I propose a power supply system which is capable of supplying a voltage adjustable from 0 to 80 volts, with an adjustable current limit from 0 to 10 amps. The voltage and current setpoints will have 7 bits of resolution, and the supply will be easy and practical to use for any application within the power constraints of the converter.

**Background**

Electronics projects and lab instrument setups often have a wide range of voltage and current requirements, and it can be difficult to find an appropriate supply. Often lab supplies are overkill (and appropriately overpriced) for simple applications.

The goal of this system is to build a simple, straightforward, and very capable lab supply that will be useful for most electronics projects requiring a lot of power at non-critical noise and voltage ripple levels. The power supply will use a rectified mains input, so the buck converter must meet the following specifications:

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
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<tbody>
<tr>
<td>80 volts unregulated, from 80VAC transformer</td>
<td>0 to 80VDC, 0 to 10A, less than 100mV ripple in all situations</td>
</tr>
</tbody>
</table>

Although efficiency is a concern in the design of the system, it is only a concern insofar as the power dissipation of individual components must be controlled to not cause problems with reliability.

**Hardware Description**

The attached schematic shows an overview of the power supply system. At the core of the system is a synchronous buck converter with an 80V input rail. The half-bridge pair (IRF730 FETs) will be controlled by a single half-bridge driver chip, the IR2184. The 600V offset voltage of the IR2184 allows an 80V rail to be used. The driver chip will be controlled with a 125kHz PWM signal from a microcontroller, an Atmel AT-Mega48. The microcontroller is then used to close the two control loops in software (and it can appropriately select which control loop to use based on user input) by monitoring two feedback inputs. The user will select voltage and current maximums, and the system will attempt to keep the output within these maximums regardless of load or line transients.

One feedback input is the voltage feedback, which comes from a resistor attenuator on the output of the power supply. When the system is operating in a controlled-voltage mode, the microcontroller compares the feedback voltage (using a built-in ADC)
to a known value, and adjusts the duty cycle of the 125kHz PWM output appropriately to compensate for error. Tuning this control system in software allows the transient response of the system to be adjusted carefully. Current feedback will come from an Allegro ACS704 current sensor IC, connected in series with the output. The built-in ADC on the microcontroller will also be used for this sensor, with a similar feedback loop.

The control system will require both +5V (for the control logic) and +12V (for the gate driver ICs) voltages, which will probably be implemented with LM78XX-series linear regulators. These will be driven with separate transformers (or separate secondaries on the same transformer). Although this is a sacrifice in efficiency, this is acceptable because the current consumption of these components will be minimal compared to the total output power, so their impact on efficiency and thermal dissipation is fairly inconsequential.

At the output of the half-bridge will be an LC circuit consisting of a large toroidal inductor (approx 350uH) and a large electrolytic capacitor (approx 1000uF). The inductor value is chosen to allow CCM at 40V output voltage (which results in the maximum current ripple) and a 20W output load. This is a small enough output load to allow an extra “dummy load” to be switched onto the output of the power supply when the load is to small to normally allow CCM. A 350uH inductor results in a 0.4A current ripple, which is less than the current drawn by the dummy load at 40V. The output capacitor will be chosen to result in less than 100mV of output voltage ripple in all circumstances.

The dummy load will consist of two switchable 400 ohm power resistors in parallel, in TO220 packages and capable of handling 70W of combined dissipation. This will allow the dummy load to dissipate enough power at 40V to stay in CCM but not dissipate too much power at 80V.

Project Scope and Management

The core component of this project is the buck converter. If nothing else, the buck converter should be run open-loop with a lab power supply providing the rails and driving a dummy load. The next layer of functionality is the feedback loops, including the voltage and current sensing and a basic interface to allow the user to select the current and voltage limits.

There are a few other features that could be added to improve the usefulness of the device but are secondary to the main operation. For example, the switchable dummy load to keep the inductor in CCM could be added after the fact. Another possible addition to make the supply easier to use would be an automatically adjustable frequency to compensate for light output loads.

Special Component Needs

Most components necessary for the project are available from the lab already, with the exception of some of the control chips. These chips will be obtained from samples or my private collection.
**Timetable**

Week of November 14:  
Assemble and test buck converter open-loop

Week of November 21:  
Add open-loop buck control with MCU, auxiliary supplies on-board (+5V, +12V)

Week of November 28:  
Close voltage feedback loop, test transient response

Week of December 5:  
Close current feedback loop, test transient response

Week of December 12:  
Integrate thresholds, add dummy load to improve operation consistency

If time allows:  
Add frequency modulation and improve interface