One Handed Saxophone Adaptation

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Background to the Adaptation

From the age of nine (1981) to my motorcycle accident in 1991, although not particularly adept, I enjoyed playing keyboards and woodwind instruments, namely clarinet, flute, and saxophone. The motorcycle accident left me with a permanent brachial plexus injury (C4, C5, C6, C7, C8, and T1). This is basically an injury to the group of nerves that work the arm, in my case, the right arm. Five of the six nerves (C5, C6, C7, C8, ant T1) in this group were torn from the spine. Surgery restored some movement to C5, control of the bicep, but the remainder of the arm and hand have no motor function and little to no sensation of touch…. Chronic nerve pain, however, has not diminished in the 27 years since the accident.

Keyboard playing was still possible using a Roland PK5 MIDI pedal board. However, believing that playing woodwind was no longer going to be an option, I began learning to play trumpet, and later, with the restoration of some bicep function, the trombone; using an adapted ten pin bowling wrist support to hold the trombone to my mouth while playing left handed.

In recent years, I have, on occasion, tried to play the saxophone using the three side keys, D, D#, and E* [*Fig 1*], which gives just under two octaves (minus F and F#). Repeatedly, however, I would encounter the need to play an F or F# in a piece of music, causing frustration and driving my embarkment on the path that brings me to this point in time.

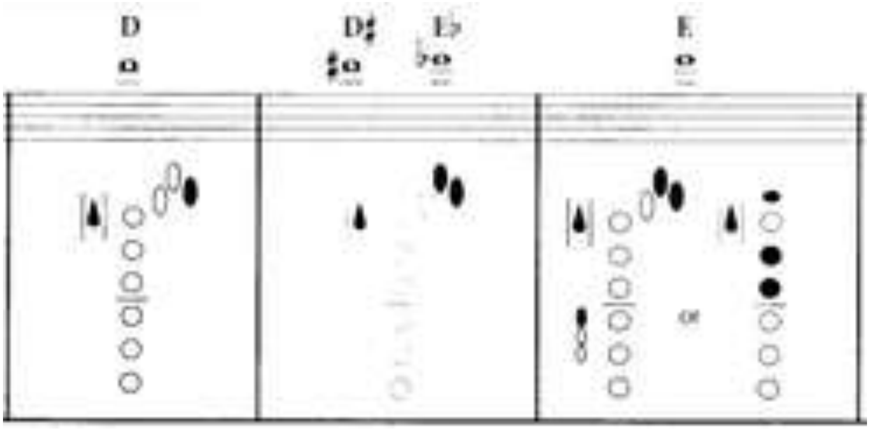


Fig. 1: Alternate side key fingering for D, D#, and E

Description and Function

The adaptation, in its present state, provides the ability to play a full chromatic scale from lower B^{b} [*Fig 2*], through to top E* [*Fig 3*].

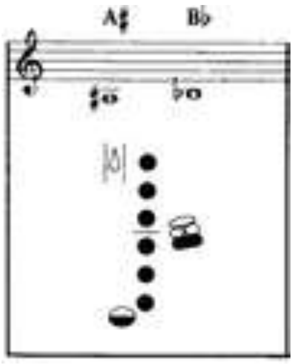


Fig. 2: Lower B^{b}

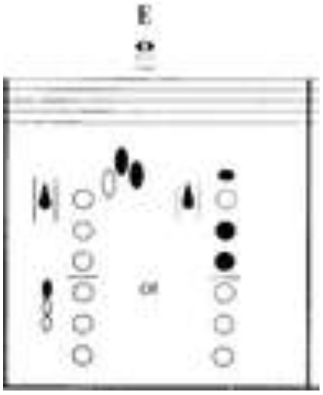


Fig. 3: Upper E

* I press the three side keys to produce the E. I acknowledge the sound of this E is off, particularly on my alto, but is not too bad on my tenor. In short, the tone is close enough when you have no other option. With my two horns, I have not been able to hit top E using the fingering on the right, nor does this fingering appear to work with the mid-range E that would, under normal circumstances, be played using the octave key plus first to third fingers on the left hand, and first and second fingers on the right hand.

Operation of the right hand keys is achieved with the use of micro-switches located on, or around, the left hand keys. Each switch is connected to a solenoid via a dedicated solenoid driver. The driver allows an initial burst of electricity to the solenoid, causing it to activate and press the relevant key on the instrument, before dropping the voltage to a level that is low enough to hold the solenoid in position without causing excessive heat in the solenoid windings.

The adaptation is powered using an 11.1 volt, 2200 mAh Li-Po (Lithium Polymer) battery. These batteries are typically used in remote control cars, and are, therefore, compact and light weight. Alternatively, a suitable 12v mains power supply may be used, however, it must be of suitable amperage to deliver sufficient current to the circuit. The battery is strapped to a key guard located on the lower part of the instrument [*Fig 4*].

Fig 4: Li-Po battery in location

The solenoids and driver circuit board are mounted on a bracket, which in turn is attached to the key guard covering the lower B and B^b holes [*Fig 5*, *6*]. The bracket is hand fabricated from stainless steel.

Fig. 5: Solenoid and driver circuit mounting bracket attached to guard cover

Fig. 6: Solenoid and driver assembly

A single charge of this battery has been sufficient to power the solenoids for up to an hour of continuous use. Typically, each solenoid draws approximately two amps of power during the split second of activation. Larger capacity versions of this battery exist, some exceeding 5,000 mAh, which would offer longer performance time (in the region of 2½ hours). However, such batteries can be expensive and take longer to charge. A better option may be to cycle two, or more, smaller capacity batteries. It would also be possible to connect equal capacity batteries in parallel to give extended performance time.

The design of this adaptation means it is completely portable and allows the instrument to be played in the traditional way, without the need of a stand to hold the instrument while playing. While it would be possible to power the driver circuit board using a suitable 12v mains power supply, the use of a battery means the musician can move freely while playing. Playing ability, while using the battery power source, is not impaired while walking around.

The weight of this adaptation is minimal; somewhere in the region of 250 grams.

Development Background

Development of this adaptation has taken over a year and has been a long process of design, test, and redesign. The circuit to drive each solenoid has consumed the majority of that development time. Initially, each solenoid was activated directly from a 9.6v battery, sourced from a Black & Decker cordless drill. This direct connection resulted in rapid draining of the battery and overheating of the solenoid windings.

The second attempt at driving the solenoids made use of a resistor and capacitor operating in parallel. On completion of the circuit, the full voltage from the battery flows through the path of least resistance, in this case, the capacitor, which activates the solenoid and begins charging the capacitor. As the capacitor charges, its resistance increases until the path of least resistance transfers to the resistor. The potential difference across the resistor results in a decreased voltage output to the solenoid, suitable for holding the solenoid in its actuated position (known as duty cycle). Although simplistic, this circuit was problematic on three levels:

1. The duty cycle delay (the time between full voltage dropping to the holding voltage level) was directly based on the combination of the size of the capacitor and the size of the resistor, making it difficult to use a variable resistor as a means of adjusting the holding voltage; changing the resistance directly affected the delay time, meaning a different size capacitor would be required.

2. The temperature of the resistor quickly reached a point that was deemed unsafe and may have caused fire.

3. The third problem with this circuit was also the main reason for its rejection. While the circuit functioned properly on the initial activation of the solenoid, it was noted that attempting to release and reactivate the solenoid, as would be the case in changing back and forth between notes, resulted in either a delayed response from the solenoid, or a complete failure to reach the fully activated (key fully pressed) position. The reason for this was due to the length of time it took for the charged capacitor to discharge itself. In order for this circuit to work, the capacitor must fully discharge between the release of a key and it being pressed again. On some occasions, it was observed that the stored charge of the capacitor was sufficient to briefly hold the solenoid in its fully activated position, meaning the key did not release as it should.

After some reading of specification documents on the Texas Instruments website [2], and advice from the experts in their discussion forum [5], a test circuit was created on a breadboard using a Texas Instruments DRV101 [4] solenoid driver, which Texas Instruments provided free of charge as a sample [*Fig 7*]. After a process of testing various capacitors and resistors, a working configuration was finally achieved. A capacitor that gave a duty cycle delay of 0.5 seconds was found to be a “happy” medium, and functioned quite consistently throughout the temperature changes in the circuit. It was also possible to incorporate a potentiometer (variable resistor) into the circuit, which gave a degree of adjustment for the holding voltage; critical for maintaining cooler operation of the solenoids.

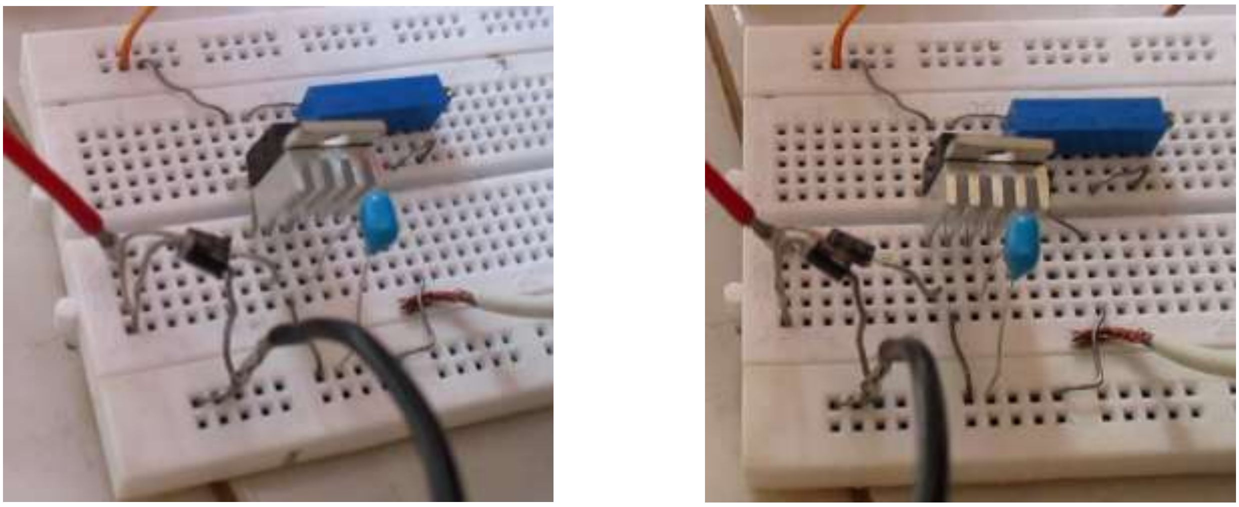


Fig. 7: Breadboard test circuit

A more permanent circuit was made using a solder-able breadboard and scraping away areas of the copper strands on the board to create the required circuit. At this stage, ten DRV102 [6] drivers were purchased. These were favoured over the DRV101 [4] as they offered a broader operating temperature range. The completed board [*Fig 8*] looked incredibly rough and crude, but functioned quite well.

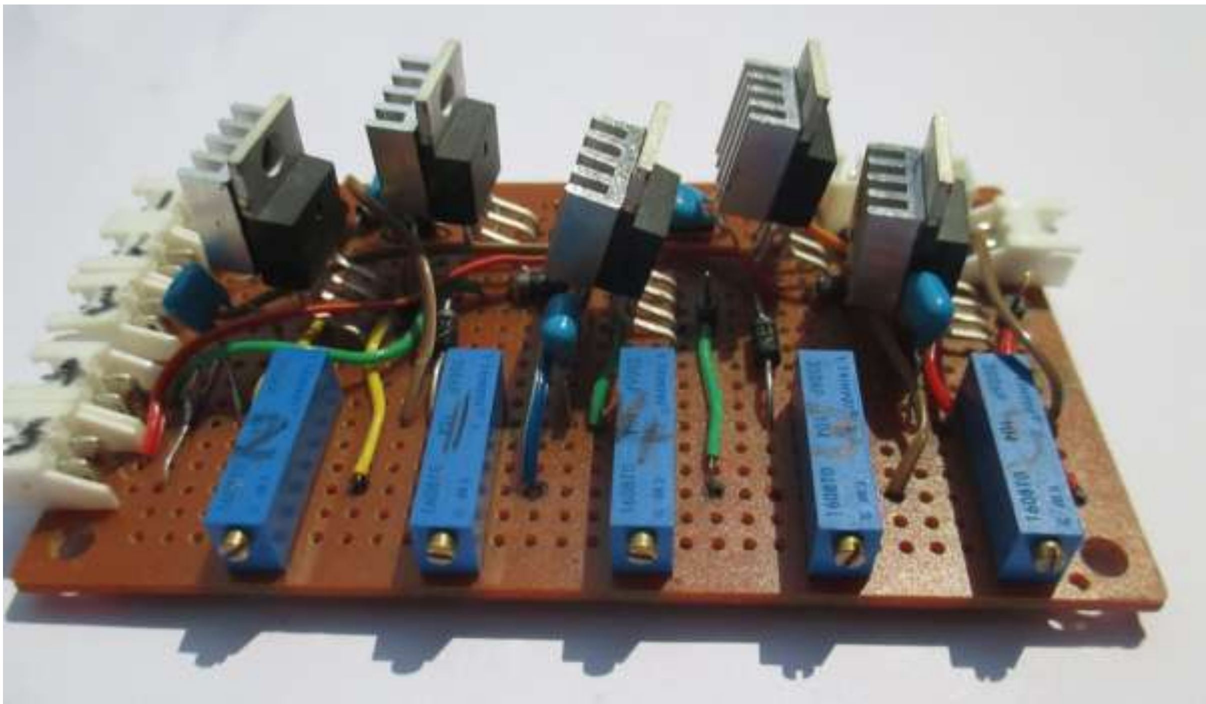


Fig. 8: Solder-able breadboard circuit

Finally, using the EasyEDA website [1], a proper PCB design was produced and subsequently manufactured using their portal to the JLCPCB [11] website [*Fig 9, 10*].

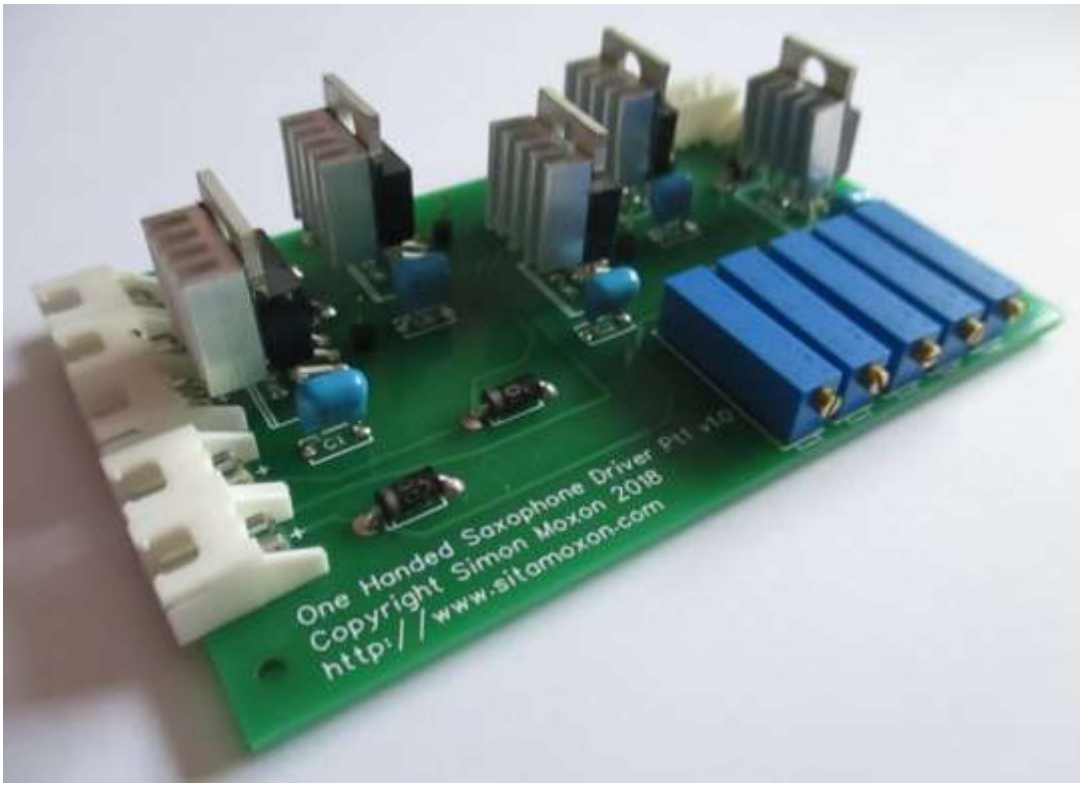


Fig. 9: Components soldered onto manufactured PCB Version 1.0

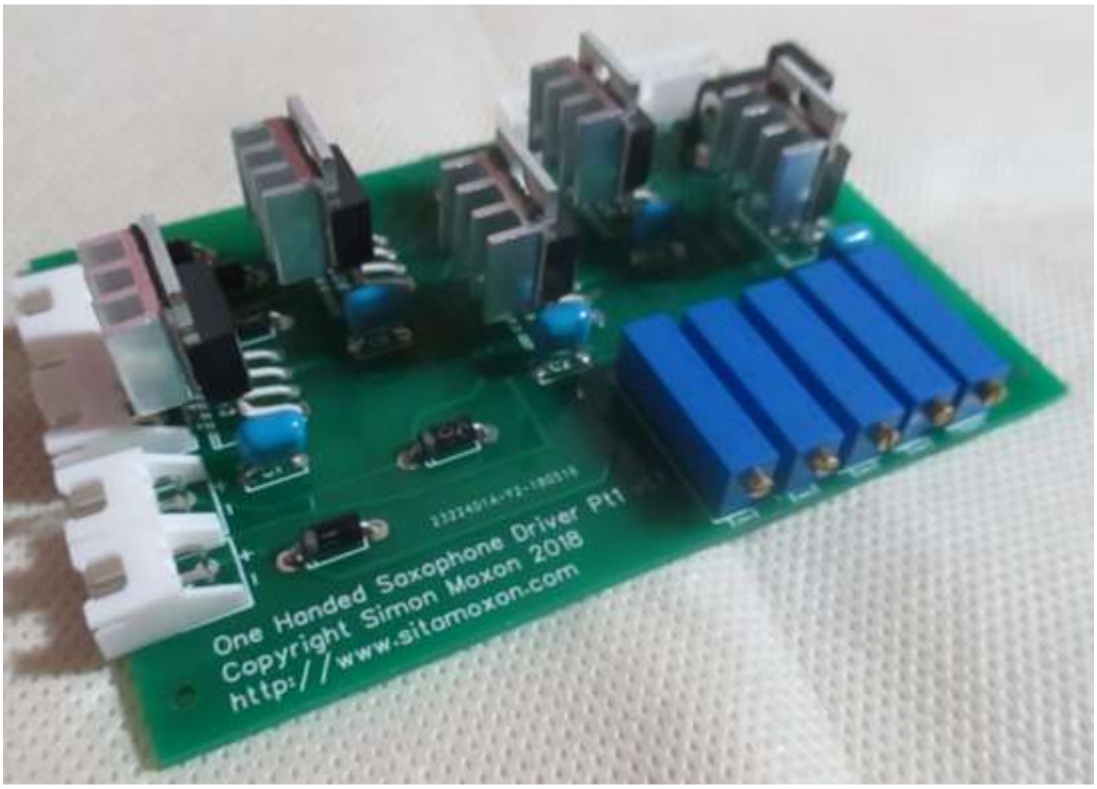


Fig. 10: Components soldered onto manufactured PCB Version 1.1

Since completing the initial stage of the circuit design, I have modified the circuit to include a standard DC input jack and a more robust means of connecting the cables to and from the switches; the single pin connectors were found to be easily displaced. Version 1.1 of the PBC (Printed Circuit Board) is shown in figure 11.

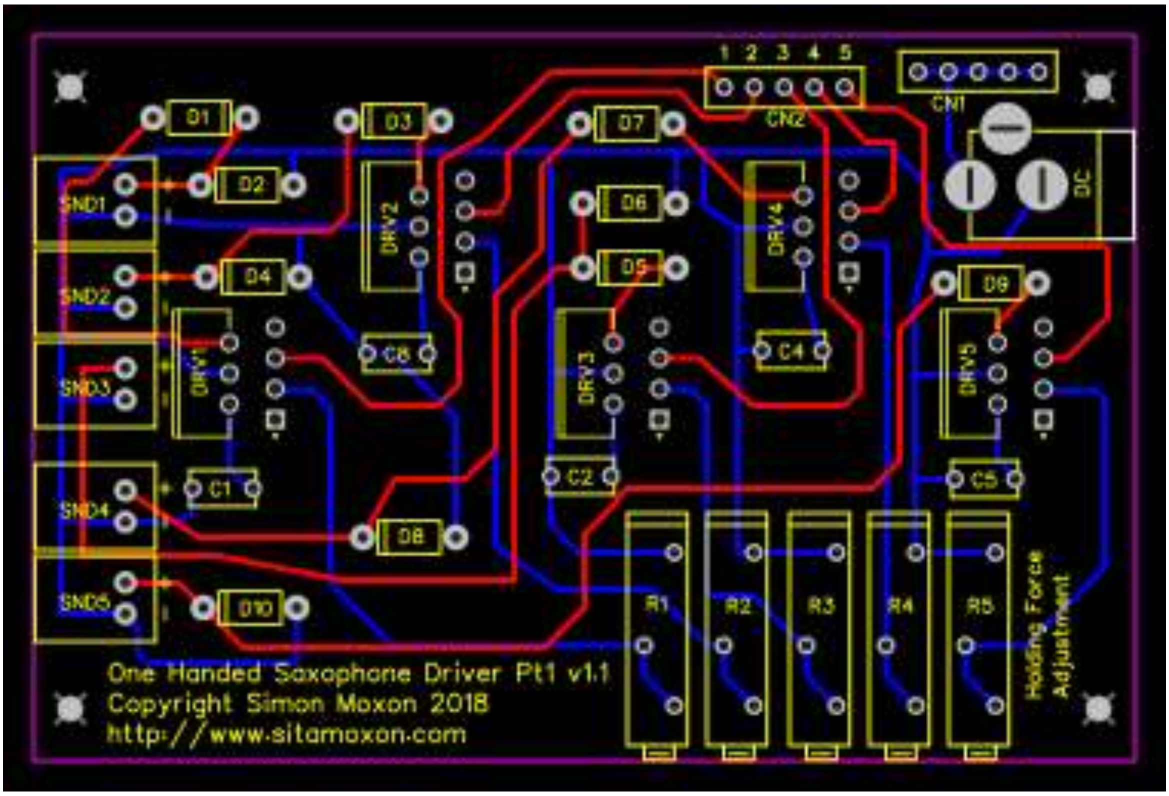
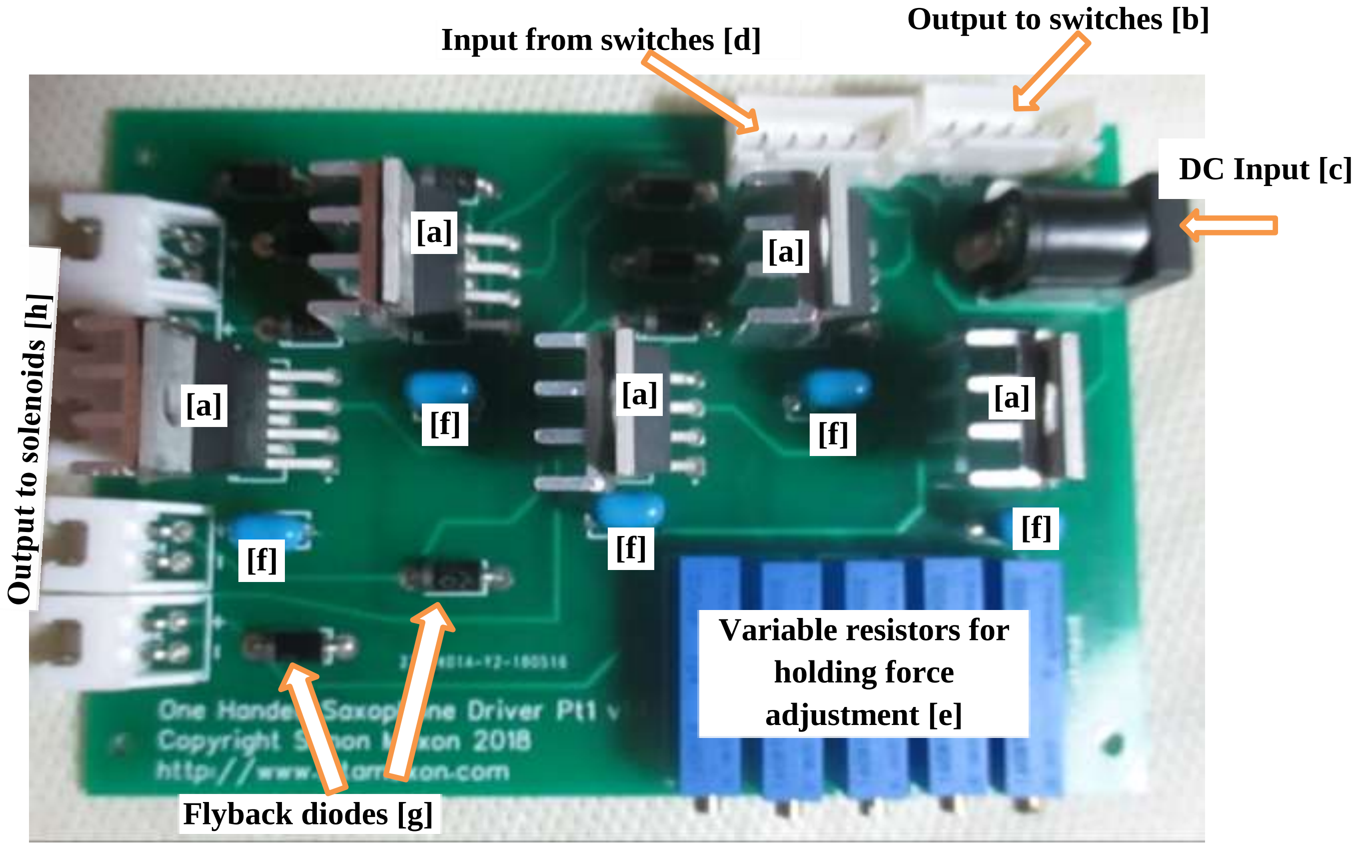


Fig. 11: Version 1.1 PCB layout

A set of files for the completed PCB design, known as Gerber files, have been included along with this documentation. These files can be used in conjunction with websites, such as JLCPCB [11], to produce the PCB. At the point of writing, JLCPBC can produce ten of these PCB boards for just $2 (plus P&P). Their boards are very good quality and solder far easier and cleaner than any other PCB kits I have soldered in the past.

Circuit Explanation and Configuration



Power from the DC input **[c]** is sent through the output block **[b]** to each of the switches located on the left hand keys of the instrument. On activation of a switch, power is sent back to the board and enters and the input block **[d]**, where it sends power to the relevant driver **[a]**. Full power is sent via a diode **[g]** to the relevant output **[h]** and onto the appropriate solenoid. Based on the size of the duty cycle delay capacitor **[f]** the output voltage will remain constant before dropping to the holding voltage, which is controlled using the relevant variable resistor (potentiometer) **[e].** Due to their inductive nature, on deactivation, the solenoid is capable of discharging a high voltage back through the circuit as their electromagnetic field collapses. This has the potential to cause serious damage to the components. To prevent this, flyback diodes **[g]** are fitted across the positive and negative poles of each solenoid. This prevents electricity returning back up the circuit from the solenoid to the driver. Instead, electricity is cycled between the solenoid and ground until fully purged, or reactivation of the solenoid. No delay or lag in response has been observed using this driver circuit.

Each driver has two diodes, one fitted across the poles of the solenoid to safely discharge any surge in current during the collapse of the electromagnetic field, the other, fitted to the output pin of the driver to prevent any current passing back into it.

Holding force voltage can be adjusted using the relevant variable resistor. Turning the adjustment screw in a clockwise direction, with the screw facing you, increases the resistance and hence reduces the holding force voltage. Turning in an anti-clockwise direction has the reverse effect. As stated previously, this is known as Duty Cycle.

Each variable resistor offers a resistance range from zero to 150kΩ via 15 turns of the adjustment screw. This gives a duty cycle range from 90% of the input voltage to approximately 18% of the input voltage (Full duty cycle rage is 10% to 90%). For an input voltage of 11.1v, this enables the holding voltage to be as low as 1.99v. If a lower duty cycle were needed, the variable resistor could be exchanged for a higher rated version such as 200kΩ or 500kΩ. This, however, would affect the sensitivity of adjustment and seems unnecessary given that the minimum duty cycle is 10% (1.11v in this case). If the instrument keys could be held with a voltage lower than 1.99v, it would be beneficial to test if a lower voltage power source would be capable of fully activating the solenoids, as this would reduce the operating temperature of the solenoid, and prolong its serviceable life.

Duty cycle delay, the time before the driver drops the voltage to the holding voltage level, can also be adjusted by using smaller or larger capacitors. It was found in testing that the 0.47µF capacitor created a delay of approximately 0.5 seconds, giving enough time for actuation without causing excessive heat. Using a lower rated capacitor will reduce the delay time, using a higher rated capacity will increase the delay time. Actual required capacitance would depend on the distance required for the solenoid to travel, the time it takes to complete that stroke based on the resistant force the solenoid encounters, and the initial input voltage driving the solenoid. Heat within the circuit and solenoid, which effects resistance and conductivity, along with the number of solenoids activating from the same power source, would also influence the optimal capacitance selection. Suffice to say, a more conservative selection of capacitance would ensure easier, more reliable configuration of the duty cycle delay. If this circuit were to be produced as a generic adaptation, the value of the duty cycle capacitor would be of significant importance.

After adjusting the holding force for each solenoid in turn, further adjustment may be required in order for multiple solenoids to be activated simultaneously. This is due to the input voltage being shared between the solenoids, resulting in a slightly lower holding force voltage.

Configuration Development

In addition to the development of the circuit, a number of facts were discovered relating to the placing of the solenoids and switches, and how best to configure them.

During initial research into this adaptation, only one previous adaptation was sourced that used solenoids to operate the keys that were otherwise inaccessible to a one handed musician [3]. It was noted in this adaptation that the designers had chosen to leave the return spring for each solenoid in place [*Fig 12*]. It was also noted that the designers reported one of the solenoids failed to fully close its corresponding key. Although not particularly strong, it is my opinion that the solenoid return springs cause unnecessary resistance and are not required as the return springs on the saxophone keys are sufficient enough to push the solenoid back to its rest position. During testing, it was found that the solenoid return springs could in fact be located on the opposite side of the solenoid to assist in its activation and pressing of the saxophone key [*Fig 13*].

In the aforementioned adaptation, it was noted that the designers had also devised some form of device to lower the voltage to the solenoid once the holding position was reached. Unfortunately, the authors of that study have not elaborated on the design of their solenoid saving device. It is also noted that their adaptation requires the instrument to be secured to a stand and use a mains power supply via a control box, which was partially operated by the musician's feet. This renders the musician static and not free to move naturally while playing. Based on their report, their solenoid driver circuit appears to be efficient at maintaining a cool operating temperature. It is such a shame that they do not appear to have made the schematic for their circuit open source.

It was found that the pushing force of the solenoid from its deactivated, rest position, was quite low in comparison to the force it could generate part way through its activation stroke. Using a small locking bush, it was possible to prevent the solenoid from returning to this weaker rest position. This modification, also assisted in keeping the leading face of the solenoid in contact with its corresponding key, reducing noise and impact on the key each time the solenoid was activated [*Fig 13*]. In addition, it also meant the relevant keys on the instrument could be held in a partially closed position, thus improving the response time of the solenoid to close the key.

Fig. 12: Return spring left in place

Fig. 13: Return spring used to assist solenoid activation and locking bush to prevent full retraction of the solenoid

The keys for F, E, and D were easily controlled using micro-switches placed on the left-hand keys B, A, and G respectively, and operated in a similar manner to the toggle key adaptation currently in use [*Fig 14*]. The operation of the D# (little finger) key was achieved with another micro-switch, this time located on the octave key, and operated by a rocking motion of the thumb [*Fig 15*].

Fig. 14: Location and operation of switches for lower F, E, and D

Fig. 15: Location of the switch for lower D#

However, lower C# down to B^b represented a problem as, with the exception of lower C♮, these notes require two keys to be pressed simultaneously. Fortunately, it was discovered that linkages already in place on the instrument cause the G# key, normally operated by the left hand little finger, to also be pressed when pressing any of the lower C#, B♮, and B^b keys. It was also noted that pressing the G# key while playing lower C♮ had no noticeable effect on the tone of the note. It was, therefore, decided to locate a fifth micro-switch over one of the linkages connected to the G# key. This switch would operate the lower C♮ key (right hand little finger). Pressing any of the lower C#, B♮, and B^b keys would also activate this switch, and hence, press the lower C♮ key [*Fig 16*].

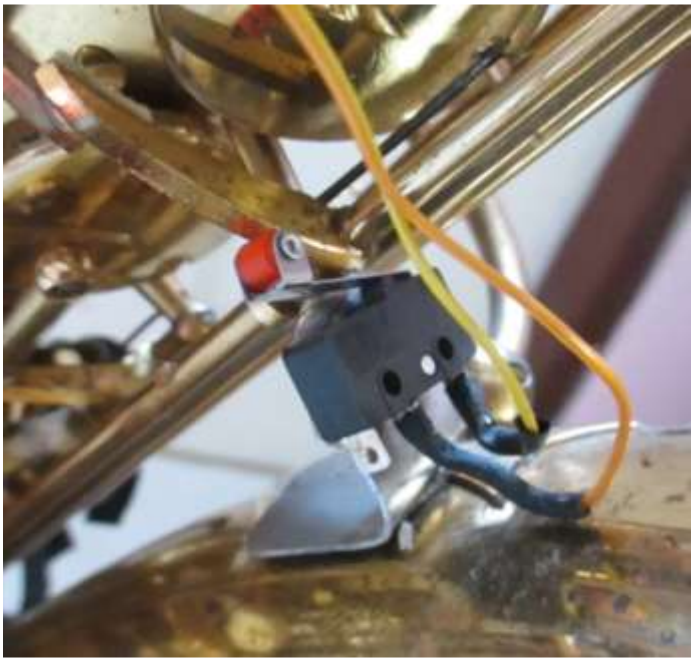


Fig 16: Location of the switch for lower C♮

As can be seen from the location of the switches for the lower little finger controlled notes; an attempt has been made to try to maintain the standard orientation of these saxophone keys so that it is more intuitive to one-handed players who, like me, already have experience of playing the saxophone from before losing their right hand, or right arm function. It also means no structural changes would need to be made to an existing saxophone in order to “bolt on” this adaptation.

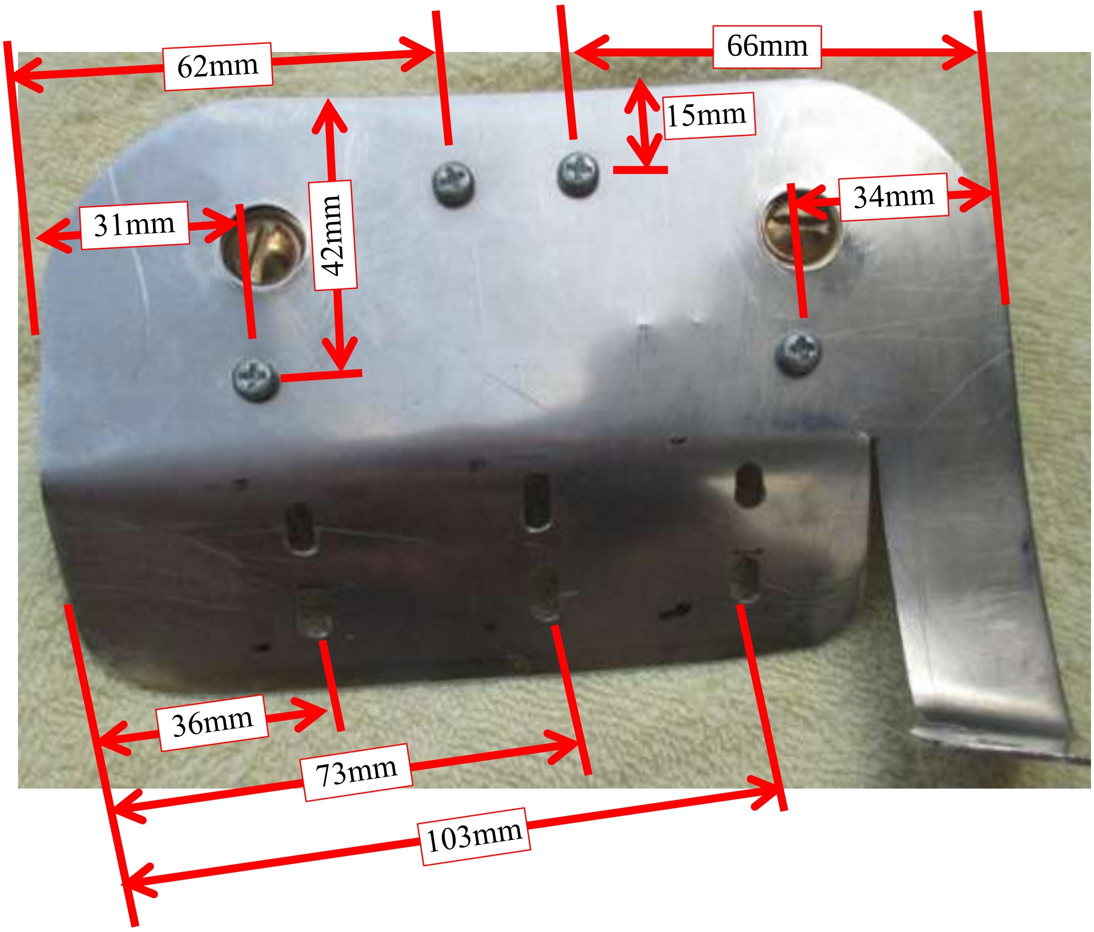
Mounting Plates

The plate to mount the five solenoids used in this adaptation was fabricated from 0.6mm stainless steel plate. Stainless steel was selected as it would be resistant to oxidising or other reaction due to moisture from playing the instrument. It also has mechanical strength properties that were believed to be better suited to this adaptation. Thicker brass plate may be better suited due to its more decorative properties, but such material could not be sourced. Aluminium plate was considered due to its lighter weight and more malleable properties. However, aluminium tends to oxidize quite quickly and could potentially form a galvanic reaction with the brass metal of the saxophone.

Two plates were fabricated in this instance; one to mount the solenoids, the second to mount the micro-switch that resides below the G# key linkages and operates the lower C♮ key.

The diagrams displayed here are intended as a guide for their reproduction. However, it is thought that different instruments may require slightly different designs.

Holes for affixing the solenoids are elongated to allow for adjustment, so these can be made to suit the instrument. Dimensions for the solenoids used in this adaptation, and the layout of their mounting holes are given in the enclosed solenoid documentation.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66mm
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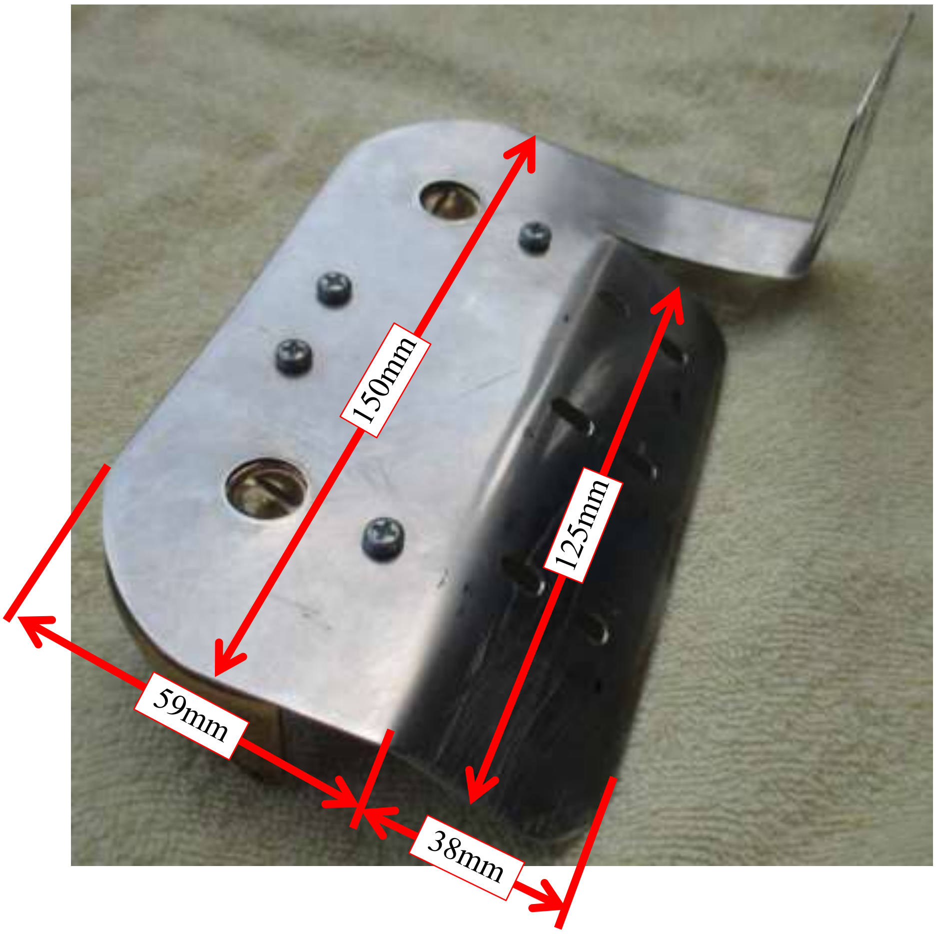
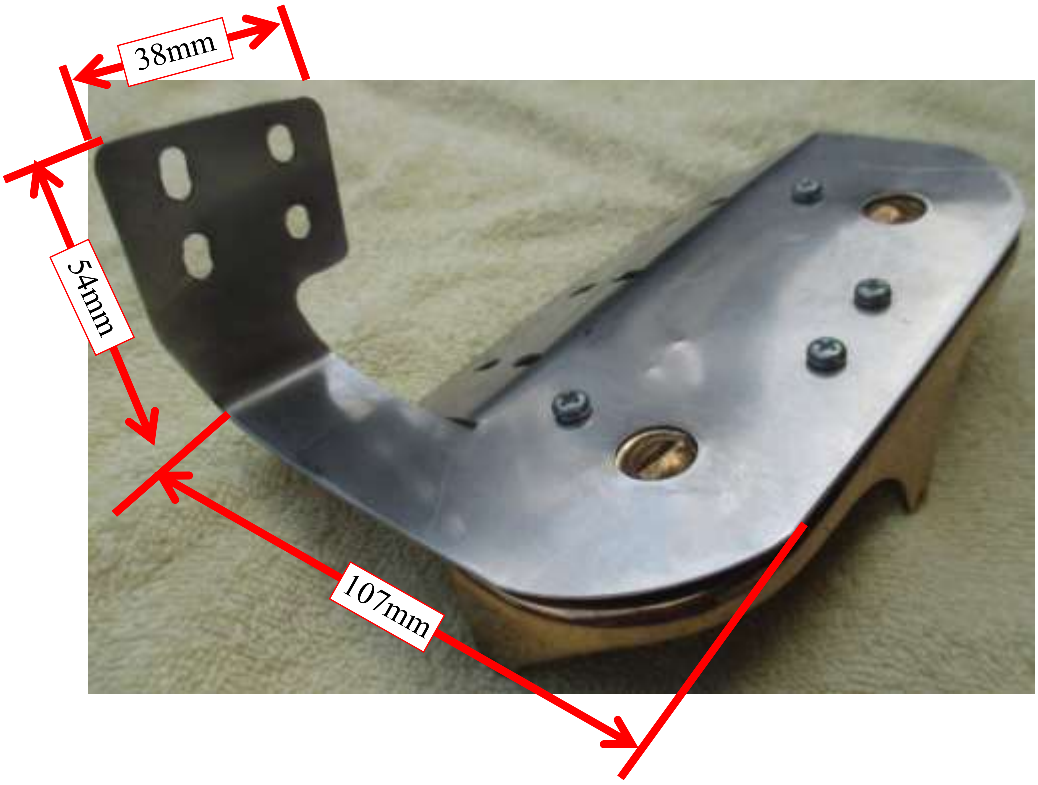
42mm
34mm
36mm
73mm
103mm


150mm
125mm
59mm
38mm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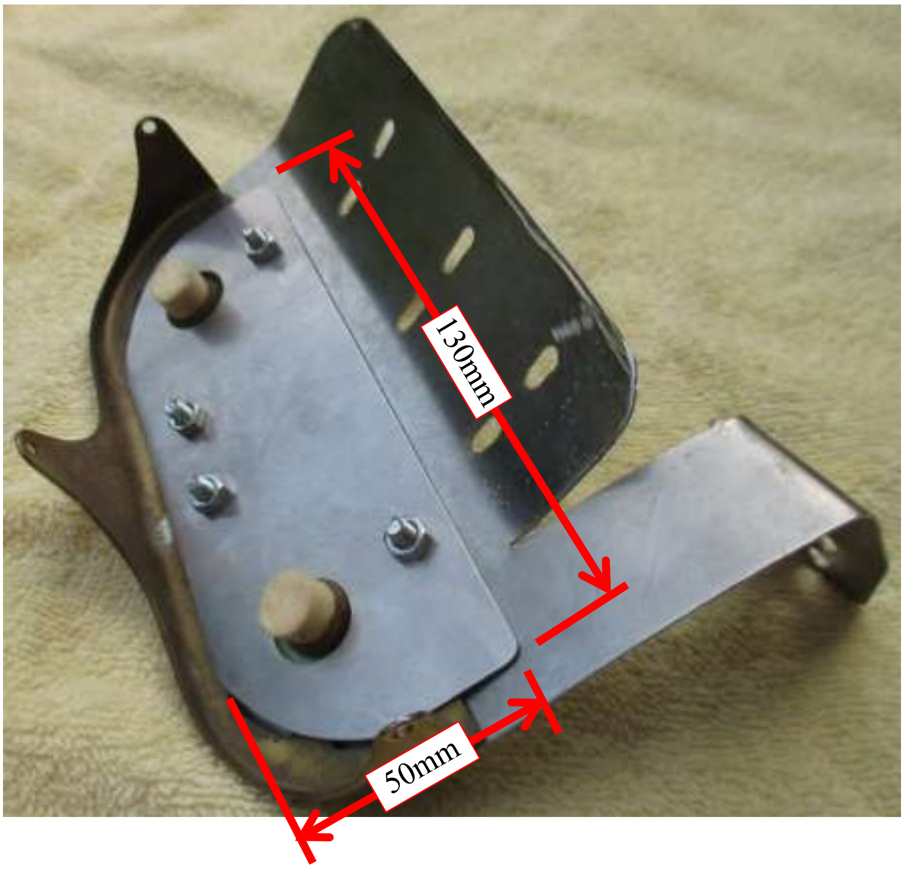
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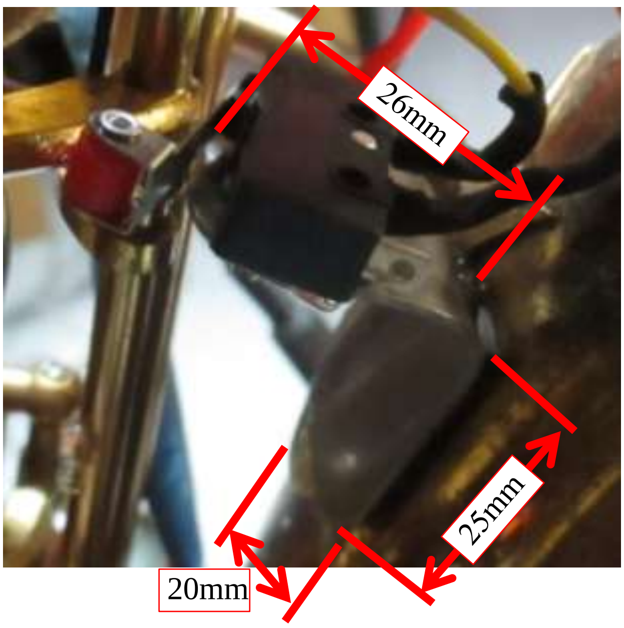
50mm



Future Enhancements

At present, the micro-switches, and bracket for the G# micro-switch, are held in place using glue from a hot glue gun. Aside from making a more secure fixing for these switches, it would make playing considerably easier if a more ergonomic solution could be designed. It has been found that, playing down through the notes is relatively easy and smooth, but playing upwards through the notes, D, E, F, and F♮ to F# in particular, is not such a natural movement and often results in the release of one or more of the left hand keys G, A, or B; it feels natural to release these fingers as you play up through the scale.

In terms of reducing the overall size of the driver circuit board, it would be possible to replace the DRV102 [6] driver with the much smaller DRV103 [7]. Experts on the Texas Instruments forums [5] originally recommended these, and I attempted to evaluate them during the initial breadboard circuit testing, but personally found them too small and delicate to work with by hand. They were too small to fit to the breadboard so required soldering to a PCB converter board. However, soldering them was beyond my ability, and they were pretty much destroyed or contaminated with flux in my attempts to solder them. These drivers have four connection tags on two opposing sides, yet are only about $4mm^2$ in size.

In addition, figure 17 in the DRV102 [6] specification sheet suggest the use of a power switching array would enable up to eight solenoids to be driven by a single driver. However, based on the data sheet for TPIC6273 [8] it is my understanding that this arrangement would not work as required in the saxophone scenario where keys may be pressed or released while other keys remain in the pressed position. If my understanding is correct, once the first solenoid has been activated, the driver would drop voltage to the holding voltage level. Therefore, attempting to press other keys while still holding the first key would result in only the holding voltage being sent to these other solenoids, which would not be sufficient to activate them. Hopefully, my understanding is incorrect, in which case this would greatly reduce the size and cost of the driver circuit board. However, I see no means to independently control the holding voltage for different keys in such an arrangement, meaning the highest holding voltage would need to be applied to all keys. This is certainly an area for future investigation, particularly for someone with a more comprehensive knowledge of electronics. The experts in the Texas Instruments forum [5] also suggest two other forms of array switches, ULN2003A [10] and TPL7407LA [9]; however, my comments above remain.

A significant factor in the efficient function of each solenoid relates to its location and rest position. It is important to have the solenoid reach (as close as possible) the full stroke of its activation in order for it to hold in place at the reduced voltage level. It also aids the initial pushing force of the solenoid if it is not positioned at the fully deactivated position when at rest; the pushing force increases as the central shaft passes through the energised coil. Holding the solenoid in a partially activated position when not energised greatly aids its ability to press the key from rest. Based on this, it would greatly aid the adjustment and setup of the solenoid location if their fixing screws were more readily accessible. At present, their position can only be adjusted by removing the entire mounting plate. This results in a lengthy process of trial and error. Fixing each solenoid to a small moveable plate, which in turn attach to the main mounting plate, would enable adjustment from the exterior of the saxophone and would greatly facilitate the setup and maintenance process; replacing a faulty solenoid for example.

Another hindrance to the efficiency of each solenoid is the resistance caused by the return springs of each saxophone key. If it were possible to somehow weaken these springs without causing ill effect to the functioning of the instrument, the power needed by each solenoid to activate and hold their associated key(s) would be greatly reduced; less power equals less heat.

It is noted that, after continuous play, the solenoids still heat up to a temperature that may, over time, reduce their reliability. If the holding voltage could be further reduced, it would greatly improve the performance and longevity of the adaptation.

Switching between the notes for the right hand and left hand can be sloppy at times as the process required the fingers to slide over the keys without actually releasing the downwards pressure; changing upwards from E to G for example. This action would be greatly improved if some form of sliding mechanism were in place on each of the three keys, B, A, and G. Such a mechanism might also incorporate the switch to operate the solenoid, which would make positioning of the switches easier, more accurate, and more secure. However, the design would need to be such that the sideways movement of the fingers is not restricted as sometimes one finger may need to press two keys simultaneously; first finger only method of playing B^b for example.

Bill of Materials and Costing (for v1.1 PCB)

Itm	Qty	Description	Cost (Ea)	Total
1	1	Printed Circuit Board	£1.60	£1.60
2	5	Solenoid Driver	£6.90	£34.50
3	5	5 PCS 11 x 11 x 5mm Adhesive Aluminium Heat Sink	£1.20	£6.00
4	5	Trimmer Potentiometer 100kΩ	£0.50	£2.50
5	1	Female DC Power Jack 3A/30v	£0.39	£0.39
6	2	2.5mm 5 pin connector housing (female)	£0.05	£0.10
7	2	2.5mm 5 pin wafer connector (male)	£0.05	£0.10
8	20	2.50mm Terminal crimp connector	£0.02	£0.40
9	5	Radial Capacitor 0.47µF/250VDC +/-10%	£0.25	£1.25
10	5	DC 6v 300mA 5N / 10mm Solenoid	£2.00	£10.00
11	10	Silicon Rectifier Diode 50v/1A	£0.02	£0.20
12	1	6 Wire Ribbon Cable (4.5 meters)	£2.00	£2.00
13	3	Mini Microswitch - SPDT (Roller Lever, 2-Pack)	£1.95	£5.85
14	5	Dubro Dura-Collars 1/8"	£0.40	£2.00
15	5	2.5mm 2 Pin Housing Connector (female)	£0.01	£0.05
16	5	2.5mm 2 Pin Wafer Connector - Right Angle (male)	£0.02	£0.10
17	1	11.1v 2200mAh 30C 3 Cell Li-Po Battery	£17.00	£17.00
18	1	Titan B3 2-3Cell 7.4v 11.1v Li-Po Battery Balance Charger	£7.40	£7.40
19	1	Stainless Steel Plate (50cm^2 Offcut - Far more than needed!)	£10.50	£10.50
			Total:	**£101.94**

A more detailed BOM is included in the attached Excel document.

Limitations

This adaptation, while far from perfect, has given me the ability to play many of the tunes I once enjoyed playing. At this stage, some tunes are too complicated to play, but I'm sure this will improve as I get used to the different way of playing.

There are, however, a number of limitations with this design that should be noted and which can hopefully be ironed out with different eyes and skills looking at the design.

1. Function has only been restored to the keys used most frequently by the right hand; the group of side keys that are mostly operated using the side of the right hand index finger have not been included at this stage. It is hoped that smaller solenoids can be used for these keys. However, no thought has yet been given to how they would be operated.

2. There is clearly a limitation on play time, governed entirely by the capacity of the battery. This could be improved as battery technology improves, or through the use of more efficient solenoids.

3. Fully assembled, the saxophone no longer fits into its carrying case as the two solenoids used to operate the D# and C♮ keys stand proud of the saxophone and prevent the lid from closing. If it were possible to somehow fold these two solenoids into a lower position, the lid (on my instrument at least) would close as normal.

4. As previously stated, the switches used in this adaptation are fixed in a temporary way (as I have no other means of fixing them more permanently). This is something that could easily be addressed by someone with access to machine tools and/or instrument servicing/repair tools. I'm sure more suitable switches could also be sourced through the right contacts.

5. Moving from lower C♮ to C#, B♮, or B^b is awkward as there is no roller on the G# key to facilitate this movement. There is quite a step to reach these three side keys from the G# key when it is fully pressed.

6. In its current configuration, the use of the G# key to operate the solenoid for C♮ appears to cause an issue when moving from G# to F or F# if the G# key is not released. Ordinarily, linkages on the instrument would override the G# key if either the F or F# key were pressed. However, with this adaptation, the lower C♮ key remains pressed, causing the note to sound out of tune. If pressing of F or F# were to release the C♮ solenoid, it would not be possible to play any notes below D. Solving this issue may require the use of two micro-switches; one to press the C♮ key in isolation, and a second to press the C♮ key if either of the C#, B, or B^b keys are pressed. This may be problematic as suitable locations for this second switch would be in an area of the instrument that typically rests against the body while playing, and a means to operate the C♮ switch would need to be designed.

7. Playing the lower B♮ and B^b can be problematic as the action requires pushing forwards on the three switches to operate the right hand keys, while swivelling the left hand slightly so the little finger can reach the keys for these two lower notes. This may be facilitated if the switches had a wider area of contact, such as in figure 17.

Fig. 17: Push switch with wider contact area

Closing Comments

It is hoped that this adaptation, while limited in certain areas, can provide a cheap and easy means to modify a standard saxophone to enable a left hand only musician to enjoy playing with a very usable range of notes. I openly share my design in the hope that other contributors may help to improve it and possibly produce it as a simple kit that can easily be attached and removed from a standard instrument by any individual.

As outlined, the cost for me to manufacture this version (excluding my failed attempts) has been quite reasonable, about £100. This, I am sure, would put such an adaptation in the reach of many potential one handed musicians.

I welcome any questions or comments from others who may be interested in adapting their own instrument, or are able to take this design to the next level.

About the Developer

The developer of this adaptation, Simon Moxon, has a background in mechanical engineering. He served an indentured apprenticeship with British Aerospace Plc, now Airbus, Chester, from August 1988 until his motorcycle accident on 7th August, 1991. He has some ten years' experience in engineering having worked as a design engineer post-accident, designing hydraulic and pneumatic pressure vessels, accumulators, and compensators.

In later years, he attained a first class honours degree in Applied Computing and Software Engineering from Staffordshire University, and also attained Microsoft Certified Professional status for programming in Visual C#.NET. He has worked as a software developer on ticketing solutions for venues including Royal Opera House, Sepang International Circuit, West Indies Cricket, and football clubs such as Liverpool, Manchester United, Aston Villa, Arsenal, and West Ham.

In November, 2007, following a short period of lecturing in UK, he emigrated to Thailand, where he has worked as a teacher to students aged 5 to 15. He is a licensed teacher in Thailand, and has a Master of Education degree in Teaching and Technology from Assumption University, Thailand.

In his free time, he enjoys jogging, web design, and scuba diving. He is a PADI certified Dive Master and regularly dives at the national parks in the Koh Lanta area.

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