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Investigation on Inverter Arc Welding Circuit

Nethra K, Bansilal Bairwa, Christina Sundari V Himabindu
k.nethra@reva.edu.in

School of EEE, REVA University,Bangalore, India 560064

Abstract

Arc welding is a type of welding process using an electric arc to generate heat to melt and join metals. A power supply produces an electric arc between a consumable or non-consumable electrode and the base material using either direct (DC) or alternating (AC) currents. Orthodox welding machines use grid frequency transformers to reduce the arc voltage to a lower voltage, then chopper circuit is used to adjust welding current. But grid frequency transformers are bigger and heavier than high frequency transformers. Thus, portability poses as a disadvantage in conventional welding machines. To solve the problem of weight and size of conventional arc welding machine, an inverter circuit was also developed. The inverter provided much higher frequency than 50Hz or 60Hz for transformers used in welding circuits. In this paper, we have proposed to develop an entire inverter section for an arc welding machine along with the necessary high frequency step-up transformer. The aim of developing the inverter circuit for an arc welding machine is to serve the foundation for developing weld machines based on the other available methods like Tig, CO2 etc. variables such as operating frequency, output voltage and current are the only factors in design.
Keywords: Arc welding, frequency transformers.

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1.1 Introduction

Welding equipment has become one of the most important tools that a producer can possess hence the need to design and construct an inverter welding machine[1, 2, 3]. By introducing a PWM generator into the circuit control over the frequency of inverted output from the inverter section is achieved. The inverted output is stepped up to the arc required voltage using an appropriate step-up transformer[4, 5, 6]. In this paper, new onsite small scale inverter welding machines are designed and be used.

1.2 Methodology

The first objective is to calculate and design the entire circuit according to the flow of the block diagram and simulate the circuit on the Simulink program in MATLAB, followed by implementing the designed circuit on hardware and proceed further to obtain the arc parameters at the output.High Power MOSFETs (IRF9540) can switch over 60A and 30V and are TO-220 package. In this, the MOSFETs acts as switches in the inverter section to produce an alternating current controlled by a PWM generator. The SG3525A pulse width modulator control circuit offers improved performance and lower external parts count when implemented for controlling all types of switching power supplies. The output stage of the SG3525A features NOR logic resulting in a low output for an off-state.

- 8.0V to 35V operation
- 5.1 $V_{trimmed}$ reference
- 100Hz to 400kHz Oscillator range
- Separate Oscillator Sync Pin
- Adjustable Dead-time Control
- Input Under Voltage Lockout
- Latching PWM to prevent Multiple pulses
- Pulse-by-pulse shutdown
- Dual source/Sink outputs: -400mA peak
- Pb-free packages are available

A high frequency step-up transformer s used to step-up the voltage to an arc sufficient voltage from the outputs of the inverter section. Given that arcs in smaller scale welding takes place between voltages of 30 to 50V, a suitable transformer s selected based on the iput and output requirement. DC-DC boost converter is used to step up to higher voltage. PIC is a fam-

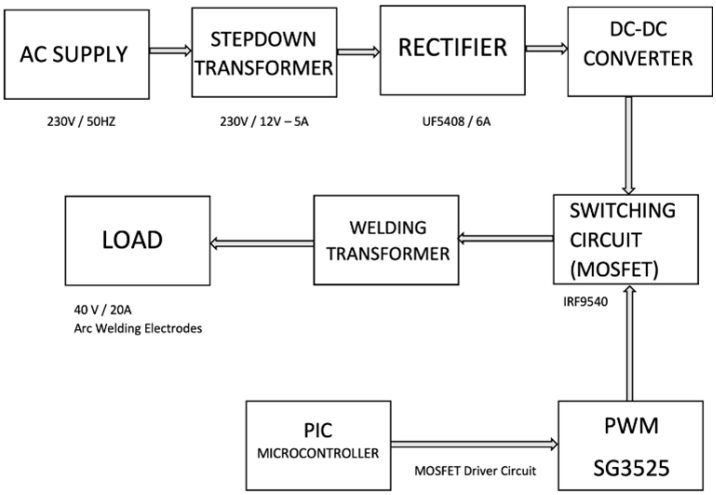

Figure 1.1 Block Diagram of Inverter Arc Welding Circuit [1]

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ily of modified Harward architecture micro-controllers made by Microchip technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division. The initially referred to **Peripheral Interface Controller**. This PIC micro-controller having a feature of high performance RISC CPU. Capacitors are used as filters in the power supply unit. The action of the system depends upon the fact, that the capacitors stores energy during the conduction period and delivers this energy to the load during the inverse or non-conducting period. In this way, time during which the current passes through the load is prolonged and ripple is considerably reduced [7, 8, 9, 10].

$$Switching\ frequency = \frac{1}{C_t * (0.7R_t + 3R_d)} \tag{1.1}$$

$$D = 1 - \frac{V_s}{V_o} * \eta \tag{1.2}$$

$$L = \frac{Vs_{min} * D}{F_s * \Delta I_L} \tag{1.3}$$

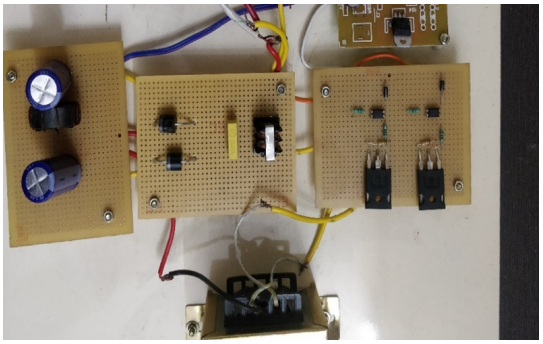

Figure 1.2 Hardware implementation of the filter circuit and Snubber circuit .

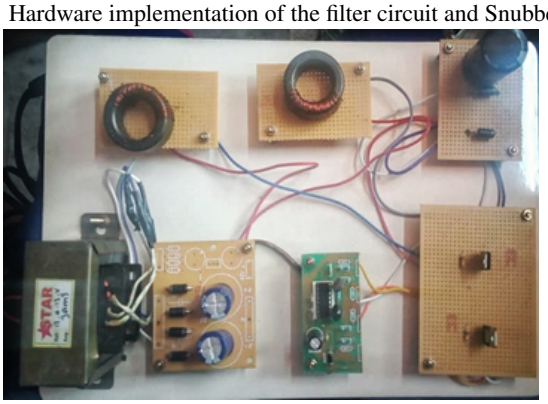

Figure 1.3 Hardware implementation of the inverter section along with the SG3525 IC .

Table 1.1 Parameters values adopted for this research

S.No	Parameters	Remarks
1.	Switching frequency	200 x 103 Hz
2.	C_t	0.1nF
3.	R_d	100 Ω
4.	F_s	200khz
5.	D	0.35
6.	C	10.93 μF
7.	L	9.85 μH
8.	I_0	2.5 A
9.	Load Resistance	16 Ω
9.	V_{in}	13 V

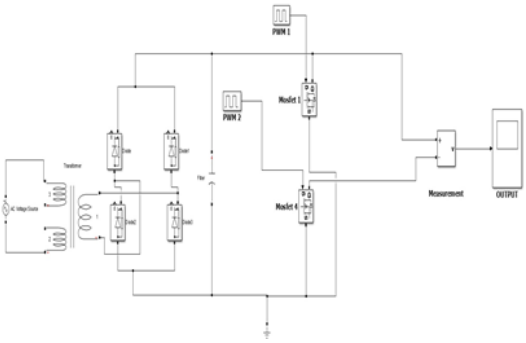

Figure 1.4 Block Diagram of Inverter Arc Welding Circuit.

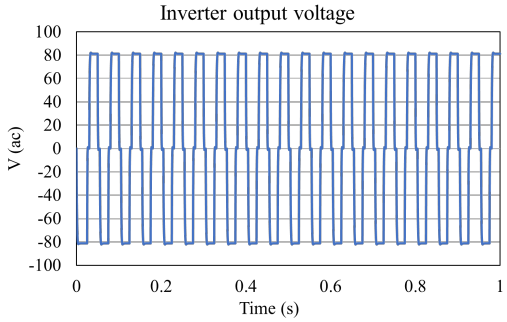

Figure 1.5 Simulation output for inverter.

1.3 Results and Discussion

We developed a MATLAB Simulink modelfor the welding inverter, along with a separate simulation of the DC-DC Boost converter section with parameters set almost equal to practical desired values. This work carried out simulation of an inverter along with full bridge rectifier circuit shown in Figure 1.4 Hardware implementation of the filter circuit and Snubber circuit as shown in Figure 1.2. Hardware implementation of the inverter section along with the SG3525 IC have been used in this work. Table 1.1 represents the parameters and their values adopted for this research.

1.4 Conclusion

By developing this inverter circuit we aim to implement it into an end user portable welding machine and also frame a cost effective product delivering the required job work to the user irrespective of availability of a power source

and place. However, since the circuit is a DC operated one, there comes into picture a frequent maintenance of the said battery. One of the proposed dc source that can be used for the machine is a 48v 100Ah battery, capable of sustaining welds for considerate amount of time. This however is subject to availability. In conclusion the proposed inverter circuit for use in application of an arc welding machine will prove to be propitious and constructive to its user. An introduction of an isolator circuit such as an optocoupler can be done for the protection of power components within the circuit. LCD displays can be used with the machines for ease of use and also detecting and monitoring faults in the system.

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