Voltage-Source Parallel Resonant Class E Oscillator

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Outline

1. Research Background
2. Proposed Circuit
3. Circuit Experiments
4. Conclusion
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1. Research Background

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4. Conclusion
1. Research Background

Demands

- Increasing the power density → Downsizing

\[ X_L = 2\pi fL \quad X_C = 1/2\pi fC \]

Class E switching condition

Minimizing Dissipated Power:

At the switching instant
- ZVS (Zero-Voltage Switching)
- ZVDS (Zero-Voltage Derivative Switching)
- ZCS (Zero-Current Switching)

Features

- Low switching loss
- Low noise
1. Class E Amplifier

**Features**
- Achieving ZVS, ZVDS and ZCS
- High efficiency even at high operating frequency

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1. Tuned Power Inverter and Oscillator

**Features**
- Switching device is driven by the gate driver

**Point**
- Making a self-oscillation using the feedback mechanism

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Features

- Switching device driven by the feedback voltage from the ac output
- Achieving ZVS, ZVDS and ZCS
  → High efficiency even at high operating frequency
- Several types of Class E oscillators proposed
  → Class E/F[15], Parallel tuned class E[16], Load-independent class E[17]

1. Voltage-Source Parallel Resonant Class E Inverter [8]

Voltage-source parallel resonant class E inverter[8]

**Features**

- $L_s$-$C_s$ resonant circuit
  → No choke inductor or dc blocking capacitor

- Parallel resonant tank
  → Robustness against load fluctuations

- Achieving ZVS and ZVDS
  → High efficiency even at high operating frequency

Outline

1. Research Background

2. Conventional Circuits

3. Proposed Circuit

4. Circuit Experiments

5. Conclusion
2. Voltage-Source Parallel Resonant Class E Oscillator

Voltage-source parallel resonant class E oscillator

**Features**
- \( L_S-C_S \) resonant circuit
  → no choke inductor or dc blocking capacitor
- Parallel resonant tank
- Achieving ZVS, ZVDS and ZCS
- P-ch power MOSFET
2. Design Method of the Feedback Network

Voltage-source parallel resonant class E inverter[8]

Equivalent circuit under fundamental frequency

Phase shift from gate to drain under ZVS/ZDS condition

Voltage $v_{DS}(\omega t) = -v_o(\omega t) - v_{LS}(\omega t) = -V_{DS} \sin(\omega t + \phi + \varphi) = V_{DS} \sin(\omega t + \theta)$
2. Design Method of the Feedback Network

Phase shift from gate to drain under ZVS/ZDS condition

$$\varphi_{AH} = \varphi_{GH} + \varphi_{CD} + \varphi_{AB} = \theta$$
Outline

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3. Parameters in Circuit Experiment

**Specifications**
- Oscillation frequency $f = 800$ kHz
- On duty ratio $D = 0.5$
- Loaded quality factor $Q = 2.00$
- Input voltage $V_{in} = 10.0$ V
- Load resistance $R_L = 50.0$ Ω
- Output power $P_{out} = 1.00$ W

**Proposed circuits**

```
10.0V

300Ω

700Ω

1.16nF

15.1µH

6.20µH

8.12nF

50.0Ω

52.3pF

543pF

108µH(2.00Ω)

S
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**Experimental setup**
3. Experimental results

Power conversion efficiency = 89.49%
Oscillation frequency = 786.4kHz
Outline

1. Research Background

2. Proposed Circuit

3. Circuit Experiments

4. Conclusion
4. Conclusion

✓ Voltage-Source Parallel Resonant Class E Oscillator has been proposed

**Features of the proposed oscillator**

- Switching device driven by feedback voltage
- No choke inductor or blocking capacitor
- Parallel resonant tank

✓ Measured power conversion efficiency was 89.49% at the oscillation frequency 786.4kHz and output power 1.056W

Thank You

If you have any questions, feel free to ask me “4320516@ed.tus.ac.jp”


Reference


