Module 2

Introduction: Voltage, Current and Power

Introduction: Voltage, Current and Power

Educational Objectives:

REVIEW Electric circuits with resistors, capacitors and inductors
UNDERSTAND Voltage, current, and power
EXPLORE Behavior of resistors, capacitors, and LEDs
LEARN How to use an oscilloscope
MEASURE Voltage and current in resistors, capacitors and LED

Prerequisites (Module 1)

- Running code on the LaunchPad (Module 1)

Recommended reading materials for students:

- Volume 1 Section 1.1,
  Embedded Systems: Introduction to the MSP432 Microcontroller ISBN: 978-1512185676, Jonathan Valvano, copyright (c) 2017

or

- Volume 2 Sections 8.1, 8.3.1, and 9.1
  Embedded Systems: Real-Time Interfacing to the MSP432 Microcontroller, ISBN: 978-1514676585, Jonathan Valvano, copyright (c) 2017

This module serves as a brief overview of the electrical engineering terms used in the circuits of this class. As a prerequisite of this course, we expect the students to have basic understanding of resistors, capacitors, and inductors. The electrical circuits for the robot explorer are either given or very simple, so this course does not entail circuit design. However, students will need to understand voltage, current, and power as they apply to these circuits. This module presents formal definitions of voltage, current, and power. The lab provides a simple means to discover these parameters for resistors, capacitors, and LEDs.

Current (I) is defined as the movement of electrons. Current is directional and measured at one point as the number of electrons travelling per second. Current has amplitude and a direction. Because electrons are negatively charged, if the electrons are moving to the left, we define current as flowing to the right.

Voltage (V) is an electrical term representing the potential difference between two points. The units of voltage are volts (V), and it is always measured as a difference. Voltage is the electromotive force or potential to produce current.

Another important parameter occurring when current flows through a device is **power**. The power (P in watts) dissipated in a device can be calculated as the product of voltage (V in volts) times current (I in amps). Interestingly, although voltage has a polarity (+ and –) and current has a direction, power has neither a polarity nor a direction. Resistors, capacitors, LEDs, and motors dissipate power in different ways.

The **energy** (E in joules) stored in a battery can be calculated from voltage (V in volts), current (I in amps), and time (t in seconds). Energy has neither polarity nor direction.

An **oscilloscope**, or scope, graphically displays information about an electronic circuit, where the voltage amplitude versus time is displayed. A scope has one or more channels, with many ways to trigger or capture data.
A scope is particularly useful when interfacing sensors and actuators to the robot explorer.

A **signal generator** is a device that creates a voltage versus time output. Example waveform shapes are square waves, pulses and sine waves. Some generators allow you to control frequency and voltages of these waves.

In the lab associated with this module, you will build some simple circuit with resistors, capacitors, and LEDs. Using a voltmeter and current meter, you will study the steady state response (direct current, **DC**) of resistor and LED circuits. In this way, you can discover voltage, current and power. Using a signal generator and an oscilloscope, you will study the transient response (alternating current, **AC**) of the resistor/capacitor circuits.

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