Building a Radio-Frequency Acousto-Optic Modulator Driver

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http://seamusholden.files.wordpress.com/2012/04/lasers.jpg
Motivation

Condensed Matter Systems ⇔ Ultracold, optically trapped atoms

http://24.media.tumblr.com/tumblr_lh7ijnZGsv1qbtip01_500.jpg


Cool:

Trap:
The A cousto-Optic Modulator (AOM) & Driver

- The AOM *driver* generates a sinusoidal voltage that drives (powers) the AOM

The AOM modifies:
- Frequency
- Intensity
- On-off state

AOM driver:

Output signal

AOM:
Goal: Build a More Practical Driver

- Bulky
- Expensive
- Long lead time
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- Bulky
- Expensive
- Long lead time

- Cheaper
- Space efficient
- Customized
Selecting the “Perfect” Parts

Data sheet/technical specifications:

Calculations:
- Amplifier must provide 27dB of gain
- 4 drivers will require 4.8A @ 12V
The Assembly

- Design the layout
- Machine the chassis
- Solder the circuits
- Install the components
The Final Product – Internals

Side view

Top view
The Final Product – Interface
Results

It works!
Performance

Driver produce maximum power when generating a signal around its central frequency.

Planned operation range (270 – 430 MHz)
Achievements

- Reduced cost from $1,500 to $800 per driver (nearly 50% savings)
  - Will need appx. 30 drivers for all of our experiments (save about $20,000 total)

- Appears that chassis can suit 4 drivers
Achievements

Space efficient!

Manufacturer’s AOM driver
Achievements

- Documents my work
- Contains architecture for future AOM driver builds

The power supply (PSU):
In our case, the power supply is used to convert AC power from the wall to DC power at the voltages required to properly power the internal devices (listed above). The devices are connect to the power supply in parallel via voltage rails (wires that supply current at a certain voltage referenced to ground). The supply lead of a component is attached to the rail with the correct supply voltage, and the ground lead is connected to the ground/common rail. In other words, the component that we want to power bridges the supply rail and the ground rail, causing current to flow through the device. See the image below for an illustrative example.

There are two main types of power supplies: linear and switching. Switching power supplies are relatively cheap and can convert AC power to DC power with about 70-85% efficiency. The downside with switching supplies is that they produce relatively strong amounts of ripple (−120mVp-p). On the other hand, linear power supplies have very low ripple (−5mVp-p), but they are relatively inefficient (about 40-60% efficiency) and are generally more expensive.

Some power supplies have leads denoted as +/- S. These are the "remote sense" leads. Here are some good explanations of what these pins are used for:

Important: if your power supply has the remote sense feature, the leads can only be attached across a single device! If you do not plan to use the remote sense feature, then you must connect these leads to the corresponding voltage lead (e.g. connect S+ to V+). Do NOT leave the sense leads open!

Additionally, here is a good explanation about the difference between earth ground and floating ground (F.G.):
Future Plans

- Improve upon current design for future drivers
- Share this architecture with other labs on campus
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Figure 1.1 Optical transitions for $^6$Li and $^7$Li.
AOM Driver Schematic

Control Input (Manual/PC) → Voltage controlled oscillator → TTL (Switch) → Voltage variable attenuator → Amplifier → AOM

- Low power signal generated by VCO
- Signal is attenuated
- Signal is amplified and sent to AOM
- AOM receives no signal

TTL ON

TTL OFF