

Getting Started With EEMBC® ULPBench™ on MSP-EXP430FR5969

This is a getting started guide for obtaining the ULPMark™-CP score using the Embedded Microprocessor Benchmark Consortium (EEMBC) ULPBench and EnergyMonitor with the MSP430FR5969 microcontroller (MCU). This document uses the [MSP-EXP430FR5969 LaunchPad](#) development kit as the target evaluation module (EVM) for performing the benchmark. [ULPBench](#) is a EEMBC benchmark providing an industry-standard method to measure ultra-low-power capabilities of MCUs.

The ULPBench firmware can be downloaded from the [EEMBC website](#).

Contents

| | | |
|------------|--|---|
| 1 | The MSP-EXP430FR5969 LaunchPad Development Kit | 1 |
| 2 | Download ULPBench and Setting Up | 1 |
| 3 | Modifications Required to Use EnergyMonitor | 2 |
| 4 | Programming ULPBench Firmware | 2 |
| 5 | Execute ULPBench Test | 4 |
| 6 | References | 6 |
| Appendix A | Installing the USB Drivers | 7 |

List of Figures

| | | |
|---|---|---|
| 1 | Default Jumper Configuration for J13 | 2 |
| 2 | Default Power Configuration | 3 |
| 3 | Remove J13 Jumpers Before Starting ULPBench | 4 |
| 4 | VCC and GND Connection | 5 |
| 5 | EEMBC EnergyBench Monitor Software | 6 |

List of Tables

1 The MSP-EXP430FR5969 LaunchPad Development Kit

The ULPBench-ready MSP-EXP430FR5969 LaunchPad™ features the MSP430FR5969 microcontroller and on-board emulator for programming and debugging. The MSP430FR5969 features the following:

- 16-bit RISC architecture up to 8-MHz FRAM access and 16 MHz system clock speed 64KB non-volatile FRAM/2KB SRAM
- 5x timer blocks
- Analog: 16Ch 12-bit single/differential input ADC, 16Ch comparator
- Digital: AES256, CRC, DMA, HW MPY32

2 Download ULPBench and Setting Up

ULPBench firmware can be downloaded from the [EEMBC website](#). Create a new folder where the files can be extracted on your local computer.

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3 Modifications Required to Use EnergyMonitor

No physical hardware modification is required to use this EVM with EEMBC EnergyMonitor v1.0. The LaunchPad requires several jumper configurations, as detailed in [Section 4.1](#), to program the device with the ULPBench firmware. Then, the jumpers must be re-configured to perform ULPBench measurements, as detailed in [Section 5](#).

4 Programming ULPBench Firmware

The MSP430FR5969 device must first be programmed with the ULPBench firmware. This LaunchPad has an onboard emulator that will be used to program the device. The LaunchPad, by default out-of-the-box, is configured ready for programming.

4.1 Hardware Configuration

Before proceeding with programming, check whether the jumpers are properly configured. [Figure 1](#) depicts the default jumper configuration on J13. At a minimum, ensure GND, +V, RST, and TST are connected for programming and debugging the MSP430FR5969 device.

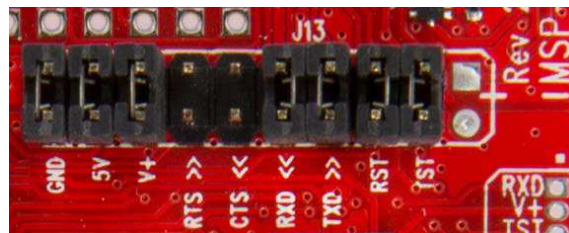


Figure 1. Default Jumper Configuration for J13

For the power configuration, [Figure 2](#) depicts the default configuration to power the device from the debugger. Ensure the jumpers are connected as shown in [Figure 2](#).

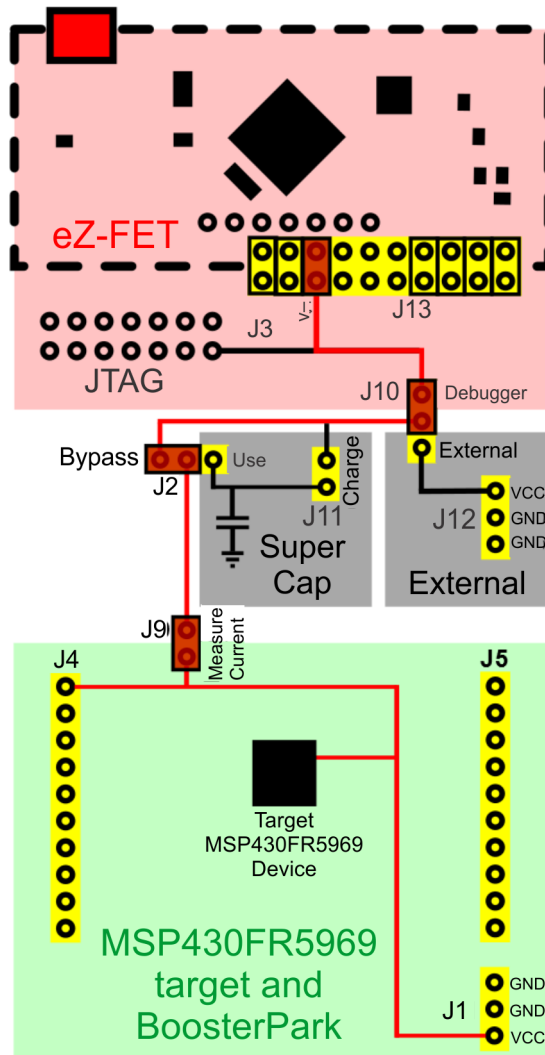


Figure 2. Default Power Configuration

The jumper configuration from [Figure 2](#) is summarized as:



- Ensure J9 jumper is connected
- J2 jumper set to bypass mode
- J10 jumper set to debugger

Connect the Micro-USB from the EVM to the PC.

4.2 Software Requirements

To install the ULPBench firmware, IAR Embedded Workbench® v6.10.3 or newer is required. Download the free kickstart version and install the integrated development environment (IDE) from www.iar.com/msp430.

4.2.1 Embedded Workbench IAR

1. Open the IAR ULP_StateMachine.eww workspace project.
2. Click the Download and Debug button , which downloads the ULPBench firmware to the device.
3. Terminate the debug session by clicking Stop Debugging .

5 Execute ULPBench Test

The EEMBC EnergyMonitor is used to source power to the target device and measure the energy consumed. The LaunchPad must be configured through several jumper configurations such that the EnergyMonitor does not back-power the emulator circuit, which would skew the measurements.

5.1 Hardware Configurations

Remove all jumpers from J13, as shown in [Figure 3](#), to isolate the MSP430FR5969 MCU from the emulator. Perform this step only after the device has been programmed with the ULPBench firmware as detailed in [Section 3](#).

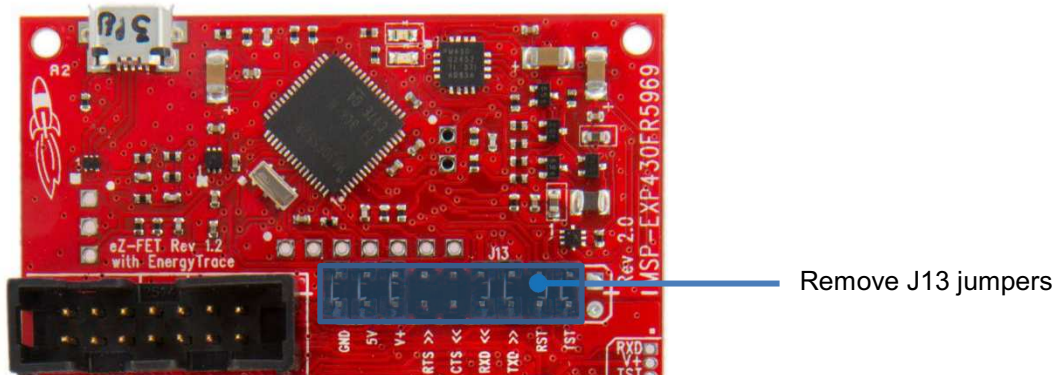


Figure 3. Remove J13 Jumpers Before Starting ULPBench

Connect 2 jumper wires from EnergyMonitor for GND and VCC to the EVM's GND and VCC pins as depicted in [Figure 4](#).

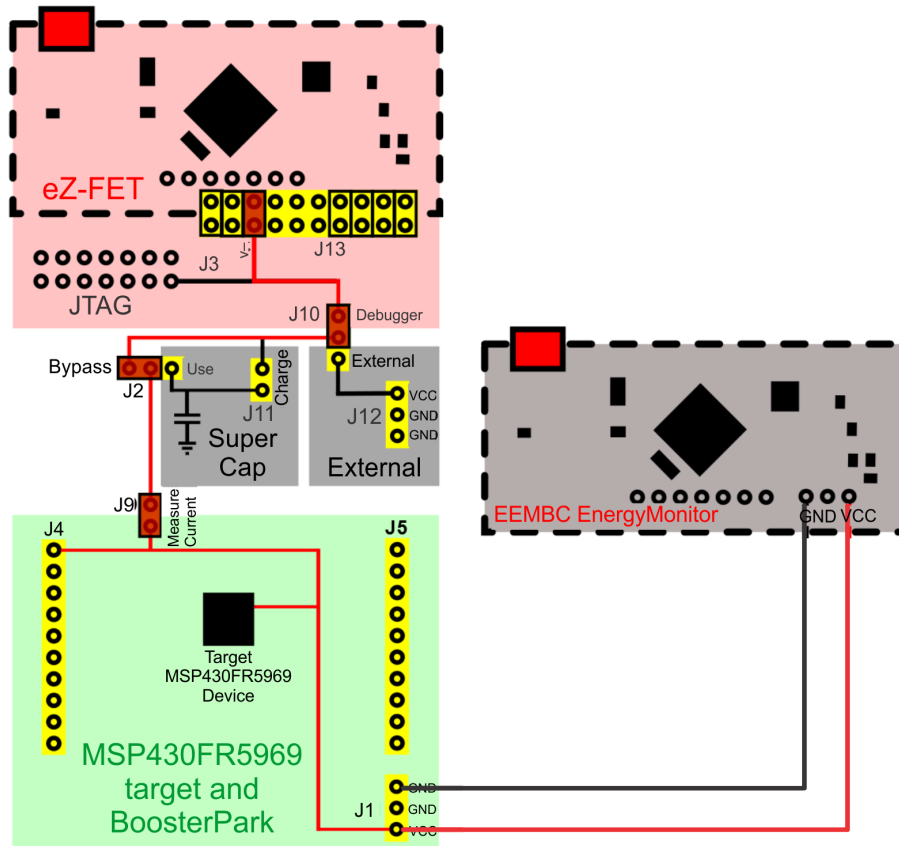


Figure 4. VCC and GND Connection

Connect the Micro-USB from the EEMBC EnergyMonitor board to the PC. If this is the first time connecting this board, see [Appendix A](#) on installing the USB drivers.

5.2 Software Tools

To measure the energy and obtain the ULPBench-CP score, open EnergyMonitor.exe software under the bin folder.

In [Figure 5](#), showing the *Configuration Options* section, if you see a red light (and have completed the steps in [Appendix A](#)), close the EnergyMonitor graphical user interface (GUI) and restart it.

Push the *Run ULPBench* button. When the *Accumulated Energy* window displays a staircase line, the ULPBench is started. You will also be able to see the energy consumption of the device in the *History* window and the *Intermediate Results* window.

The energy measurements would then run several times before reporting a score.

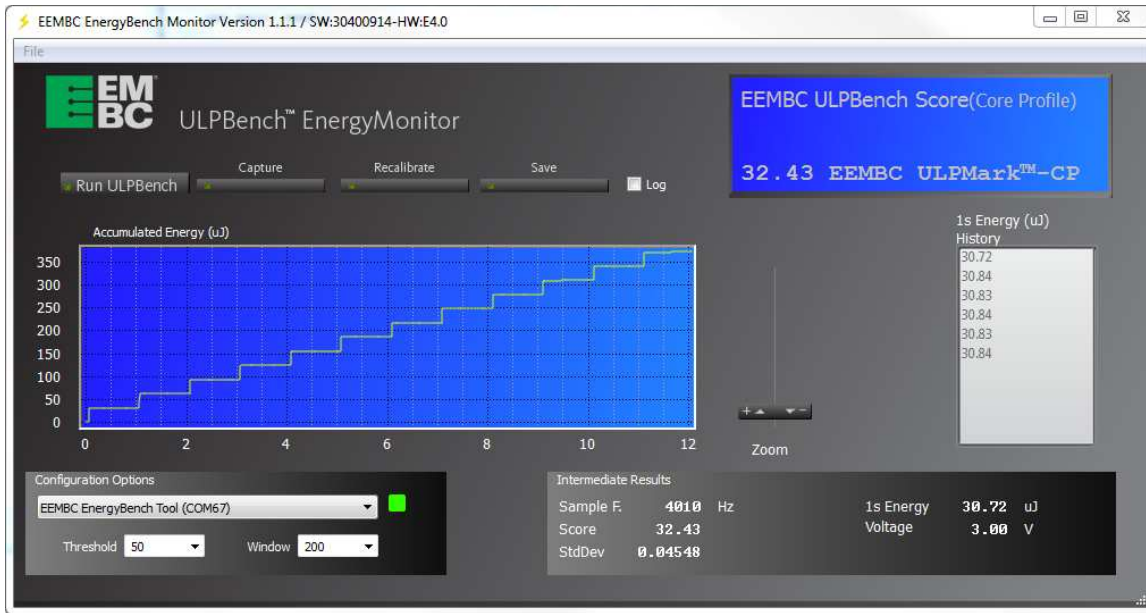


Figure 5. EEMBC EnergyBench Monitor Software

Once the test is completed, the final score will appear in the *Benchmark Status* window.

6 References

- EEMBC ULPBench-CP <http://www.eembc.org/ulpbench/>
- *MSP-EXP430FR5969 LaunchPad™ Development Kit User's Guide (SLAU535)*

Appendix A Installing the USB Drivers

Since this is the first time connecting the EnergyMonitor to the computer, it is an unrecognized USB device to that computer.

1. Click on *Next* and choose the option to manually locate USB drivers. The USB drivers are included in the ULPBench zip files: EEMBCmonitor_drivers.cat and EEMBCmonitor_drivers.inf.
2. If that message does not come up, go to your device manager and locate the devices that say EEMBC Application UART1 and EEMBC Energy Tool V1. Click on each to install the driver.
3. After starting the driver installation, you will get a message from Windows security saying it cannot verify the publisher of this driver software. Click on *Install this driver software anyway*.
4. After Windows has successfully updated your driver software, close the update window.

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