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Three Phase To Two Phase Matrix Converter

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ABSTRACT

AC-AC matrix converters are also known as frequency converters. Matrix converters are used to convert an AC signal to an AC signal with different voltage and different frequency. To produce two phase voltage, Scott transformers are widely used for industrial purposes. But their cost and core loss is much higher than electronic matrix converter. In matrix converter, the number of switches are reduced to decrease the switching loss and to eliminate commutation problem in line side. Control techniques are used for applying control pulses to bidirectional switches of the matrix converter. The hardware implementation of matrix converter consists of bidirectional switches realization, input filter design, control techniques using micro-controller.

KEYWORDS : matrix converter, bidirectional switch, input filter, micro-controller.

INTRODUCTION

In power electronics systems following converters are used for variable frequency and variable voltage drive:

1.AC/DC/AC(using diode rectifier)

2.AC/DC/AC(back-to-back converter)

3.AC/AC (cycloconverter)

4.AC/AC (matrix converter)

Matrix converter may be:

1. Direct matrix converter

2. Indirect matrix converter

There are two structures of three phase to two phase matrix Converter:

1. Two leg structure

2. Three leg structure

MATRIX CONVERTER

Direct matrix converter

Direct matrix converter converts AC-to-AC without energy storage DC link. To reduce switches of direct matrix converter and to simplify commutation in protection circuit against over voltage, indirect matrix convertor is introduced.

Indirect matrix converter

In indirect modulation scheme of two leg two phase matrix converter the converter is modeled as a two stage equivalent circuit with a fictitious dc link which is decoupled into rectifier and inverter stage with no dc link element. The equivalent circuit consists of three phase rectifier in series with four switch inverter. Therefore the inverter stage should be fed by two split virtual dc voltages, whose mid-point is connected to the neutral of the load. Considering load neutral is connected to the supply neutral, the rectifier stage need to construct to equal fictitious dc voltages with respect to supply neutral.

Modulation technique for rectifier stage

Rectifier stage creates two conceptual split dc voltages with equal amplitude in imaginary dc link. The center tap of the dc voltages is provided by virtual ground, which links to supply mains and load neutrals.

Modulation technique for inverter stage

As inverter has four switches, it has four allowed switching combinations which gives non zero output voltages. The space vector modulation technique for inverter stage is based on α-β stationary reference frame. The switching function of upper switches take on binary values one and zero in closed state and open stage respectively ,while lower switches have complementary values of their upper switches.

With the active vectors α-β plane divides into two sectors which are π/2 away from each other. The inverter stage having two output legs produces no zero switching state. Therefore rotating reference vector is approximated with three active vectors in each sector.

Three Phase to Two Phase Matrix Converter

A. Two leg structure

Two phase matrix converter can drive symmetrical load such as two phase induction motor or unsymmetrical. Load such as two single phase induction motors.

In two phase induction motor, there is 900 phase shift between its main and auxiliary winding. The two leg structures, the neutral of the load is fed back to the neutral of the supply. The two leg structure consists of six directional switches. For three phase to two phase conversion it requires array of bidirectional switches as 3x2 = 6 switches. As the name suggests, the switches are arranged in matrix manner. Each line of the output can link with the any input line through bidirectional switches.

Matrix converter selects segments from input voltage to get desirable voltage, for specific time decided by modulation strategy. Modulation technique requires to control switching duty cycles so that low frequency output voltages track desired output voltages. According to operating principle of matrix converter, input and output voltages are related to modulation strategy voltage, and elements of that matrix represent duty cycles of bidirectional switches. Modulation matrix forms 2x3 matrix because converter has two output legs. Output of the matrix convertor is obtained as an average value of three switching elements in sampling time. Elements of modulation matrix denote duty cycle function of switches which connects output phase to input phase within one sampling time. The two phase output voltage waveform required has a phase difference of 900 and independent magnitudes with respect to each other. Identical output voltage magnitudes are applied to balanced loads such as symmetrical two phase motor or unsymmetrical loads such as single phase induction motors with two windings. In addition only one switch in output phase should be on at any time to avoid short circuit of the input phase and to avoid open circuit of the output phase. Two modulation indices are required for two output phases.

In two leg form input and output ground are same, therefore amplitude of output voltage cannot be more than half the input voltage amplitude.

B. Three leg structure
In three legs two phase matrix converter PWM method is used. Modulation matrix is 3x3 matrix due to addition of one leg connection load neutral point. In three leg form input ground is separated from output ground. The ratio of output to input voltage increases by $\sqrt{3}/2$. It is performed by injection of third harmonic to input voltage.

It is expected that three leg two phase matrix converter shows better harmonic characteristics of the output currents than two leg structure as it generates output waveform with less ripple components.

IV.HARDWARE IMPLEMENTATION

A.Bidirectional switch realization-
Matrix converter requires bidirectional switch which is capable of blocking voltage and conducting current in both direction which directly connects output phase to input phase. Only one switch in output phase should be ON at any time to avoid short circuit of the input phase and to avoid open circuit of the output phase.

B. Modulation techniques-
Sinusoidal PWM, Space Vector PWM may be used for modulation.

C.Input filter-
Input filters improve the input current quality and reduces input voltage distortion.

D.Optocouplers-
Optocouplers are used to switch each TRIAC. They also provide isolation.

V. Advantages of matrix converter

Bidirectional power capability

High quality input and output waveform

Compact circuits also small size because no energy saving elements like capacitor in dc bus of the converter

Input power factor can be controlled

Disadvantages of matrix converter-

Complex commutation

Complicated over voltage protection circuit

Applications of matrix converter-
Induction motor driver

Switching power supply

In aircraft industry

Voltage regulator

Unified power flow controller (UPFC)

VI. CONCLUSION

Matrix converter is an array of bidirectional switches. It directly interconnects two independent voltage system at different frequencies. The power loss is considerably low.

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