

ENEL 372– POWER ELECTRONICS 1

Buck Converter

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DC-DC converters are widely used in regulated switch-mode DC power supplies. Often the input to these converters is an unregulated DC voltage, obtained by rectifying the line voltage. DC-DC converters are used to convert this unregulated DC input into a controlled DC output at a desired level. This experiment considers the buck or step-down converter.

1. Connect a DC power supply ( $<15V$ ) to the buck converter. Using an oscilloscope probe look at the transistor base control waveform. Vary the transistor switching frequency to check that the total frequency range is available. Set the switching frequency at about 5kHz. Now vary the pulse width (duty cycle) to check the full range of controllability is available. Plot output voltage against duty cycle. What do you conclude?
2. **NOTE: Make sure that your probe grounds are connected at point X only** Set duty cycle to about 30%, switching frequency to about 5kHz, select maximum inductance and maximum capacitance. Using the same scaling on each channel, look at the input and diode currents on the oscilloscope. 1 ohm resistors are provided for this purpose. You may have to invert either one or both of these channels to make it look right (push **Ch 1 Menu**). Refer to handout top waveform. Now add channels 1 & 2 to produce a trace of the current passing through the inductor. (Push **Math Menu** button, select **Operation +** to give CH1+CH2) Compare these 3 waveforms for the ideal textbook waveforms.

Now vary the inductor down to its minimum value observing the changes in current waveforms which takes place. Using the hard copy hand out (which is set at minimum inductance) label each waveform and explain what is happening to the output current ?

Set duty cycle to 40%, switching frequency to about 5kHz, select maximum inductance and minimum capacitance. Use a probe to look at the output capacitor voltage. Vary the inductor and capacitor, noting the effect on the capacitor ripple voltage. With maximum inductance selected and 10 $\mu$ F, measure the peak-peak capacitor ripple voltage over the frequency range 1 - 10kHz and determine the relationship between them.

3. Your solar (photovoltaic) panel is going to be used to provide power and you wish to extract the maximum power from the panel. Would you design your power supply, which regulates the power out of the solar panel, to operate in continuous or discontinuous mode? Explain why!

4. In your conclusion comment on the usefulness/problems of the buck converter as a DC-DC voltage regulator. (Hint: How else can you step down a DC voltage?)

**References**

M.H. Rashid. *Power Electronics - Circuits, Devices and Applications*. 2<sup>nd</sup> Ed., pp317-20.

Mohan, Undeland & Robbins. *Power Electronics - Converters, Applications and Design*. 2<sup>nd</sup> Ed., pp 162-72

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