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# CIRCUIT FOR GENERATING A CONTINUIUS AND/OR ALTERNATING CURRENT TO A LOAD, SUPPLIED FROM MAINS AC OR DC VOLTAGE

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# Circuit for generating a continuous and/or alternating current to a Load, supplied from Mains AC or DC voltage

This publication describes different power stage topologies that can be used to supply resistive loads. Some of them are already implemented in the industry, but some, in particular the topology called “Input Half-Bridge Rectifier Totem Pole”, is considered as an innovation because, as shown at the end, is selected as the best-in-class for applications in which are required to supply several individual AC loads.

All the solutions are non-isolated topologies:

- Buck Converter with H-Bridge Inverter
- Totem-Pole Inverter
- Full Rectifier Totem-Pole Inverter
- Half-Bridge Rectifier Totem-Pole Inverter

The Buck topology is the most typical one for voltage step-down, but adding in cascade and active full-bridge switching at line frequency provides an AC output. First stage generates a full rectifier waveform, whereas the second stage provides the polarity at the output so that full rectifier waveform is turned into AC waveform.

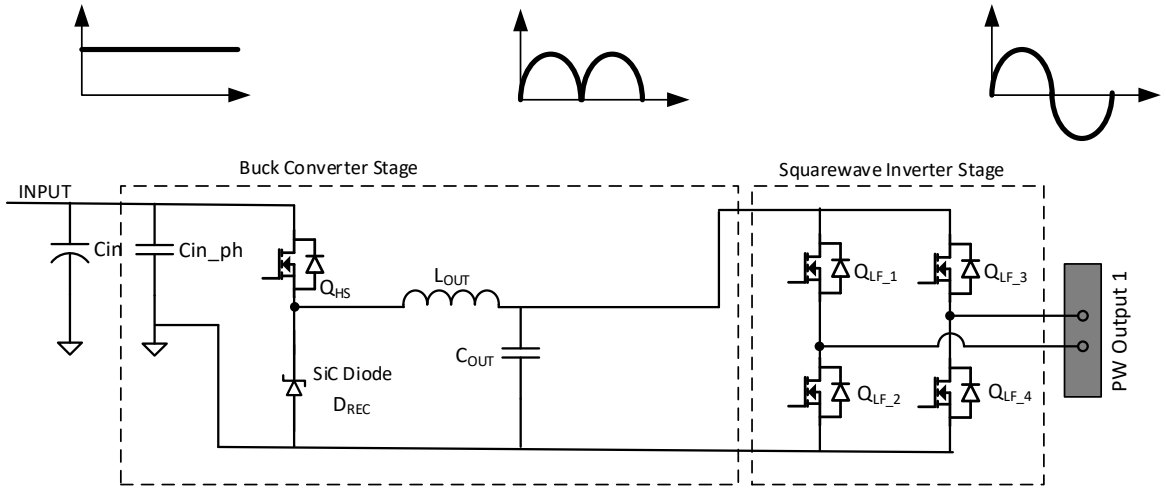


**Figure 1** Buck Topology with Square Wave Inverter

Other option to generate an AC waveform from DC signal is to use a full-Bridge topology, the topology basically works in four states during a whole line-frequency cycle. Switching devices QLF_1 & QLF_2 only switch from positive to negative semi-cycle whereas QHF_1 & QHF_2 are switching during the whole cycle. **Figure 2** shows the equivalent circuits of this topology for each operation stage.

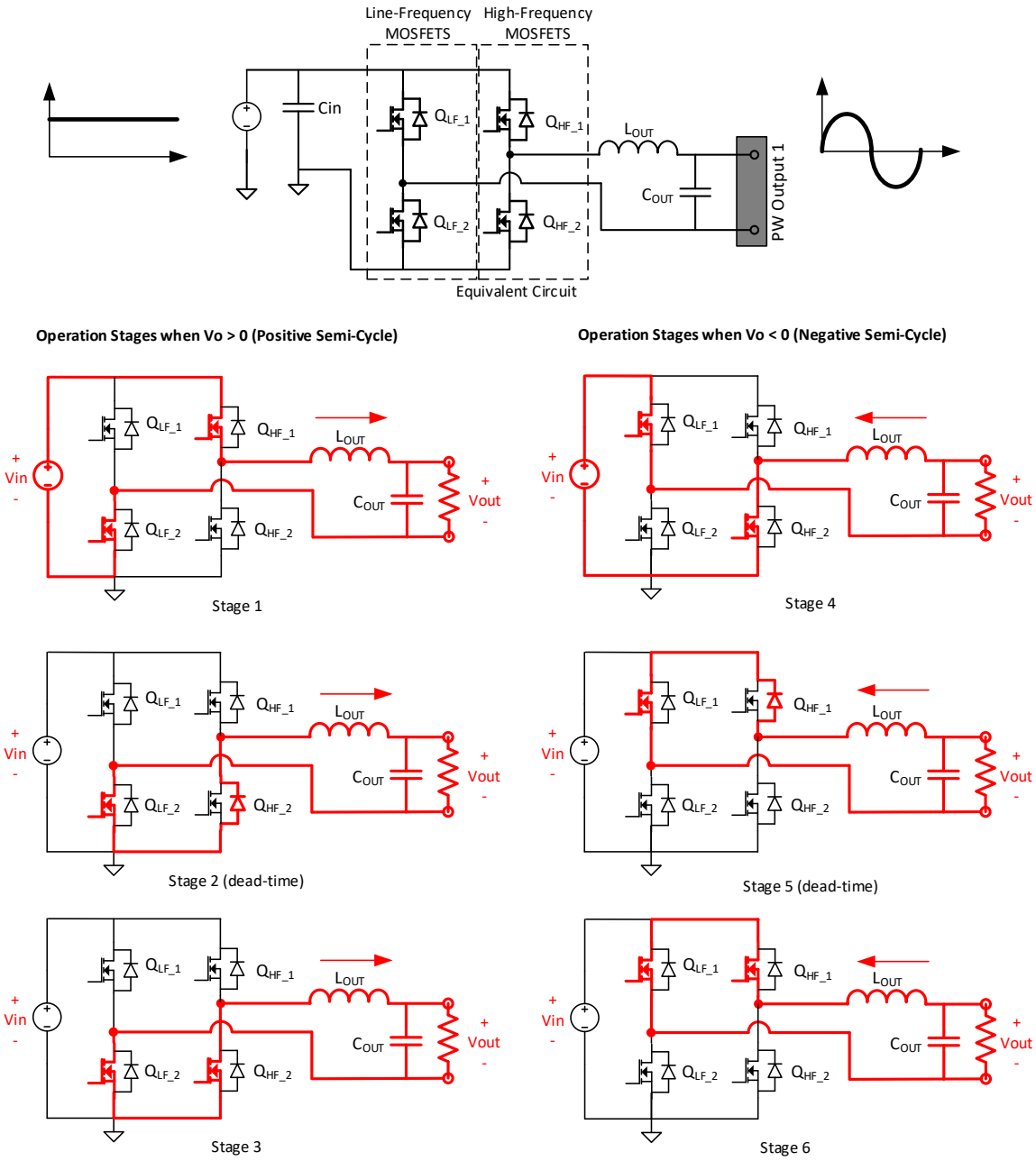


**Figure 2** Equivalent circuits for each operation stage of Totem-Pole Inverter

In case of needing to supply an AC Load with a converter connected directly from AC Mains, none of the above topologies are usable. However, it would be possible to use a Full-bridge rectifier added before the Totem-Pole topology as shown in **Figure 3**.

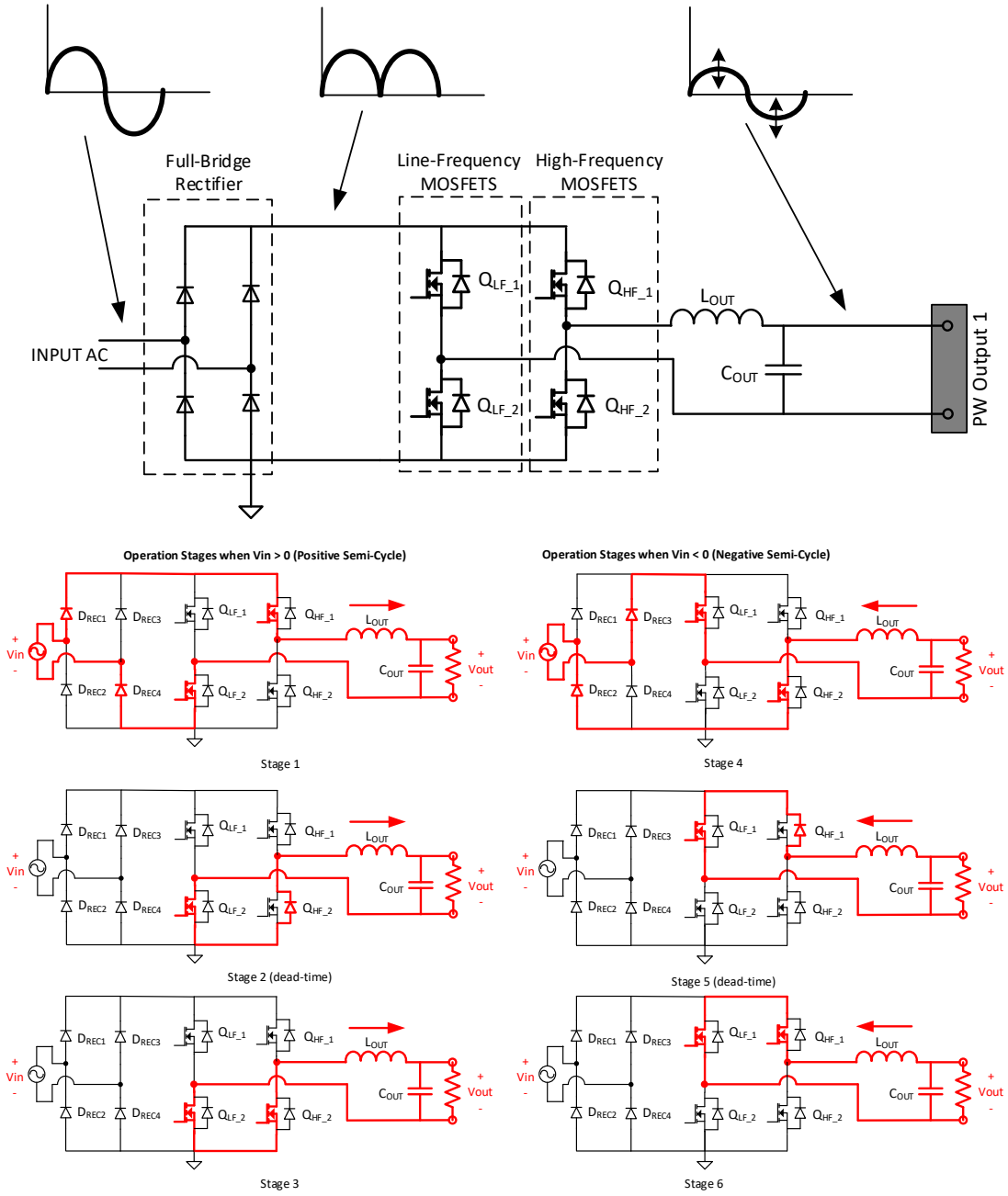


**Figure 3** Operation stages and circuit diagram of Input Full-Bridge Totem-Pole Inverter

The main advantage of the above topology is that AC/AC conversion is available without an active Front-End PFC, which allows a cost-effective solution. However, higher conduction losses through the input full-bridge rectifier must be considered when the cooling system is designed.

Having a look at the ON Stages of **Figure 3** (Stage 1 and 4), it can be observed that whenever the Low-side diode of second leg (DREC4) is in conduction mode at the same time the Low side Line-Freq Mosfet it is also enabled (QLF_2), the same behavior is also observed for DREC3 and QLF_1 .

The Input Half-Rectified Totem-Pole Inverter consist of removing one of the legs of the input full-bridge rectifier and connecting one of the input poles to the Line-Frequency leg mid-point. **Figure 4** shows the equivalent circuit and operating stages of this topology.

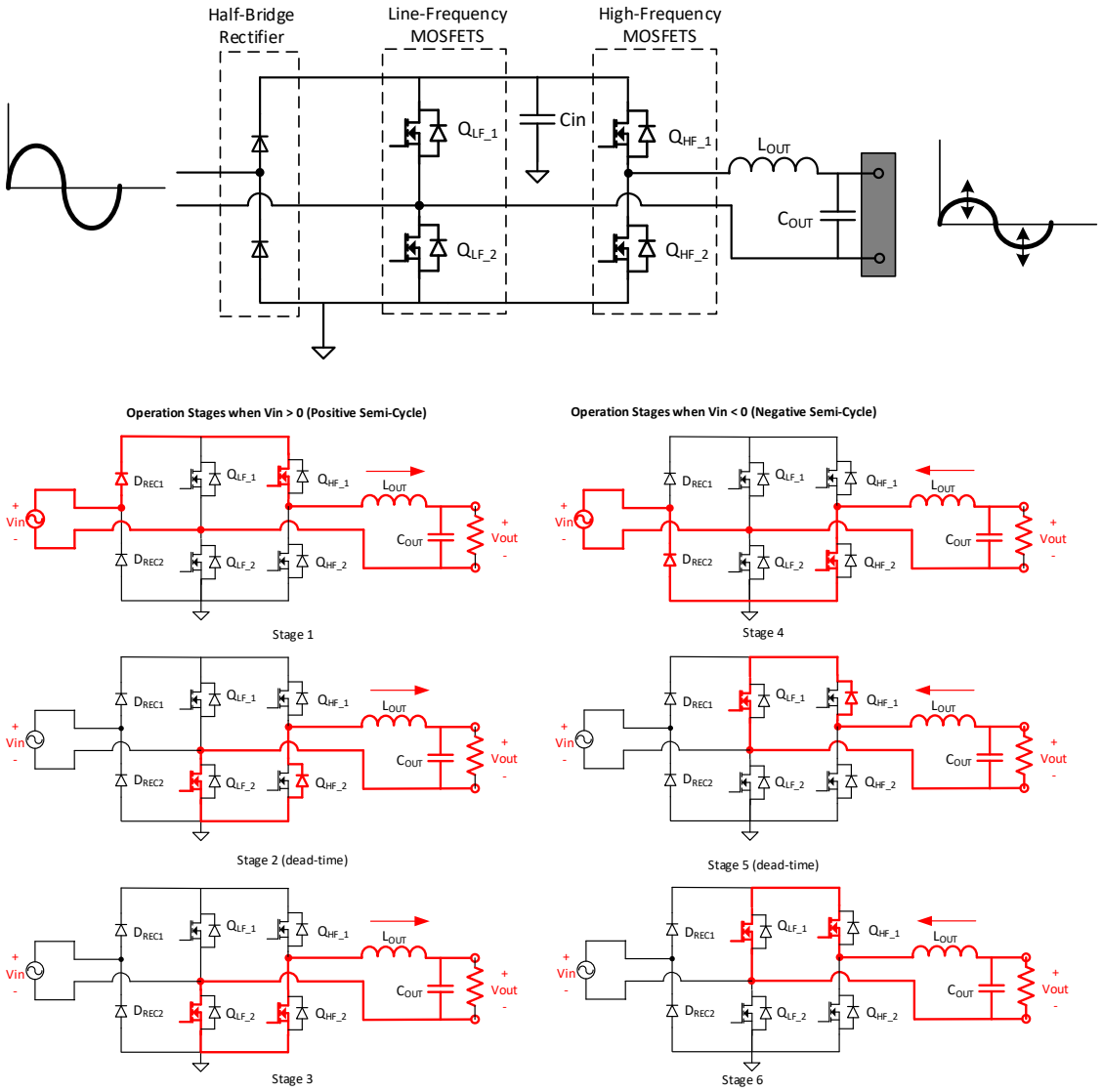


**Figure 4** Operation stages and circuit diagram of Input Half-Bridge Totem-Pole Inverter

The advantages of this topology are:

- One of the legs of input rectifier is removed, reducing the number of devices.
- Unlike the Full-Bridge Rectifier, the conduction losses are more than half because not only one rectifier leg is removed but also the RMS current value through Line-Frequency MOSFETs are reduced for a same Load condition. This is because during the ON Stages (See Stage 1 and 4 of **Figure 4**) the Line-Freq. MOSFETs are not conducting as other topologies do.
- It allows different input/output conversions, not only AC/AC but also DC/AC and DC/DC

- If the converter requires multi-output configuration, a single input half-bridge rectifier and line-frequency leg can be used for multiple outputs, duplicating only the high-frequency leg as function of number of outputs.

Additionally, the input half-bridge rectifier could be made of active devices working as synchronous rectification to improve efficiency.

***Disclosed by Albert Trenchs, Juan Manuel Zamorano, and Michele Vergani, HP Inc.***