Fig. 3 - Basic Resonant Converter Simulated vs. Waveform Still S.W. 

Note: Resonant circuit added to basic switching regulator makes only 3 vs.
Fig. 6 - Switching Stress and Switching Loss

ZCT switch

ZCT

LOAD LINE TRAJECTORIES

OFF

ON

Gate Drive

Pwm

Loss

old

new

VS

VS
Fig. 7 - Resonant Switches

- Charging & Discharging limits
- ZERO VOLTAGE
- ZERO CURRENT
- Filling & Emptying limits
- limits for when $C_s$ loss
- limits for when $C_s$ loss
Resonance

Fig. 11 - Variable Frequency Continuous

Increasing

Output

About \( f_c \) to \( f_{SW} \)

Sweep \( f_{SW} \)

Above Resonance

Below Resonance

\[ f = \frac{1}{2 \pi \sqrt{LC}} \]
ADVANTAGES:
1. Zero current switching
2. Low component stress
3. Low EMI
4. Useful parasitic elements
5. Improved diode recovery

DISADVANTAGES:
1. Greater complexity
2. Higher peak currents
3. New technology learning curve

Fig. 4 - Resonant Converter Advantages

as fs

Non-linear control loops
Quasi-Resonance Definition

As a limit at maximum load, can approach continuous resonance switched at zero current or voltage half or full cycle conduction parallel or series loaded: quasi-resonance can be:

Not true sinusoidal waveshape

Form of D.C. = $\frac{\lambda_{7/2}}{\pi}$ where $\lambda = 0, 2\pi, 4\pi$
Trigger for H-Bridge transition

Sensing for phase crossing

Fig. 13 - Quasi-Resonant Control

DC-DC Quasi-Resonant

Current Loop Control
Fig. 14 - Switch Activation

La is an issue
C36 of Q an issue
<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>ZERO-CURRENT SWITCH</th>
<th>ZERO-VOLTAGE SWITCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL</td>
<td>CONSTANT ON-TIME</td>
<td>CONSTANT OFF-TIME</td>
</tr>
<tr>
<td>SWITCH VOLTAGE WAVEFORM</td>
<td>≈ SQUARE</td>
<td>≈ SINUSOIDAL</td>
</tr>
<tr>
<td>SWITCH CURRENT WAVEFORM</td>
<td>≈ SINUSOIDAL</td>
<td>≈ SQUARE</td>
</tr>
<tr>
<td>LOAD RANGE</td>
<td>Rmin → ∞</td>
<td>0 → Rmax</td>
</tr>
<tr>
<td>SWITCH LIMITATIONS</td>
<td>PEAK ON CURRENT</td>
<td>PEAK OFF VOLTAGE</td>
</tr>
</tbody>
</table>

**ZERO-VOLTAGE USAGE:**

1. VERY HIGH FREQUENCIES WHERE SWITCH PARASITIC CAPACITANCE WOULD CAUSE EXCESSIVE POWER LOSS AT SWITCHING.

*Due to sin* \( \frac{g}{1/1} \)

---

**Fig. 15 - Switching Techniques Compared**
Fig. 17 - Quasi-Resonant Switching Operation

Assumptions: Co has constant voltage; L0 has constant current.

Buck for f0 = \frac{1}{\sqrt{LC}}

- Peak is V/2.

\text{Yes} \quad T_i = \frac{V}{f_0 L_i}

\text{Yes} \quad \text{peak is } V/2.

Please refer to the diagram for a detailed explanation.
Fig. 18 - Parallel-Loaded Resonant Converter Versions of Square-Wave Power Conversion Topologies
Fig. 1. A conventional single-transistor forward converter (a). A single-switch, resonant-reset forward converter (b).
Figure 3 - Basic Coupling Circuit
Fig. 10 - Example of Eddy Current Bearings
$Q \uparrow$ and make $f_{SW} \propto f_{LC}$

Then for our analysis with these conditions met:

1. $I_{H}^{\text{total}}$ is negligible only if $f_{LC}$

2. $i_{5}(t) \leq \sin f_{LC} \cdot t$

DC - AC - DC Converter

$\frac{V_{61}}{V_{5}} \cdot \frac{V_{DC}}{V_{out}} = \frac{V_{out}}{V_{DC}}$