

Chapter 8

EXPERIMENTAL VERIFICATION

8.1 Introduction

The objective of the conducted experiment is to assess the versatility of Induction melting technology using Quasi-Resonant converter which melts gold/silver/copper material.

In this chapter first the proposed modified quasi-resonant converter system has been described and the experimental parameter has been defined an then follows the experimental results.

8.2 Experimental System

Induction melting takes power from the 3phase mains, rectifies it & converts into dc. The power components are designed in such a way that DC-Link voltage is 200v. This is then converted into high frequency which is used to generate heat in conducting material.

The Figure 8-1 shows the micro-controller board duly assembled. The LCD placed on this board is just to display the parameters locally.

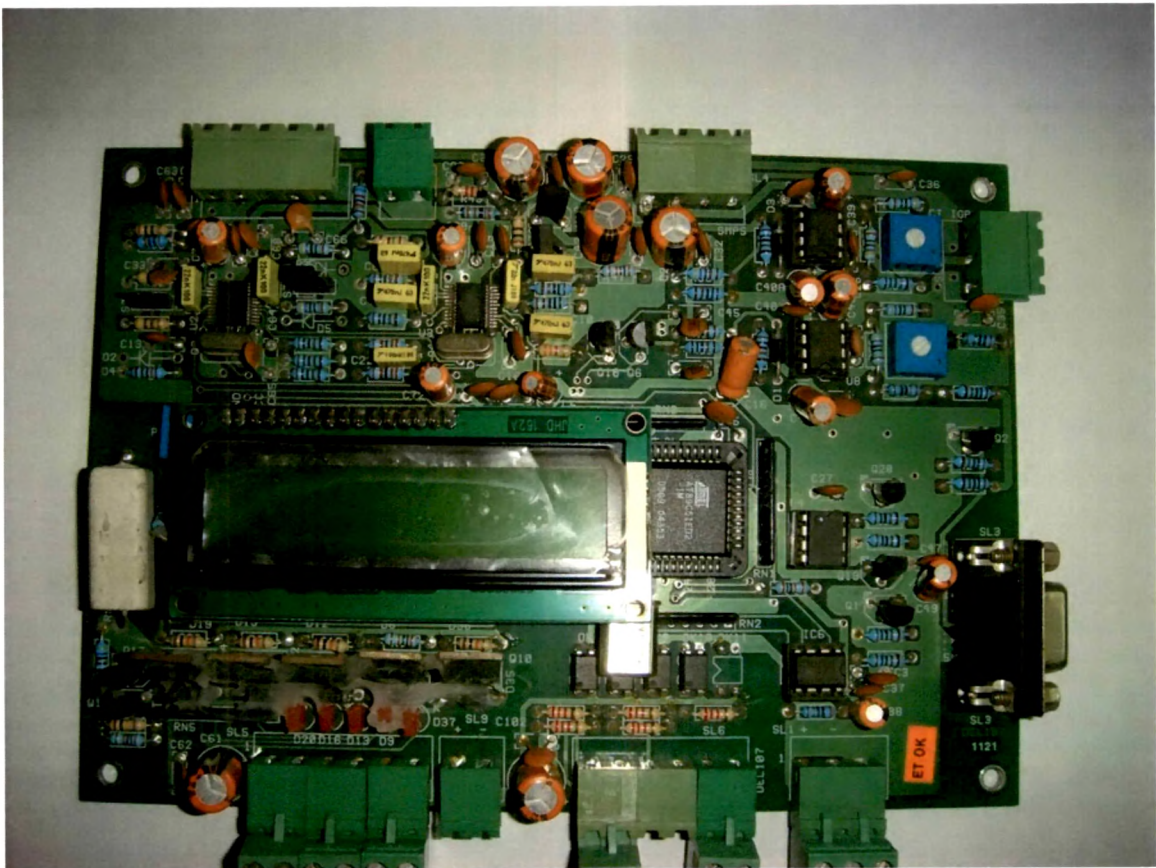


Figure 8-1 Micro-controller (AT89C51ED2) Board

The micro-controller board is divided into following 3 sections.

1. The section generating IGBT gate pulses according to the frequency burst commands received from ARM-7 board is shown in Figure 8-2. The output pulses are converted into 15v pulses to avoid noise into cable layout from this board to IGBT driver board which is placed near IGBT as shown in Figure 8-3.

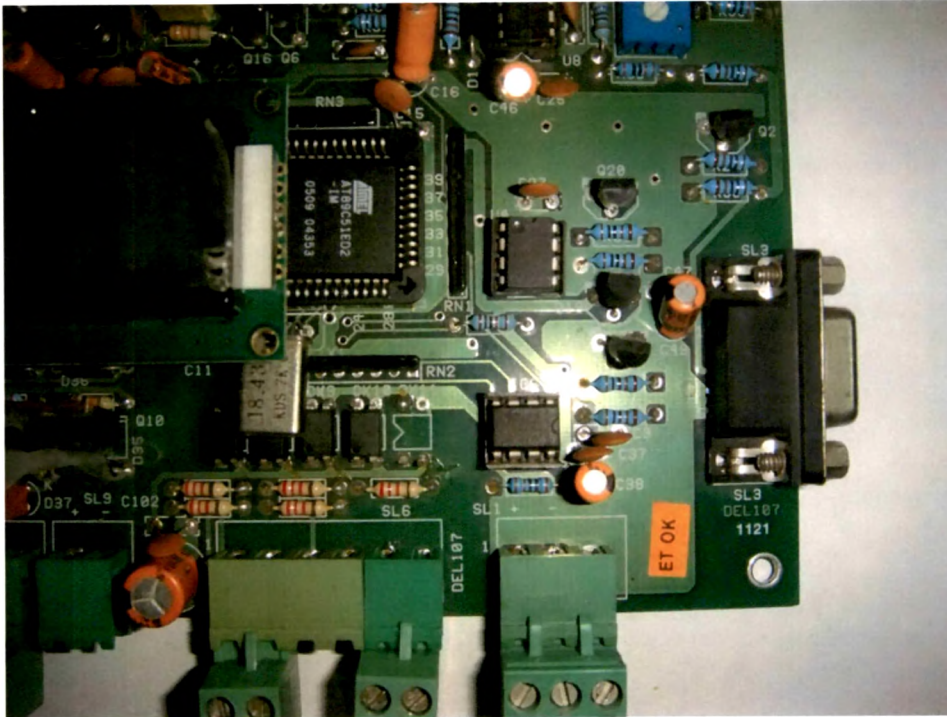


Figure 8-2 Gate firing section of Micro-controller Board

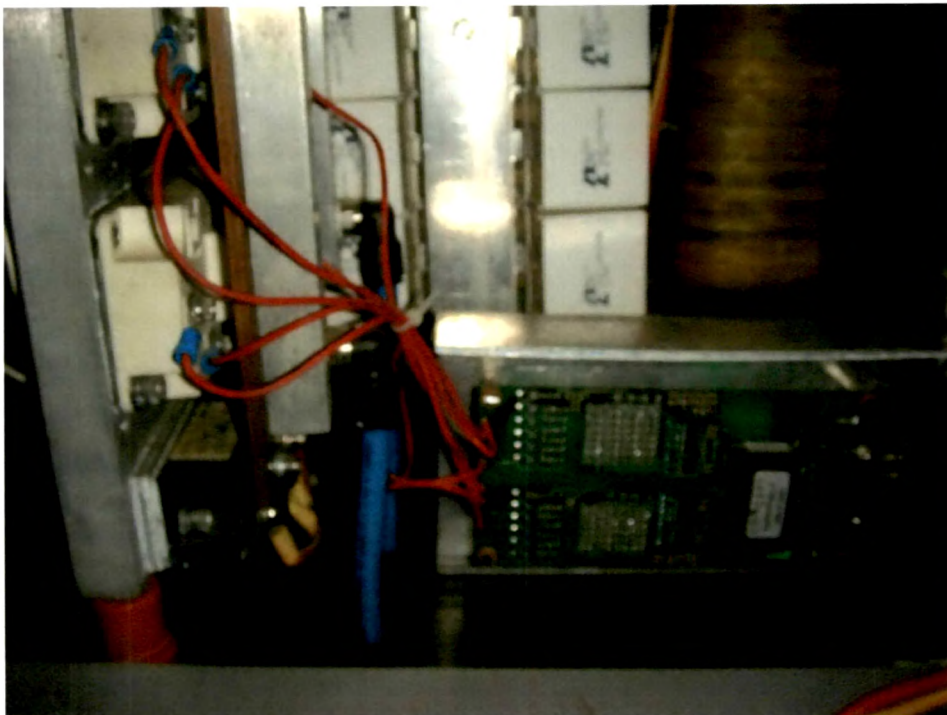


Figure 8-3 IGBT driver board placed near IGBT assy.



- 2. This section tunes on duty of the IGBT gate pulses according to the load inductance changes.

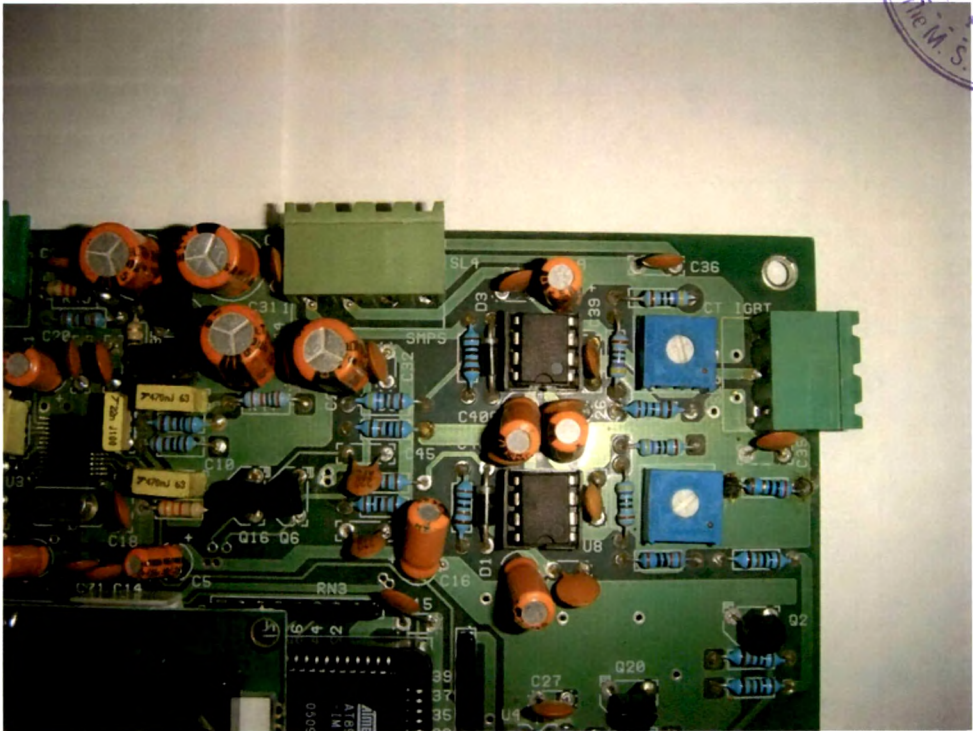


Figure 8-4 Comparator section of Micro-controller Board

- 3. This section converts thermocouple output into digital value of temperature using CS5460 IC. Through another CS5460 IC it converts the DC-Link voltage & current into their RMS values.

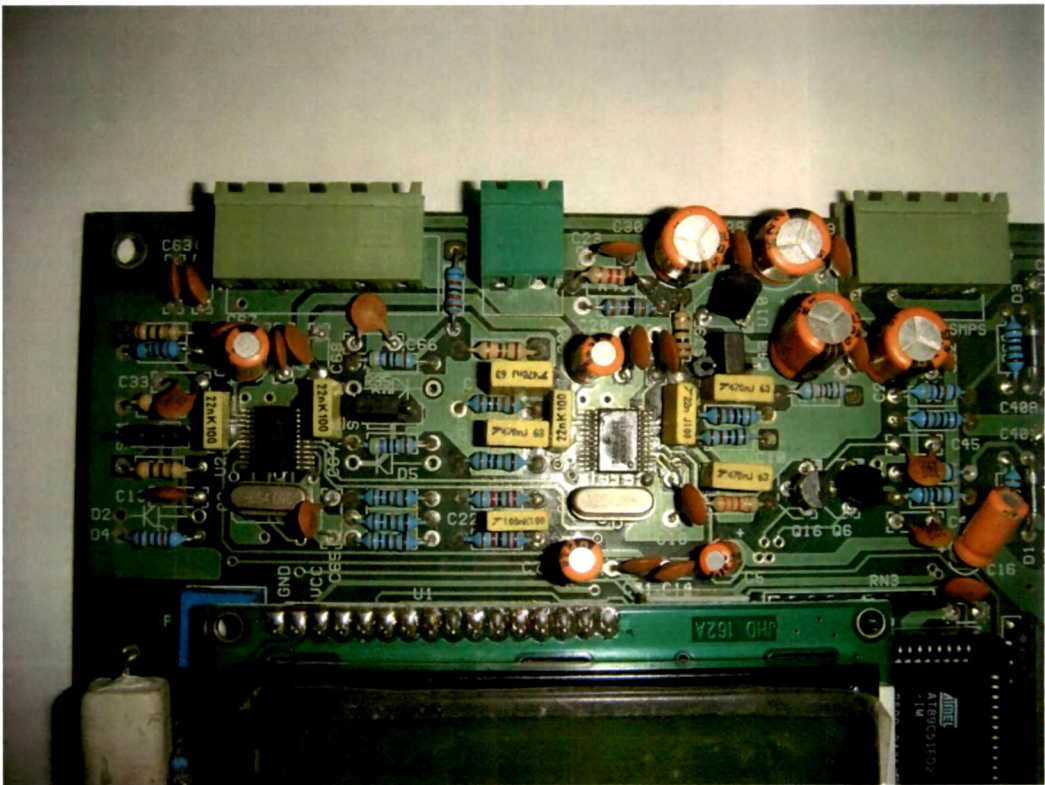


Figure 8-5 CS5460(ADC) section of Micro-controller Board

The Figure 8-6 shows the ARM-7 board duly assembled. This board is mounted on the back side of TFT & touch screen. It is connected to micro-controller board through RS485 cable.

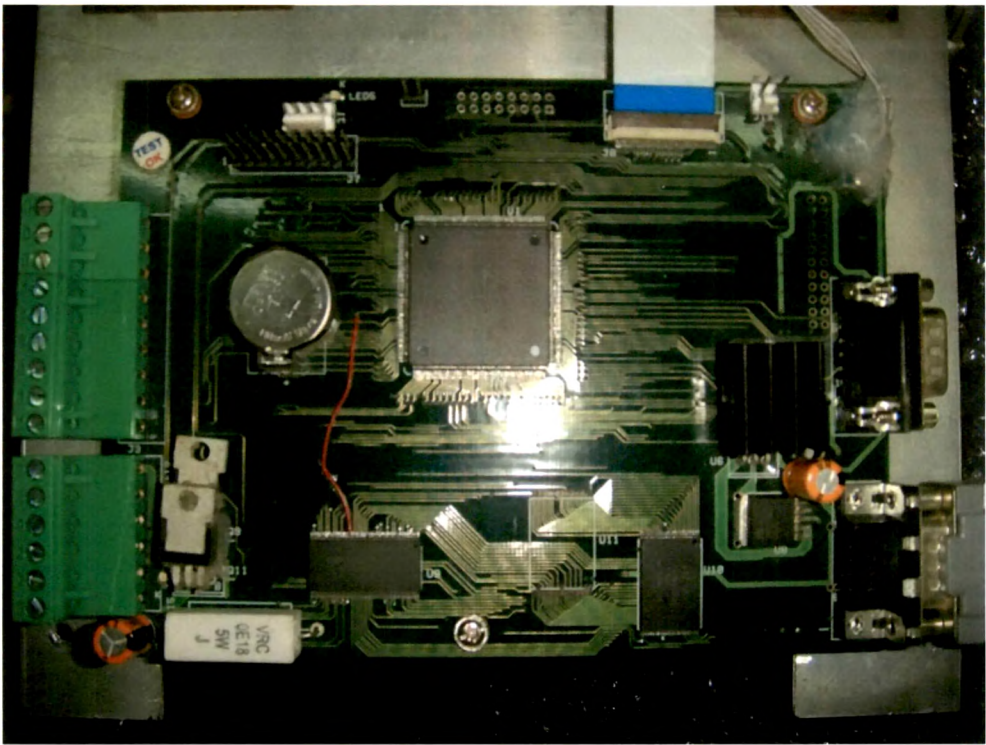


Figure 8-6 ARM-7 controller Board

The schematic of the gate drive board with 2SC0435T driver (Figure 6-22) is converted into pcb form as shown in Figure 8-7.

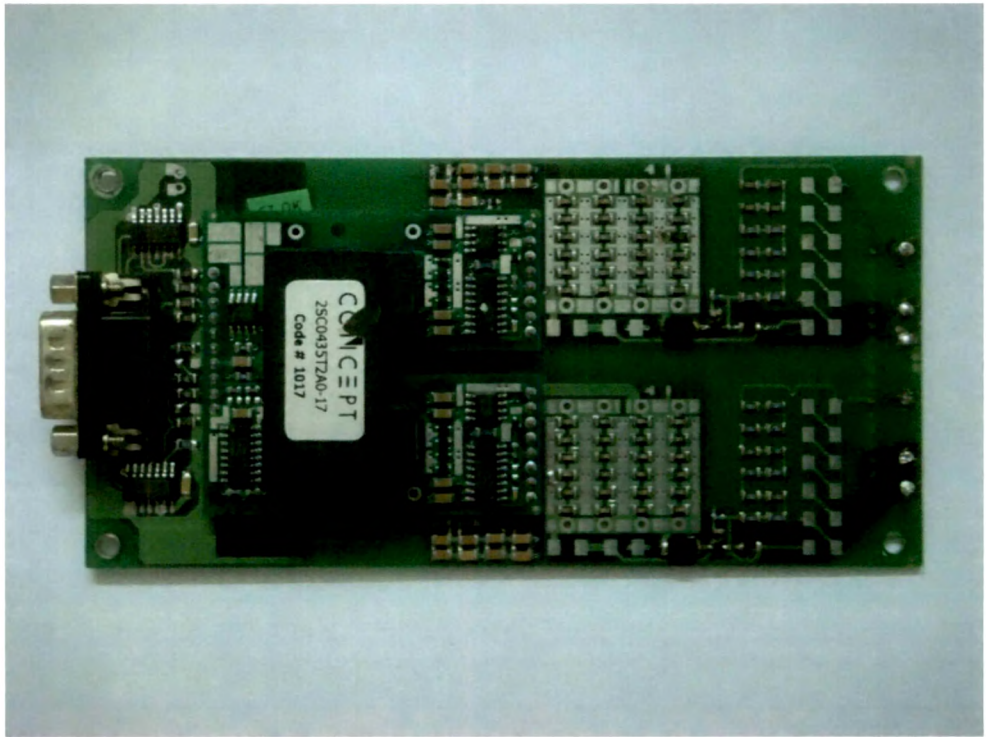


Figure 8-7 Gate drive board with 2SC0435T driver

8.3 Protection Considerations

The protection against under voltage is required, as when the voltage is less (if any one line of input 3phase supply is open creating single phasing) the converter starts malfunctioning. Thus the sensed DC-Link voltage is compared with the lower threshold and the Melter power is switched off when a under voltage condition is sensed. The over current protection is provided in three different ways.

1. Vce monitoring in IGBT gate driver circuit
2. Protection against over current in Tank circuit is accomplished by micro-controller card using comparator circuit.
3. Protection against over current in DC-Link is achieved by micro-controller card through software.

The temperature of coil as well as switching devices is controlled by flowing chilled water through them. Any leakage or breakage in the cooling system is detected by thermostat mounted on coil as well as heat sink of IGBT. The micro-controller card senses the o/p of thermostat & switches off the Melter power in case of over temperature.

8.4 Experimental Results

The experiment is carried out with the pieces of copper placed in crucible as shown in Figure 8-8.

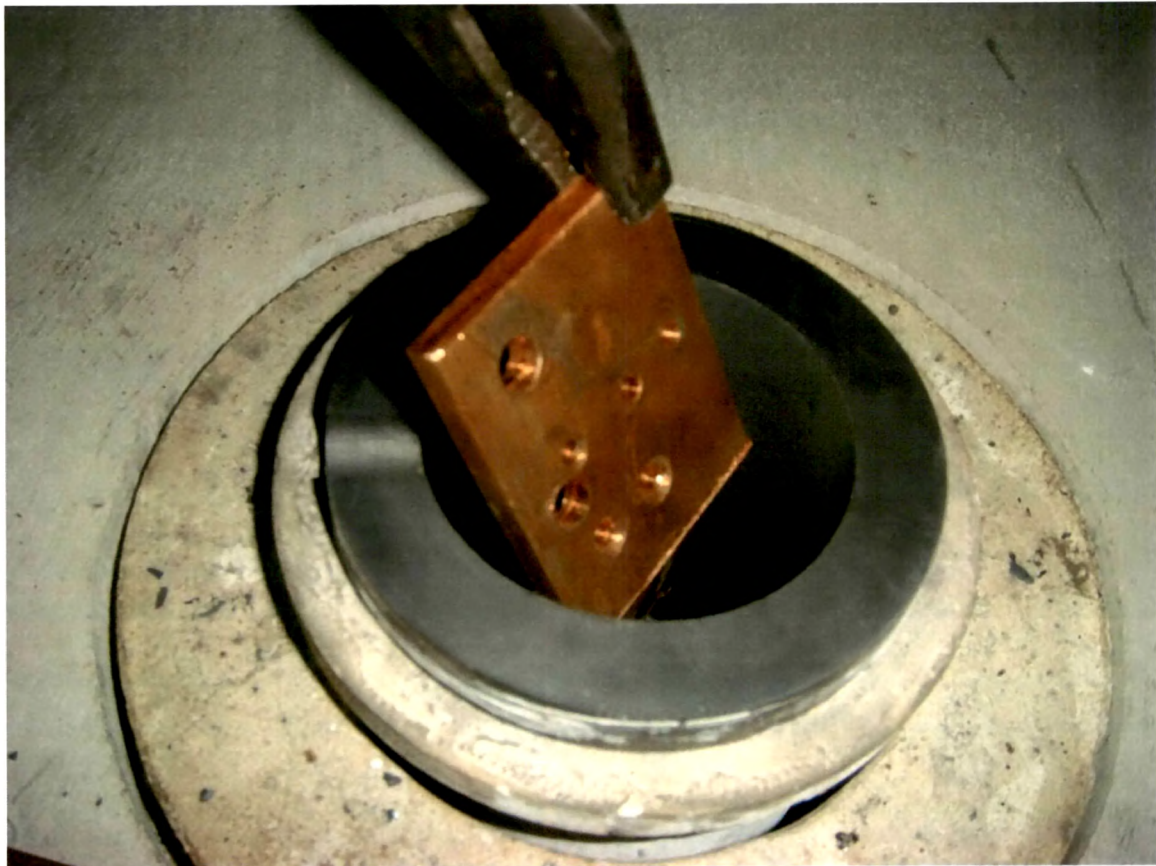


Figure 8-8 Copper work pieces kept into crucible

Experimental circuit parameters are given in Table 8.1. The Figure 8-9 shows the waveform of IGBT gate pulses & the tank circuit current. It is clear that the tank current is pure sinusoidal. The Figure 8-10 and Figure 8-11 show the waveforms of IGBT gate pulses & the DC-Link current and DC-Link voltage. The waveforms are directly stored on pen-drive by digital storage oscilloscope. Figure 8-12 & Figure 8-13 shows the waveform of DC-Link current & the power factor meter reading. The experimental sample result is shown in Figure 8-14.

WEIGHT OF WORK PIECE	2 KG	4 KG
Vab	410 V	411 V
Iab	13.4 A	6.2 A
V _{DC-LINK}	177 V	185 V
I _{DC-LINK}	46 A	24 A
Power Factor	0.999	0.999

Table 8.1 Experimental Verification Summaries

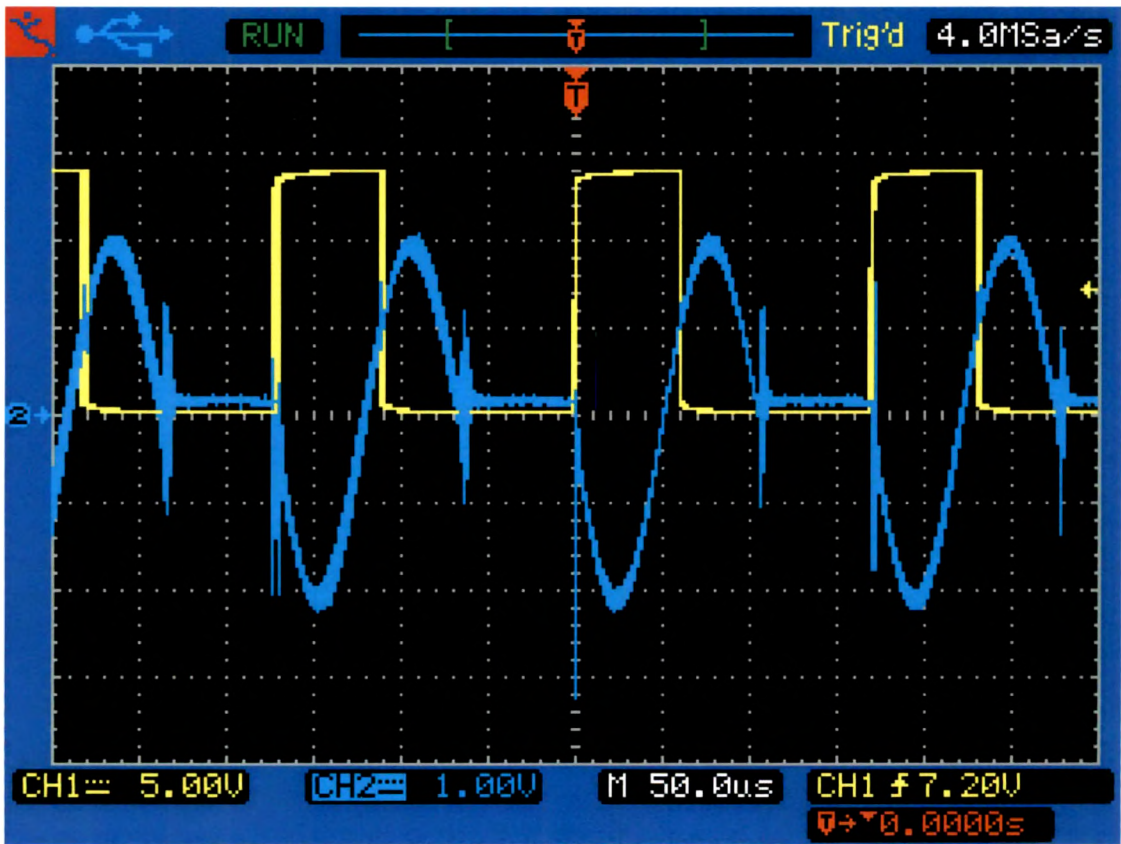


Figure 8-9 Gate Pulse v/s Tank current

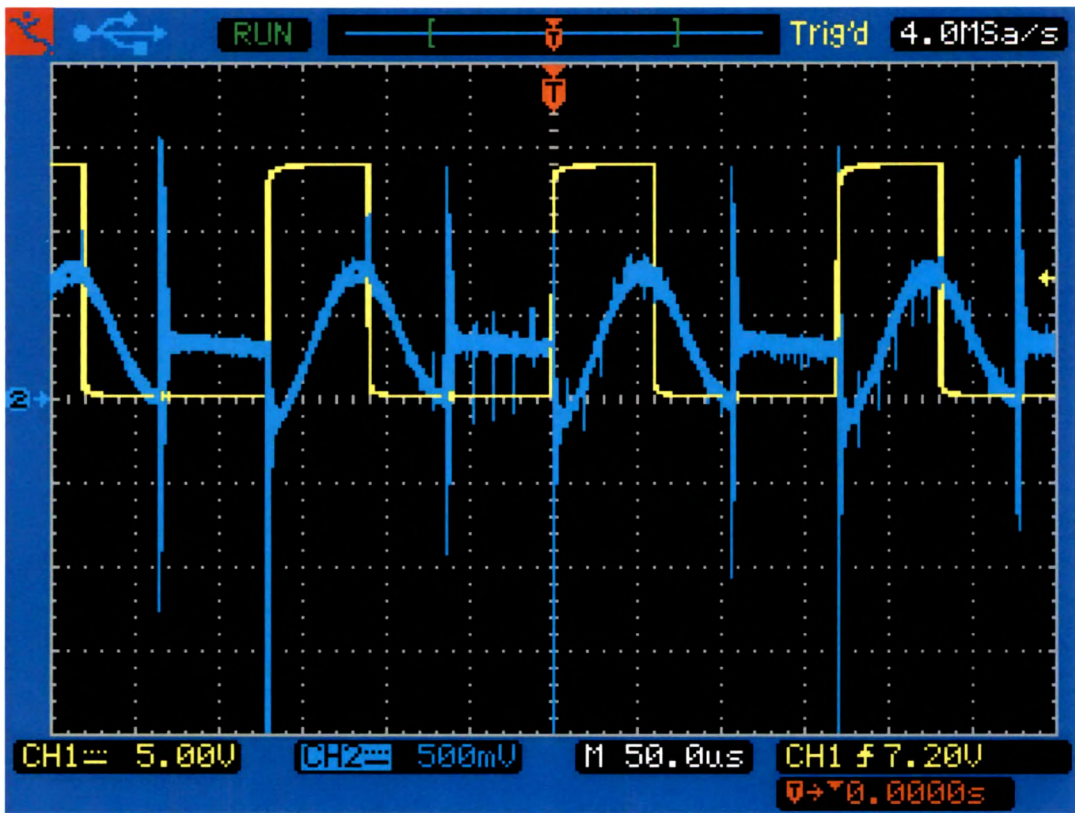


Figure 8-10 Gate Pulse v/s DC-Link current

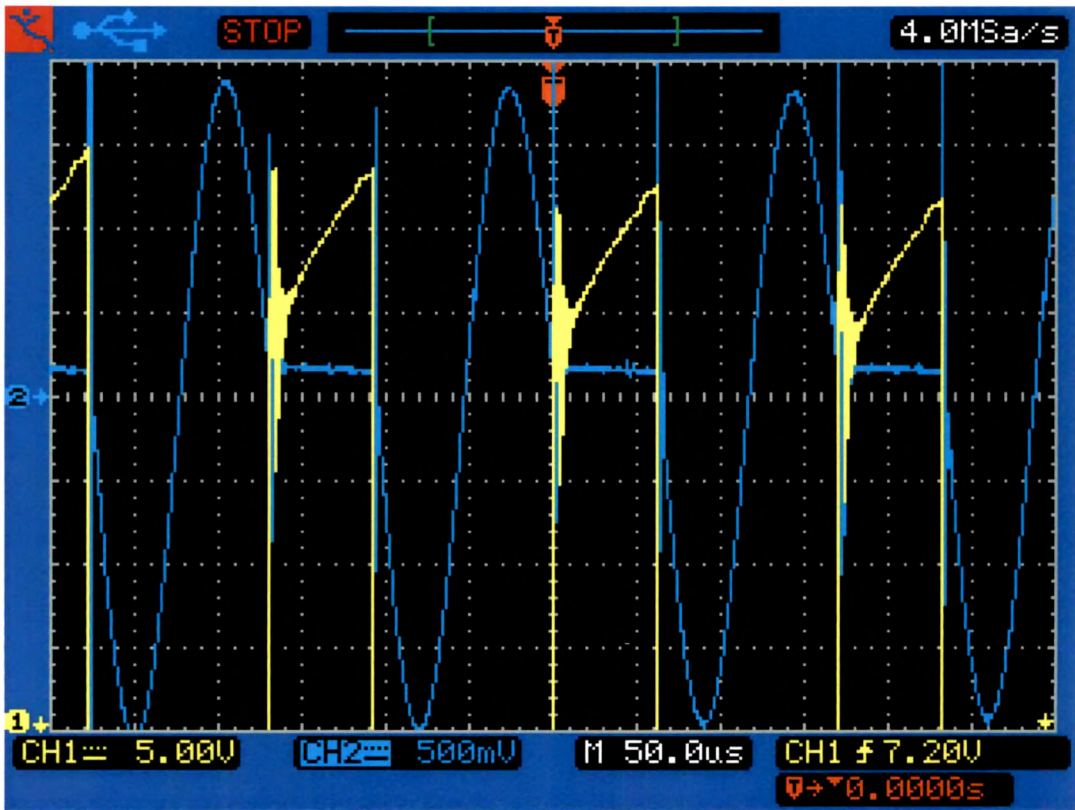


Figure 8-11 Gate Pulse v/s DC-Link voltage

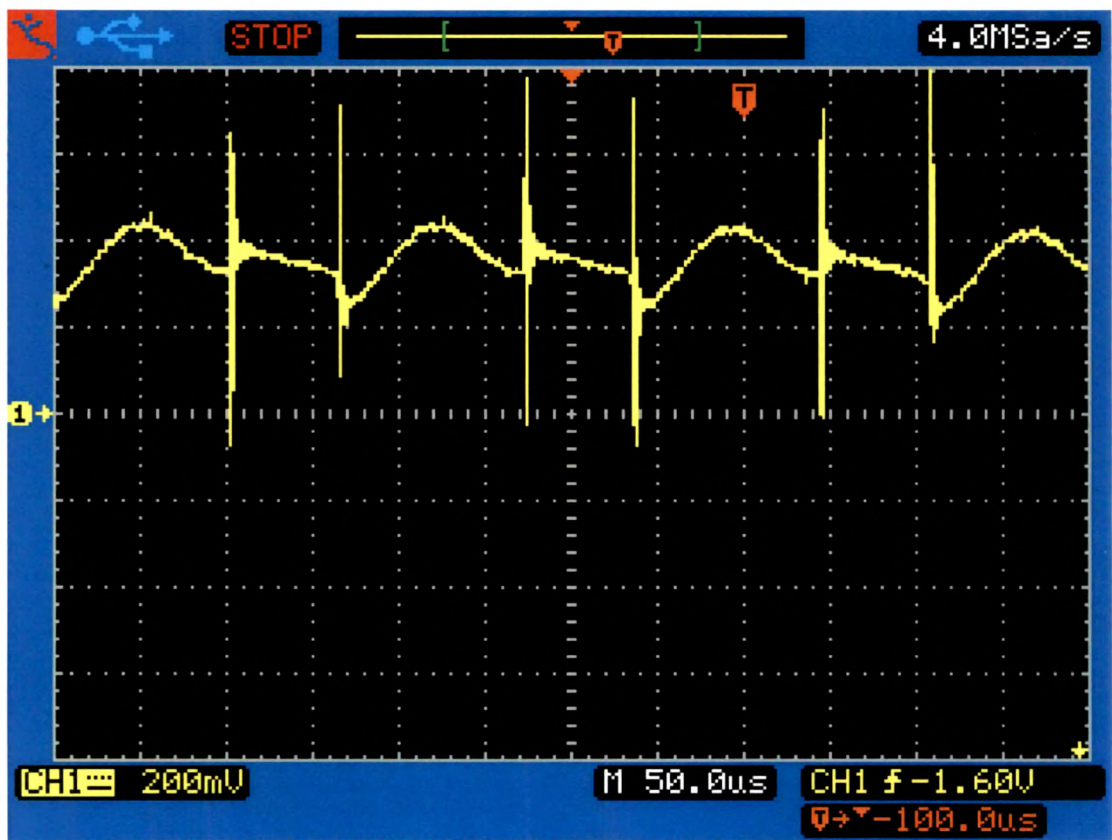


Figure 8-12 DC-Link Current

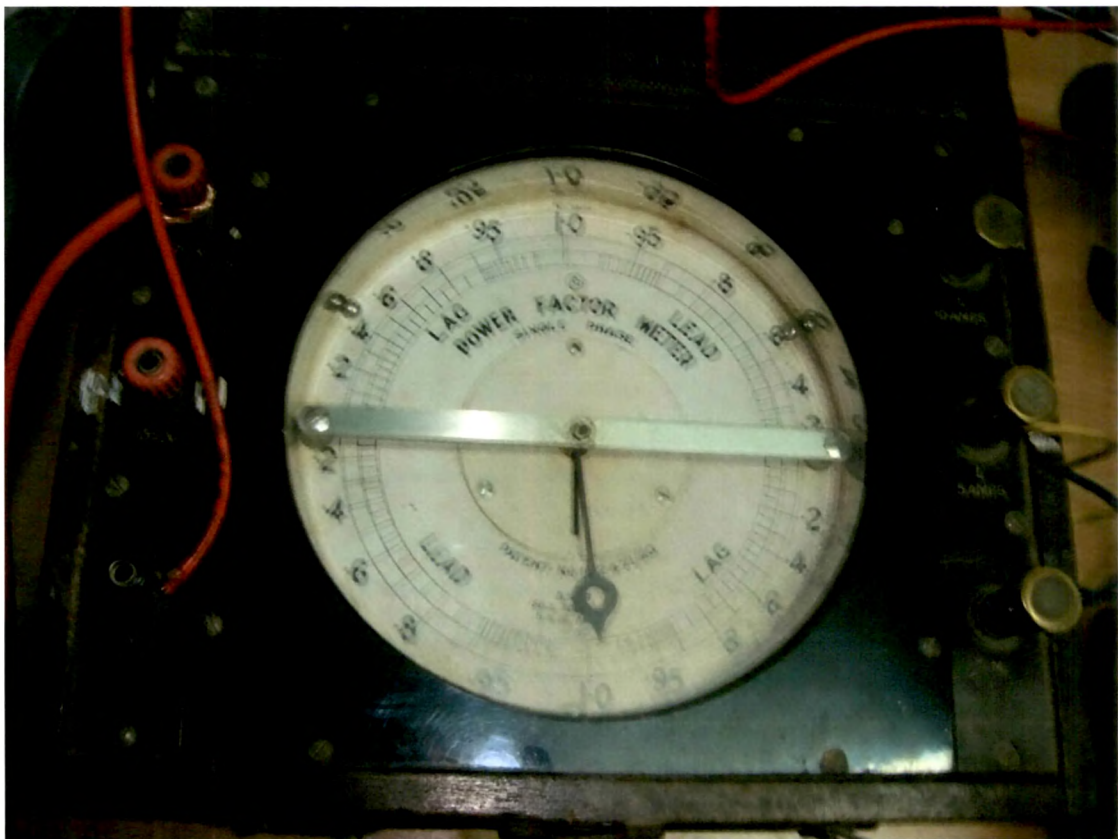


Figure 8-13 Power Factor Reading 0.999



Figure 8-14 Melted work pieces

8.5 Summary

This chapter has described an induction melting experimental control structure and following are the findings:

1. The experiment demonstrated the ability of controlling temperature of crucible at desired set power.
2. As work pieces are added the inductance changes & the converter automatically tunes itself to match the resonance frequency.
3. The frequency of operation can be valued by changing the set value of power.
4. The switching strategy minimizes the distortion in input current which improves power factor.
5. It also provides excellent output performance optimized efficiency and high reliability compared to similar conventional converters.
6. It leads to several advantages such as nearly unity power factor without any reactive elements, symmetric loading from utility point of view and almost uniform temperature. It is proved by experimental setup.