A New Isolated Current-Fed PWM DC-DC Converter With Small Inductance And No Deadtime* Operation

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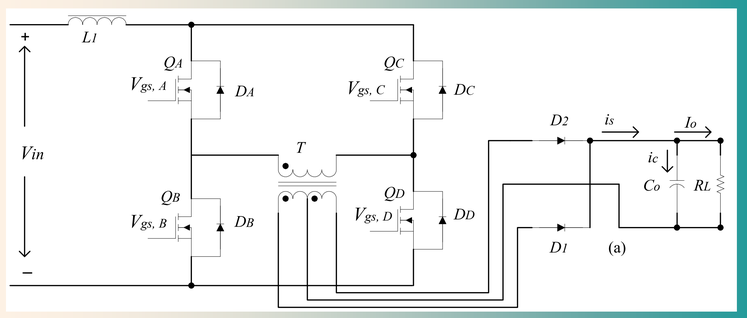
Abstract

- **A new isolated current-fed PWM DC-DC converter with small inductance and no deadtime operation is presented and analyzed.**
- **The new topology has approximately 3.5 times less inductance than that of the current-fed full-bridge DC-DC converter, which means 3.5 times faster transient response speed than current-fed full-bridge converter with same design specifications**
- **Simple self-driven synchronous rectification and housekeeping power supply because of no dead-time operation and approximately 50% duty ratio that creates a constant voltage across the secondary winding of the transformer .**
- **An input-output voltage transfer ratio that is linear with duty ratio (buck-like). This is different from most of the current-fed topologies, which have boost or buck-boost transfer characteristics and RHP zero .**
- **Substantially smaller output filter capacitance compared with typical current-fed topologies. This is because the load current is not retained solely by the output capacitors during the whole operating period (The effect of the commutation of the rectification diodes is not considered here) .**
- **Significantly reduced current ripple in contrast to the flyback-current-fed push-pull topologies.**
- **Low voltage stress on all primary side power switches, not greater than the maximum input voltage.**
- **No start-up problem that the current-fed full-bridge converter suffers.**

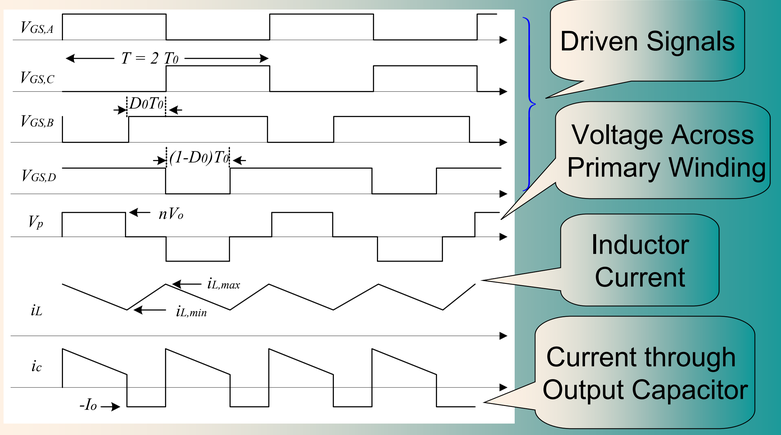
***by deadtime we mean the time duration in an operating period that is essentially needed to obtain a regulated output voltage. During the deadtime, the energy transmission from input DC source to output load is not continuous.**

Conventional Current-Fed Full-Bridge DC-DC Converter

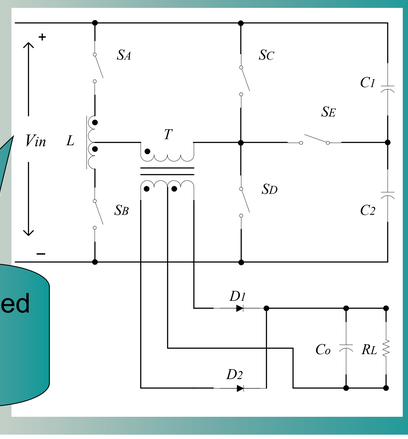
- Schematic of Current-Fed Full-Bridge Converter



- Ideal Waveforms of Current-Fed Full-Bridge Converter

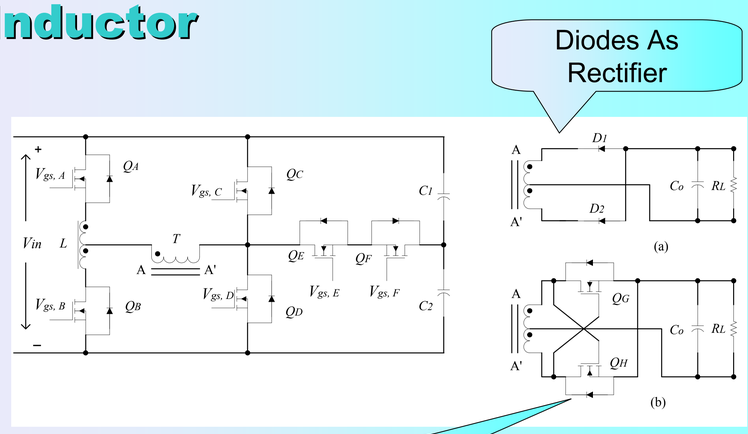


Principle of Proposed Topology

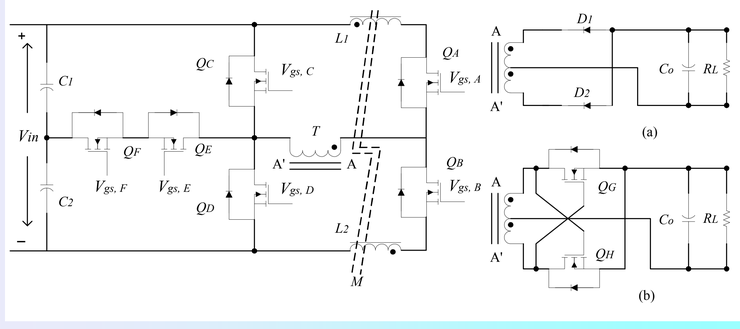


Proposed Isolated Current-Fed DC-DC Converter With Center-Tapped Inductor

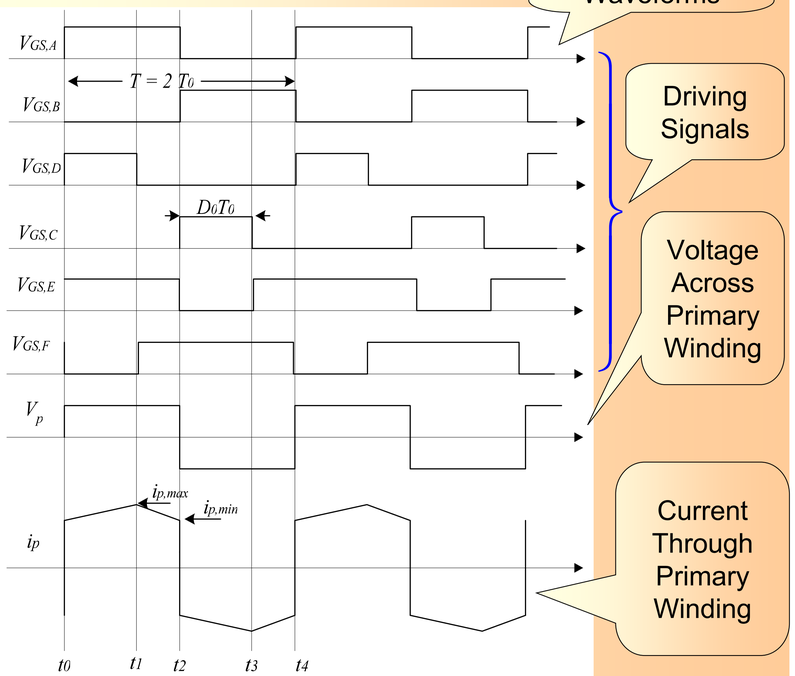
Implementation of Proposed Isolated Current-Fed DC-DC Converter With Center-Tapped Inductor



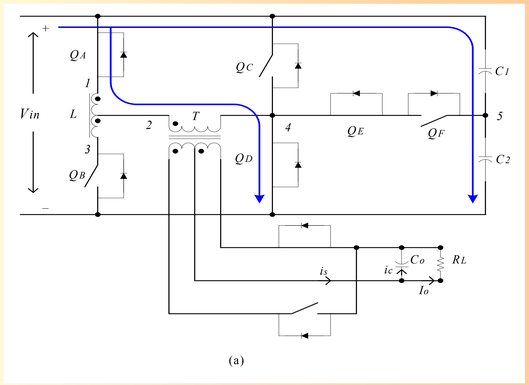
Implementation of Proposed Isolated Current-Fed DC-DC Converter With Two Coupled Inductors



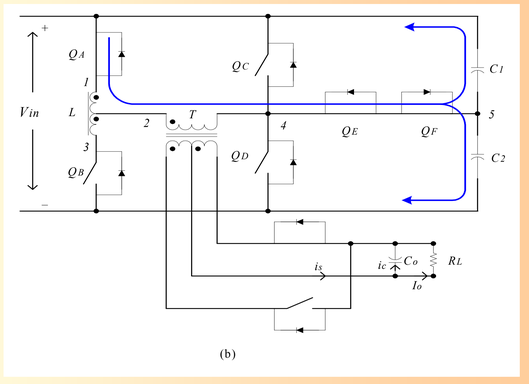
Operation of Proposed Converter (with Center-Tapped Inductor)



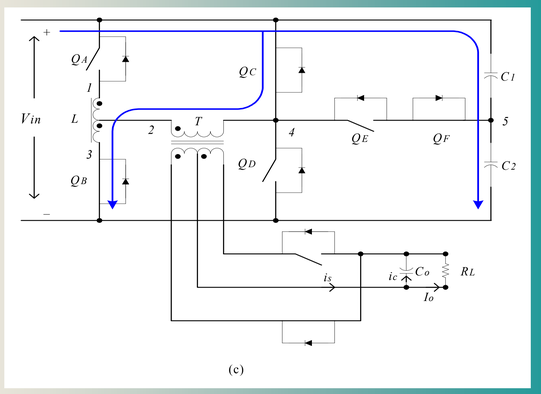
t0 – t1 Time Interval



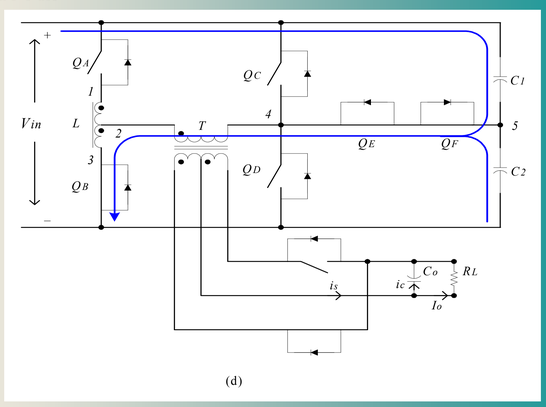
t1 – t2 Time Interval



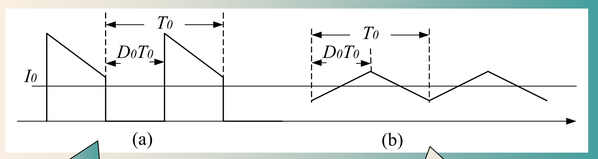
t2 – t3 Time Interval



t3 – t4 Time Interval

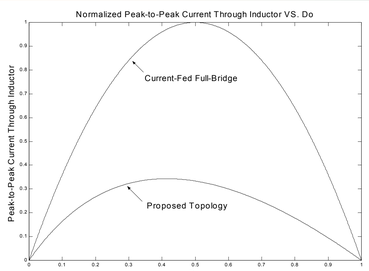


Current Waveform at Rectifiers output



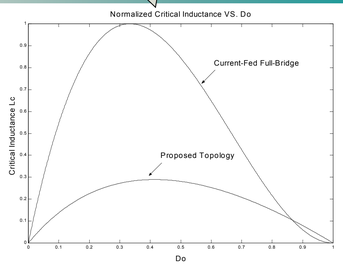
Current-Fed Full-Bridge

Proposed Topology



Normalized Peak-to-Peak Current Through Inductor VS. D0

Normalized Critical Inductance VS. *D0*



Input-Output Voltage Transfer Ratio

Proposed Topology

$$\frac{V_o}{V_{in}} = \frac{1 + D_o}{2n}$$

Current-Fed Full-Bridge

$$\frac{V_o}{V_{in}} = \frac{1}{2n}\frac{1}{1 - D_o}$$

Experimental Results

prototype of the proposed current-fed converter:

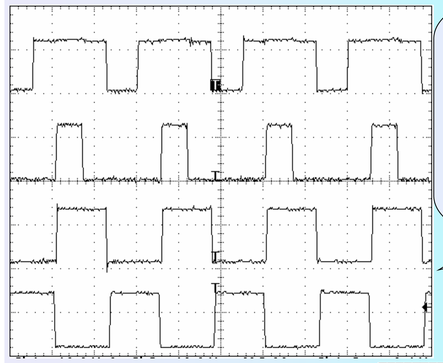
V_{in} = 36 – 68VDC

V_o = 5V, $I_{o,max}$ = 20A

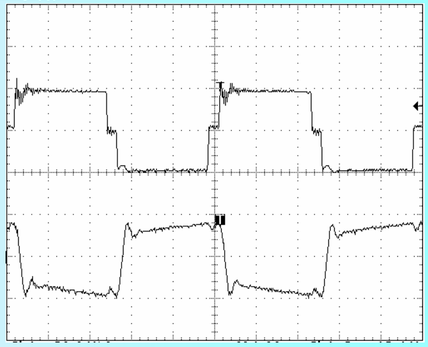
f = 200kHz, T_0 = 2.5μs

Transformer: Philips planar E18/4/10 – 3F3 combined with PLT 18/10/2 – 3F3 (18x10x6 mm3, effective volume is 800 mm3)

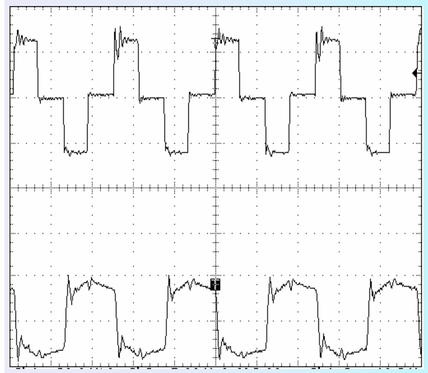
inductor : Philips planar E18/4/10 –3F3 – 250 totally 14 turns of center-tapped windings.



Control Signals of Proposed Converter. From bottom trace to top trace: (10*V/div*)
1. $V_{GS,A}$ 2. $V_{GS,B}$,
3. $V_{GS,C}$ 4. $V_{GS,F}$,
Time base: 2 *us/div*



V_{in} = 38*V*, V_o=5*V*, i_o=20*A*.
From bottom trace to top trace:
1. i_p (5*A/div*)
2. $V_{DS,D}$ (20*V/div*).
Time base: 1*us/div*



V_{in} = 48*V*, V_o=5*V*, i_o=20*A*.
From bottom trace to top trace:
1. i_p (5*A/div*)
2. $V_{DS,D}$ (20*V/div*).
Time base: 2 *us/div*