Monitoring Power Consumption – Installation Supplement
Introduction

Your Texas Instruments (TI) TMS320C55x™ Power Optimization DSP Starter Kit (DSK) includes built-in hardware for monitoring power consumption along with a ready-to-run software program written in National Instruments LabVIEW software. This document discusses considerations for power monitoring, including:

- Additional hardware and software for more accurate or advanced power monitoring applications
- The importance of power management and optimization
- Key considerations for power monitoring

![TI TMS320C55x™ Power Optimization DSK](image1)

Figure 1. The TI TMS320C55x™ Power Optimization DSK includes a ready-to-run software program written in NI LabVIEW.

Valuable Hardware and Software Resources from National Instruments

Your TMS320C55x™ Power Optimization DSK includes a built-in USB-based power-monitoring hardware subsystem from National Instruments and an NI LabVIEW software executable file. However, if you require more advanced power-monitoring capabilities with increased accuracy or different analysis, you can choose from many other NI hardware and software options. Your choice depends on the accuracy level you require and your preference for either ready-to-run software or a programmatic approach.

For the most accurate power measurements and direct current measurements without add-on hardware, National Instruments recommends NI 407x high-performance digital multimeters (DMMs). These DMMs provide the measurement capability found in two common test instruments, a high-resolution digital multimeter and a digitizer. As digital multimeters, they deliver fast, accurate voltage measurements down to ±10 nV and current measurements down to ±1 pA. NI 407x DMMs provide up to 26 bits of resolution compared to the 14-bit resolution of the ADC designed into your hardware supplied. In the high-voltage, isolated digitizer mode, these special DMMs can acquire voltage and current waveforms at sampling rates up to 1.8 MS/s. You can quickly and accurately perform
power measurements on your digital signal processor (DSP) with this measurement capability along with the built-in analysis functions in LabVIEW software.

Figure 2. The NI 407x DMMs provide up to 12 additional bits of resolution compared to the 14-bit ADC built into the Power Optimization DSK.

An additional cost-effective, modular hardware solution for power monitoring is the NI SCC signal conditioning system, which is combined with NI PC-based data acquisition devices available for PCI, USB, and other standard computer buses. With modules for current, voltage, and sensor inputs and outputs, SCC products condition a variety of analog input and digital I/O signals. Take advantage of this modular design to choose your conditioning on a per-channel basis and have all signals routed back to the data acquisition device. SCC also offers custom connectivity options that you can match to your signal connection type.

Figure 3. NI SCC signal conditioning is a modular, cost-effective solution for improving the accuracy of sensor measurements.
In addition to the LabVIEW executable that is a part of the built-in USB-based power monitor DSK, National Instruments data acquisition hardware works with three other types of NI software for power monitoring with TI DSPs:

1. **VI Logger** – ready-to-run data logger software that provides configuration-based data logging, analysis, and direct export of data to Excel and other data analysis tools.

2. **SignalExpress** – interactive software for quickly acquiring, comparing, automating, and storing measurements.

3. **LabVIEW** – the most flexible option – a graphical development environment for data acquisition, analysis, and presentation. While VI Logger and SignalExpress provide the easiest-to-use interfaces with simple data logging and interactive, configuration-based programming, respectively, LabVIEW offers complete customization of acquisition, analysis, and presentation, so you can create your own custom power-monitoring system. The source code to your TI Power Optimization DSK is available free of charge from ni.com, so you can edit it to better fit your application needs.

### Understanding the Increasing Need for Power Management and Optimization

DSPs often form the core of telecom infrastructure, consumer electronics, and industrial hardware systems. Such products continually require improved features and performance, with significant value placed on product operating life, portability, and size. As a result, engineers often focus on optimal power consumption in their embedded hardware designs just as they must pay attention to appearance and usability. To you, the designer, this means that not only must the design be smaller than ever with superior system performance, but also it must incorporate advanced power management for prolonged battery life and reduced thermal cooling to avoid excessive components such as cooling fans.

To effectively develop low-power devices using DSPs, it is important to understand not only the lowest possible power for a processor at run time but also the amount of power consumed when the processor is communicating with peripherals, running specific algorithms, or idling in sleep mode. To do this, you need to understand the power drains on your products while emulating the behavior of the processor when embedded in the end application. Start by running these power monitoring consumption tests during various device operation with initial prototypes early in the design process and continue as the design iterates.

To continue to help designers maximize battery life and reduce costs in portable applications, TI (NYSE: TXN) announced a family of low-power DSPs and new eXpressDSP™ power design tools that you can use together to optimize power consumption. This combination of TI DSPs and the essential tools to optimize power consumption and maximize battery life helps you create best-of-class portable, multimedia products.
Important Considerations for Power Monitoring

Whether using dedicated power meters or PC-based data acquisition (DAQ) devices, the most important features to consider when choosing an effective power monitoring system apply to all methods. They include:

- **System Setup Time** – Because you are most likely facing time-to-market pressure, you probably want to gather power consumption data without the overhead of setup time. With some designs, you would need to modify your prototype design to facilitate current measurements with a voltage source, power resistor, and voltage access points. Some processor evaluation platforms may save you some time by allowing direct current measurements, without the necessity of a soldered power resistor. The TI C55x™ Power Optimization DSK has simplified the process by integrating power monitoring circuitry into the evaluation hardware design. This feature reduces setup time to two simple steps – plugging in a cable and opening the included DSP development environment and the ready-to-run software program to begin taking measurements. If you need more measurement accuracy or different analysis capabilities, consider the previously discussed NI hardware and software options for power monitoring.

- **Measurement Accuracy** – Several different error sources exist in any power monitoring system. For instance, a power resistor for current measurements can add as much as 1 percent of variance to the measurements. The hardware that digitizes the analog voltage into a digital signal can potentially add another 1 percent error. To optimize system accuracy, you must first determine the tolerances at which you are willing to operate. You may just need a rough estimate, or you may require very precise measurements. Using those tolerances, you can then select the correct hardware and proper setup based on the level of accuracy you require. Measurement hardware manufacturers typically specify accuracy in terms of **digits** of resolution (typically for DMMs) or **bits** (typically for power meters and PC-based data acquisition hardware). You can improve power measurement accuracy by selecting high-resolution hardware with direct current measurement capability and onboard device calibration. To minimize environmental causes of error, conduct measurements with consistent ambient room temperatures and allow sufficient time for system warm-up.

  The power monitor circuitry built into your TI C55x™ Power Optimization DSK consists of a 14-bit, high-performance digitizer. Three shunt voltage resistors convert current to voltage and multiplex these signals to the digitizer. For more information, review your DSK hardware user manual.

- **Real-Time Data Viewing and Logging** – Using real-time analysis, you can use iterative power optimization because you can identify areas of high power consumption quickly and work to minimize power where possible. To get a more complete picture, your power monitoring analysis can include functions such as maximum power, average power, RMS power, and even limit testing. You also can incorporate into the system the ability to easily record all test data, so that you can use data offline for test comparison, benchmark data publishing, or even auditing purposes.

  The Power Optimization DSK includes a LabVIEW executable file to observe and record real-time power data to disk. With the addition of the LabVIEW Full Development System software, you can download the Power Optimization DSK application source code from ni.com and edit this graphical code to best fit your application needs.
About National Instruments

National Instruments (www.ni.com) is a technology pioneer and leader in virtual instrumentation – a revolutionary concept that has changed the way engineers, scientists, and OEMs in industry, government, and academia approach measurement and automation. Visit ni.com for more details on National Instruments measurement hardware and software.