A New PWM and Commutation Scheme for One Phase Loss Operation of Three-Phase Isolated Buck Matrix-Type Rectifier

ABSTRACT:
In this paper, a new PWM scheme and commutation method is presented for one phase loss operation of three-phase isolated buck matrix-type rectifier. With the proposed PWM scheme, the maximum allowable voltage gain for one phase loss operation can be achieved, which permits the continuous operation of the converter to deliver 2/3 of rated power and regulate the output voltage with maximum output voltage drop less than 5% of nominal output voltage. In addition, with the proposed commutation method, a safe transition from one phase loss operation to normal operation and vice versa can occur with minimum commutation steps (two-step) under zero voltage switching (ZVS) condition. The performance of the proposed PWM scheme and commutation schemes with one phase loss operation is evaluated and verified by simulations and experiments on a 5kW prototype.

KEYWORDS:
1. PWM
2. Commutation
3. Matrix converter
4. Three-phase
5. One phase loss
6. Isolated
7. Buck rectifier
8. ZVS
9. MOSFET
10. High frequency

SOFTWARE: MATLAB/SIMULINK

CIRCUIT DIAGRAM:

Fig. 1. ZVS three-phase PWM rectifier.
EXPECTED SIMULATION RESULTS:

Fig. 2. Simulated waveforms for \( 2/3PQ_{\text{max}} \), \( vLL = 480 \text{V} \) and \( ma = 0.75 \) when “phase C” is shorted at \( t_1 \) and recovered at \( t_2 \): (a) input phase voltages, (b) input phase currents, (c) transformer secondary voltage, (d) output of bridge rectifier, (e) output voltage and battery set point, (f) output inductor current.
CONCLUSION:

In this paper, operation of the three-phase isolated Buck matrix-type rectifier under one phase loss condition is described and a new PWM scheme and commutation method for the one phase loss operation is proposed. With the proposed switching scheme and commutation method, two step commutation with ZVS (here either using ZVS or zero voltage turn-ON) can be realized for one phase loss operation and also for the transition from normal operation to one phase loss operation and from one phase loss operation to normal operation. Operation and performance of the converter with the proposed PWM and commutation method are verified with simulation and experimental results. Based on the experimental results obtained from a 5 Kw prototype, it is shown that the converter is able to deliver 2/3 of maximum output power to the load and regulate the output voltage with maximum voltage drop less than 5% of nominal output voltage. Current stress of the converter and input current THD and spectrum analysis are also provided in the experimental results with one phase loss operation. The relatively large THD (around 40%) is one of the drawbacks for this converter when operating under one phase loss condition.

REFERENCES:

