

## MULTIDIRECTIONAL TRANSTHORACIC DEFIBRILLATOR: CONTROL CIRCUIT FOR HIGH VOLTAGE SWITCHING.

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### Abstract

Biphasic waveforms are used to minimize the intensity of the electric field applied to the heart during defibrillation. Multidirectional defibrillation has been shown to be an alternative method to reduce defibrillation shock energy. Here the control circuit for a multidirectional, biphasic defibrillator was designed and bench-tested.

Key words: *Instrumentation, Embedded System, Defibrillation.*

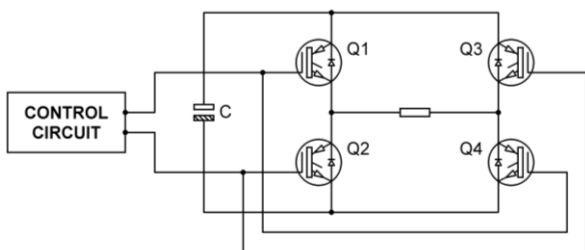
### Introduction

The electrical defibrillation is the only treatment available to reverse the ventricular fibrillation<sup>1</sup>. However, the application of high intensity electric fields, such as during defibrillation, can cause cell death and cardiac arrhythmias<sup>2</sup>.

A transthoracic multidirectional defibrillator was designed to increase the defibrillation efficacy, (MCTI-CNPq 014-2013, No. 475621 / 2013-1). The device allows for lower energy level application by varying the electric field in 3 directions (vs. 1 as in conventional defibrillators)<sup>3</sup>. In the present work the control circuit for switching high power in the 3 directions of the defibrillator was developed and bench-tested. Results indicate a good level of success in generating the appropriate waveform using an H-bridge circuit based on IGBT components.

### Results and Discussion

The circuit is intended to control the discharge of capacitors for multidirectional, biphasic stimulation. Insulated bipolar transistors were used (IGBT, IXBX25N250, IXYS Corporation, CA, USA) as electronic switches in an H-bridge configuration (Figure 1).

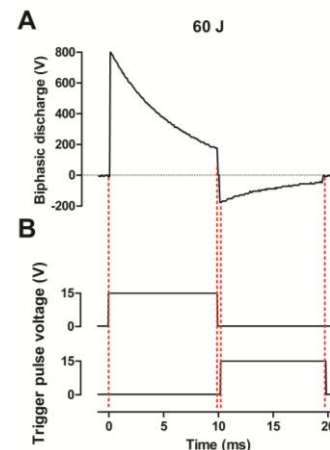


**Figure 1.** Schematic circuit of H-bridge with IGBTs (Q1-Q4). (Viana, MA - unpublished).

An embedded system based on the PIC18F4550 microcontroller (Microchip Technol. Inc., Chandler, AZ, USA) would generate pulses to switch 1 or 3 H-bridges (uni- or multidirectional) for capacitor discharge and to control the shooting time. An analog to digital converter is available for

viewing on a display the level of the applied voltage.

Figure 2 shows the typical bipolar pulse, in this case, the capacitive discharge occurs through Q1 and Q4 of the H-bridge and the remainder charge is delivered to the other diagonal (Q2 and Q3), generating the exponential truncated waveform.



**Figure 2.** Biphasic discharge (60J) in one direction. (Viana, MA - unpublished).

### Conclusions

The embedded system proved fully applicable for H-bridge switching control. Likewise, the junction control and switching were effective to produce the truncated exponential biphasic curve as necessary for defibrillation.

### Acknowledgement

We thank the technical support of R & D group of the Centro de Engenharia Biomédica (CEB-UNICAMP) and CNPq for the financial support (Proc N. 102684/2014-6).

<sup>1</sup> Koster, R.W.; Walker, R.G.; Van Alem, A.P. *Crit Care Med.* **2006**, *34*, 423.

<sup>2</sup> Oliveira, P.X.; Bassani, R.A.; Bassani, J.W.M. *IEEE Trans Biomed Engin.* **2008**, *55*, 2635-2642.

<sup>3</sup> Viana, M.A.; Petrucci, O.; Marques, D.A.; Bassani, R.A.; Bassani, J.W.M. *J Thorac Cardiovasc Surg.* **2014**, *148*, 3213.