHLIB. The data indicates that in most cases, there is a negligible difference in accuracy between the existing math.h library and MSPMATHLIB. Results were obtained using Code Composer Studio IDE.

Table 1. Accuracy Benchmarks

Function	math.h	MSPMATHLIB
sin	1.51E-07	1.51E-07
cos	8.15E-08	9.84E-08
tan	6.58E-05	6.61E-05
asin	1.87E-06	1.95E-06
acos	6.79E-04	6.81E-04
atan	1.28E-07	6.12E-08
atan2	1.32E-07	5.48E-08
exp	1.00E-06	1.00E-06
log	1.05E-07	1.67E-07
1/x	7.63E-08	7.63E-08
sqrt	9.68E-08	8.24E-08
fmod	6.10E-08	6.10E-08

3 Using MSPMATHLIB

3.1 Code Composer Studio™ IDE

1. Run the MSPMATHLIB installer to extract the library.
2. Open a CCS project.
3. Open the project properties, select *eabi* as the Application binary interface, and select the desired code model and data model (see Figure 2).

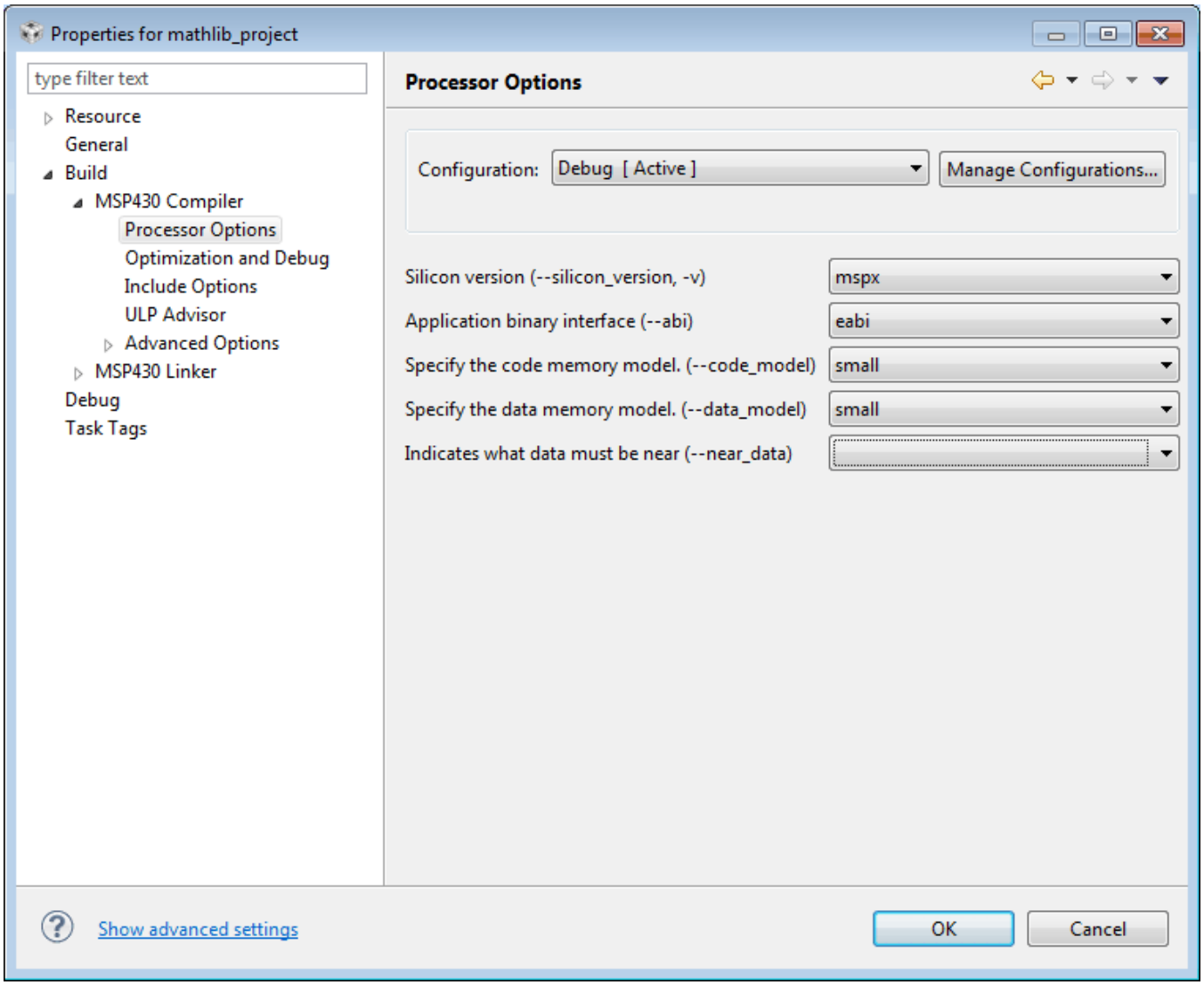

Figure 2. Properties for Project

4. Right click the project and select Add Files.

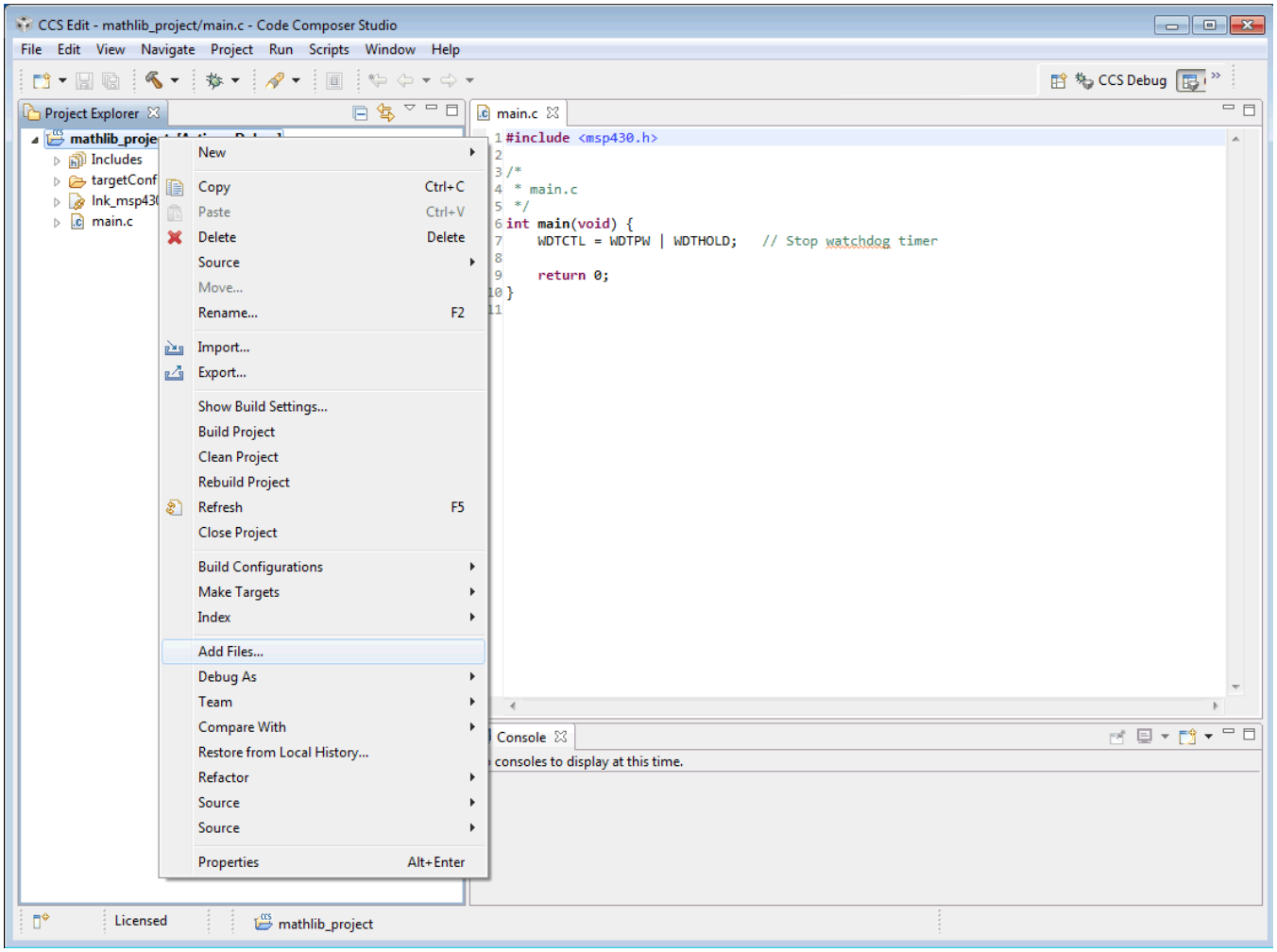

Figure 3. Add Files to Project

5. Select the library that matches the code and data model (see Figure 4).

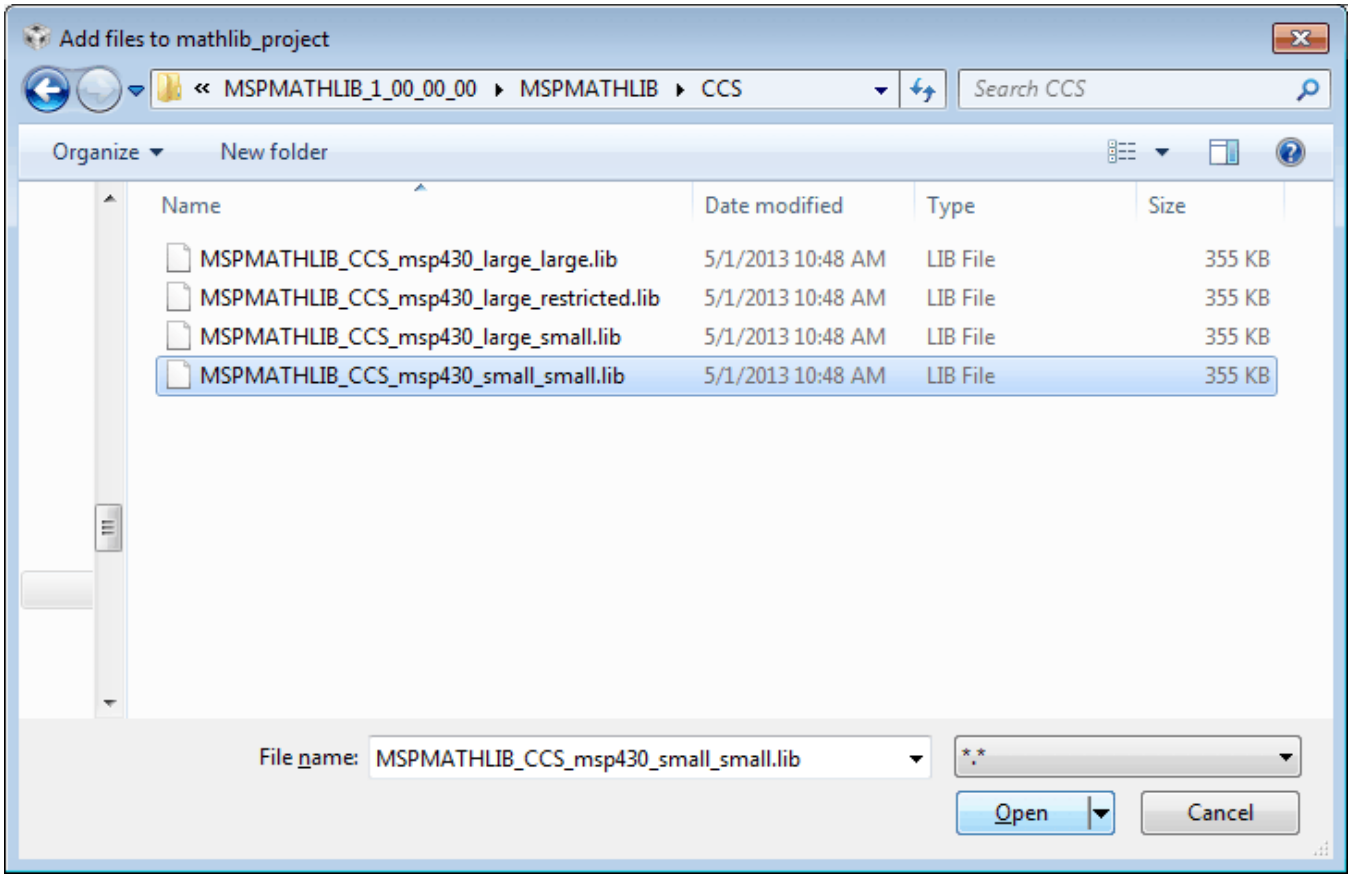

Figure 4. Select Library

6. Replace all inclusions of math.h with the msp430_math.h header file that is located in the top-level include directory (see Figure 5). msp430_math.h includes math.h and redefines the function names to link the included library functions. Functions that are not included in MSPMATHLIB continue to use the compiler implementation.

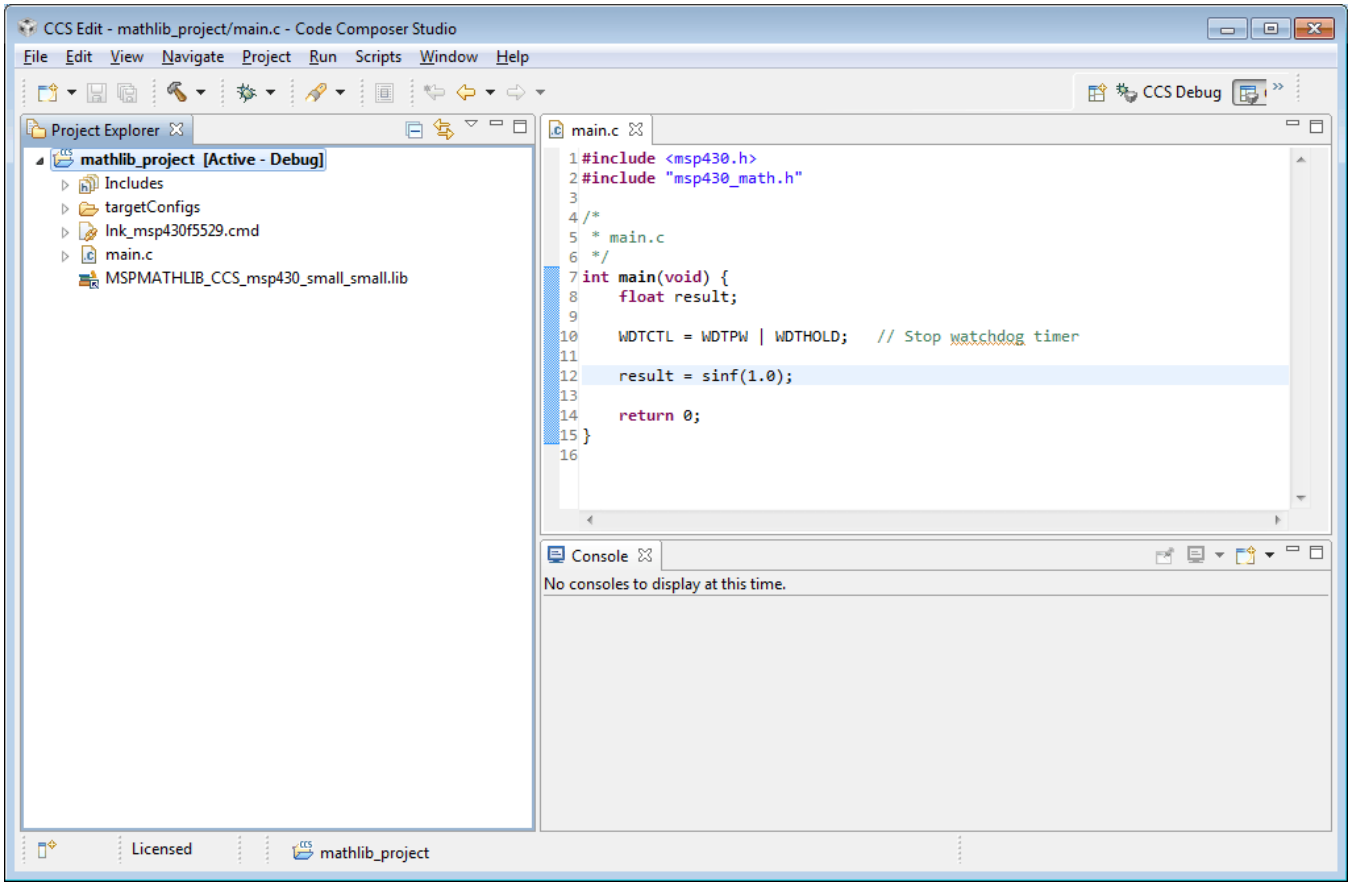

Figure 5. Replace Includes of math.h With msp430_math.h

7. You can now build the project (see Figure 6). The MSPMATHLIB functions are linked in place of the standard math.h functions. The function prototypes are identical and require no additional considerations when coding.

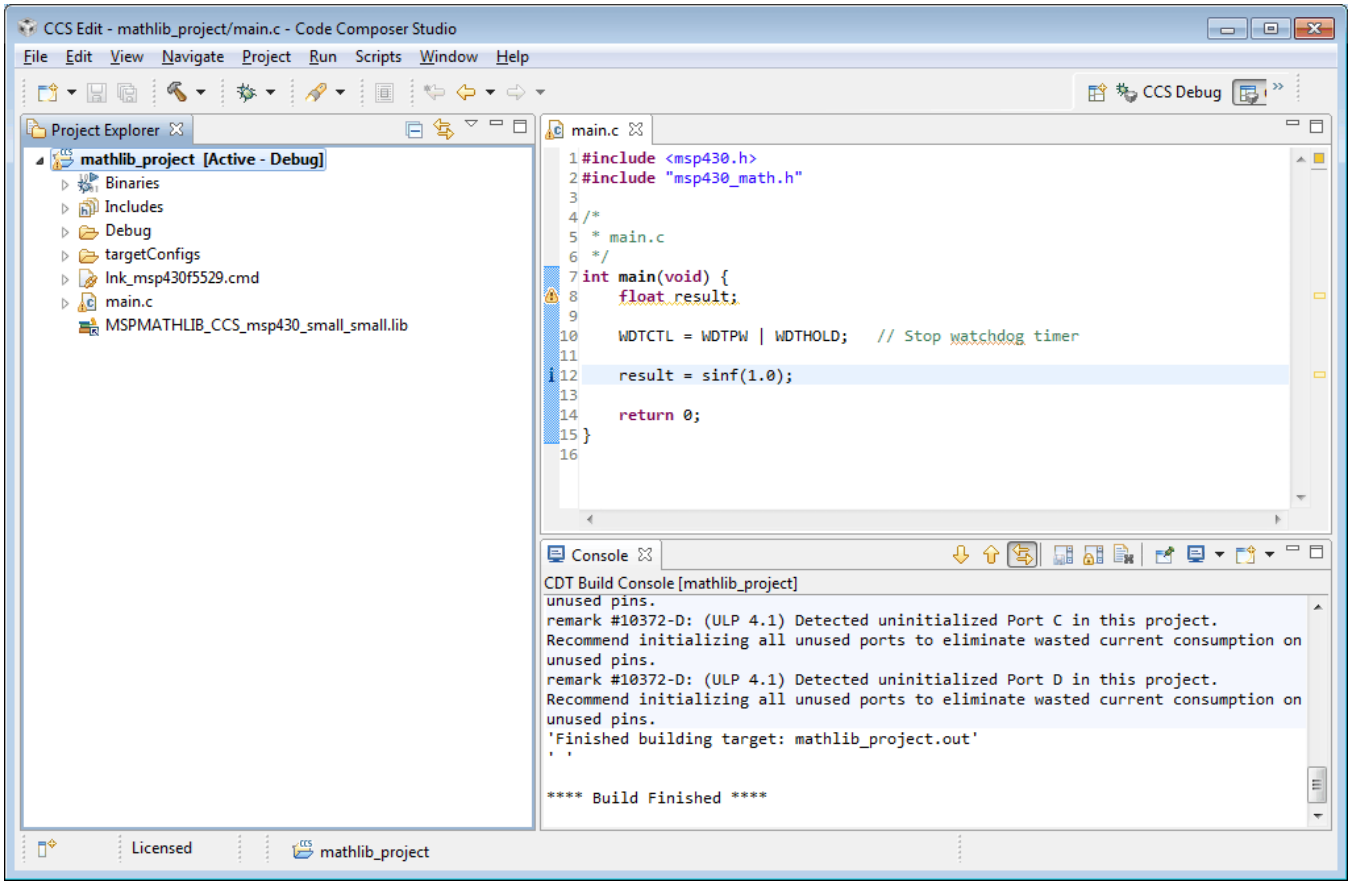

Figure 6. Build Project

3.2 IAR Embedded Workbench™ IDE

1. Run the MSPMATHLIB installer to extract the library.
2. Open an IAR project.
3. In the General Options category, select the data model to use (see Figure 7).

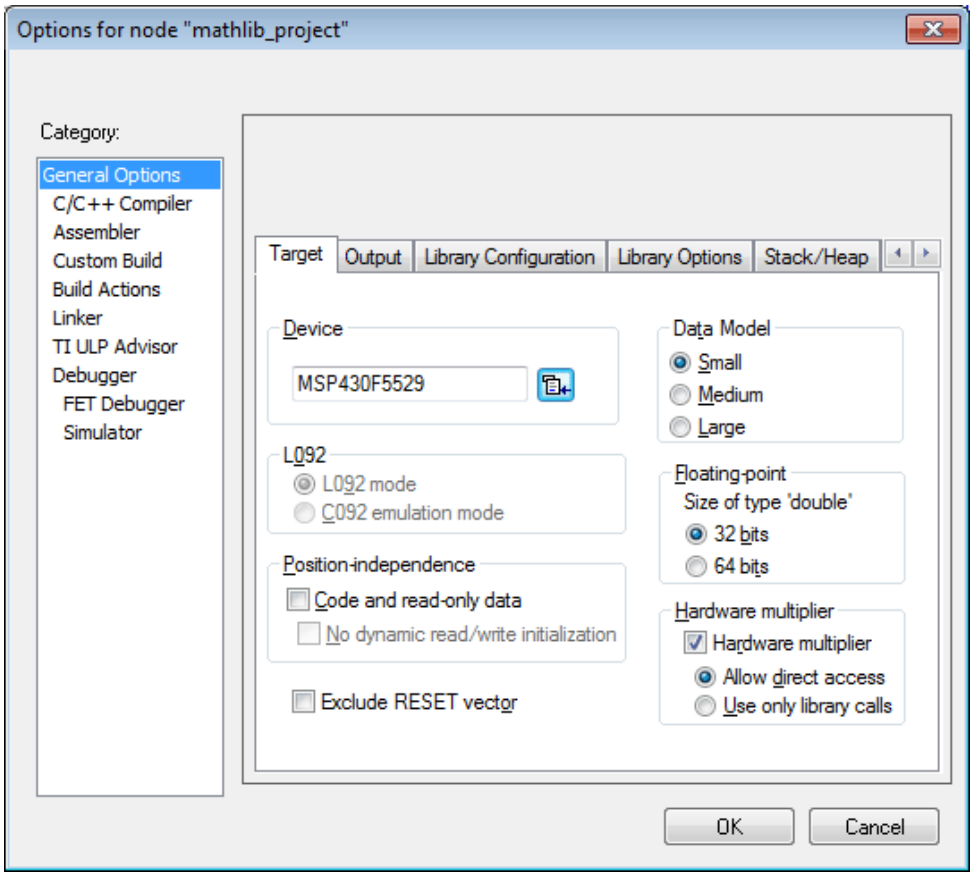

Figure 7. Options for Project

4. Right click the project and select Add Files (see Figure 8).

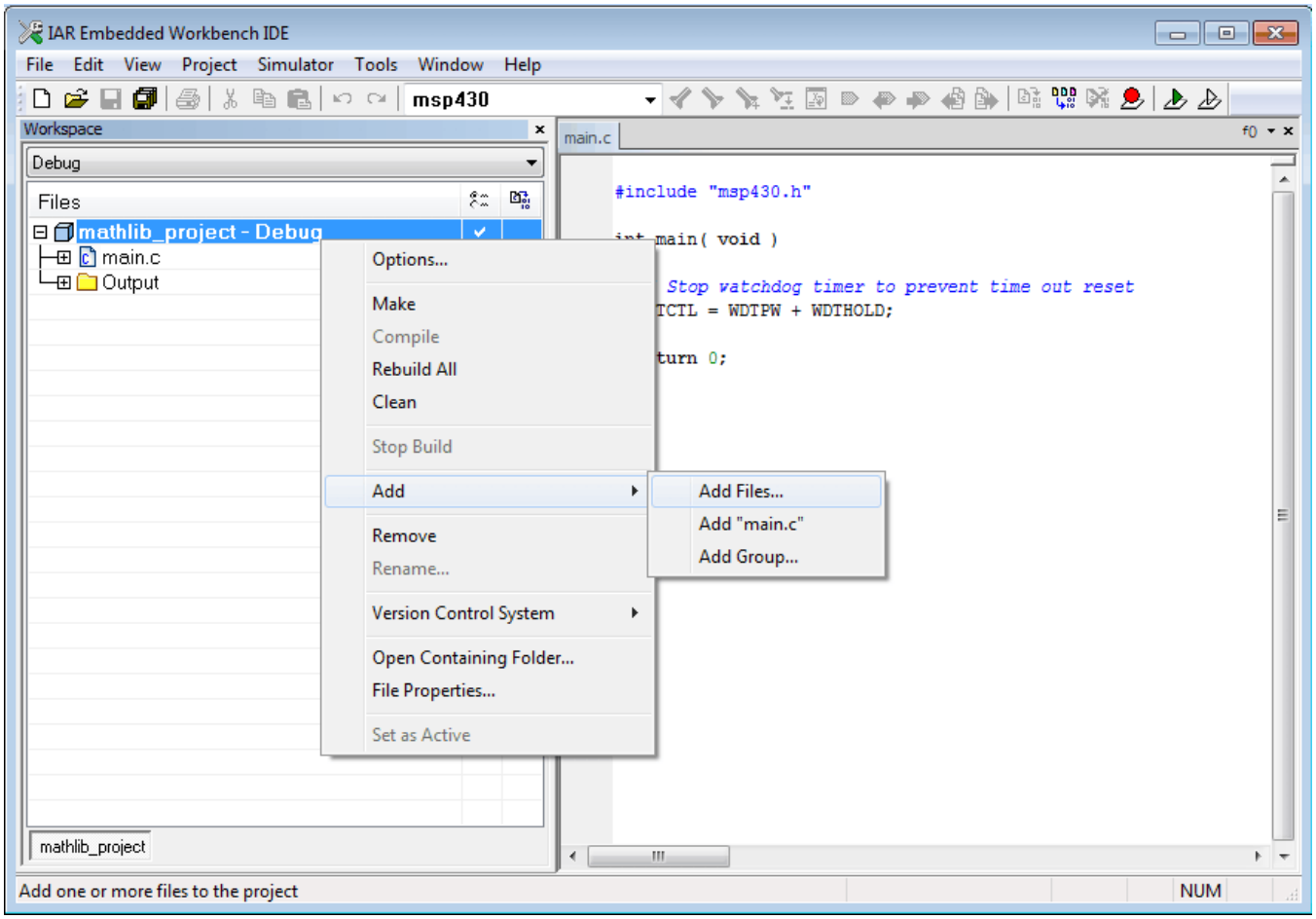

Figure 8. Add Files to Project

5. Select All Files and then select the library that matches the data model (see Figure 9).

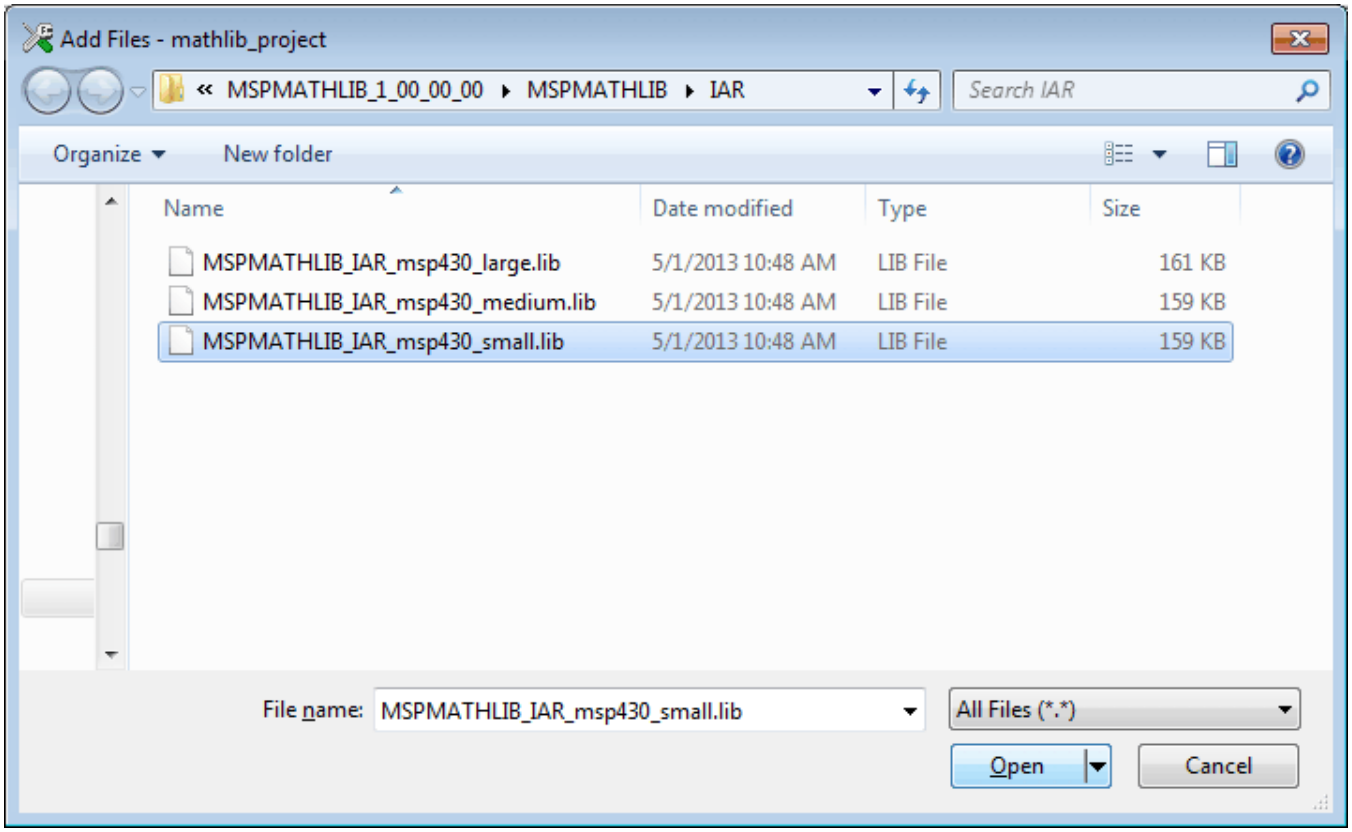

Figure 9. Select Library

6. Replace all inclusions of math.h with the msp430_math.h header file that is located in the top-level include directory (see Figure 10). msp430_math.h includes math.h and redefines the function names to link the included library functions. Functions that are not included in MSPMATHLIB continue to use the compiler implementation.

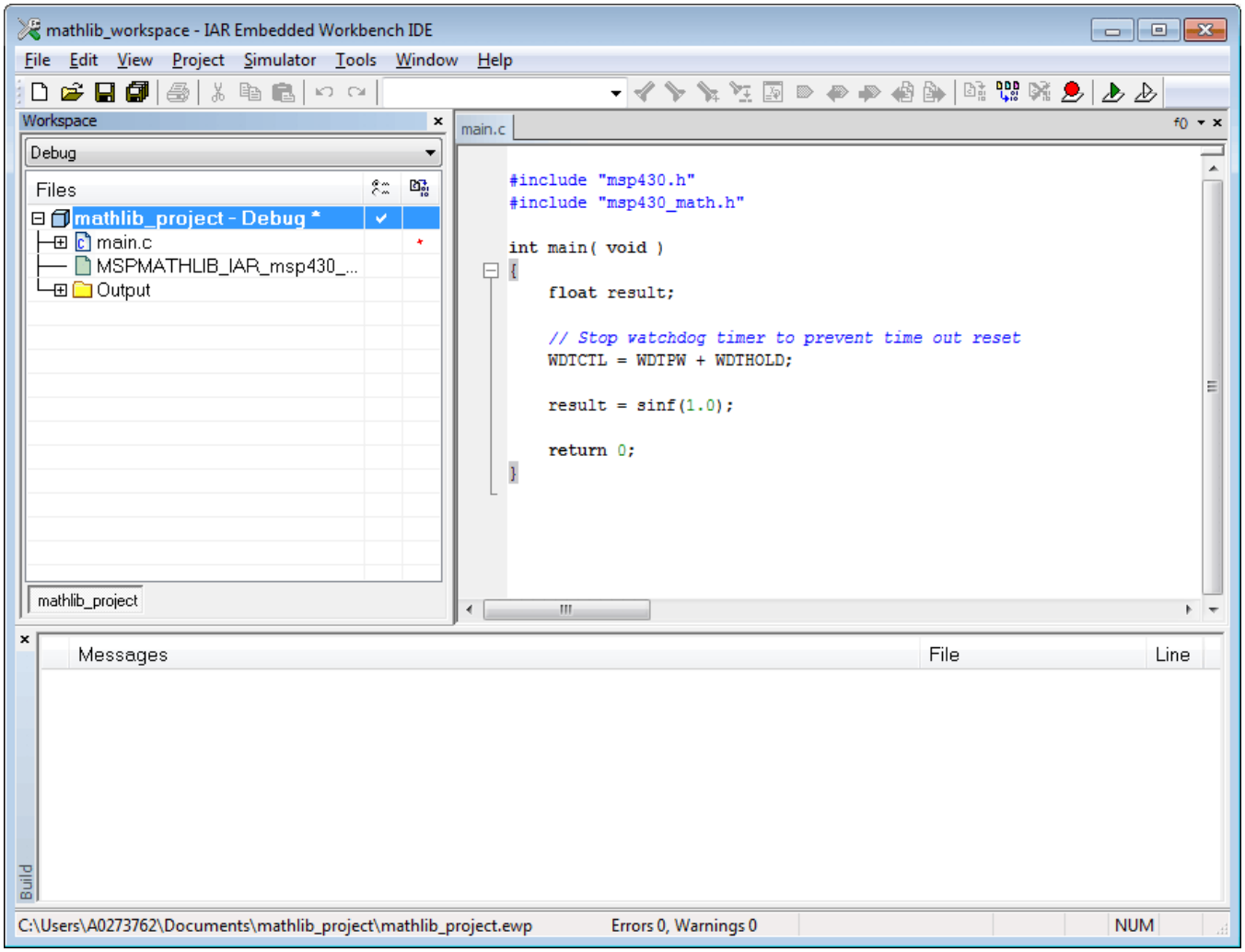

Figure 10. Replace Includes of math.h With msp430_math.h

7. You can now build the project (see Figure 11). The MSPMATHLIB functions are linked in place of the standard math.h functions.

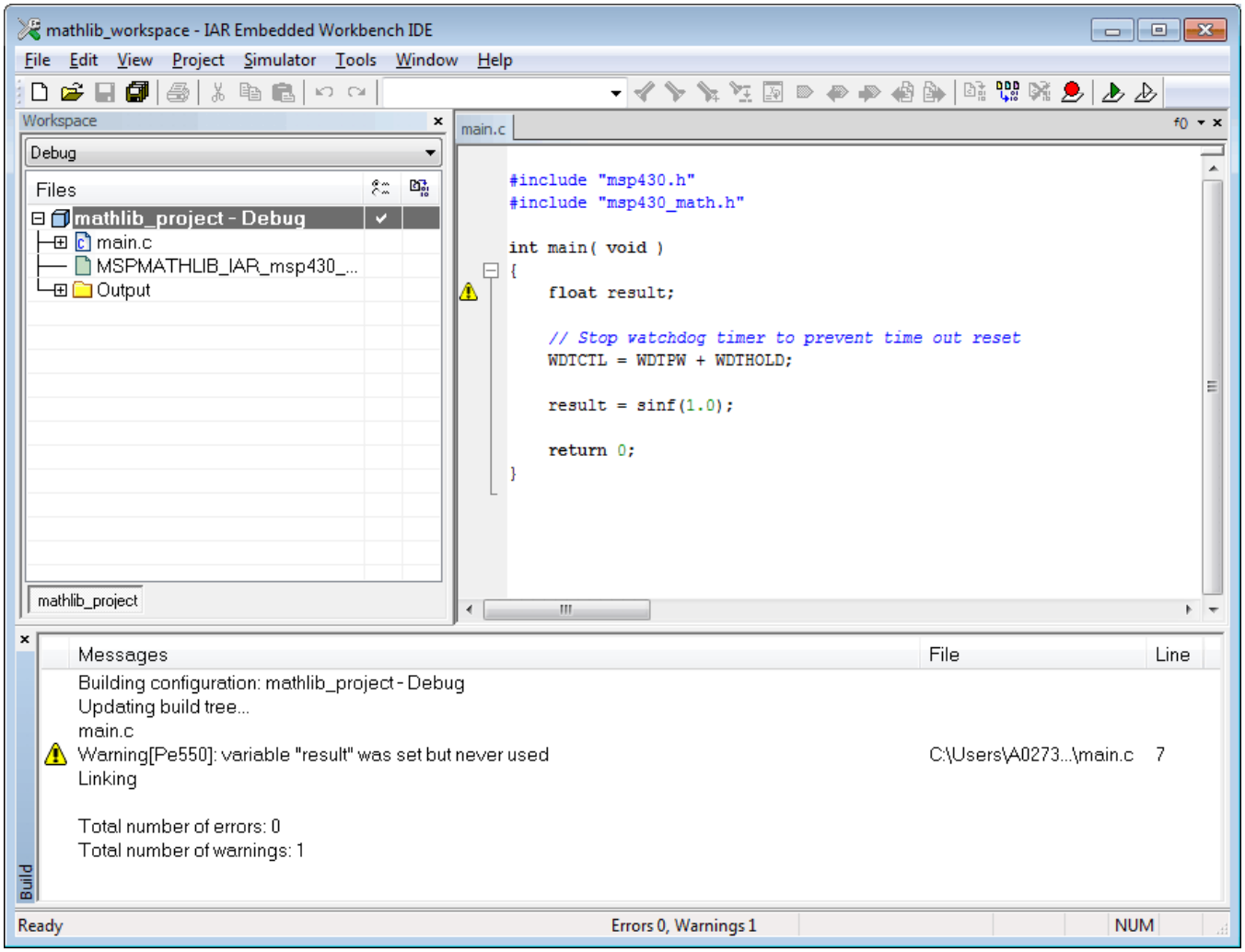

Figure 11. Build Project

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