Fault Diagnostic & Reconfiguration Scheme for PV System

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Introduction

- Interleaving of converter is done to minimize input ripple drawn from PV Panel
  - Improve the extraction efficiency of the PV panel
  - Prolonged the lifetime of input capacitor of the converter

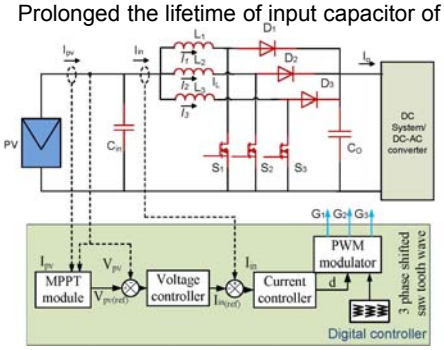

Fig. 1. Three-phase interleaved boost converter

- Open circuit fault in the semiconductor switch is common that destroy the above benefit and could lead to unbalance sharing of current

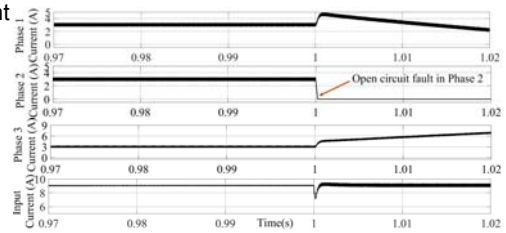

Fig. 2. Phase and input currents for open circuit fault in phase-2 at t = 1s, time scale: 0.02 s/div.

A real time fault detection, identification, and reconfiguration system has to be developed to control the converter operation under faulty condition.

Proposed Fault Detection, Localization & Reconfiguration Scheme

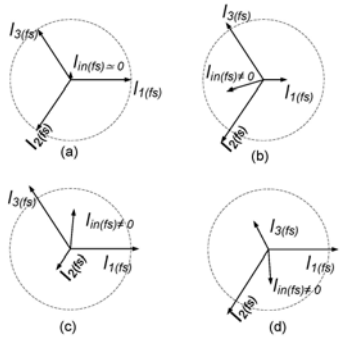

Fig. 3: Phasor representation
(a) in normal operation (b) for phase-1 OC
(c) for phase- 2 OC (d) for phase-3 OC.

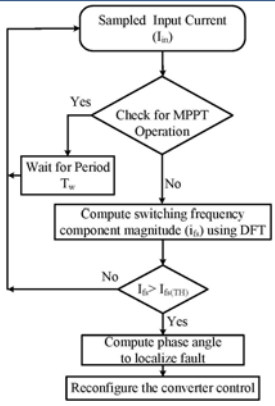

Fig. 4: Proposed fault detection, identification and reconfiguration algorithm.

Reconfiguration and control of converter in the faulty conditions

Table 1:Corresponding phase shift for different fault

Faulty phase	Phase 2 shift (in degree)	Phase 3 shift (in degree)
1	120°	300°
2	-	180°
3	180°	-

Current reference modification to avoid overloading of phases

$$I^*_{in(ref)} = I_{in(ref)} \quad \text{if healthy}$$
$$I^*_{in(ref)} = 2 \times I_{max} \quad \text{if faulty and } I_{in(ref)} > 2 \times I_{max}$$
$$I^*_{in(ref)} = I_{in(ref)} \quad \text{if faulty and } I_{in(ref)} < 2 \times I_{max}$$

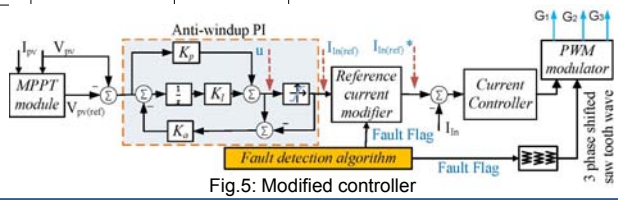

Fig.5: Modified controller

Simulation & Experimental Results

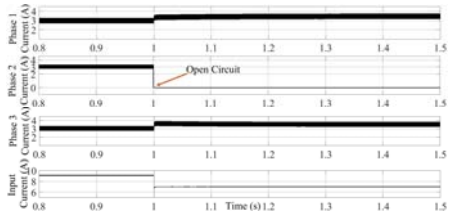

Fig. 6. Currents after implementation of proposed scheme when reference input current is more than the combined rating of healthy phases, time scale=1s/div.

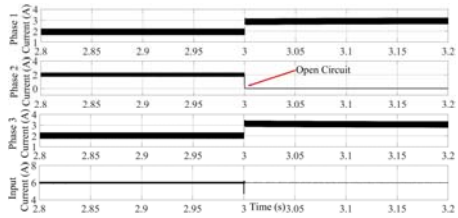

Fig. 7. Currents after implementation of proposed scheme when reference input current is less than the combined rating of healthy phases, time scale=1s/div.

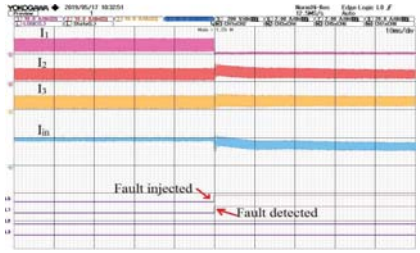

Fig. 8. Experimental waveforms for fault in Phase-1 with proposed scheme: time scale=10ms/div

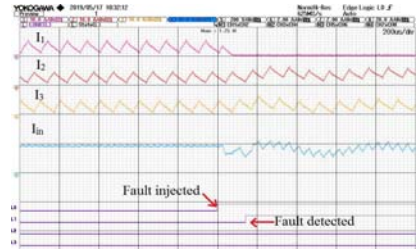

Fig. 9. Zoomed waveforms for fault in Phase-1 with proposed scheme: time scale=200 us/div

Specification of System

Parameter	Variable	Value
Maximum Power	P_{MPP}	1076 W
Voltage at Pmax	V_{MPP}	96.62 V
Current at Pmax	I_{MPP}	9.08 A
Short circuit current	I_{SC}	10.1852 A
Open circuit voltage	V_{OC}	118.52 V
Switching frequency	f_s	10 kHz
Inductance in each phase	L	1 mH
Output capacitance	C	370μF

Conclusions

- Proposed a non-invasive technique for open circuit fault detection of semiconductor switches in interleaved boost converter interfacing PV system to the DC grid.
- Verified the proposed approach using simulation and experimental studies.

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