Simulation of Modified One Cycle Controlled Three Phase Bi-directional AC/DC Converter Using SIMULINK

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Abstract
Rectifiers are widely used in industries and domestic application. But, because of the nonlinear, it draws non sinusoidal current. One cycle controller is used as single/ three phase boost converters, active filters and power factor corrections. But this one controller exhibits instability during light load condition. Also it is not possible to operate in inverting mode. Modified one cycle controller is proposed in this paper and it overcome problems associate with one cycle controller. This paper discusses the design, simulation, and performance evolution of modified one cycle controller for AC/DC bidirectional boost converter.

Keywords—controlled rectifiers, harmonic elimination, one – cycle controller, power factor improvement.

INTRODUCTION
Electricity is major commodity for the development of any country. Majority of utilities electricity is generated from fossil fuels. Because of the scarcity, storage devices such as battery, super capacitor, SMES, fuel cell, etc., and hybrid renewable energy systems are used to provide reliable electricity. Storage devices are storing the electricity in direct current (DC) which is derived from alternating current (AC) via rectifiers. These rectifiers pollute the utility with lower order harmonics. Pulse width modulated converters are employed to eliminate these lower order harmonics \cite{1}. The switching frequencies of PWM converters are varied. This leads an attractive feature over one cycle controller \cite{2}-\cite{3}. Moreover these converters cannot shift its operation from rectifying mode to inverting mode of operation. In order to address these problems a modified one cycle controller is presented. This paper deals with the design, mathematical model development, simulation and performance evolution of modified one cycle controller for AC/DC bidirectional boost converter is discussed in this paper.

I. AC/DC CONVERTER
Schematic circuit diagram three phase bidirectional boost converter is shown in fig 1. It consists of six controlled switches, a dc link capacitor, source inductance with three phase AC supply and DC load/battery. The converter is operated in both rectification and inversion mode.

![Figure 1](image1.png)

II. MODIFIED ONE CYCLE CONTROLLER.
The Block Diagram of Modified One Cycle Controller for Three Phase AC/DC Converter is shown in fig 2.

![Figure 2](image2.png)
component of the source current of the converter. This signal is integrated with appropriate gain and subtracted with the same signal to generate bipolar saw tooth waveform. A fictitious current $i_F$ is generated by multiplying the sensed source voltage with the gain $1/R_f$. The fictitious current is added with the sensed source current to obtain $i_{s(t-\alpha)R_S}$. The signal $i_{s(t-\alpha)R_S}$ is then compared with the bipolar carrier saw tooth waveform to obtain the switching pulses for the controlled switches $S_1$ and $S_2$. Similarly, the switching pulses for the rest controlled switches are derived. The logic of generating the switching pulses for six controlled switches of converter is shown in figure 3.

Phase A Current:

$$i_A = \frac{R_S V_0}{2V_m} + jwL_A$$

$$V_A \left(1 - \frac{R_S}{R_f} \frac{V_0}{2V_m} \right)$$

$$\left(\frac{R_S}{R_f} \frac{V_0}{2V_m}\right) < 1$$ the converter operating as rectifier

$$\left(\frac{R_S}{R_f} \frac{V_0}{2V_m}\right) > 1$$ the converter operating as inverter

The average model of the three phases modified one cycle controller based converter is shown in figure 4.

The power drawn three phase modified one cycle controlled AC/DC converter is expressed as follows:

$$P_0 = \frac{V_m}{2R_S} \frac{V_m^2}{V_m^2}$$

IV. SIMULATION OF MODIFIED ONE CYCLE CONTROLLED THREE PHASE CONVERTER

The simulation is carried out in MATLAB 7.2/SIMULINK platform. The current and voltage wave forms of varies units are observed and presented in figure 5.
Figure 5.
Observed waveforms from the simulation of modified one cycle controlled converter operated in rectification mode.

From the figure 6 it is observed that the dc load draws sinusoidal current and voltage from the three phase AC source. The modified one cycle controlled converter is operating in both inversion and rectification mode. Figure 7 shows the observed waveforms from simulation to justify the operation in both inversion and rectification mode.

Figure 6.
Observed waveforms from the simulation of modified one cycle controlled converter operated in both rectification and inversion mode.

CONCLUSION
Modified one cycle controlled three phase boost bidirectional AC/DC converter is proposed. The conventional one cycle controller exhibits instability in current controllability during light load and inverting mode of operation. The inherent limitations of conventional OCC converter are overcome in proposed scheme. The simulation
results of modified one cycle controlled three phase boost rectifier and bidirectional AC/DC converter are presented.

REFERENCES


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