

Chapter 10 Generating Energy from Bike

The bike experiment was a demonstration built to display usage of various types of light bulbs. The ones on the left are the old style incandescent and are 50 watts/each. So if one were to pedal the bike with all five on, he would be generating 250 watts of energy. The ones on the right are LED and consume about 1 watt/each. They are a much lighter load. The small switches shown between the two columns of lights allow the various bulbs to be turned on/off. The display at right is the Siemens HMI display and is used to display calories expended as the student pedals the bike.



Bike at left – Above Lights for Loading. Incandescent 50 W/ea. LED 1 W/ea.

The bike has two inputs, one for current and one for voltage. Power is the instantaneous value $V \cdot I$.

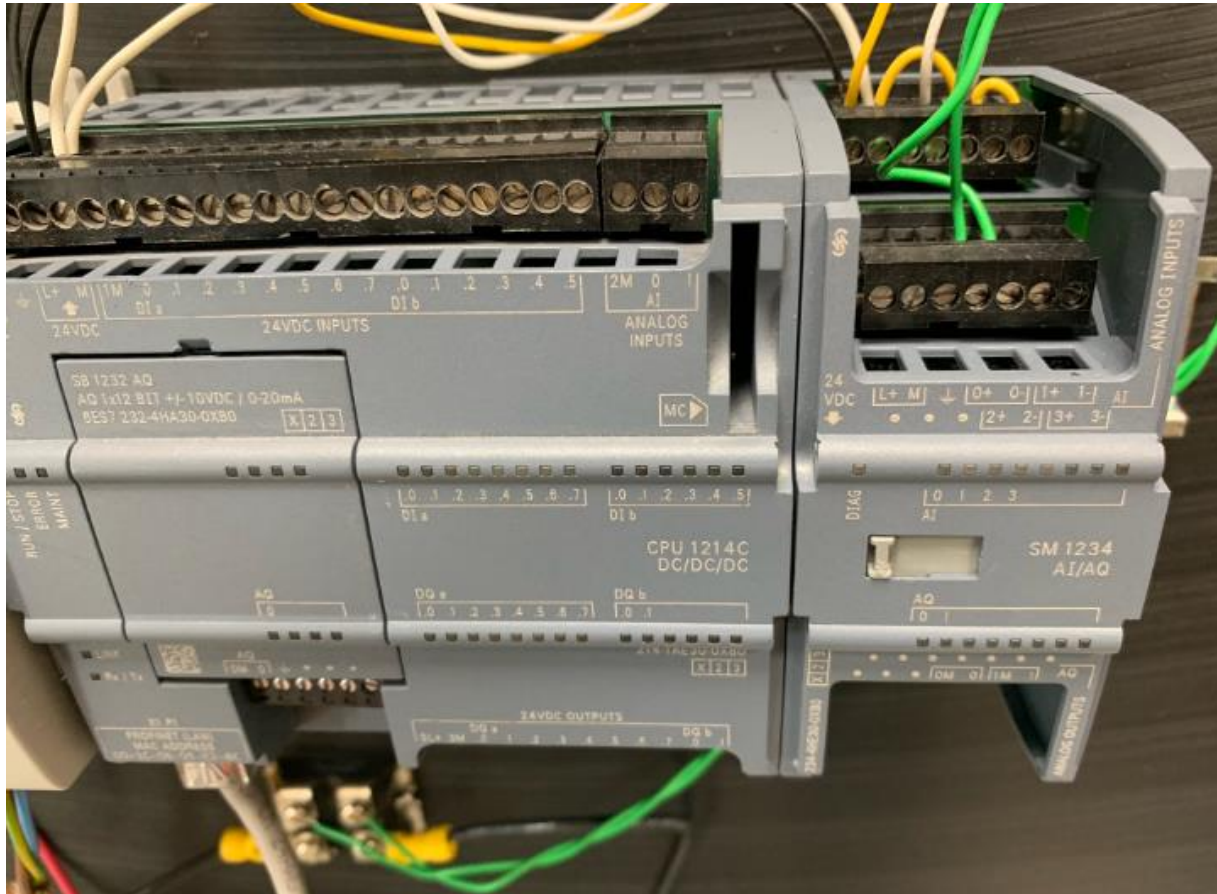
The relationship of power to energy is:

$$\text{Power(Watts)} = \text{energy(Joules)} / \text{time(seconds)}$$

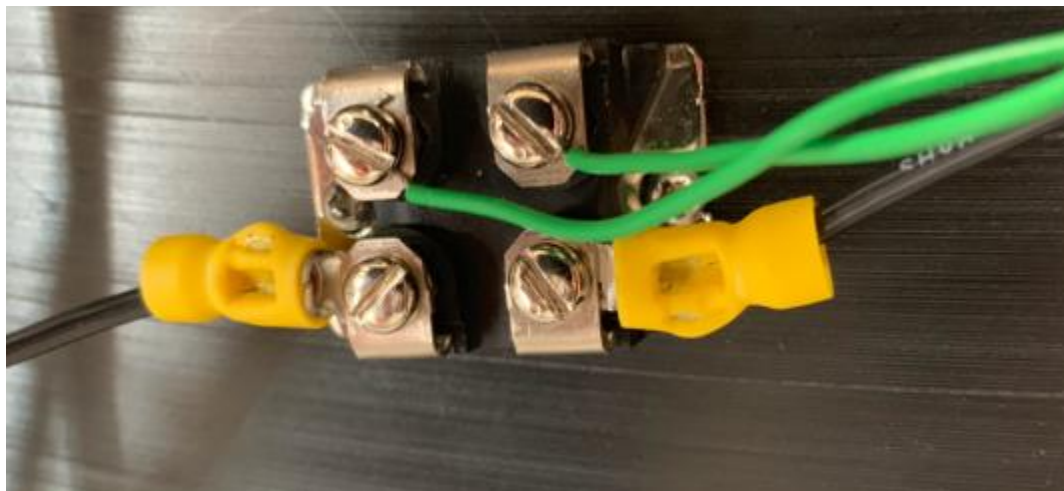
and

$$1 \text{ Joule} = 0.238902957619 \text{ calories}$$

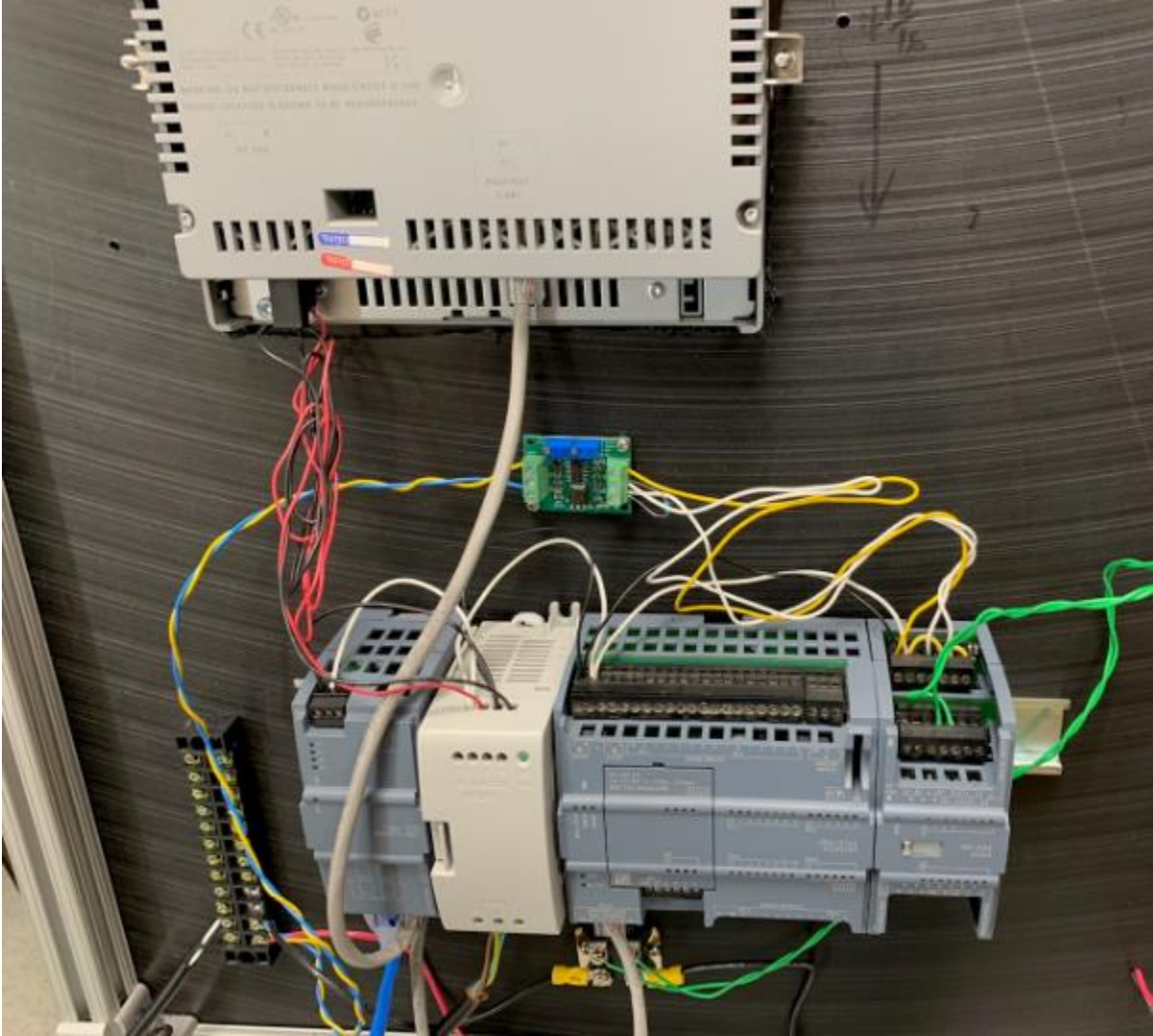
The processor was not capable of providing the analog inputs as needed. A card was added to the right side – the SM 1234 Analog Input Module.



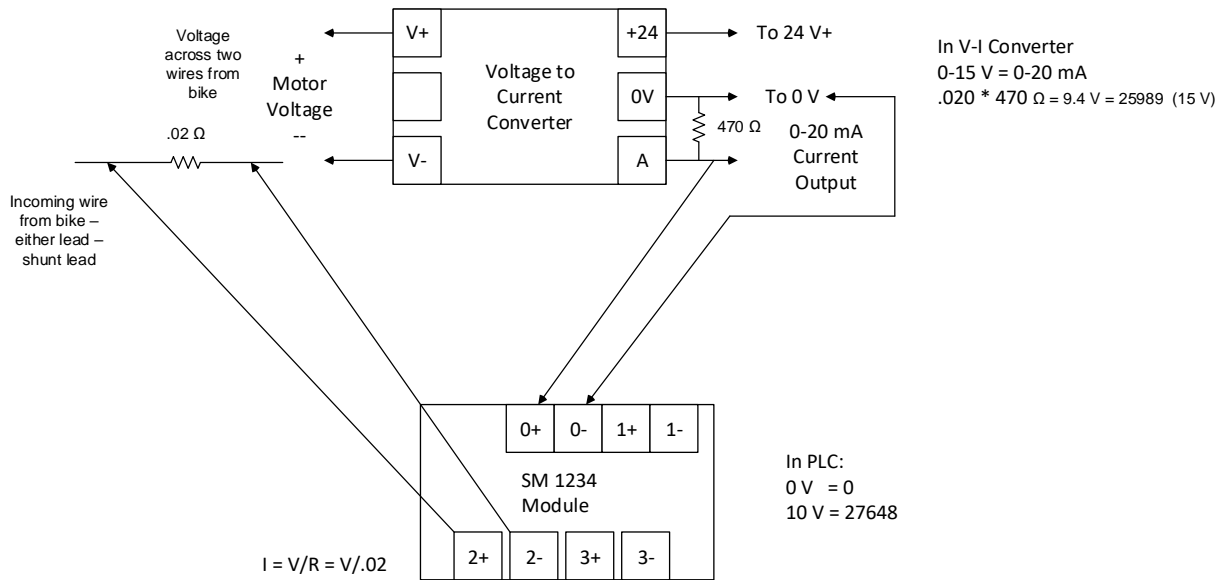
The following figure shows the wiring for the .02 ohm resistor. This resistor is commonly referred to as a shunt resistor. The green wire on the left is the V+ voltage reference (2+) and the green wire on the right is the V- voltage reference (2-).



The entire assembly from the back can be seen below. At the top is the back of the display. Then the voltage converter and finally the processor and shunt relay.



The current and voltage is input to the PLC using the following diagram:



The object is to create a display that denotes volts, amps, watts, joules and calories.

Details of the voltage to current converter:

Why must we convert voltage to current in the first place. The answer is due to the range of the voltage input which is 0-10 v. The range of the bicycle is 0-12 V or even higher. We must protect the voltage input from over spiking. So, we convert voltage to current and put the current through an appropriate resistor to be able to stay in range of the analog input on the Siemens processor.



NOYITO Voltage to Current Module 0-2.5V 3.3V 5V 10V 15V 24V Voltage to 0-20mA 4-20MA Current 0/4-20mA Signal Generator Moudle (0-15V to 0-20mA)

Size: 0-15V to 0-20mA

- Voltage to Current module, can 0-2.5V / 3.3V / 5V 10V / 15V / 24V voltage conversion to 0-20mA / 4-20mA current signal output, by adjusting the voltage to adjust the size of the current. Can be used to generate the signal source, valve adjustment, inverter control, PLC debugging, instrumentation test, LED test, analog transmitter.
- Implement the industry standard voltage (0-2.5V / 3.3V / 5V 10V / 15V / 24V) into an industry standard current (0-10mA, 4-20mA). Drive capability MAX15mA, linear output, the output signal can be directly connected to the AD converter, with the AD function with the microcontroller connection.
- Using single-chip embedded technology. The module is small and easy to use in different places.
- Easy to operate, can be fine-tuned by potentiometer.
- Module working voltage: DC24V . 【Please see the product pictures on the left side of the page for the wiring diagram of the product.】

Product description

Size: **0-15V to 0-20mA**

Features:

Using single-chip embedded technology.

Implement the industry standard voltage (0-24V) into an industry standard current (0-10mA, 4-20mA).

Drive capability MAX15mA, linear output, output signal can be directly connected to the AD converter.

Can be connected with a microcontroller with AD function.

Easy to operate, can be fine-tuned by potentiometer.

Module operating voltage: DC24V

Pin Description:

24V: Operating power supply 24V DC +.

GND: 24V DC-.

P1: Adjustable potentiometer 1 pin;

VIN + (V + / P2): Input voltage 0-2.5V / 3.3V / 5V 10V / 15V / 24V DC- (OR adjustable potentiometer 2 pin).

VIN- (V- / P3): INPUT DC- (OR adjustable potentiometer 3 pin) 0V: Output current 0-20mA / 4-20MA.

Special Instructions:

The working voltage connected to V + and V-, cannot be reversed, so as not to damage the control panel and components. In the VIN terminal control voltage, the range is 0-5V, there is a corresponding output at the output current. The correspondence between voltage and current can be fine-tuned by adjusting the potentiometer.

The purpose of the lab is to calculate power from $V \cdot I$ and then calculate the joules of energy expended. Then convert joules to calories and display on a graph as the student pedals the bike. The program is created in a timed interrupt program. I suggest a 1.0 sec interval. The video shows the various parameters involved. The calculations and final display is the task of the student.

An aside:

If a bike is not available, a high capacity DC power supply is acceptable. The voltage will dip rather quickly, however, with a large number of 50 W bulbs energized.



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