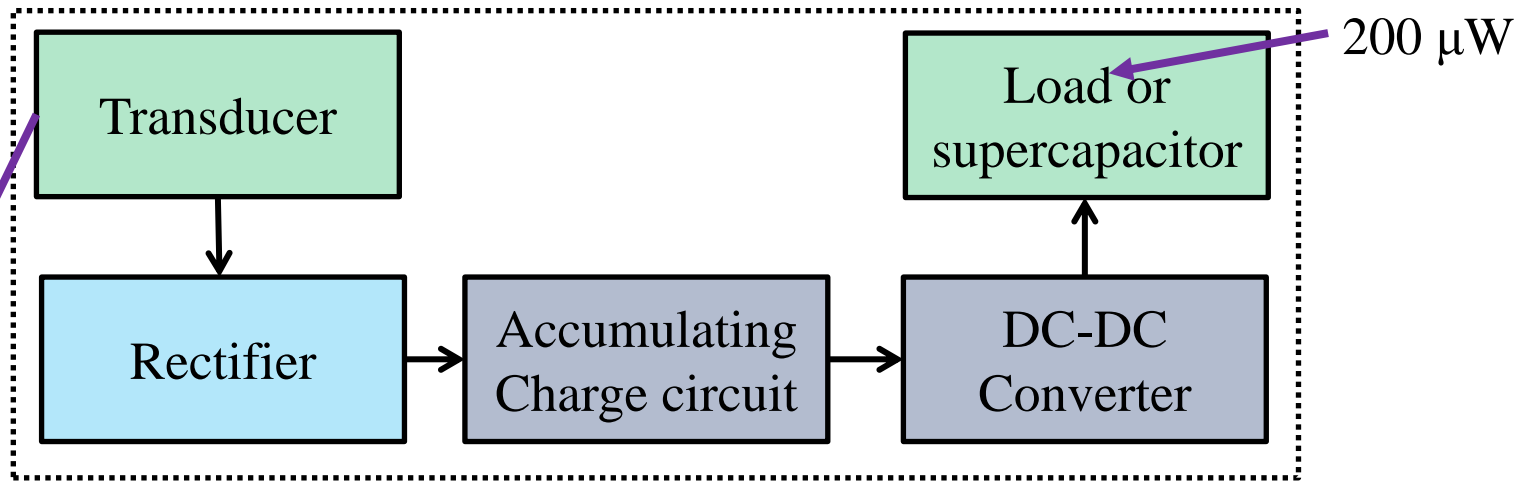


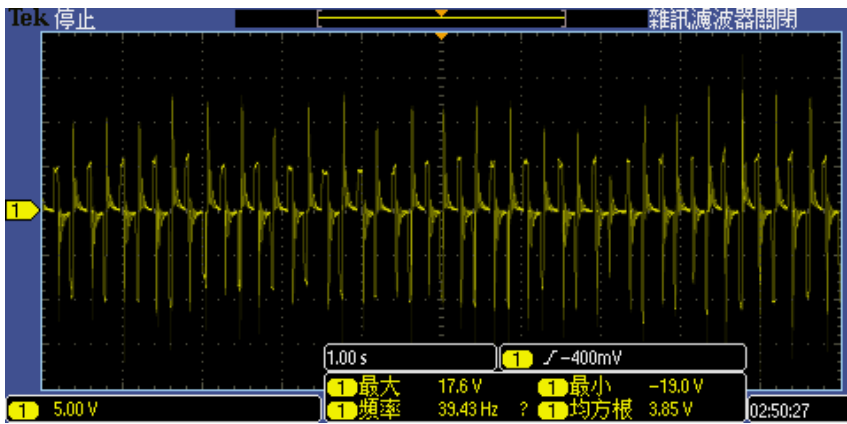
Low Power Consumption Control Circuits of Buck Converter for PZT Energy Harvester

System Function Block



Piezoelectric transducer:

The only power source for the system

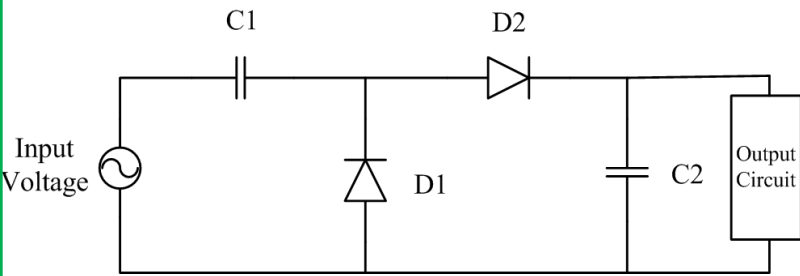


Specifications:

- $V_{out} : 17.6 \sim -19 \text{ V}$
- $V_{rms} = 3.85$
- **Output Power : $P = 29.645 \mu\text{W}$**

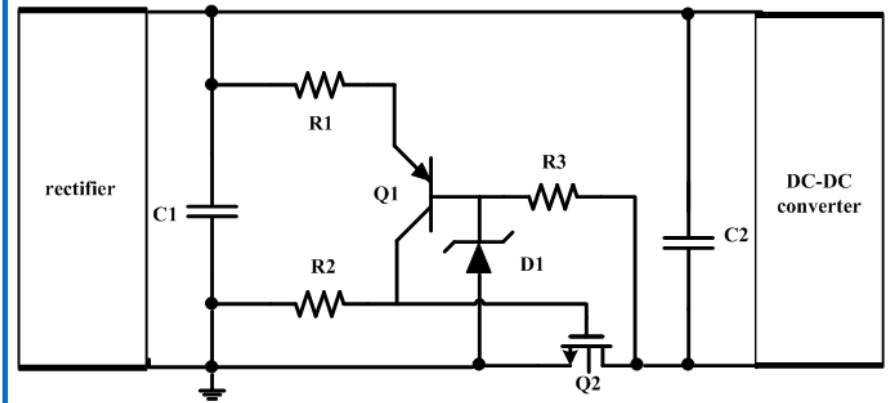
Measurement at $R_{load} = 0.5 \text{ M}\Omega$

Voltage Doubler



Accumulating Charge Circuit

Act like a SCR(Silicon Controlled Rectifier)



➤ Control Algorithm of the Buck Converter

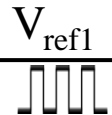
<Control signal1>

Compute the average voltage
of the input

Comp1

<Change sawtooth waveform V_{saw} >

Compare V_{avg} with V_{ref1}



V_{saw}

**Prolong
RC charge time**

(Input voltage decrease)

**Shorten
RC charge time**

(Input voltage increase)

Output Voltage

<duty cycle>
decide Output Voltage

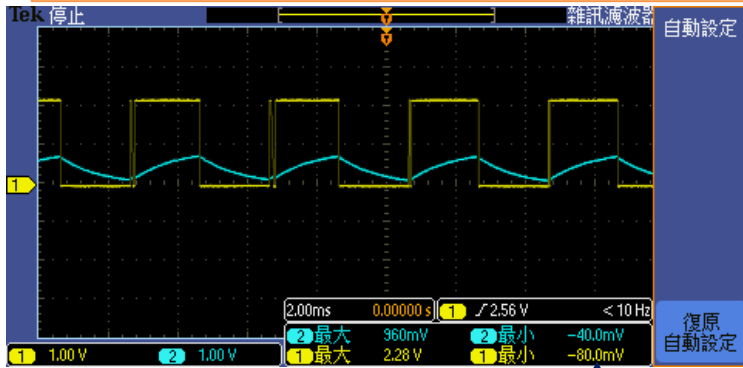
<Control signal2>
 V_{ref2}

Comp2

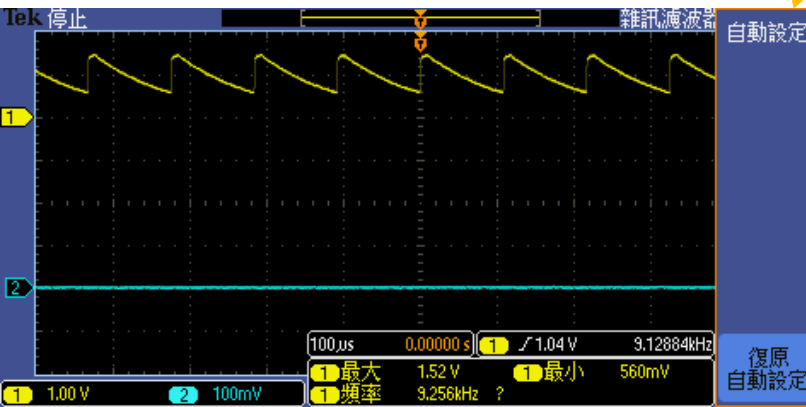
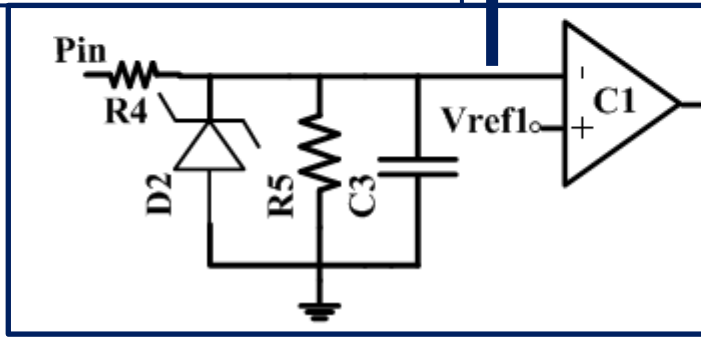
<PWM>

Compare V_{saw} with V_{ref2}

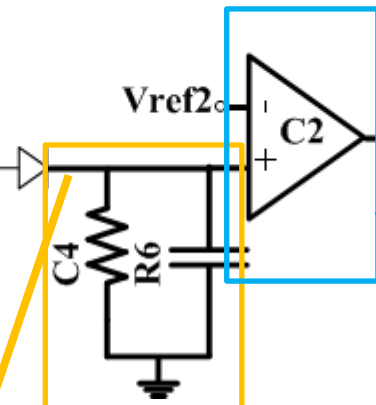
Implemented Buck converter: control circuit consumption about 50 μ W



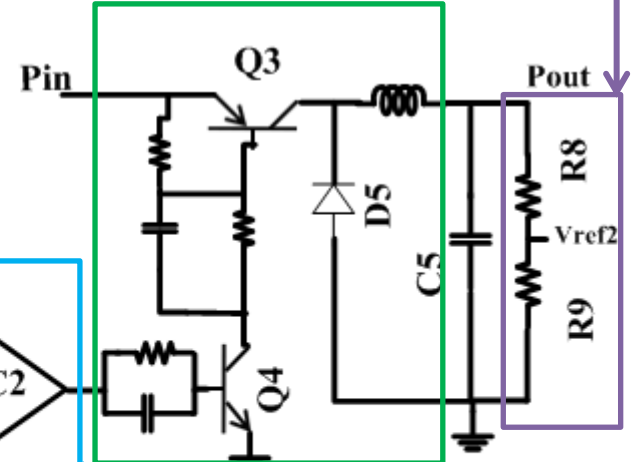
Forwarding:
detect input power level



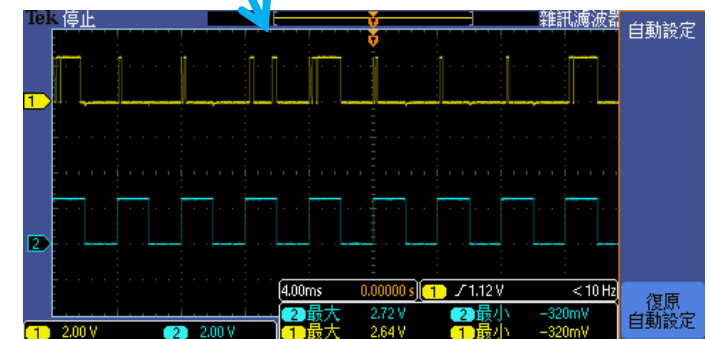
Sawtooth Wave



detect output voltage signal

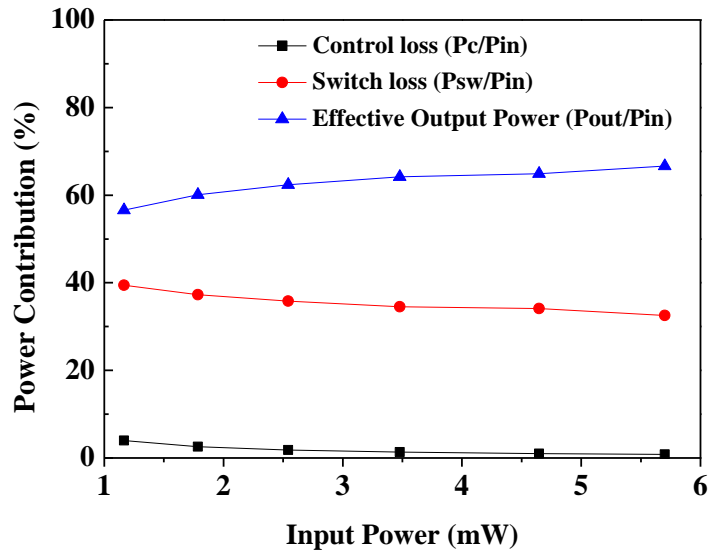


PWM Control Comparator



Transducer Output Power: $\sim 30\mu\text{W}$

Buck Converter



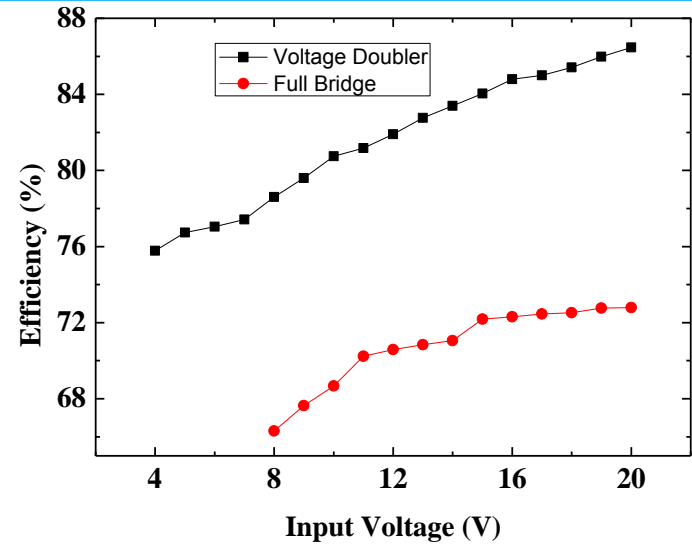
Control Consumption:

- **0.81% ~ 3.98 %** at 1.16 ~ 5.7 mW

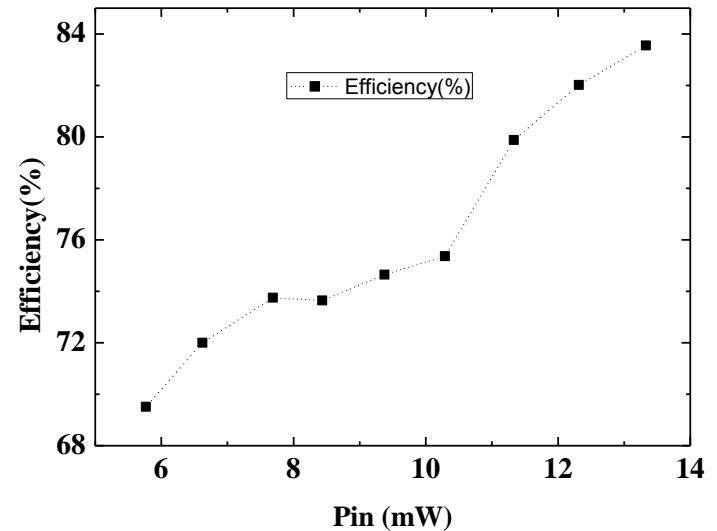
Switch Consumption:

- **39.45% ~ 32.52 %** at 1.16 ~ 5.7 mW

Voltage Doubler & Full Bridge Rectifier



Overall Energy Harvesting System Efficiency



System Efficiency

- **69.51~82 %** at 6~14 mW