Funder NZ Artificial Limb Board
Researcher: Steve Liggett, Senior Lecturer / Automotive Electronics
Project: Generic Shoulder Relief Device
Amount of Grant: $5000
Date of Report: 30th of January 2013

Executive Summary

This project has researched, designed and developed a product that will help rehabilitate amputees by making it easier to operate - and in particular 'start' their vehicle.

The completed product titled "A Generic Shoulder Relief Device" eliminates the traditional ignition barrel that requires the amputee to twist the affected arm to turn a key. Instead, standard switches such as the brake pedal and door switch are used along with a suitably located push button to start the engine.

The location of the start button can be conveniently situated to suit the amputee's range of movement, and in many cases an existing plastic dash panel can be used to house the button. This can then be cheaply replaced and will not effect the resale of the vehicle should it be removed.

This project has been designed to aid amputees who have had an upper extremity amputation start/stop their vehicle. It benefits both those with a transradial (arm missing below the elbow) or transhumeral (arm missing above the elbow) prosthesis.

The Push start product has been designed for keyless ignition controls permanently mounted in passenger cars, MPVs, and trucks 10 000 GVWR and under. It does not apply to remote start/remote stop systems that provide remote controls to start or stop a vehicle engine from outside the vehicle as highlighted in the SAE guide to 'Keyless Ignition Control Guidelines'(J2948).

Background

This project came about after the author observed a colleague attempting to operate his vehicle after having had his right arm permanently immobilized in a motorbike accident. As difficult as some tasks are, operating a vehicle and in particular starting the engine should not be one of them. The pushbutton start product replaces the very awkward and uncomfortable maneuver of twisting the ignition key with a prosthesis.

Aims and Objectives

The aim of the project was to design a microprocessor based control system to interpret button press durations and control the ignition modes of the vehicle. The result was intended to provide the following features:

1. Simple button press interpretation to sequence through the various ignition modes.
2. Single button press to automatically cycle through the ignition modes and start the engine with RPM feedback to disengage the starter.
3. A means of immobilising the vehicle to add further theft protection over and above the standard OEM immobilizer.
4. Entering the vehicle through the driver's door automatically switches the accessory circuit on so that users may use entertainment climate control etc.
5. Can be retrofitted into any make of vehicle.

These features are beneficial to amputees as the difficult task of attempting to start a vehicle is now very straightforward.

Methodology

This product was developed using the 'Keyless Ignition Control Design Guidelines' set out by the SAE KEYLESS IGNITON SUBCOMMITEE., (J2948, 13-01-2011, Issuing Committee: Controls and Displays Standards Committee, Society of Automotive Engineers International (SAE)).

The surface vehicle recommended practice includes such guidelines as design recommendations, operating logic, indication of ignition status and physical control characteristics. The electronic hardware was designed with good rules of practice so as to prevent Electro Magnetic Interference (EMI) and comply with Electro Magnetic Compatibility (EMC) standards.

All hardware was simulated using industry standard spice tools and an In Circuit Emulator was used to prove the firmware operation.

All software was developed and tested using tools such as In circuit Emulation and an RFID development kit.

Outcomes/findings

The aims as set out in the AGREEMENT FOR SERVICE document have been met and have included the successful development of a commercial product. The final product is currently installed in the author's vehicle; this includes an ABS enclosure with appropriate labeling and machine cutouts for quality Molex connectors. Looms have been produced using automotive grade cable. The engine rpm detection loom incorporates coaxed shielding to prevent radiated emissions.

Implications and recommendations

Overall this product has met the objectives as set out in the Agreement and is a viable product for assisting in the rehabilitating of amputees. Those that have had an upper extremity amputation, and that operate a motor vehicle will benefit from the use of this product. In addition, those suffering from acute arthritis that have difficulty in grasping and twisting an ignition key will find benefits also.

Cost of Manufacture
Quantities of 100 would put the manufactured unit cost of around $170. This cost is higher than initially estimated in the original application due to the following reasons:

1. Additional micro relays have been included to ensure the product will meet the various different manufacturers Ignition System Options.
2. Automotive grade high current Molex Connectors and PCB headers have been added to make installation more straight forward.
3. Local manufacturing costs have been used.

It would be advisable to have the boards built and populated with components overseas to take advantage of cheaper manufacturing costs, rough estimates of around $85 for 100 off quantities would be expected.

The next step to improve the product would be to include Radio Frequency Identification. This would then make it hands free by allowing the operator to access the vehicle using only a key fob.

Further research could be conducted to take advantage of Radio Frequency Identification (RFID) this would then turn this product into a true Passive Keyless Entry (PKE) device.

Further independent laboratory testing such as compliance for the C-Tick process, although not legally a requirement for this type of product is advisable.

As the device is microprocessor controlled testing to a generic emissions standard like EN 61000-6-3 would be beneficial. Testing to this standard would cost approx $2100 + GST.

Financial Reconciliation

Item	Estimated costs	Actual
Development Equipment	550	1189
PCB manufacturing, Components, connectors & enclosures	4100	3615
Printing, stationary	350	200
Total	**$5,000**	**$5004**

APPENDIX

Hardware Design Block Diagram

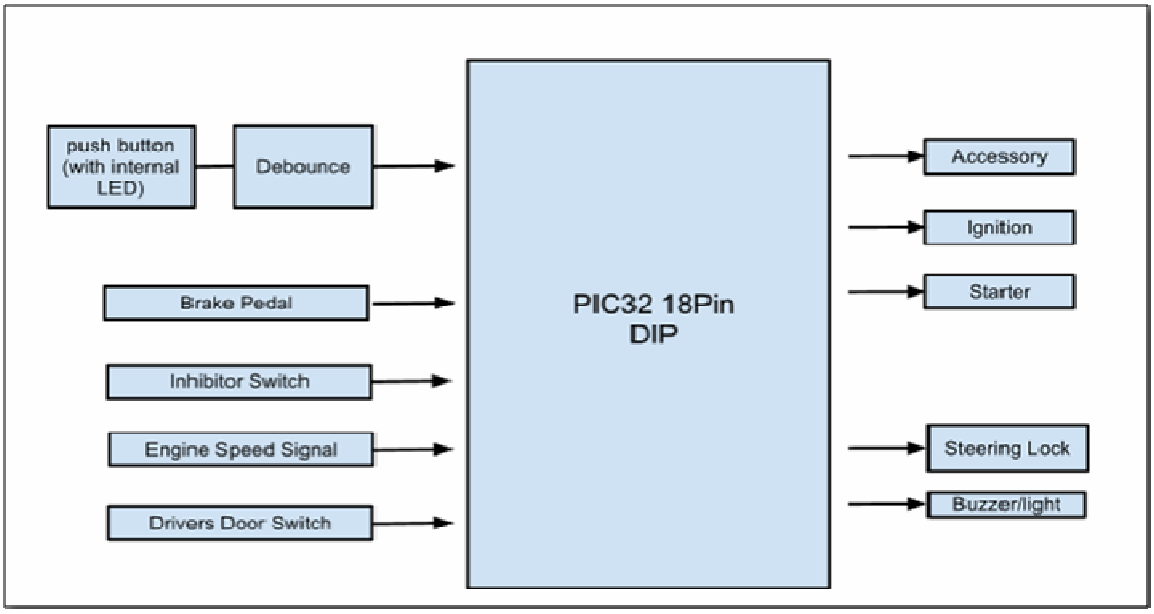


Fig 1.0 Block Diagram Overview

Hardware Design Schematics

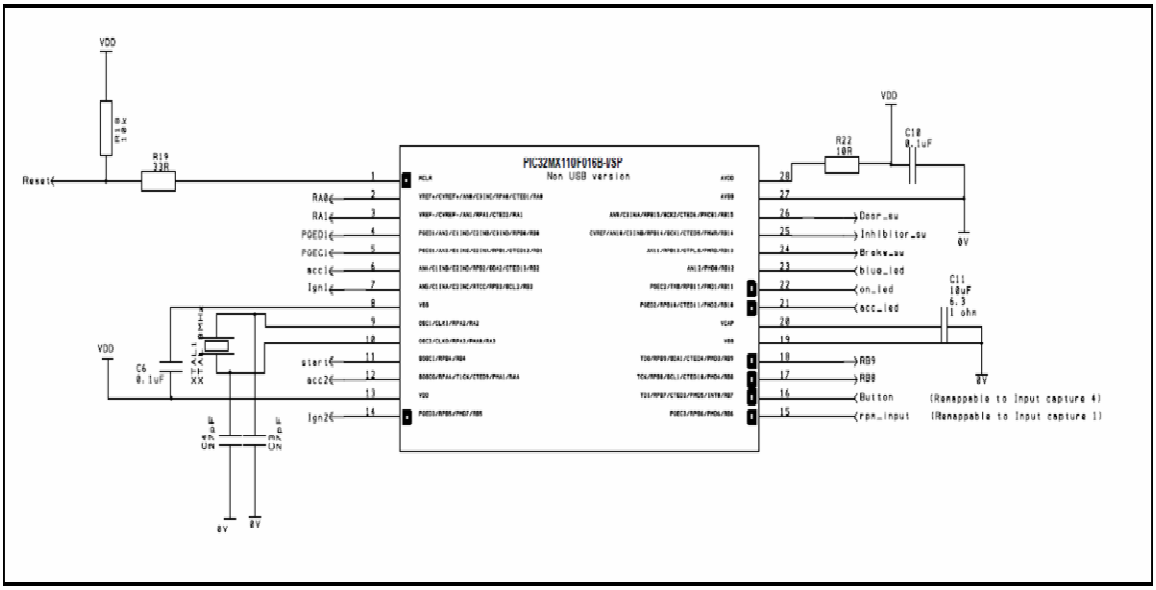


Fig 2.0 32 Bit Processor

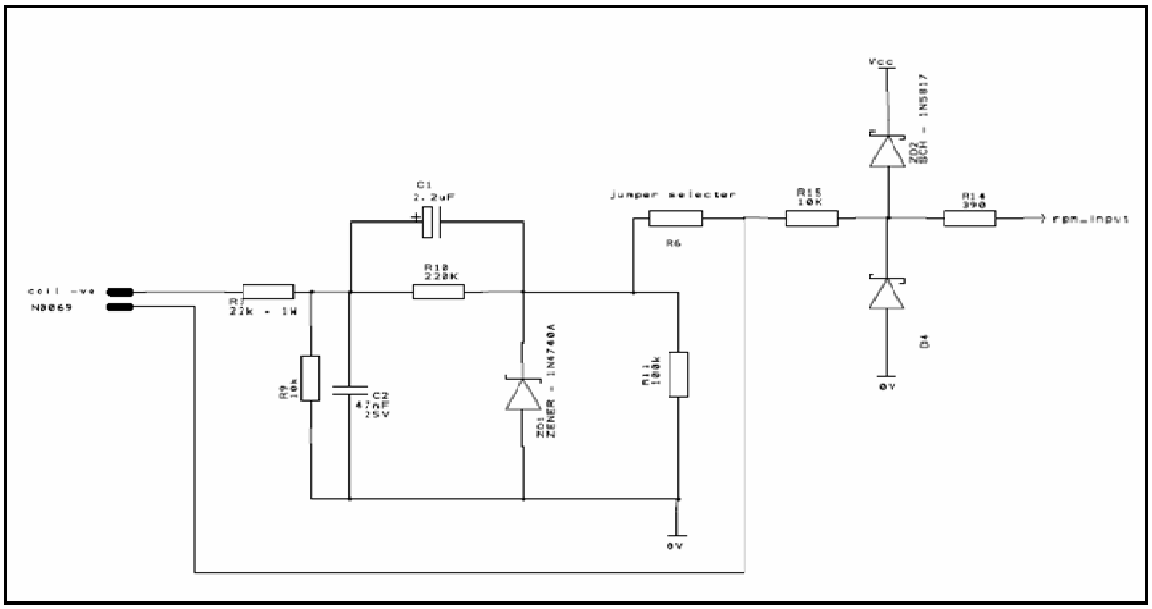


Fig 3.0 Engine Speed Condition Circuit

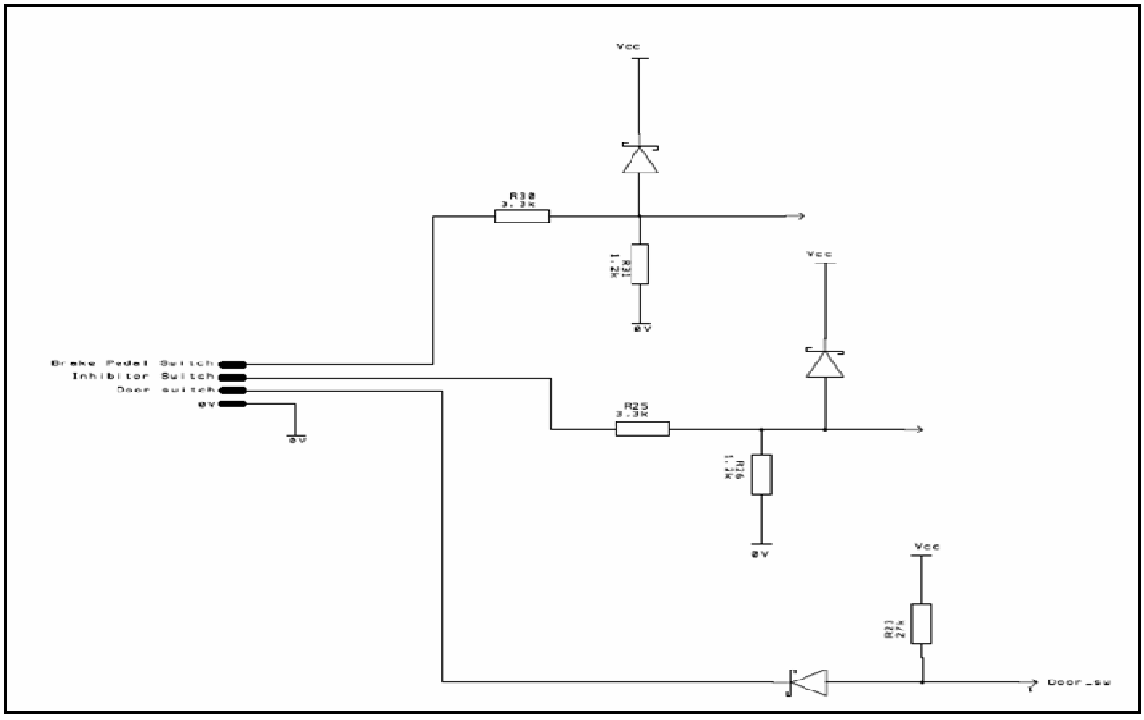


Fig 4.0 Input Signal Conditioning

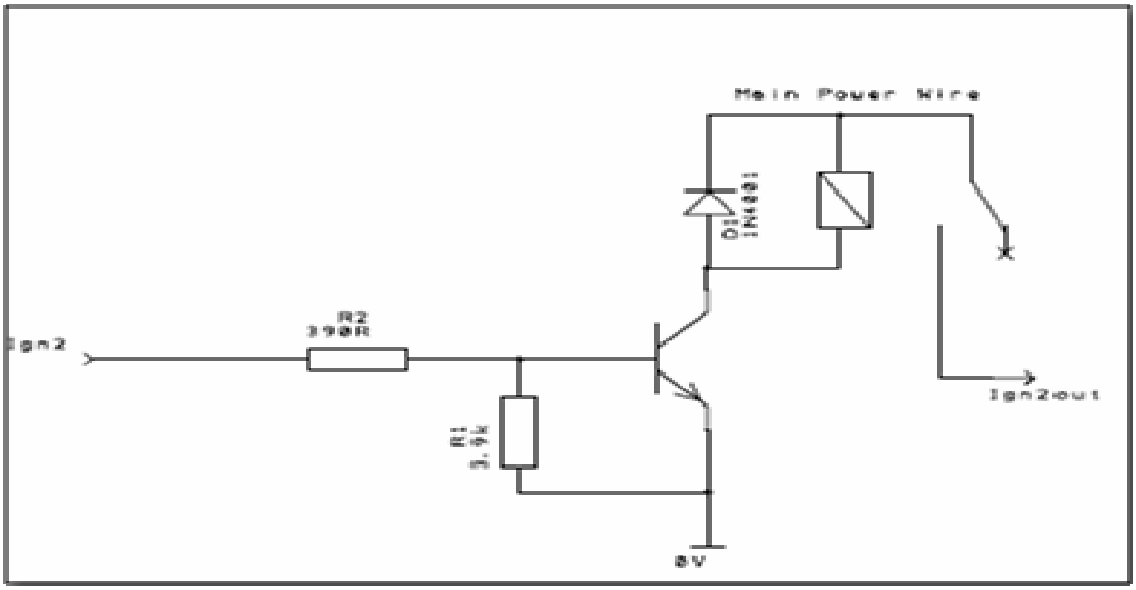


Fig 5.0 Output Drive Circuits (1 of 5) only 1 shown

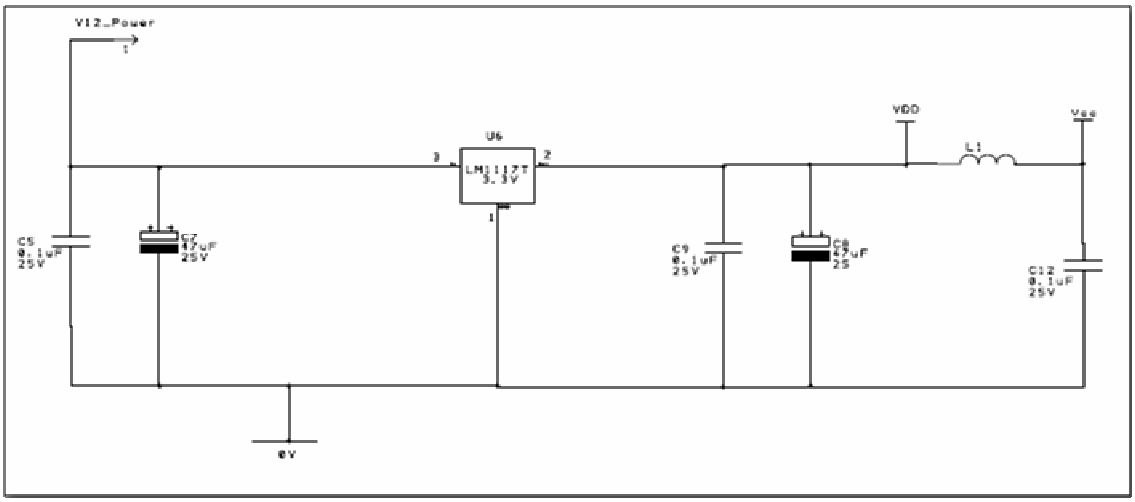


Fig 6.0 Power and Ground including filtering

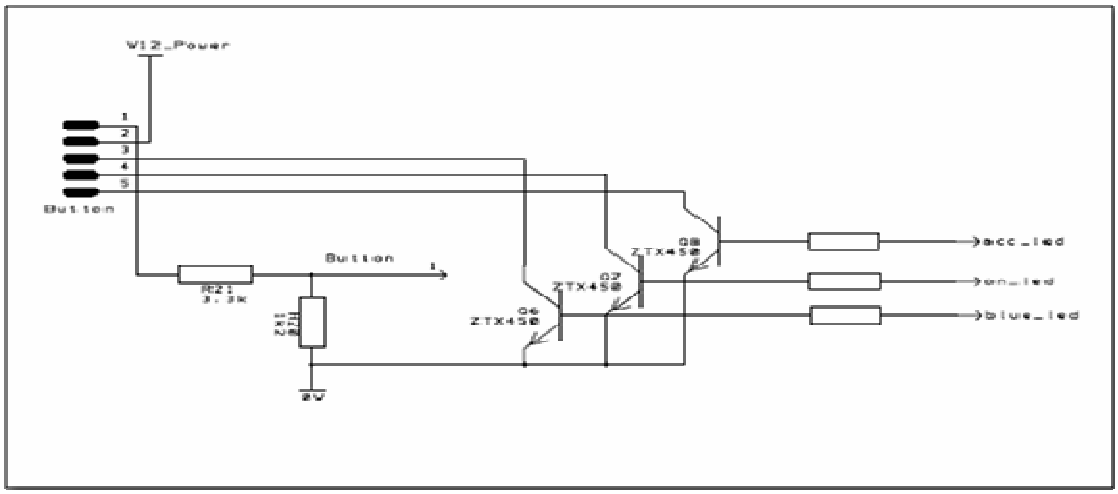


Fig 7.0 Button LED Driver circuit

Printed Circuit Board Layout.

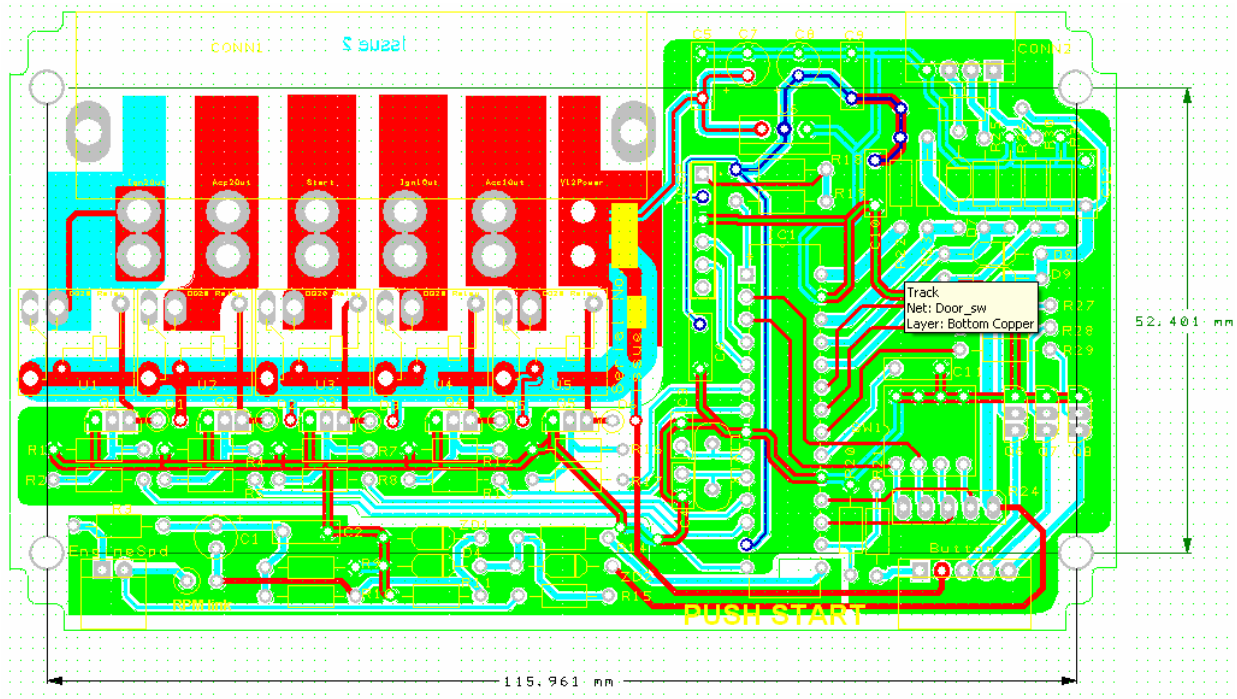


Fig 8.0 Printed Circuit Board (PCB) Throughhole layout

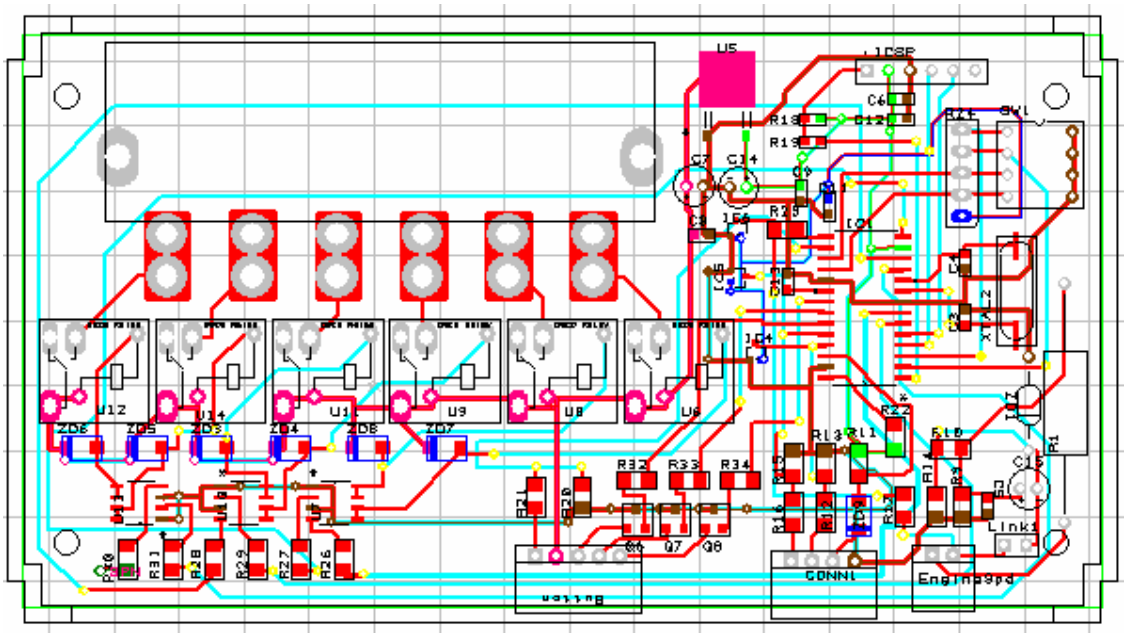


Fig 9.0 Printed Circuit Board (PCB) Surface Mount Design layout

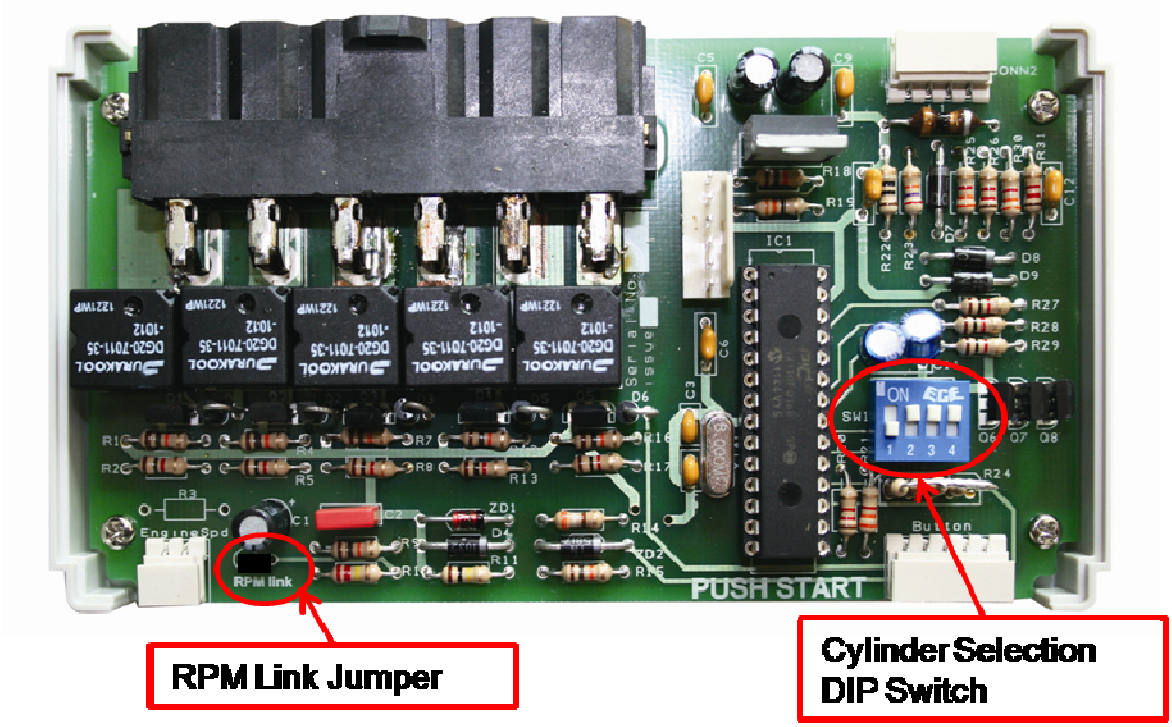


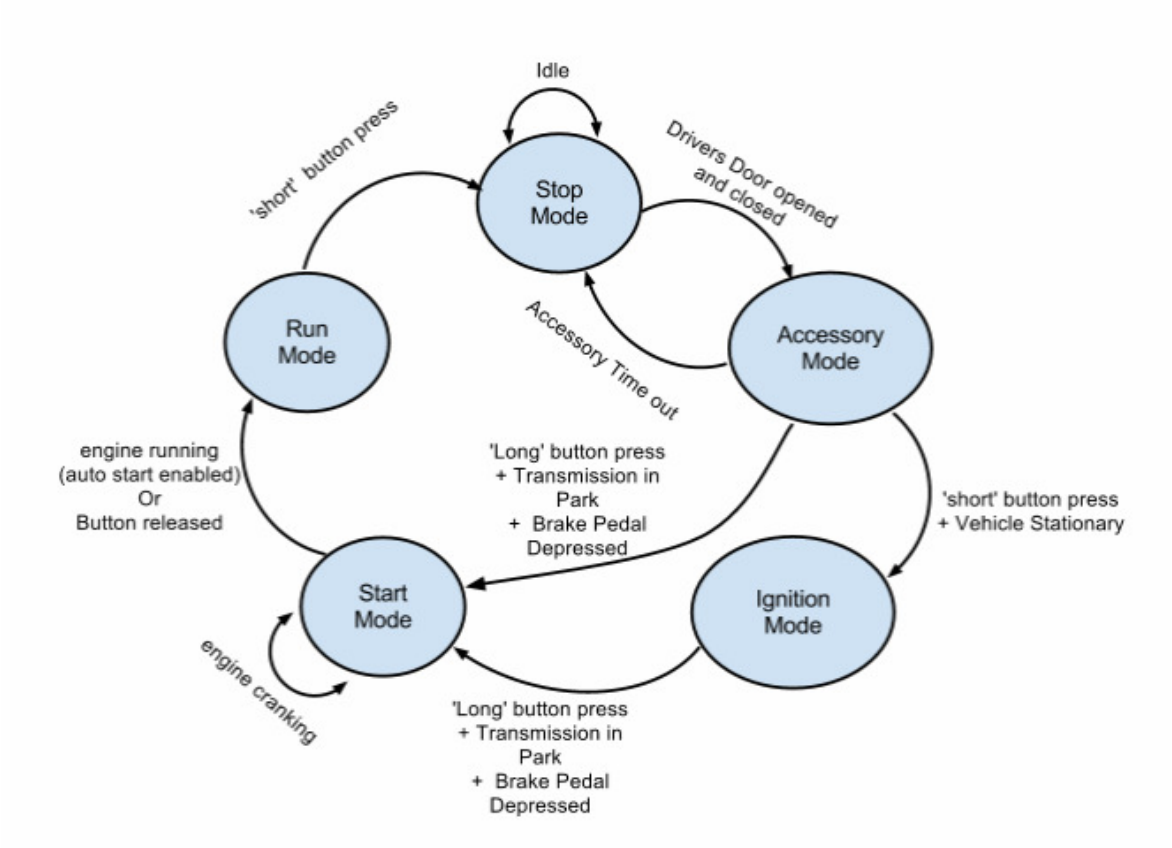
Fig 10 Printed Circuit Board (PCB) Image with components installed.

Fig 11 Push Start Product Image Top View.

Software Design

To operate as a finite state machine (FSM) in mealy mode and sequence between the following three states.

Condition/action	**State**
Single press:	State: 'Accessory'
Second Press:	Ignition: 'On'
Third Press:	Engine 'Crank and Start'
Fourth Press:	All 'Off'



Embedded Code

Written in embedded 'C' using Microchips MPLAB Integrated Development Environment and microchip C compiler.

All source files available on request.