TEN SWITCH 15 LEVEL INVERTER

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Abstract – In *this paper the single phase 15-level Sub-Multilevel Cascaded H-Bridge Inverter (SMCHBI) is designed. It consists of H bridge inverter configuration and sub-multilevel modules. Stepped DC link voltage and current into sinusoidal waveform using H Bridge Inverter. Stepped DC link voltage and current from the DC sources synthesize by using Sub-multilevel switches. The proposed system employs the reduced number of power switches, DC sources Compared with conventional Cascaded Multilevel Inverter (CMLI). The proposed system not only reduces the overall system cost but also reduces the voltage stress across the inverter switches. The proposed model will be developed using MATLAB/Simulink.*

Key Words: *Cascaded Multilevel Inverter, Zero Voltage Switching (ZVS), Multilevel Cascaded H-Bridge Inverter*

1.INTRODUCTION

A wide spread scope for efficient operation of power converters due to advancement in power electronics. Power electronic converters have the responsibility to carry out these tasks with high efficiency. Variable speed drives plays a vital role in present day industries. Voltage Source Inverter (VSI) and Current Source Inverter (CSI) are Traditional power electronic inverters. The variable speed of industrial drives works on two-level VSI topology is the simplest topology used to achieve. Multilevel Inverters (MLI) are emerging as the new breed of power converter options for high power applications. Flying Capacitor Multilevel Inverters (FCMLI), Cascaded Multilevel Inverter (CMLI) and Diode Clamped Multilevel Inverters (DCMLI) are three topologies of Multilevel Inverter (MLI).

Among all topologies of inverter, as the voltage level increases, FCMLI is difficult to be realized because each capacitor must be charged with different voltages. The FCMLI also known as a neutral clamped converter is difficult in DC link voltage unbalancing to be expanded to multilevel because of the natural problem. High voltage stress can be occurring in Two- level inverters and multilevel inverters of FCMLI and DCMLI. To reduce the voltage stress across the inverter switches, by using resonant soft switching circuits we can reduce the voltage stress across the inverter switches. Most solar cell installation involves the use of Multiple solar panels or modules, which are connected in series or parallel with CMLI. Lower semiconductor voltage stress, better harmonic performance, lower Electro Magnetic Interference (EMI) and lower switching losses are the most popular advantages of CMLI compared with the traditional two level voltage source inverters. Because of controlled power switches for higher voltage levels and more number of DC sources, the efficiency of the CMLI system is degraded.

Increase the efficiency of the inverter operation and reduce the THD level in the operation of inverter can be achieved by multilevel inverter circuit which is used. Diode clamped, capacitor clamped and cascaded multilevel inverter are three types of topologies in multilevel inverter. It is cheaper in cost compared with transformer combined structure due to H-bridge structure takes no dc to dc boost converter and no additional transformer connection. Multilevel inverter converter several DC sources to AC output voltage.

2. STRUCTURE OF SUB-MULTILEVEL CASCADED H-BRIDGE INVERTER

The equivalent structure of 15-level SMCHBI is shown in Figure 1. The structure consists of DC voltage source in series with sub-multilevel modules connected in inverter is asymmetrical in manner. The output voltage is always positive or zero of each sub-multilevel module. The voltage polarity in every half cycle can be changed in order to operate as an inverter.

An H-bridge inverter is added to the output of series connected sub-multilevel modules in order to obtain output voltage positive and negative. Each sub-multilevel module consists of a DC source and (s+1) switches.

CMLI configuration has Number of levels can be expressed as;

$$N_{level} = 2s + 1 \quad (1)$$

CMLI Number of switches can be expressed as;

$$N_{switch} = 4s \quad (2)$$

SMCHBI configuration number of levels can be expressed as; $N\ level = 2(m+1)^S + 1$ (3)

SMCHBI Number of switches can be expressed as;
$N\ switch = 2s + 4m$ (4)

Where,

m is the H-bridge inverter number

s is the DC source number

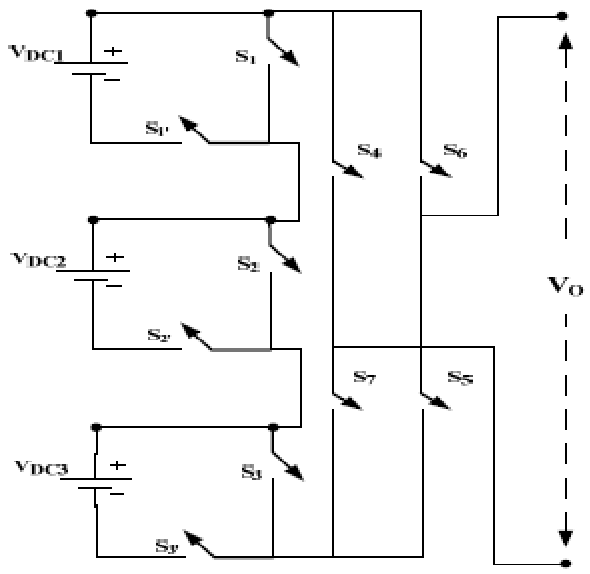

Figure 1 15-Level SMCHBI- Equivalent Structure

3. MODES OF OPERATION

The proposed system can be operated under 15 modes of operation in order to obtain 15-level AC output from the asymmetrical DC sources

3.1. Mode 0

All the switches are getting turned OFF in mode 0 operation. The output voltage is zero of sub-multilevel module and H-bridge inverter.

3.2. Modes 1& 8

The output voltage of 1st level of inverter, S_1', S_2 and S_3 sub-multilevel switches, S_4 and S_5 H Bridge switches are getting turned ON. Hence, the DC voltage source VDC_1 is linked with the drive load. The H-bridge inverter output voltage can be expressed as;

$V_0 = V_{01} = VDC_1$ (For Positive Cycle) (5)

The output voltage of 8th level of inverter, S_1', S_2 and S_3 sub-multilevel switches, S_7 and S_8 H Bridge switches are getting turned ON. The H-bridge inverter output voltage can be expressed as;

$V_0 = -V_{01} = -VDC_1$ (For Negative Cycle) (6)

3.3. Modes 2 and 9

The output voltage of 2nd level of inverter, S_1, S_2' and S_3 sub-multilevel switches, S_4 and S_5 H Bridge switches are getting turned ON. Hence, the DC voltage source VDC_2 is linked with the drive load. The H-bridge inverter output voltage can be expressed as;

$V_0 = V_{02} = VDC_2$ (For Positive Cycle) (7)

The output voltage of 9th level of inverter, S_1, S_2 and S_3 sub-multilevel switches, S_6 and S_7 H Bridge switches are getting turned ON. The H-bridge inverter output voltage can be expressed as;

$V_0 = V_{02} = VDC_2$ (For Negative Cycle) (8)

3.4. Modes 3 and 10

The output voltage of 3rd level of inverter, S_1', S_2' and S_3 sub-multilevel switches, S_4 and S_5 H Bridge switches are getting turned ON. Hence, the DC voltage source VDC_1 and VDC_2 are linked with the drive load. The H-bridge inverter output voltage can be expressed as;

$V_0 = V_{03} = (VDC_1 + VDC_2)$ (For Positive Cycle) (9)

The output voltage of 10th level of inverter, S_1', S_2' and S_3 sub-multilevel switches, S_6 and S_7 H Bridge switches are getting turned ON. The H-bridge inverter output voltage can be expressed as;

$V_0 = -V_{03} = -(VDC_1 + VDC_2)$ (For Negative Cycle) (10)

3.5. Modes 4 and 11

The output voltage of 4th level of inverter, S_1, S_2 and S_3' sub-multilevel switches and S_4 and S_5 H Bridge switches are getting turned ON. Hence, the DC voltage source VDC_3 is linked with the drive load. The H-bridge inverter output voltage can be expressed as;

$V_0 = V_{04} = VDC_3$ (For Positive Cycle) (11)

The output voltage of 11th level of inverter, S_1, S_2 and S_3' sub-multilevel switches and S_6 and S_7 H Bridge switches are getting turned ON. The H-bridge inverter output voltage can be expressed as;

$V_0 = -V_{04} = -VDC_3$ (For Negative Cycle) (12)

3.6. Modes 5and 12

The output voltage of 5th level of inverter, S_1', S_2 and S_3' sub-multilevel switches and S_4 and S_5 H Bridge switches are getting turned ON. Hence, the DC voltage source VDC_1 and VDC_3 is linked with the drive load. The H-bridge inverter output voltage can be expressed as;

$V_0 = V_{05} = VDC_1 + VDC_3$ (For Positive Cycle) (13)

The output voltage of 12th level of inverter, S_1', S_2 and S_3' sub-multilevel switches and S_6 and S_7 H Bridge switches are getting turned ON. The H-bridge inverter output voltage can be expressed as;

$V_0 = -V_{05} = -(VDC_1 + VDC_3)$ (For Negative Cycle) (14)

3.7. Modes 6 and 13

The output voltage of 6th level of inverter, S_1, S_2' and S_3' sub-multilevel switches and S_4 and S_5H Bridge switches are getting turned ON. Hence, the DC voltage source VDC_2 and VDC_3 is linked with the drive load. The H-bridge inverter output voltage can be expressed as;

$V_0 = V_{06} = VDC_2 + VDC_3$ (For Positive Cycle) (15)

The output voltage of 13th level of inverter, S_1, S_2' and S_3' sub-multilevel switches and S_6 and S_7 H Bridge switches are getting turned ON. The H-bridge inverter output voltage can be expressed as;

$V0 = -V06 = -(VDC2 + VDC3)$ (For Negative Cycle) (16)

3.8. Modes 7 and 14

The output voltage of 7th level of inverter, S1', S2' and S3' sub-multilevel switches and S4 and S5 H Bridge switches are getting turned ON. Hence, the DC voltage source VDC_1, $VDC_2$and VDC_3 is linked with the drive load. The H-bridge inverter output voltage can be expressed as;

$V_0 = V_{07} = VDC_1 + VDC_2 + VDC_3$ (For Positive Cycle) (17)

The output voltage of 14th level of inverter, S1', S2' and S3' sub-multilevel switches and S4 and S5 H Bridge switches are getting turned ON. The H-bridge inverter output voltage can be expressed as;

$V_0 = -V_{07} = -(VDC_1 + VDC_2 + VDC_3)$ (18)

4. SIMULATIONS AND RESULTS

The software MATLAB was used in the simulations to obtain the results for the single phase 15-level Sub- Multilevel Cascaded H-Bridge Inverter as shown in figure 2.

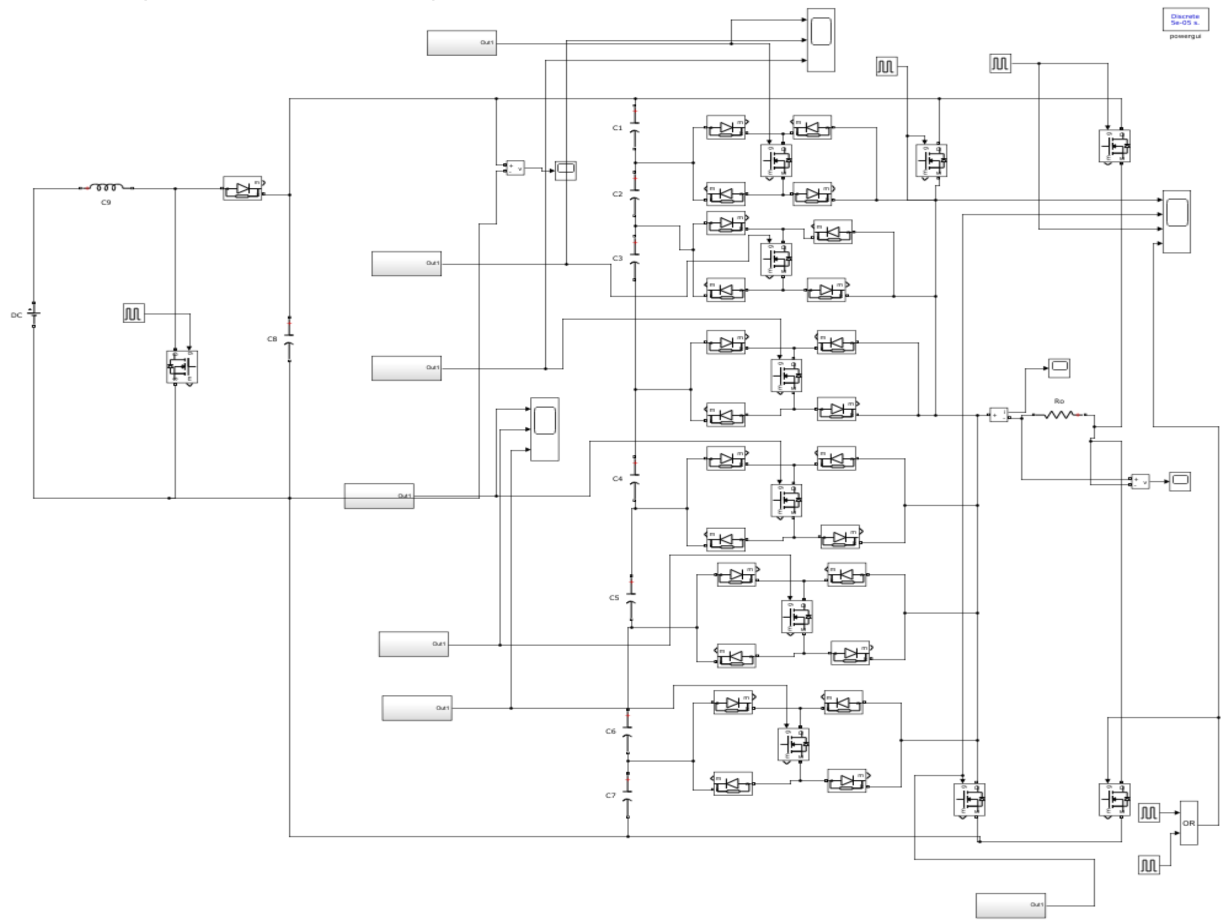

Figure 2 Simulation Circuit - single phase 15-level Sub- Multilevel Cascaded H-Bridge Inverter

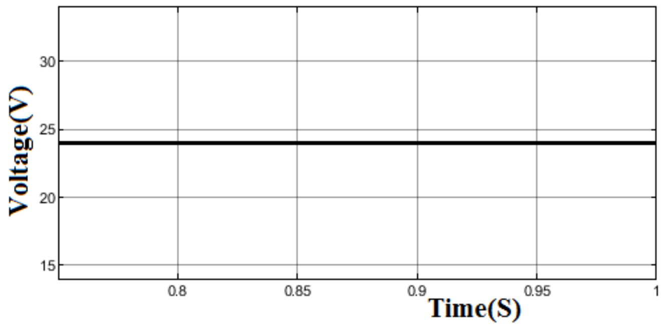

Figure 3 Input Voltage

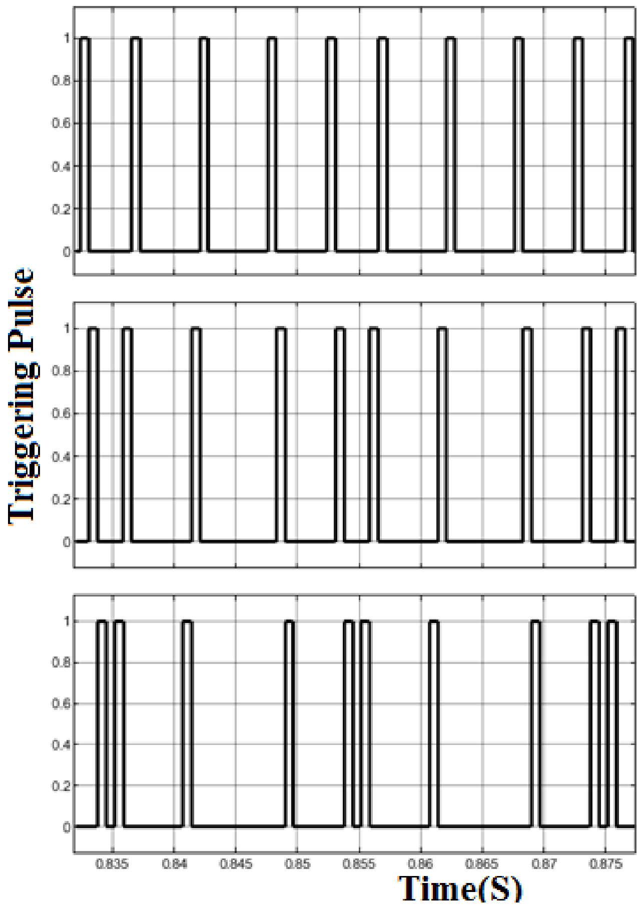

Figure 4 Triggering Pulse at Switch S1,S2,S3

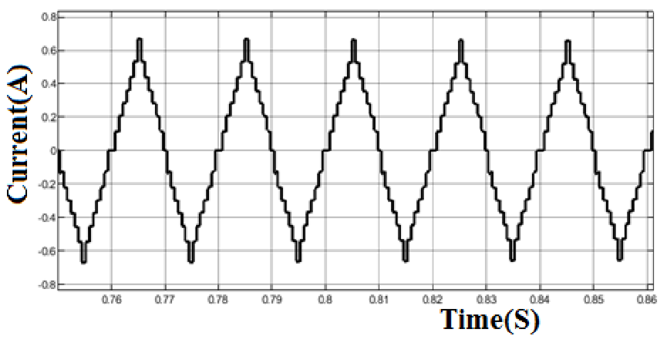

Figure 5 Output Current

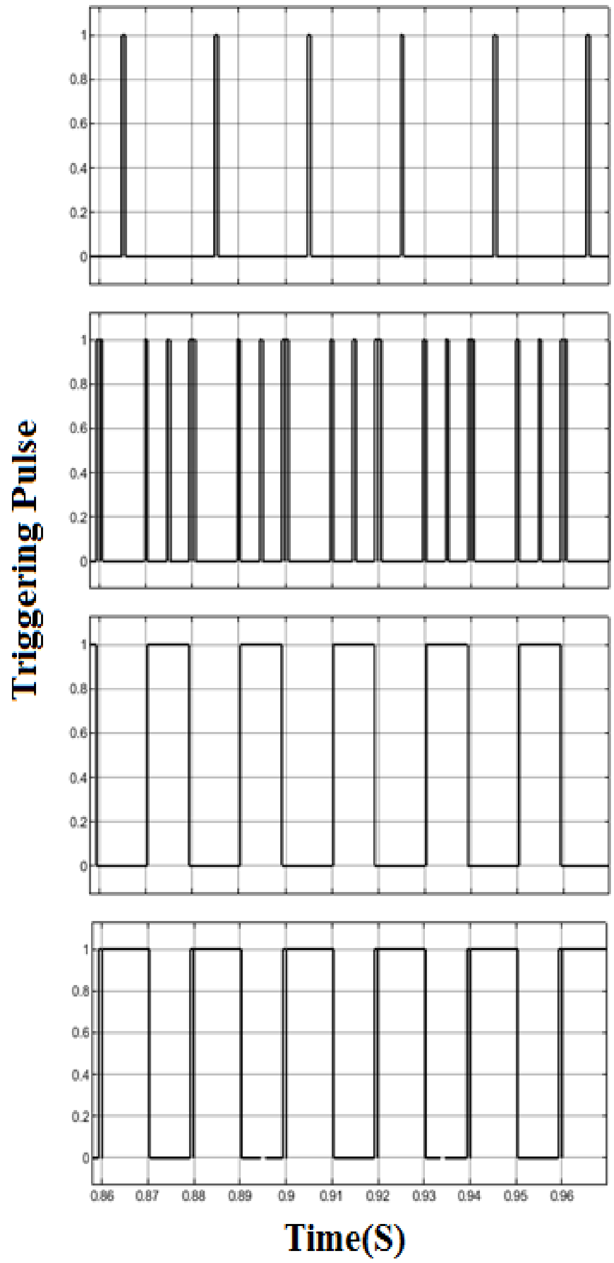

Figure 6 Trigger pulse at Switch S4,S5,S6,S7

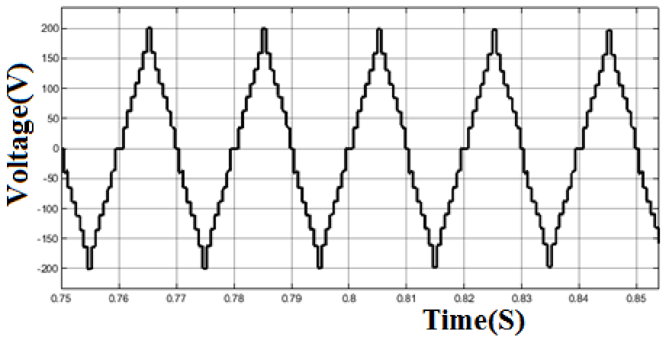

Figure 7 Output Voltage

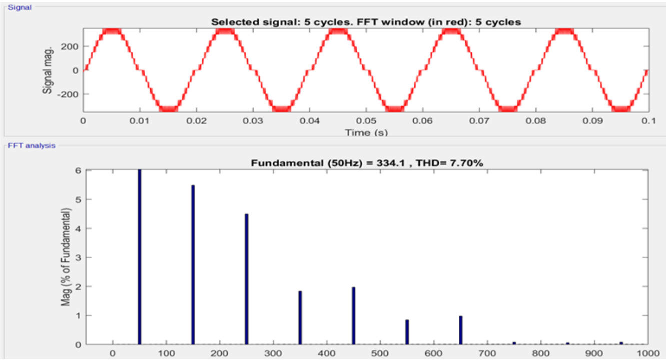

Figure 8 Output voltage FFT analysis

5. CONCLUSION

In this paper, a new structure of single phase 15-level Multilevel Cascaded H-Bridge Inverter has been proposed. The proposed system does not required additional resonant soft switching circuits for Zero Voltage Switching (ZVS) of inverter. It has been shown that the structure consisting of sub-multilevel modules and H-bridge inverter. The proposed topology extends the design flexibility and possible to optimize the power converter.

REFERENCES

[1] AmuliuBogdanProca, and Ali Keyhani, “Identification of variable frequency induction motor models from operating data,” IEEE Trans. on Energy Conv., vol. 17, pp. 24-31, March 2002.

[2] Alfredo Munoz-Garcia, Thomas A. Lipo, and Donald W. Novotny, “A New Induction Motor V/fControl Method Capable of High-Performance Regulation at Low Speeds,” IEEE Trans. Ind. Applicat., vol.34, pp. 813-821, July/Aug. 1998.

[3] J. S. Lai and F. Z. Peng, “Multilevel converters-A new breed of power converters,”IEEE Trans. Ind. Applicat., vol.32, pp. 509-517, May/June 1996.

[4] Akshay K. Rathore, Joachim Holtz, and Till Boller, “Generalized Optimal Pulse Width Modulation of Multilevel Inverters for Low-Switching-Frequency Control of Medium-Voltage High-Power Industrial AC Drives,” IEEE Trans. Ind. Electron., vol. 60, Oct. 2013.

[5] Dong Jiang, Fei Wang, and Jing Xue, “PWM Impact on CM Noise and AC CM Choke for Variable-Speed Motor Drives PWM Impact on CM Noise and AC CM Choke for Variable-Speed Motor Drives,” IEEE Trans. Ind. Applicat., vol. 49, Mar./April 2013.

[6] Jeffrey Ewanchuk, John Salmon, and Andrew M. Knight “Performance of a High-Speed Motor Drive System Using a Novel Multilevel Inverter Topology,”IEEE Trans. Ind. Applicat., vol. 45, Sept./Oct. 2009.

[7] E. Babaei “A Cascade Multilevel Converter Topology with Reduced Number of Switches,”IEEE Trans. Power Electron.,vol. 23, Nov.2008.

[8] FaridKhoucha, MounaSoumiaLagoun, AbdelazizKheloui, and Mohamed El HachemiBenbouzid, “A Comparison of Symmetrical and Asymmetrical Three-Phase H-Bridge Multilevel Inverter for DTC Induction Motor Drives,” IEEE Trans. on Energy Conv., vol. 26, pp. 64-72, March 2011.

[9] FaridKhoucha, SoumiaMounaLagoun, KhoudirMarouani, AbdelazizKheloui, and Mohamed El HachemiBenbouzid, “Hybrid Cascaded H-Bridge Multilevel-Inverter Induction-Motor-Drive Direct Torque Control for Automotive Applications,” IEEE Trans. Ind. Electron., vol. 57, pp. 892-899, March 2010.

[10] Samir Kouro, Mariusz Malinowski, K. Gopakumar, JosepPou, Leopoldo G. Franquelo, BinWu, Jose Rodriguez, Marcelo A. Perez, and Jose I. Leon, “Recent advances and industrial applications of multilevel converters,”IEEE Trans. Ind. Electron., vol. 57, pp. 2553-2580, Aug. 2010.

BIOGRAPHIES

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