A Technical Report on
Design of a transistor based pulse generation circuit for Electrical Discharge machine

Kipkosgei Patrick¹, Kabini Karanja², Ikua Bernard³

Abstract—A Pulse generation circuit is a key component of an Electrical Discharge Machine (EDM) as it regulates and controls the machining process. Machining parameters such as frequency, duty cycle, machining time, voltage and their execution instructions are set through the Graphics User Interface (GUI) and executed by the pulse generator. Coupled to the pulse generation circuit is the motor driver circuit which controls the vertical motion of the tool and the workpiece. This paper presents a new approach in the development of a pulse generation and affiliated circuits for EDM machine developed at JKUAT. The current pulse generation circuit is based on resistor capacitor technology.

Keywords—Electrical discharge machining, pulse generation circuit, machining.

I. INTRODUCTION

Electrical discharge machining (EDM) is a non traditional machining process with no cutting forces between the die and the workpiece but uses thermal energy generated by a spark to remove material from an electrically conductive material [1][2]. The main components of EDM are: power supply, servo system and pulse generation circuit.

The power supply for the pulse generation circuit uses DC voltage which is obtained from a rectified and stepped down AC voltage from the mains. The servo system controls the vertical movement of the tool electrode. The movement of the tool is retraction in case of a short circuit and advancement in case of an open circuit.

There are two types of pulse generation circuits used in EDM namely: Resistor Capacitor (RC) type and transistor type. RC-type generation circuits generates a pulse when the capacitor and resistor are charged and discharged through the workpiece. Transistor-type generation circuits employ transistors to deliver the pulsed energy to the workpiece by switching on/off the DC power. RC-type generation are mostly used in conventional micro EDM although transistor-type is preferred because of its high machining removal rate (MRR) [3]. The other advantage of a transistor-type pulse generation circuit is that the duty cycle and frequency can be set independently unlike the RC-type [4].

In RC-type, the ON and OFF times cannot be independently adjusted and any adjustment causes changes in the duty cycle and frequency. This is because all these parameters are set using a range of capacitances.

The developed pulse generation circuit uses ATMEGA328P micro-controller to generate a pulse width modulated (PWM) signal where the duty cycle and frequency can be controlled independently. The PWM signal controls a MOSFET through an opto-isolator which delivers the electrical machining power. A newly developed motor driver circuit and graphics user interface are also presented.

II. EXPLANATION OF THE DESIGN

A variable transformer rated at 2 kVA is used to step down the voltage and also regulate machining voltage. A rectifier circuit is used to convert the power from AC to DC. The DC voltage is then passed through capacitors to remove ripples and get a smooth DC voltage. The pulse generation circuit and motor driver circuit are coupled to the GUI. Among the inputs fed through the GUI are; frequency, duty cycle, speed of the motor and machining time.

Two potentiometers are provided for entering the frequency and duty cycle. The potentiometers are connected to the micro-controller’s analog input of the GUI (for display purposes) and pulse generation circuit. The analog inputs have an in built 10 bit analog to digital converter that outputs a number between 0 and 1023 to represent the minimum and the maximum position of the potentiometers. For the frequency potentiometer, the micro-controller converts this number to between 5000 and 50 microseconds which represents the period of the frequency between 200Hz and 20kHz. The duty cycle ranges between 5 and 95 percent. The micro-controller in the pulse generation circuit uses two values to generate the desired square, one from the set period and the other from the set percentage.

The speed of the stepper motor is set to an optimal value of 18 rpm through the micro-controller in the motor driver circuit. The drive is provided by a stepper motor that has a 1.8 degree per step resolution.

The machining time, entered through a keypad is counted down by the GUI’s micro-controller, and when it reaches zero, the power to the pulse generation circuit is switched off. At this point, the motor driver circuit will retract the die...
for 30 seconds to provide enough space for the workpiece to be unclamped. During machining, the GUI displays the machining frequency, duty cycle, machining voltage and time remaining to the end machining. The circuit developed for the pulse generation circuit is shown in Figure 1.

![Fig. 1. Schematic of pulse generation circuit](image)

**Fig. 1. Schematic of pulse generation circuit**

### III. RESULTS

The circuits that were developed for pulse generation, motor drive and graphic user interface were installed in a panel box with the 2 kVA variable transformer supplying the required stepped down power. Figure 2 shows a sample pulsed square waveform generated by the pulse generator, captured using an oscilloscope. Figure 3 shows a discharge signal captured during machining. The discharge signal shows a healthy machining process free of open and short circuit occurrences. In case of short circuit, the discharge voltage signal goes to zero while in case of open circuit the discharge voltage remains at the maximum value.

![Fig. 2. Generated pulse at 85.4 V and 950.5 Hz](image)

**Fig. 2. Generated pulse at 85.4 V and 950.5 Hz**

![Fig. 3. Machining pulse at 82.4 V and 1.106 kHz](image)

**Fig. 3. Machining pulse at 82.4 V and 1.106 kHz**

![Fig. 4. A photograph of the developed EDM control and pulse generation circuit based on Arduino Atmega 328P microprocessor](image)

**Fig. 4. A photograph of the developed EDM control and pulse generation circuit based on Arduino Atmega 328P microprocessor**
IV. CONCLUSIONS

The pulse generation and other affiliated circuits that were developed for the electrical discharge machine generated the necessary machining pulsed signals as was intended and are currently being tested on the machine. The circuits also provided independent and smooth control of the machining parameters.

ACKNOWLEDGEMENT

This work was supported by Jomo Kenyatta university of Agriculture and Technology (JRUAT) and the Japan International Co-operation Agency (JICA).

REFERENCES


