

Optical Attenuation Sensor for Process Control

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Project Background

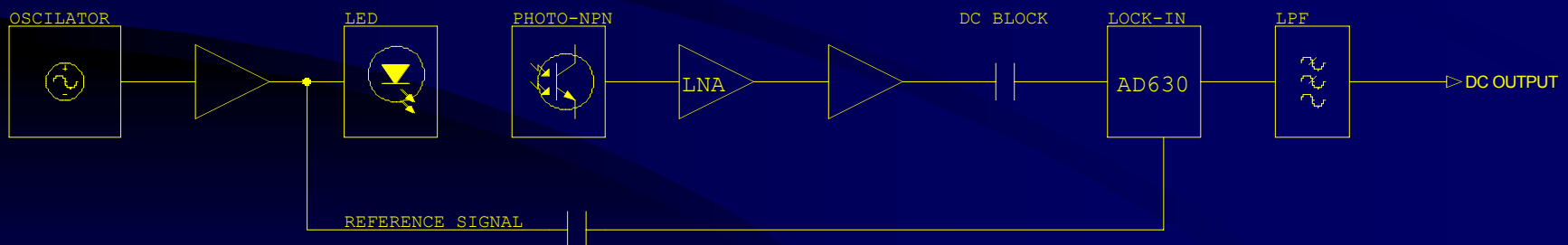
- Originated by a company in the Cleveland area
- Robotic binary epoxy sprayer
 - Currently using an optical spectrum analyzer for process control
 - Looking for an inexpensive alternative

Project Goals

- Decreased cost
- Wide dynamic range
- Strong correlation
- Stability

Our Solution

- Frequency source
- Light emitting diode – phototransistor pair
- Amplify & rectify the detected signal
- Take the DC value of the AC component

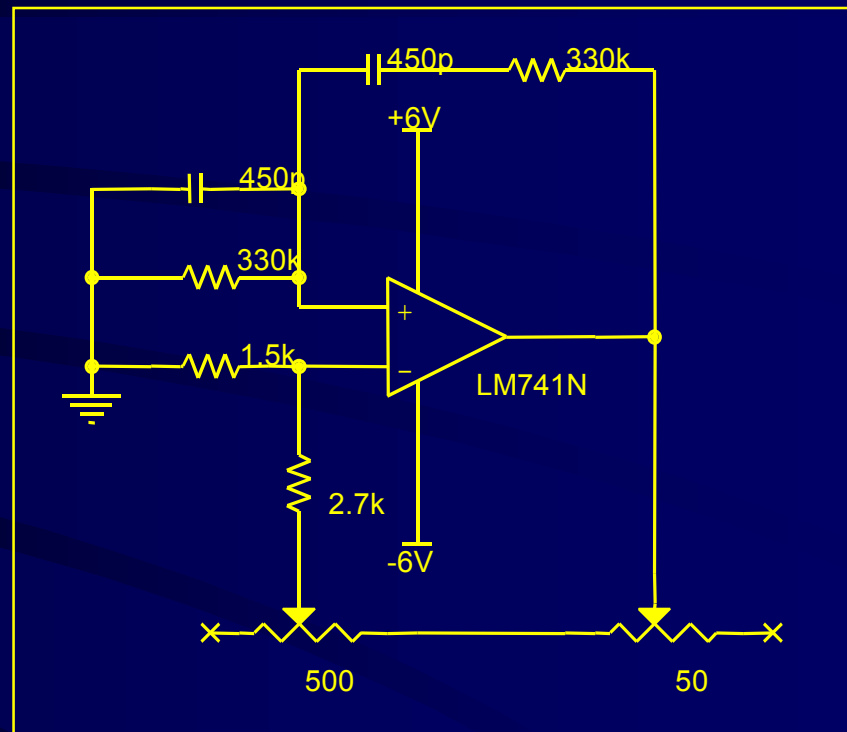


Design Considerations

- Oscillator design
- Optical transmission and detection
- Attenuation measurement
- Output

Oscillator Design

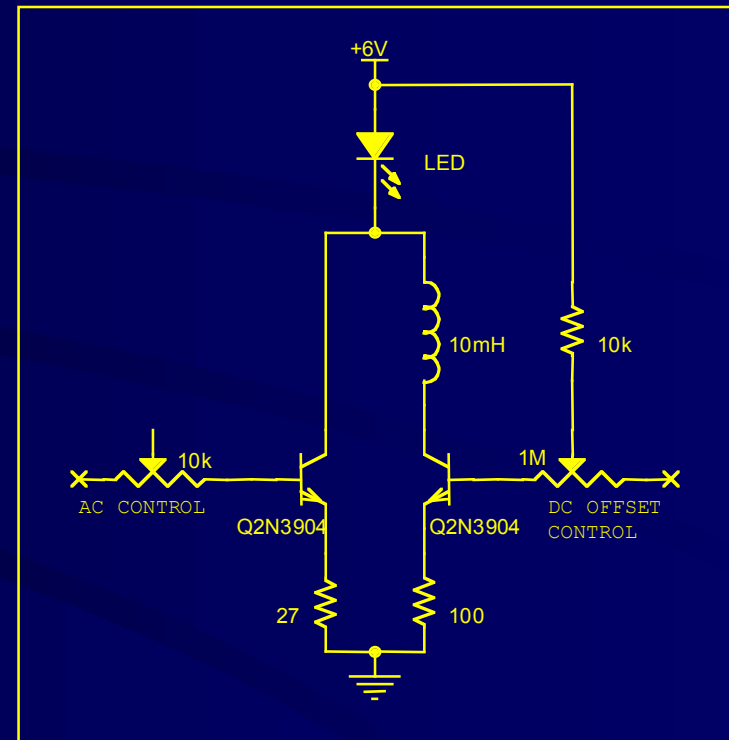
- Onboard
- Sine wave or square wave
- Wien Bridge oscillator



Wien Bridge oscillator

Optical Transmission

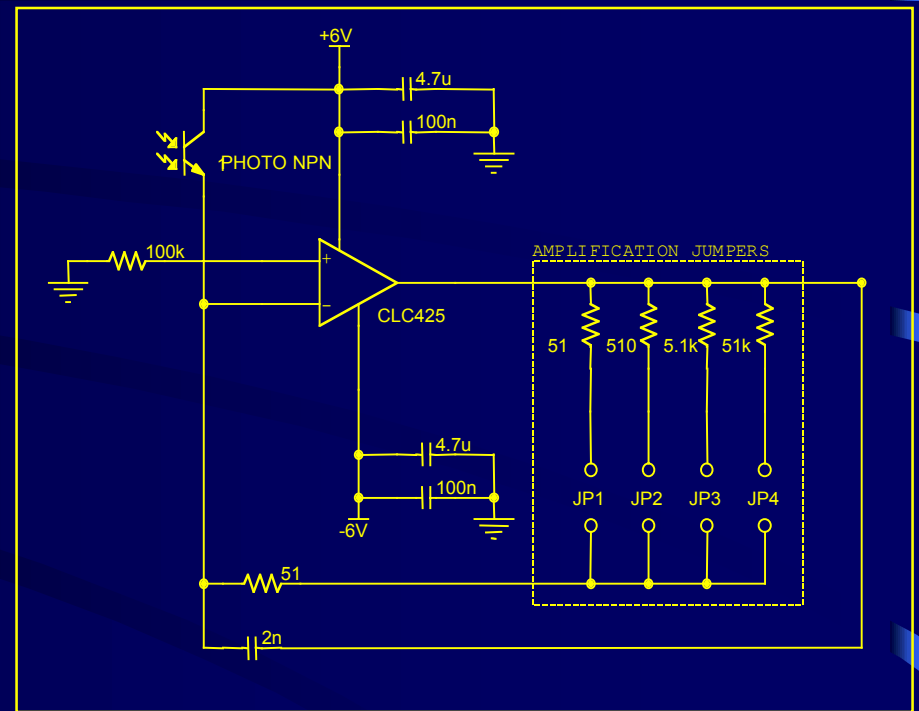
- High output infrared LED
- Separate AC & DC drive controls



LED Drive

Optical Detection

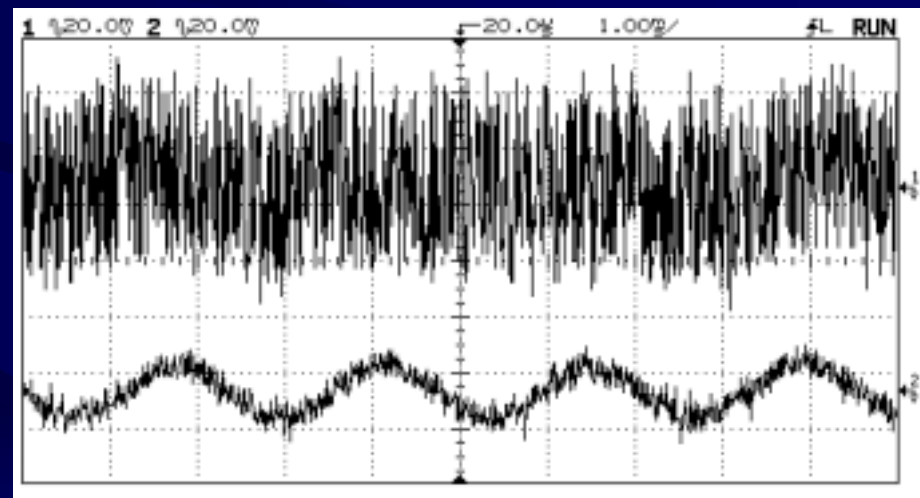
- Phototransistor instead of photodiode
- Low noise amplifier
- Variable gain
- Over-amplification detection



Photoreceiver/Amplifier

Attenuation Measurement

- AD630 - Lock-in amplifier
- Reference & received signals compared
- Low pass filter



Output

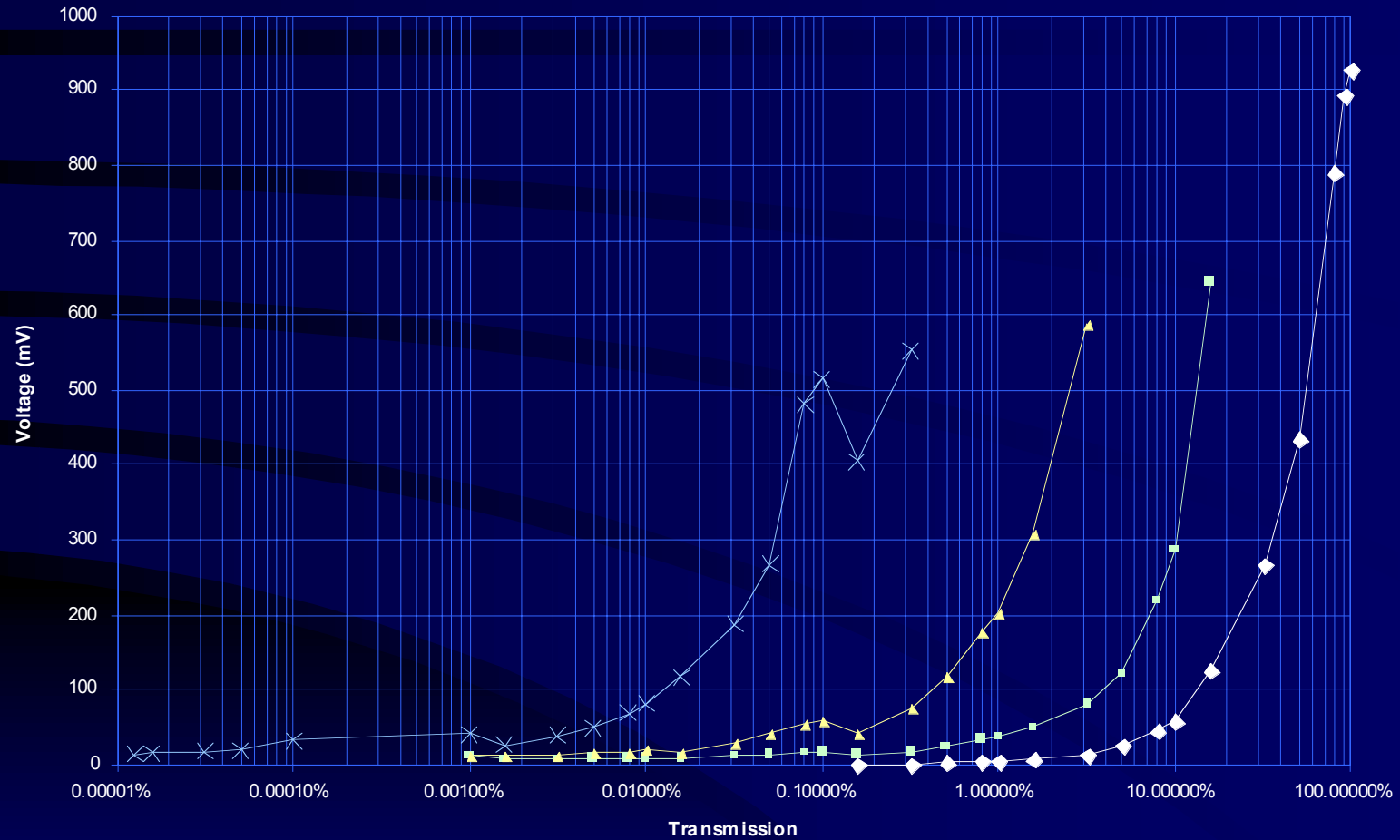
- DC value
- Output circuit
 - Adjustable set points
 - Easy to read

Results

- Over 50 dB dynamic range

Results

Output Voltage



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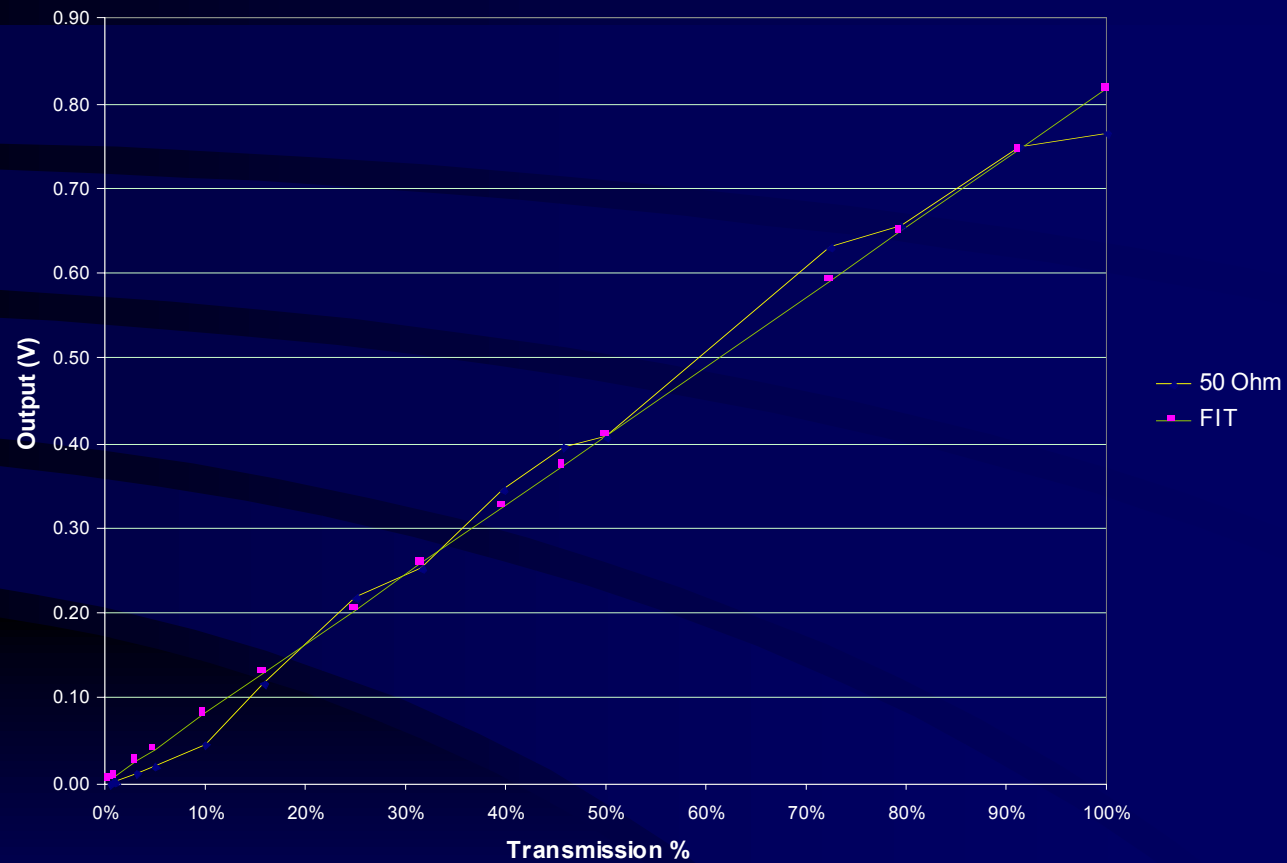
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Results

- Over 50 dB Dynamic Range
- DC output linearly correlated with optical attenuation

Results

Low Amplification



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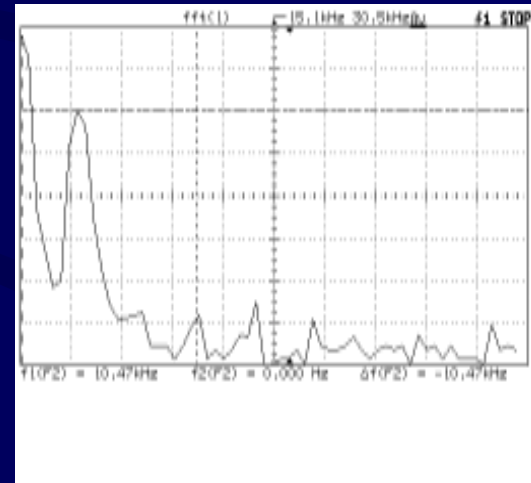
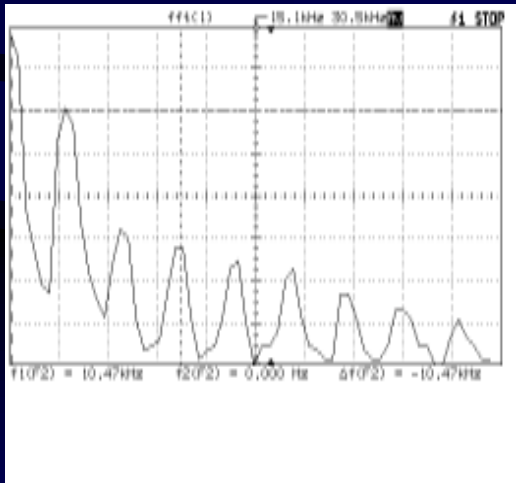
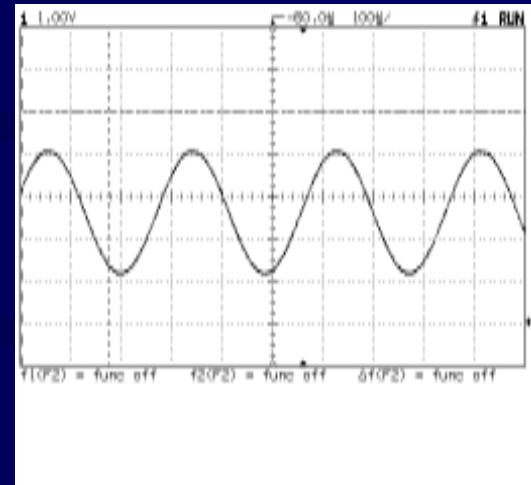
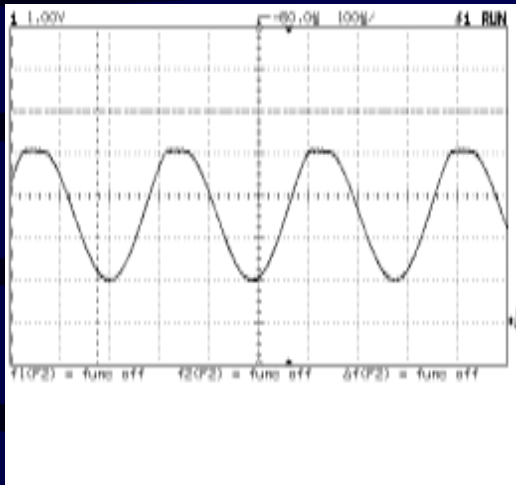
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Results

- Over 50 dB Dynamic Range
- DC output linearly correlated with optical attenuation
- Crosstalk

Results



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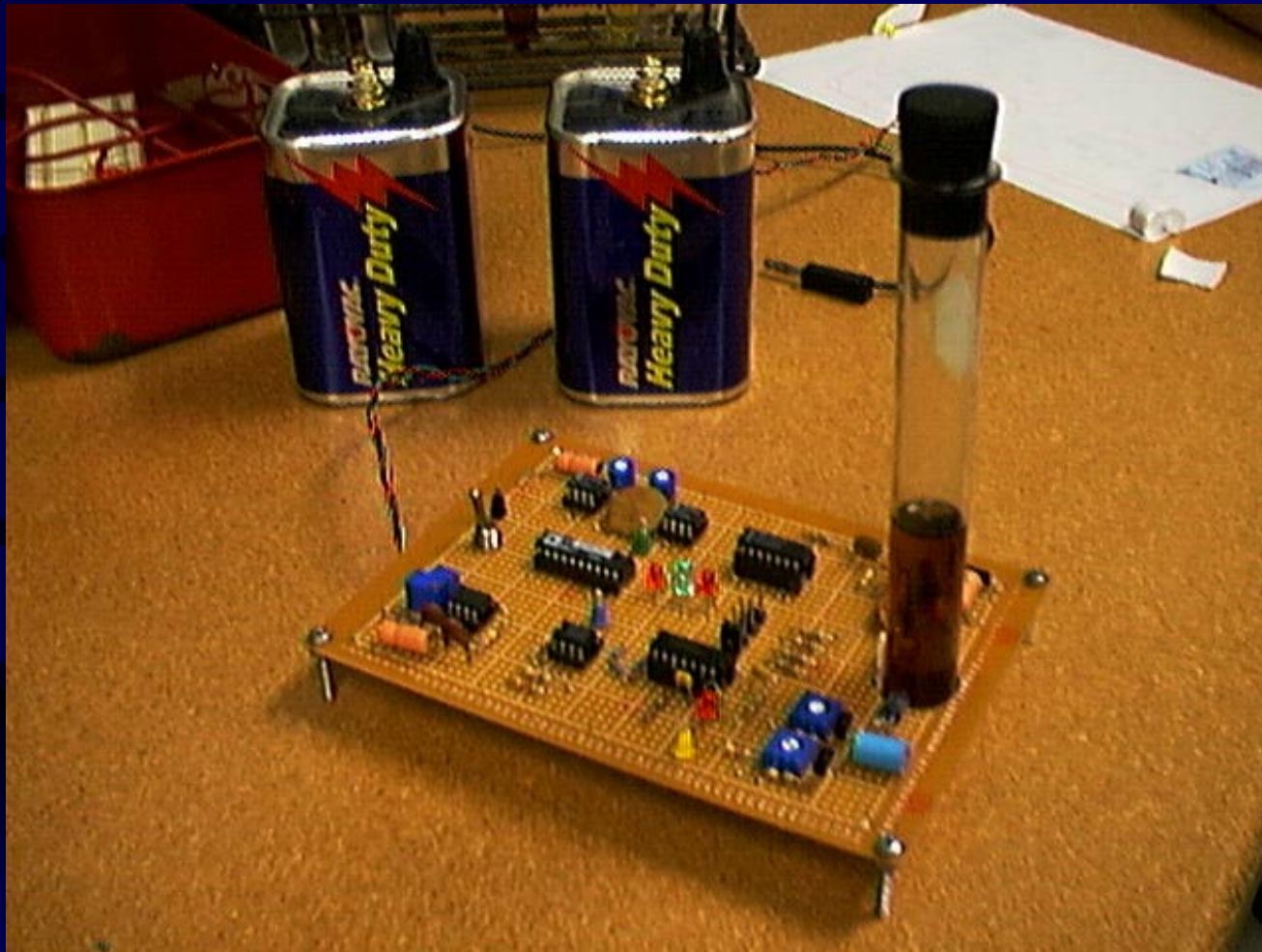
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Recommendations

- Better sine wave oscillator
- Auto-ranging or application specific
- Packaged for industrial environment
- Multiple circuits with neural network

Demonstration



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Conclusions

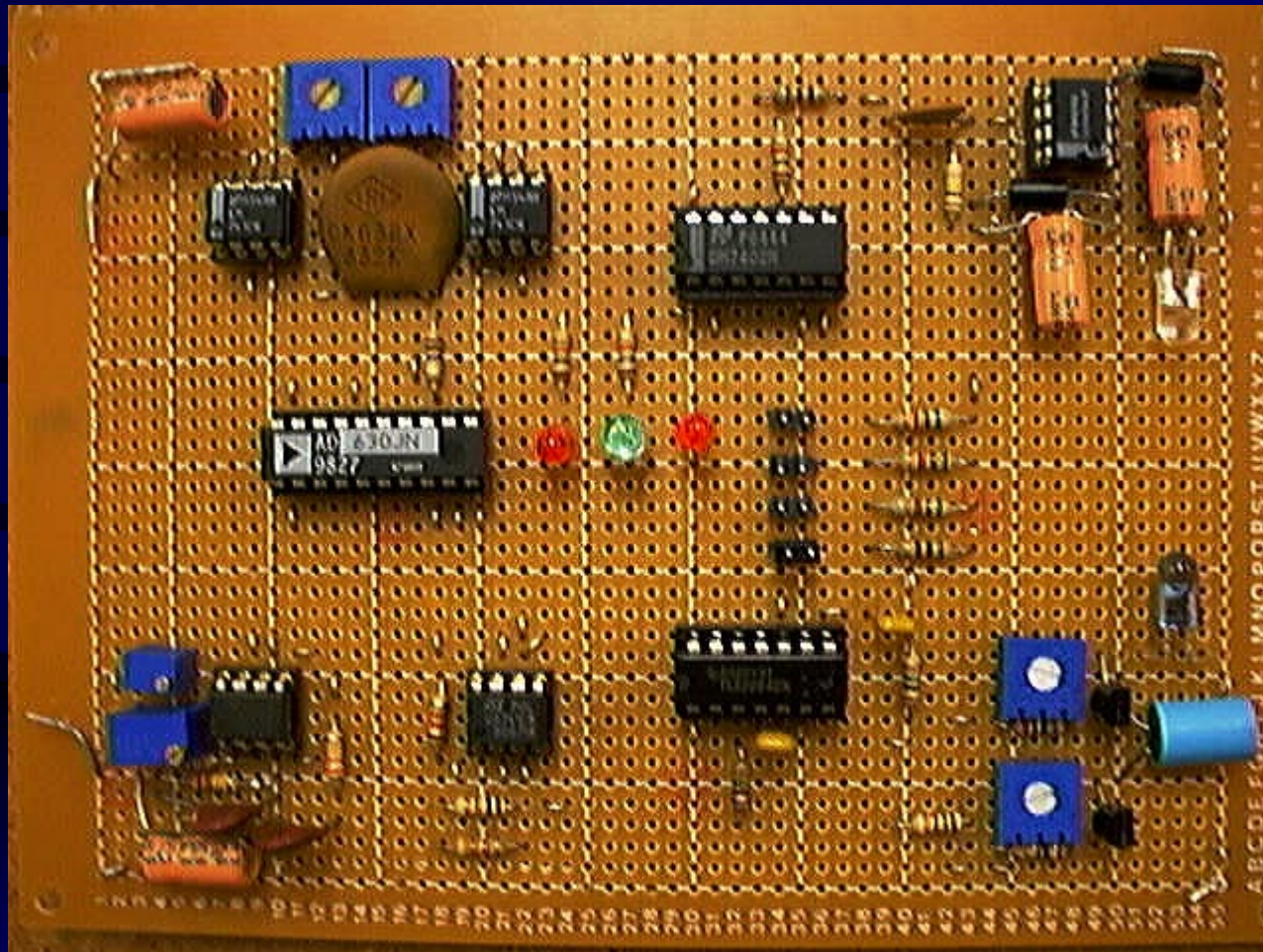
- Goals

- Decreased cost
- Wide dynamic range
- Strong correlation
- Stability

- Results

- Under \$50
- Over 50 dB
- Repeatability & Linearity
- Unaffected by Transients

Any Questions?



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