Characteristics of the resonant EOM with a passive circuit for TAMA300
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The characteristics of the new EOM which is packaged in a New Focus housing have been investigated and are presented here. The response of the modulator was found to have a center frequency of 15.225 MHz and a lorentzian linewidth of 384 kHz. The modulation efficiency was measured and found to be 0.112 rad/v_{rms}.

Figure 1 shows the experimental setup for measureing the charactersitics of the modulator. The frequency response of the modulator was measured by phase modulating the attenuated laser beam at various frequencies and measureing the power in one of the first order sidebands, relative to the unmodulated carrier beam. The pmodulator was driven with a series of sine waves that had frequencies near 15.2 MHz and an rms amplitude of 8.42 v. The power of the sidebands and carrier were by the optical spectrum analyzer, which measures the power transmitted through a scanning Fabry-Perot cavity.

To measure the modulation efficiency of the modulator the attenuated laser beam was phase modulated while the power in both first order sidebands and the carrier were measured for various amplitude 15.225 MHz sine waves applied to the modulator.

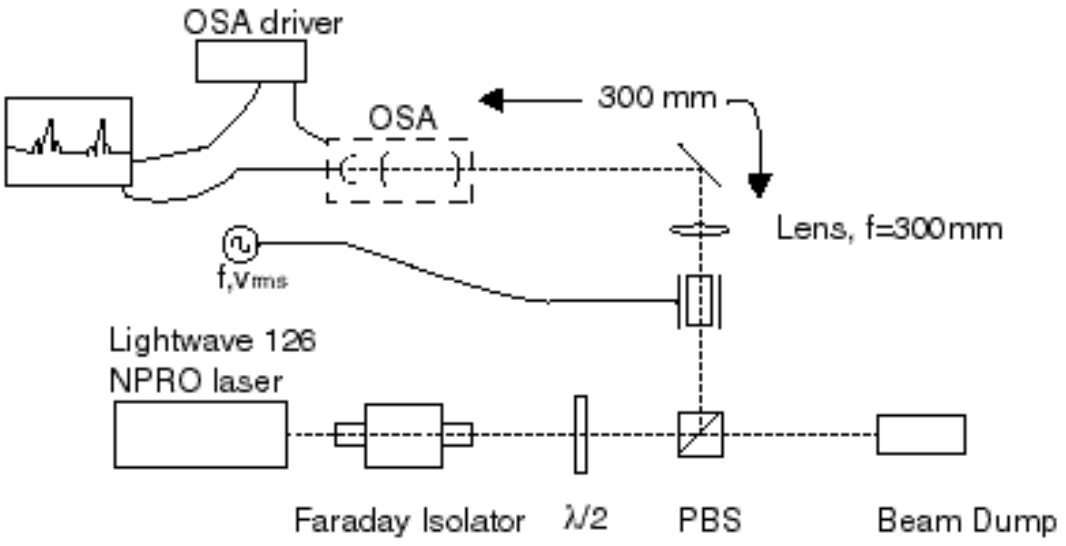

Figure 1. The experimental setup for measuring the charateristics of the electrooptic modulator. The laser beam was attenuater by a half-wave plate and polarizing beamsplitter. The attenuated beam was phase modulated by the EOM driven by various amplitude and frequency sine waves. The spectrum of the modulated light was measured by an opical spectrum analyzer.

The linewidth of the modulators response was found by measureing the response over a broad frequency range and fitting the data to a lorentzian curve with only two free parameters, the center freqeucny and linewidth. The lorenzian curve, shown in figure 2 with the data, is

$$\frac{P(w_m)}{P_0} = \frac{\Delta f^2}{(f - f_0)^2 + \Delta f^2}$$

and was best fit with the parameters f_o=15.174 MHz and Df=384 kHz. The measurement covered a broad spectrum, and so measured far into the tails of the lorentzian curve making it well suited for measuring the linewidth. With only 6 data points within one linewidth of the center frequency, however, the precision of the measurement of the center frequency was poor.

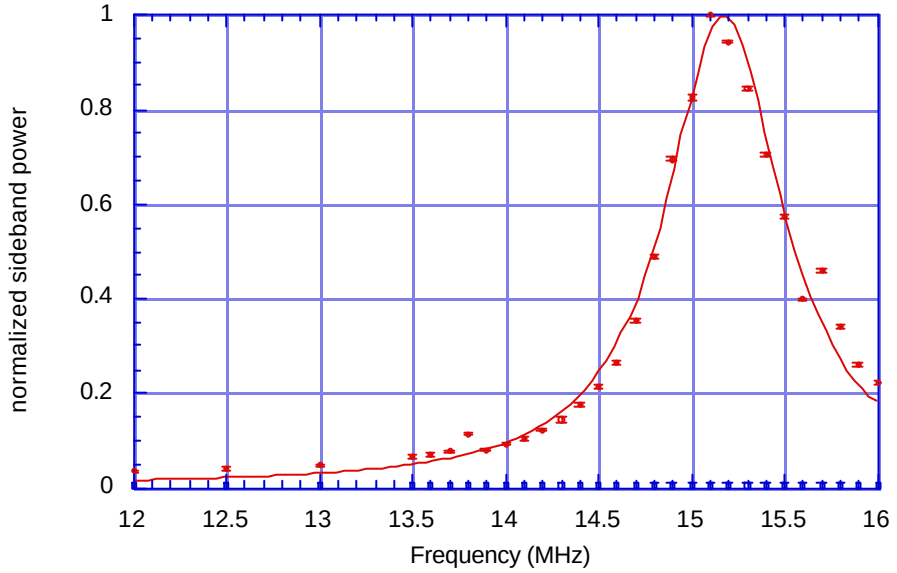

Figure 2. The response of the modulator over 4 MHz near the center frequency. A lorentzian fit to the data is also shown.

To increase the precision of the measurement of the center frequency, the response was again measured with 100 data points inside of one linewidth. The center frequency was found to be 15.225 MHz as shown in figure 3.

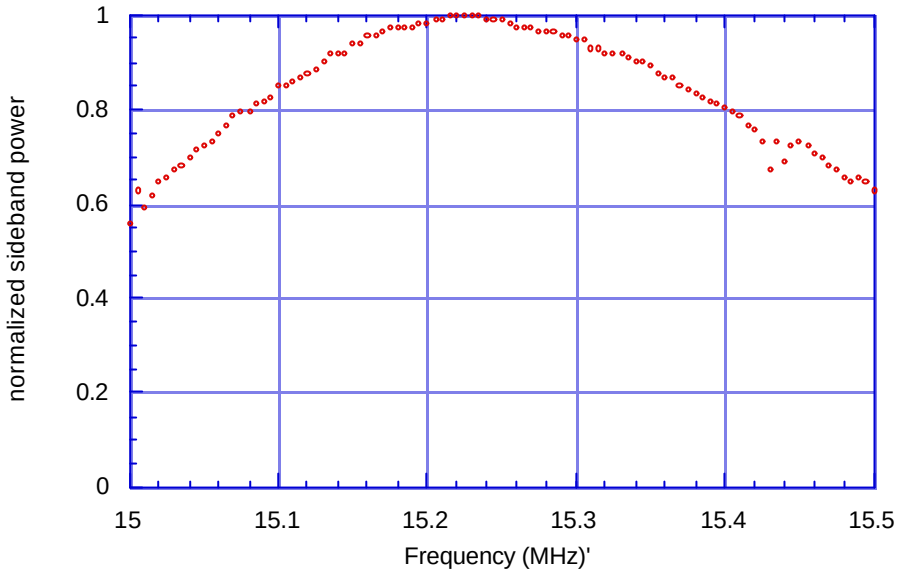

Figure 3. The response of the modulator near the center frequency. Notice the discontinuity near 15.432 MHz.

The modulation efficiency was determined by measuring the power in the carrier and sidebands at different drive voltages to the EOM. The power levels, when normalized to the unmoculated carrier power obey

$$\frac{P_0(m)}{P_0(0)} = J_0^2(m)$$

$$\frac{P_w(m)}{P_0(0)} = \frac{P_{-w}(m)}{P_0(0)} = J_1^2(m)$$

Figure 4 shows the data which fit to the these bessel functions when the modulation efficiency is m=0.112 rad/v_{rms}.

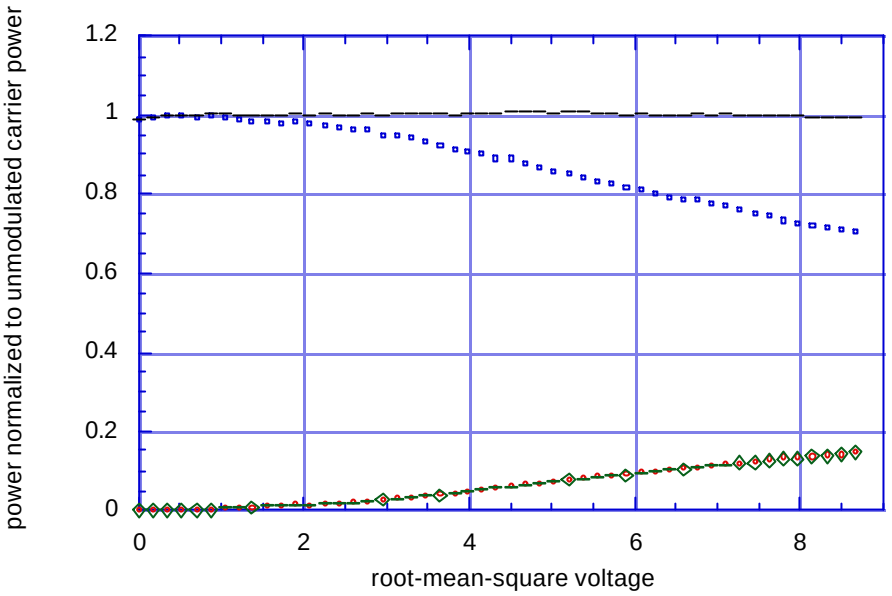

Figure 4. The power of the carrier and both first order sidebands normalized to the unmodulated carrier power as a function of the root-mean-square drive voltage on the electrooptic modulator. The square markers represnet the power in the carrier, the diamond and circular markers represent the power in each of the first order sidebands, and the line at the top is the total power measured in the carrier and first order sidebands.

These measurements characterize the electrooptic modulator. It has a linewidth of 384 kHz, a center frequency of 15.225 MHz and a modulation efficiency of 0.112 rad/v_{rms}.