Thermo-Electric Control Board for Integrated Optical Beam Forming Network

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Utilizing higher frequency “millimeter wave” (75GHz-110GHz) for communications to drastically improve data transmission rates

- Shorter wavelength = More directional beam

- Using integrated optics to steer beam

Increasing Delay

Path 1 (Most Delayed)

Path 4 (Least Delayed)

Each delay achieved by ring resonator

Each ring resonator has heater paired with it
Goal: Design 64-channel programmable current source

- Need to control 64 independent current sources to tune delays
- Controlled from PC via I²C communication
Amplifier design

- Utilizing a common op-amp feedback circuit with several additions to supply large amount of power ( > 1 Watt)
- Achieve max output conditions of 30 V, 43 mA given a 700 Ohm load

\[
\frac{R_2}{R_1} \approx 5
\]

\[
V_{out} = 6V_{in} \left(1 + \frac{R_2}{R_1}\right) V_{in}
\]

\[
V_{out} : 0-30 \text{ V}
\]
DAC Resolution Requirement

- Current sources must be precise within 0.01 mA

Since \( I = \frac{V_{out}}{R_{load}} \)

This implies that \( \Delta I = \frac{\Delta V_{out}}{R_{out}} \)

Our amplifier circuit gives us \( \Delta V_{out} = 6 \times \Delta V_{in} \)

The DAC gives us \( \Delta V_{in} = 5 \times 2^{-n} \), \( n = \) bit resolution

Solving for \( n \), we obtain \( n \approx 12 \) bits
Main tests: Linearity and Stability

- Linearity: When changing the input voltages, the output varies linearly.
- Stability: Output does not vary significantly if circuit is running at max power for long periods of time.
Testing results

Linearity

$y = 6.0281x - 0.1038$

Gain ~ 6
Stability

Max variation = 0.3%
PCB Design For Board (In progress)

Example of another PCB control board

Conclusions and Future Work

- Next Step: Finish PCB design and solder final board

- The thermo-electric control board will help tune and optimize the integrated beam forming network

- A successful integrated optical beam forming network will bring us one step closer to revolutionizing wireless communication.
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