“Performance Analysis of Modified Flying Capacitor Multilevel Inverter”

Mr. Nilay Ashok Sawalakhe
Prof. Rashmi Sing

1Department of Electrical Engineering, VIT, Nagpur
2Department of Electrical Engineering, VIT, Nagpur

ABSTRACT

This activity proposes a new access of modular-cell inverter with a bargain amount of aerial capacitors (RFCI). The adduce RFCI will abate decidedly the basic counts, cost, and admeasurement of the converter. The all-embracing achievement of RFCI will abundantly enhance as compared with the classical multilevel aerial capacitor inverter (FCI). Hence, a allusive assay of the adduce RFCI will fabricated adjoin the classical FCI in this activity abject on seven-level achievement appearance voltages.

Keywords: PD-PWM, reduced flying capacitor multilevel inverter (RFCI), Thermal harmonic distortion (THD).

INTRODUCTION

A multilevel inverter is an electrical accessory that converts a dc ability accumulation into an ac ability supply. MLI are able of administration top voltage with minimum voltage accent on switching devices, accomplish achievement voltage with minimum harmonic content, and accomplish low dv/dt and accept a lower accepted approach voltage, which aftereffect in bargain accent on motor address in drive applications.

Three types of multilevel inverter
1. Diode-clamped multilevel inverter
2. Flying-capacitor multilevel inverter.
3. Cascaded-multi level inverters.

Flying-capacitor-multilevel inverter was introduced by Meynard and Foch in 1992. The anatomy of multi akin inverter is agnate as of diode-clamped inverter alone the aberration is instead of application anchor diodes; the inverter uses capacitors at aforementioned place. The proposed agent beneath RFCI reduces decidedly the basic counts, cost, and admeasurement of the converter. The all-embracing performances of RFCI are abundantly added as compared with the classical multilevel aerial capacitor inverter (MFCI).

II. FLYING CAPACITOR MULTILEVEL
A. METHODOLOGY

- Study and simulation of FCI for an IM load.
- Harmonic analysis of the waveform of FCI
- Study and analysis of RFCI for an IM load.
- Harmonic analysis of the waveform of RFCI.
- A comparative analysis of the Proposed RFCI will make it against the Modified FCI.

B. Operating principles of 7L FCI

In the accustomed circuit, anniversary appearance leg requires minimum 12 switches (Sx1 to Sx6 and Sx1’ to Sx6’) and 5 capacitors (Cx1 to Cx3) which are clamped amid the modular beef depending on the accessory voltage ratings advised during the architecture of the converter. If the advocate is advised for three-phase systems, the aberration would be even obvious. In the proposed SIX-cell 7L-MFCI back 6 pairs of alive switches are used. For aught achievement akin two bombastic states are produced and for anniversary ±Vdc/2, ±Vdc/3 and ±Vdc/6 achievement levels three bombastic states are produced [1]. It should be acclaimed that if Sx1 conducts all absolute achievement levels are achieved, admitting all if Sx1’conducts abrogating achievement levels are obtained. Therefore, the two switches Sx1 and Sx1’ in Cell 1 are consistently assuming at axiological abundance of 50 Hz. During steady-state operation, the aerial capacitor voltages VCx1, VCx2, VCx3, VCx4 and VCx5 of SIX-cell 7L-RFCI are maintained at Vdc/6, Vdc/3, and Vdc/2, respectively.

![Fig. 2 Simulink circuit for 7 level single phase MFCI](image1)

In fig.2 for aboideau signals accustomed to the 1 ph 7 levels FCI ambit 2 PD-PWM switching adjustment are used. In subsystem1 to activate the switches switching argumentation ambit is advised [4].

A. Output voltage waveform for single phase MFCI

![Fig. 3 waveform of 1 ph MFCI](image2)

3 PH MFCI CIRCUIT

Discussion about the selection of carrier frequency and value of capacitor

The amount of carrier abundance should be alleged in such a way that the sinusoidal arresting which is reconstructed from dc antecedent should be even in attributes agency if the abundance is beneath than the reconstructed arresting will be a sinusoidal arresting and aswell at achievement ancillary it has added allotment of aboveboard beachcomber so it will be alleged as adapted sine beachcomber inverter [2]. However, the amount of carrier abundance should be called in such a way that, at achievement authentic sinusoidal waveform should be accessible application low canyon filter. Also the amount of capacitor should called in such a way that during the about-face off aeon of MOSFET the capacitor should not acquittal and in anniversary switching burning the consequence of voltage akin should be maintained. Because during switching off instance of time t_0 absolution amount of the capacitor is accustomed by

\[ V_c = V_{max} e^{(t_0/R_c)} \]

Where R = load resistance and C = capacitor
So for \( V_c = V_{max} \)
The amount of $t_0/R_c$ should be about aught. Either it should accept beneath amount of numerator or top amount of denominator [3]. We cannot access the amount of $R$, if we do so, the ability of the arrangement will belted and we get sine $I^2R$ loss. So access the amount of $C$ and abate the amount of $t_0$. Agency abridgement of capacitance amount will aftereffect the added abscission of capacitor so, again we get aforementioned after-effects as that of adapted beachcomber [2]. So, baddest college amount of capacitance and beneath time aeon of carrier abundance (more than 10K_HZ) but due to this switching losses will access and added ability will get abatement [6]. So the optimized amount for carrier abundance should be in ambit of 3K_HZ to 10K_HZ and amount for capacitor should be in the ambit of 2200uf to 4700uf because if you added access the amount of capacitor than it will be abundant on packets.

A. OUTPUT VOLTAGE VA, VB, VC

![Waveform of Va](image)

![Waveform of Vb](image)

![Waveform of Vc](image)

B. OUTPUT VOLTAGE Vab, Vbc, Vca

![Waveform of Vab](image)

![Waveform of Vbc](image)

![Waveform of Vca](image)

A. INVERTER VOLTAGE CURRENT

A. Inverter voltage

![Waveform of inverter voltage](image)

B. FFT analysis of inverter voltage

![FFT voltage](image)

A. Inverter current

![Waveform of inverter current](image)
B. FFT analysis of inverter current

![FFT Current](image)

**Fig. FFT Current**

<table>
<thead>
<tr>
<th>Line to Line Voltage</th>
<th>110 Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stator Resistance</td>
<td>0.45 ohms</td>
</tr>
<tr>
<td>Rotor Resistance</td>
<td>0.86 ohms</td>
</tr>
<tr>
<td>Stator Leakage Inductance</td>
<td>3.2 mh</td>
</tr>
<tr>
<td>Rotor Leakage Inductance</td>
<td>3.2 mh</td>
</tr>
<tr>
<td>Mutual Inductance</td>
<td>69.13 mh</td>
</tr>
</tbody>
</table>

**Table. 1**

I. MOTOR CIRCUIT

![Connected motor circuit](image)

**Fig.14 3-ph. flying capacitor multilevel inverter**

**I. MOTOR PARAMETER**

<table>
<thead>
<tr>
<th>Input Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horse Power</td>
<td>3 HP</td>
</tr>
<tr>
<td>Speed</td>
<td>1500 RPM</td>
</tr>
<tr>
<td>Phase</td>
<td>3</td>
</tr>
<tr>
<td>Frequency</td>
<td>50 HZ</td>
</tr>
<tr>
<td>Poles</td>
<td>4</td>
</tr>
</tbody>
</table>

**Table. 2**

I. ANALYSIS RESULT

<table>
<thead>
<tr>
<th></th>
<th>FCI</th>
<th>RFCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>No: of capacitors</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>No: of Cells</td>
<td>6 Cell</td>
<td>4 Cell</td>
</tr>
<tr>
<td>No: of Switch</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Fundamental Voltage</td>
<td>565</td>
<td>565</td>
</tr>
<tr>
<td>%THD</td>
<td>18.19%</td>
<td>18.26%</td>
</tr>
<tr>
<td>Fundamental Current</td>
<td>25.01</td>
<td>24.89</td>
</tr>
<tr>
<td>% THD</td>
<td>2.28%</td>
<td>1.42%</td>
</tr>
<tr>
<td>Speed</td>
<td>1493 RPM</td>
<td>1493 RPM</td>
</tr>
<tr>
<td>Torque</td>
<td>14.26 N-m</td>
<td>14.25 N-m</td>
</tr>
</tbody>
</table>

**CONCLUSION**

The plan presented actuality focuses on simulation and accomplishing of 1-phase and 3-phase aerial capacitor MLI. A abrupt appearance of the operating attempt of 1-phase and 3-phase aerial are discussed and beginning modules are shown. The 1-phase and the 3-phase aerial capacitor MLI configurations were alone advised by MATLAB. Waveforms for the voltage-source inverters, either Single appearance or three appearance configurations were aswell ample out in off time by MATLAB.
REFERENCES

“Comparison between flying capacitor and modular multilevel inverter” (reference)

[2] Ziyou Lim, Ali, and Gabriel H. P. Ooi,
“Modular-Cell Inverter Employing Reduced Flying Capacitors With Hybrid Phase-Shifted Carrier Phase-Disposition PWM”, *IEEE transactions on industrial electronics*, vol. 62, no. 7, July 2015.


