

Introduction

Industrial metal detection systems are important in industry to protect consumers and to protect valuable industrial process plant equipment. Industrial metal detectors detect and remove metal contamination in products where the metal may cause harm to persons or damage to plant equipment. Some metals may not damage plant equipment or affect the product that it is contained in while others might. Therefore it would be more efficient to only remove the metals which are damaging than to remove all metals creating large amount of reject waste. An industrial metal detector discriminator is a solution to this where it can discriminate against ferrous and non-ferrous metals.

Aims & Objectives

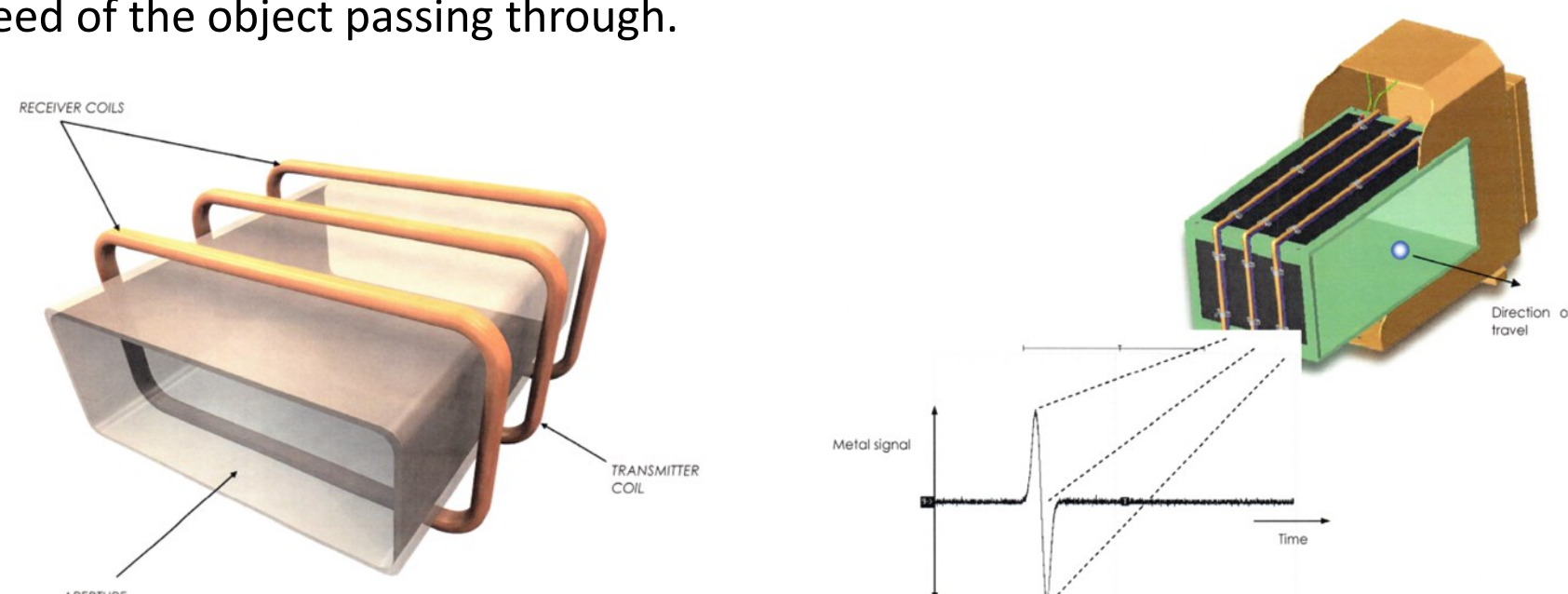
The overall objective of the project is to design and build a metal discriminator circuit which works in conjunction with an existing metal detector.

The following objectives are to be met;

- Research into metal detection technologies
- Research a solution for discriminating metals
- Design and build a circuit with separate relays for ferrous and non-ferrous detections
- The discriminator circuit must not affect the existing metal detectors sensitivity specification

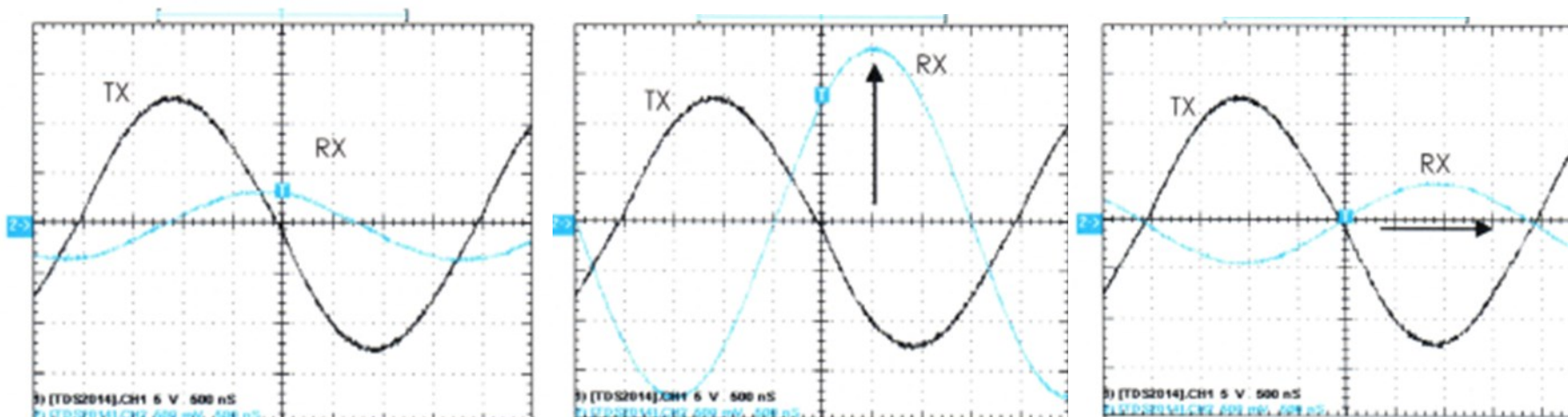
Metal Detection Technology Research

The metal detector chosen for the project is an 'E-Z Tec 9000' supplied by Eriez Magnetics. This metal detector uses balance coil technology. A Transmitter coil (Tx) is driven by a continuous sine wave which creates an electromagnetic field around the coil. Two receiver coils (Rx) are placed either side of the Tx coil coupling the signal generated from the Tx. The two Rx coils are balanced so that they are in equilibrium. Metal objects which pass through the coils changes the state of equilibrium generating a sine wave output. The frequency of this signal is determined by the speed of the object passing through.



Solution To Metal Discrimination

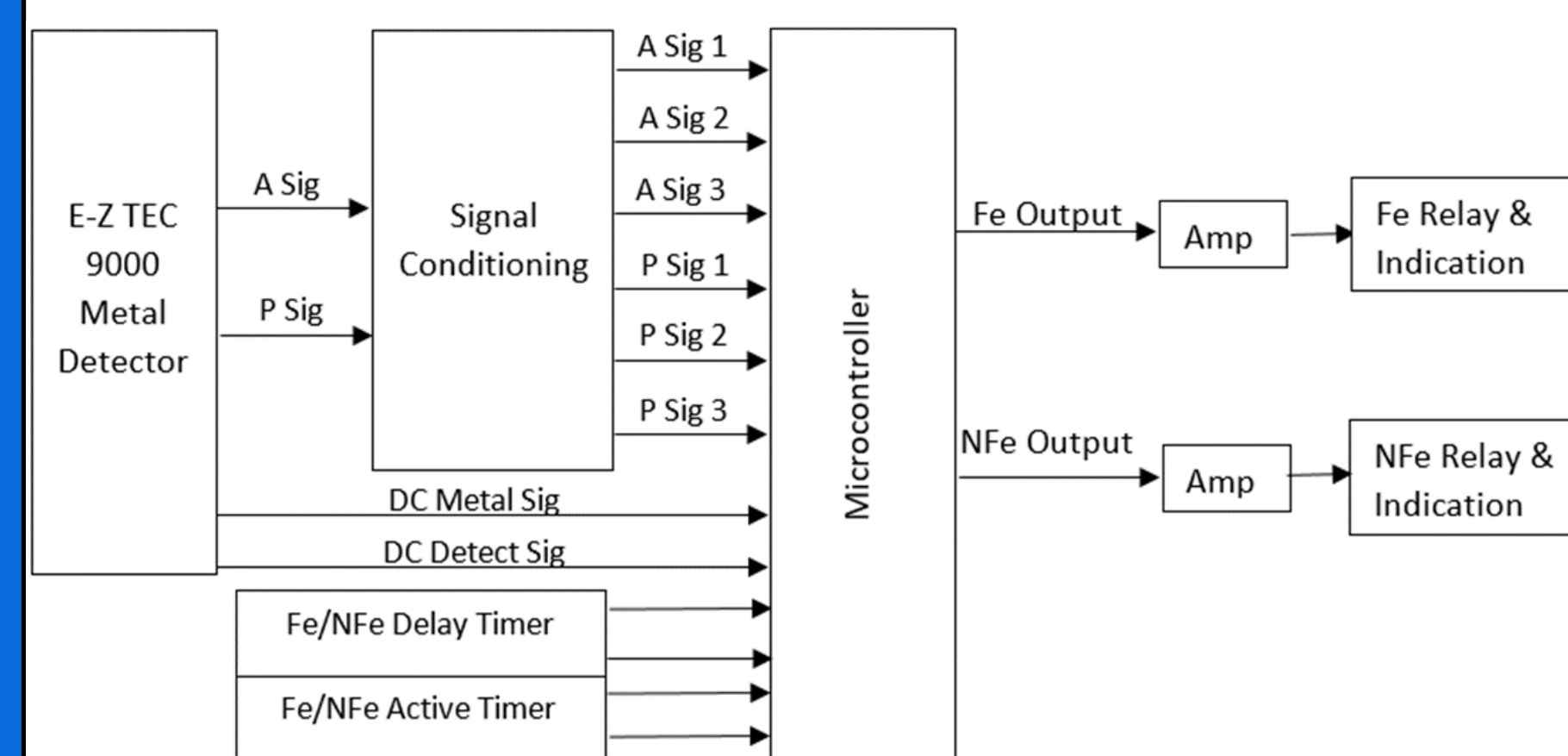
Ferrous metals have a high 'penetrability' factor which causes the coupling factor between the TX and RX coils in a balanced coil metal detector to increase. This is a reactive effect and creates a signal output with high amplitude. Non-ferrous metals are conductive and absorb some of the energy in the electromagnetic field. This is a resistive effect and creates a phase shifted output signal.



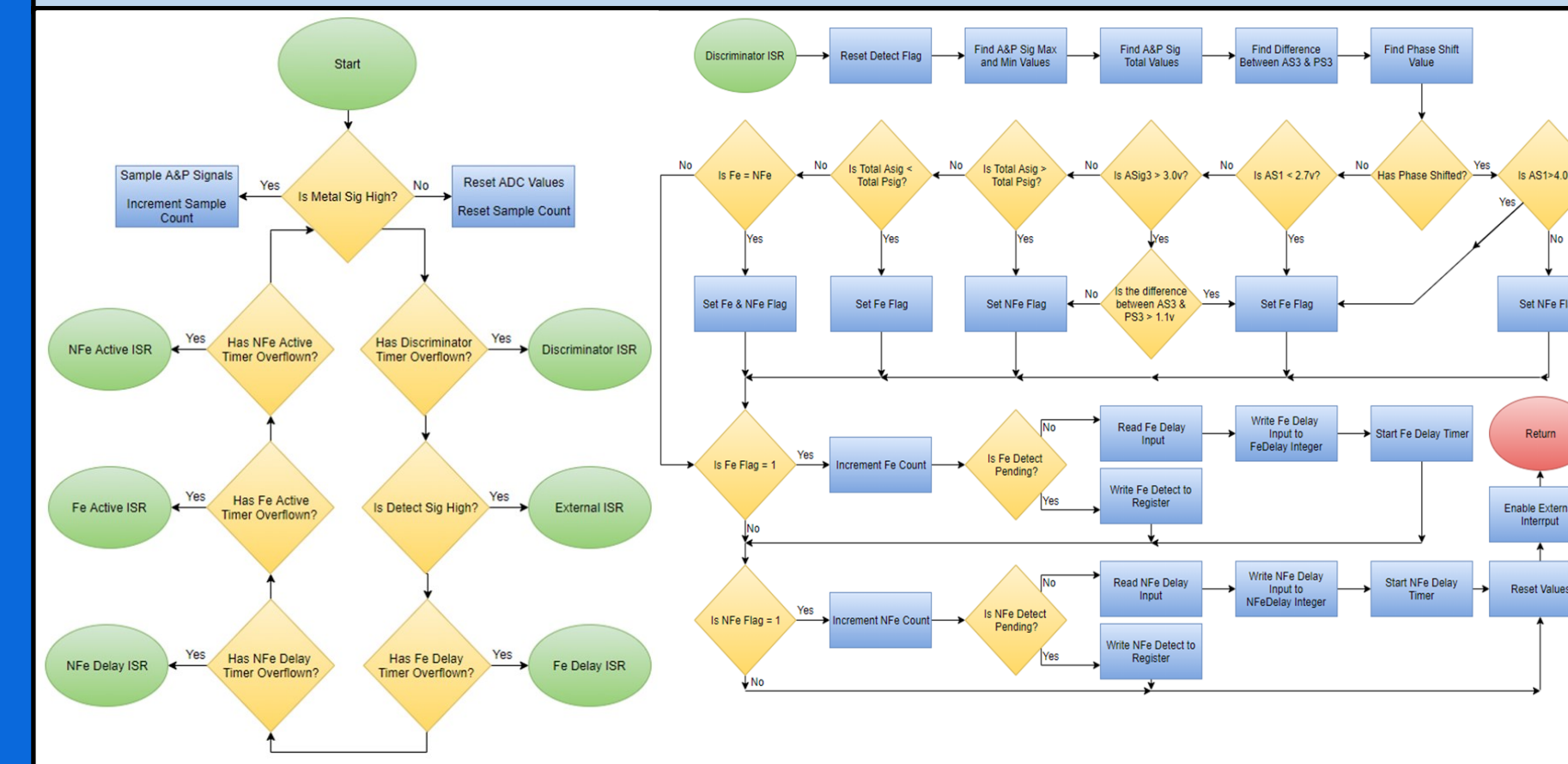
Implementation

The E-Z Tec 9000 metal detector uses two demodulator ICs which output an analogue signal that represents the amplitude (A Sig) and phase change (P Sig) in the Rx coils. These two signals can range from a few millivolts for small metal pieces to ± 15 volts generated from large metal objects. These two analogue signals are passed through three signal conditioning channels. The signal conditioning channels are used to scale the voltage from ± 15 v to 0v-5v while also having different amplification values so that the signal resolution is not lost. These signals are then connected to a microchip PIC16F1829 microcontroller. This microcontroller has a built-in analogue to digital converter used to digitise the analogue signals. The microcontroller digitally measures the analogue signals and discriminates by comparing the difference in the peak voltage and phase shift of both A Sig and P Sig.

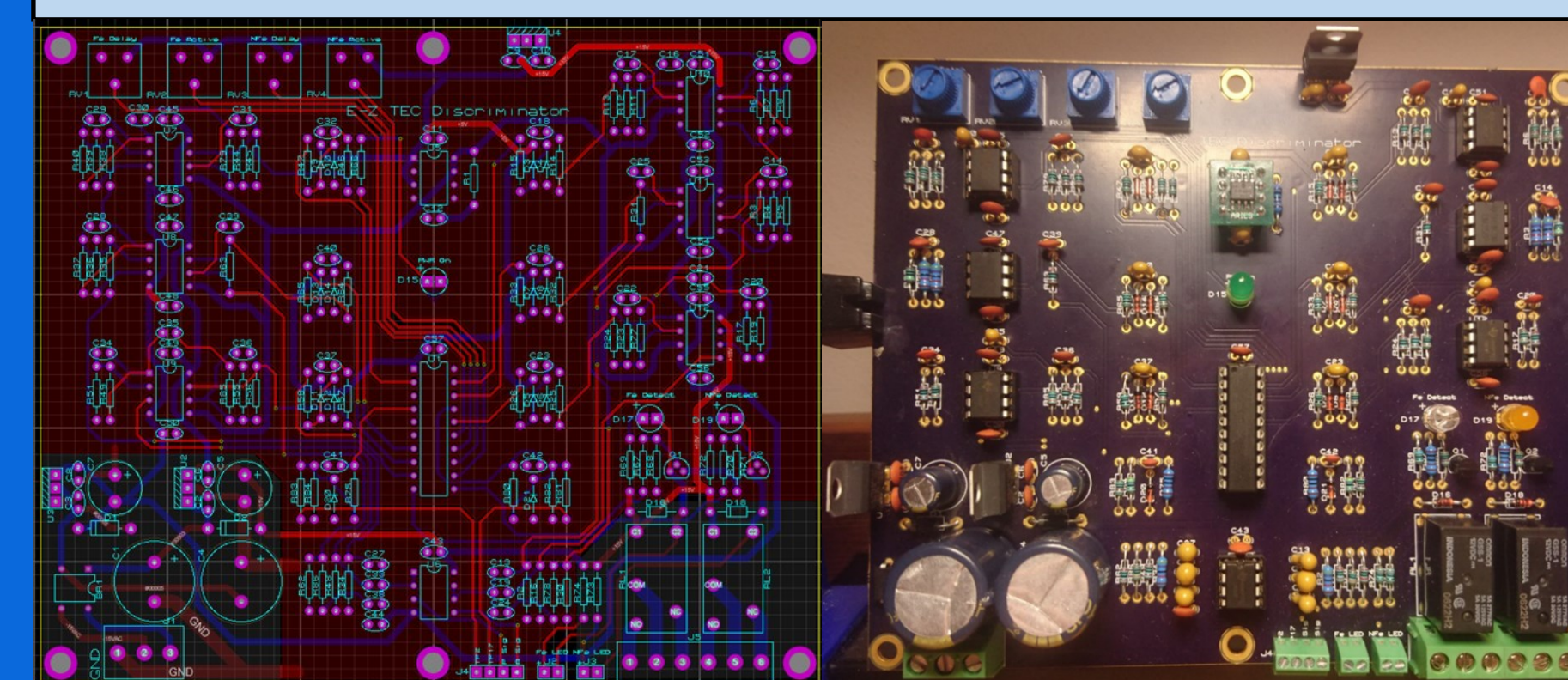
Circuit Block Diagram



Software Flowchart



PCB Design



Conclusion

In conclusion the overall project was a success. The objective was to find a solution to industrial metal detection discrimination. Research was carried out to find out how metal detection technologies work and how ferrous and non-ferrous metals affect metal detectors differently. A solution was implemented using the knowledge gained from the research and through experimental testing. A final product was manufactured that is capable of discriminating against ferrous and non-ferrous metals using an Eriez E-Z Tec 9000 metal detector.

The discriminator circuit offers a fully automated solution which could prove useful in industry by increasing productivity, increasing quality control capabilities and reducing the amount of waste material from rejected metal contamination which didn't require rejection.