Pseudo-Switch
DP4T
USAGE and CIRCUIT DESCRIPTION

From

OmberTech

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Contents

Introduction

The Pseudo-Switch is designed to bring together the convenience of fully solid-state electronics with the practicality of mechanical multiple-throw switches. It includes a push button and LED position indicators so that it can be used manually as easily a regular switch, while also offering the fast response, reliability, and versatility of a solid-state device.

Digital control can also be achieved via the Clock, Reset, and Inhibit inputs. These not only make the difficulty of controlling analogue signals with digital circuitry a breeze, but also allow multiple Pseudo-Switches to be combined for expanded functionality. By exposing the Clock signal generated by the integrated push button at the external Clock pin, the Pseudo-Switch makes it possible for a microcontroller to both read in the switch position set by the user, and advance that position automatically, using just one of its I/O pins.

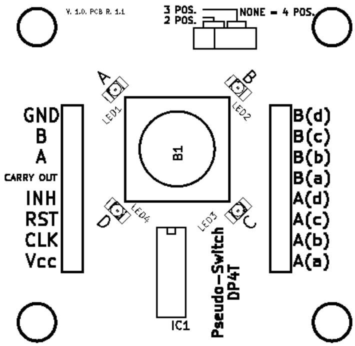
This booklet will demonstrate the basic, and advanced, circuit arrangements in which the Pseudo-Switch can find use. Then finally, we'll look into the internals to find out what makes it tick.

Supply Voltage	3.0 - 5.5V DC
Supply Current	<50mA
Max. Input Voltage	+5.0V, -4.5V(3V Vcc) +5.5V, -5.5V(5V Vcc)
Max. Switch Current	20mA
Switch ON Resistance	<120 - 500 Ohms
Switching Time	2 Microseconds
Switching Configuration	Break Before Make
Dimensions	43x42mm

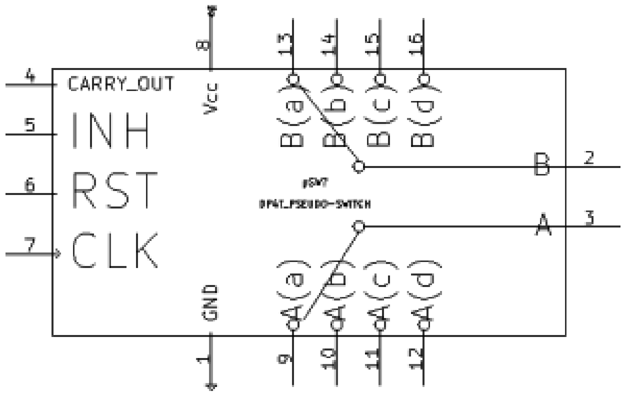
Table 1, Specifications.

Usage

The pin functions are conveniently described on the top silkscreen of the Pseudo-Switch circuit board:



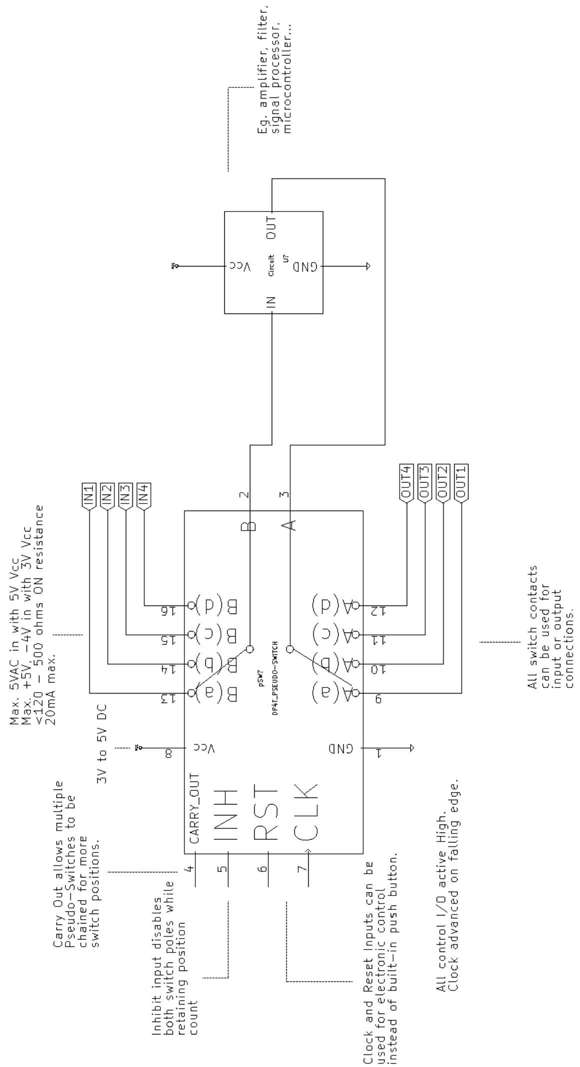
The switch connections are alphabetically labeled, so that the pole of the first switch (A) is switched between connections Aa, Ab, Ac, and Ad. Similarly, the second switch (B) joins with Ba, Bb, Bc, and Bd. This can be seen more clearly using the following functional diagram.



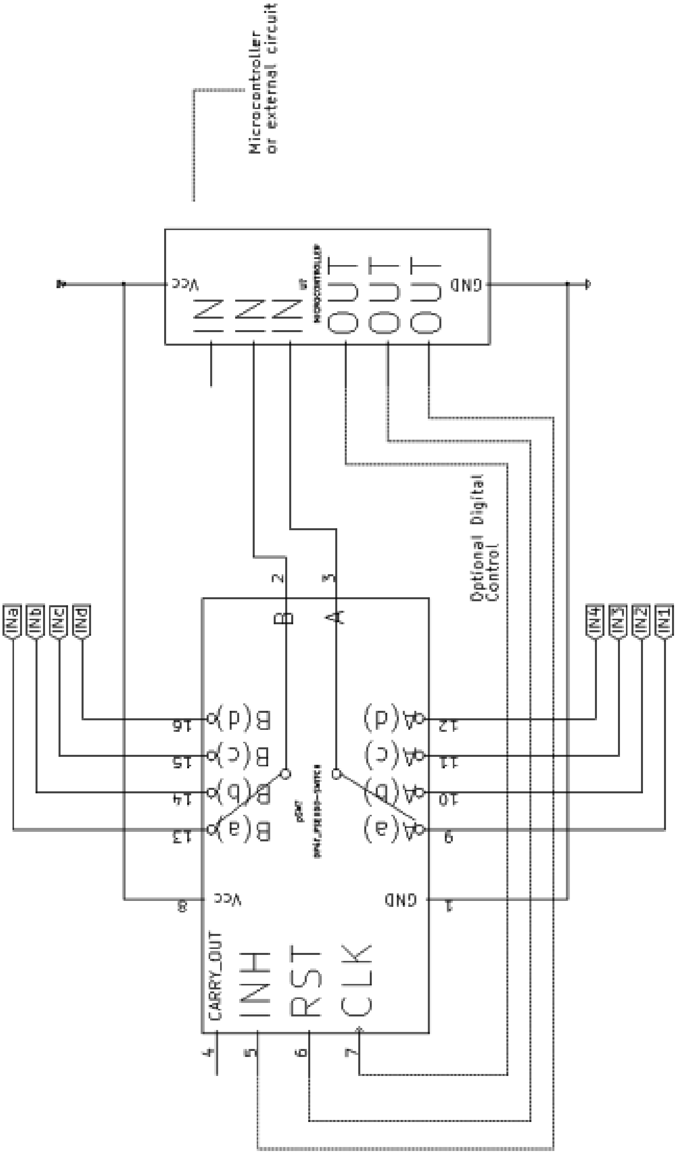
The other pins are for digital control of the Pseudo-Switch and may all be left open-circuit if only manual control using the built-in push button is required. Their functions are as follows:

- **Clock** Switch position advances when this signal transitions from High to Low. Normally pulled High via 330Kohm resistance, it is pulled Low via 16Kohms when the built-in push button is pressed and this can be detected externally if connected to a digital input. It can be connected to a digital output for external control.
- **Reset** When brought High, this resets the switch at position "A". This is helpful for making sure that the switch is at a known position before advancing it digitally. It is pulled Low internally via 56Kohms.
- **Inhibit** When brought High, this disconnects all the switch contacts regardless of which is selected. The previously selected contact is connected again when the signal is brought back Low. This is handy for multiplexing signals from many Pseudo-Switches into one input or output. It is pulled Low internally via 330Kohms.
- **Carry Out** When the end of the position range is reached, this line is pulsed before the switch resets to position "A". This can be used to connect with the Clock input of a further Pseudo-Switch to allow them to be combined for a larger number of effective switch positions.

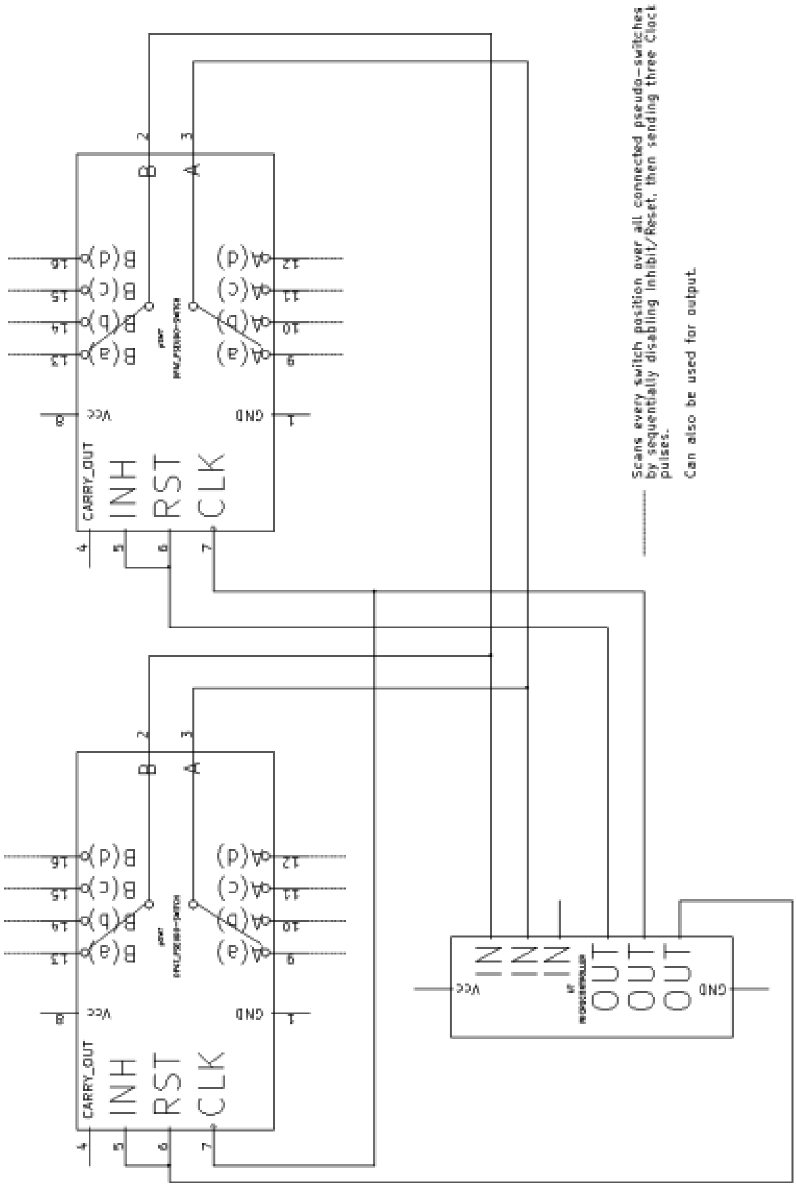
The number of positions which the switch covers before resetting back to position "A" is set using the jumper at the top of the board, as described on the top silkscreen.



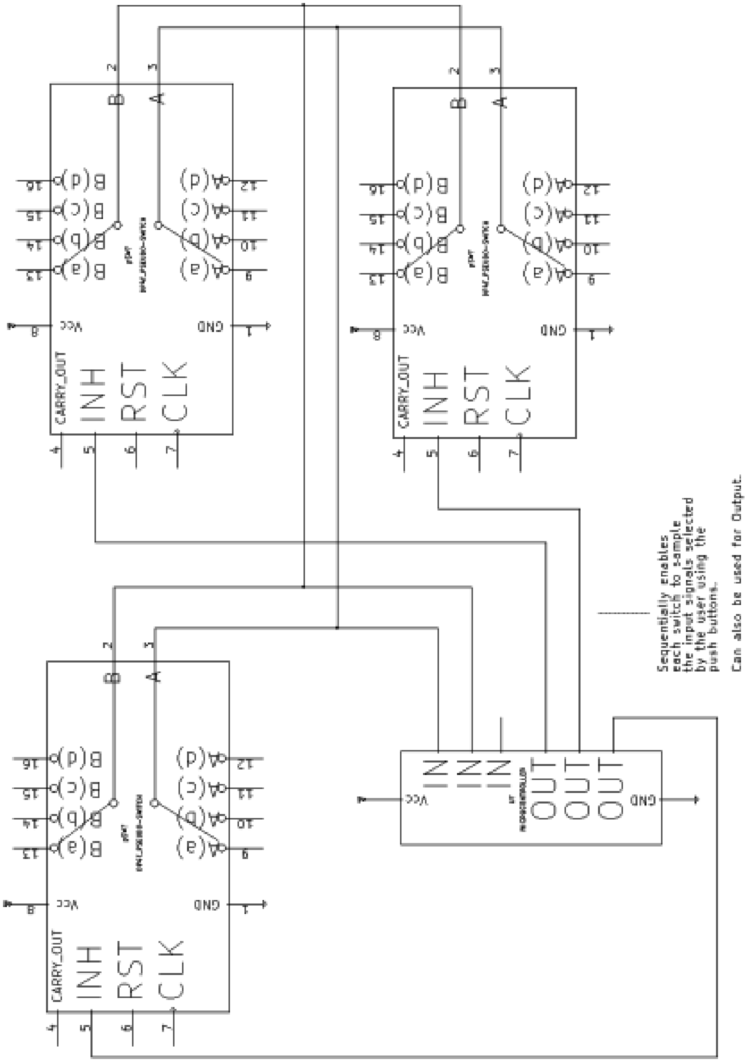
Example 1. Basic Usage - In/Out.



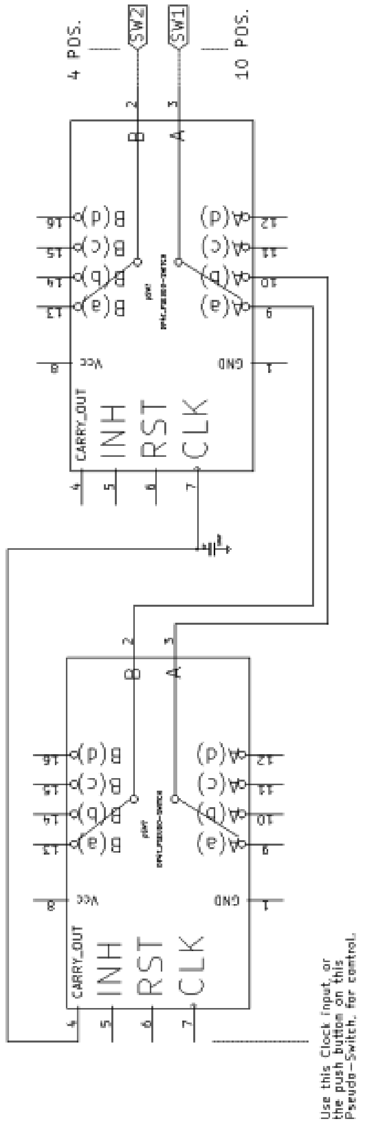
Example 2. Basic usage - Microcontroller.



Example 3. Switch Select.

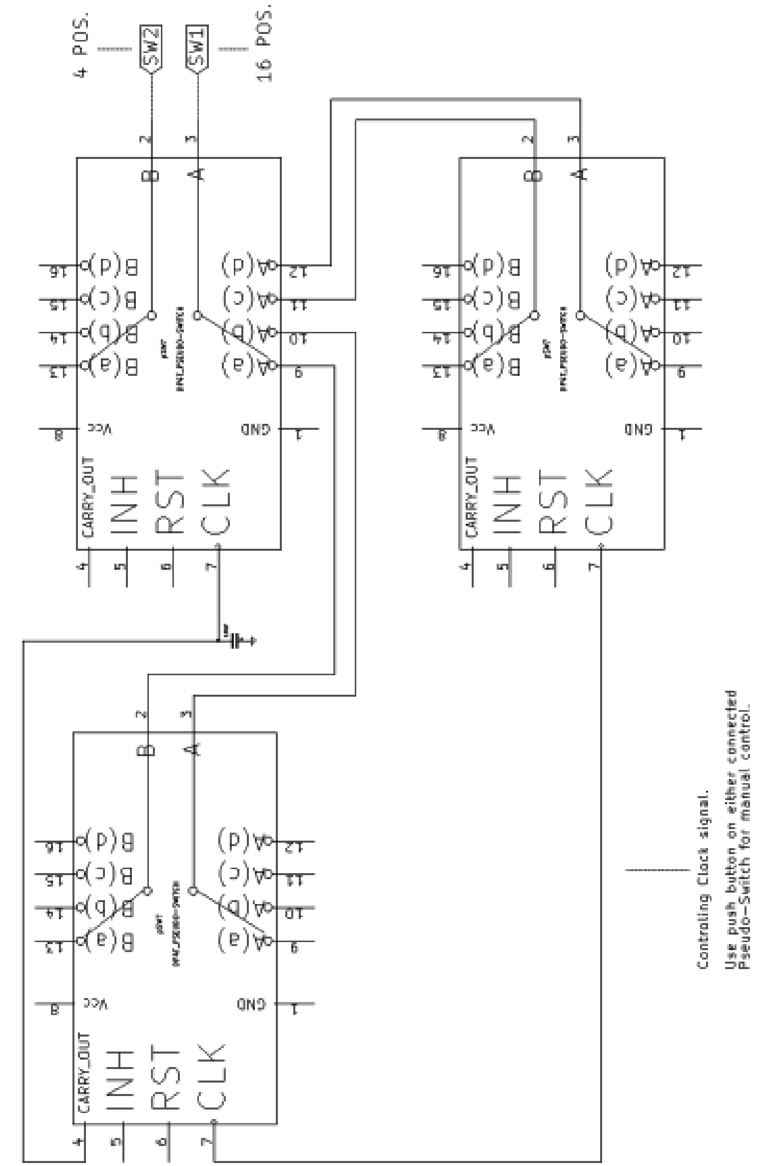


Example 4. Multiplexing.

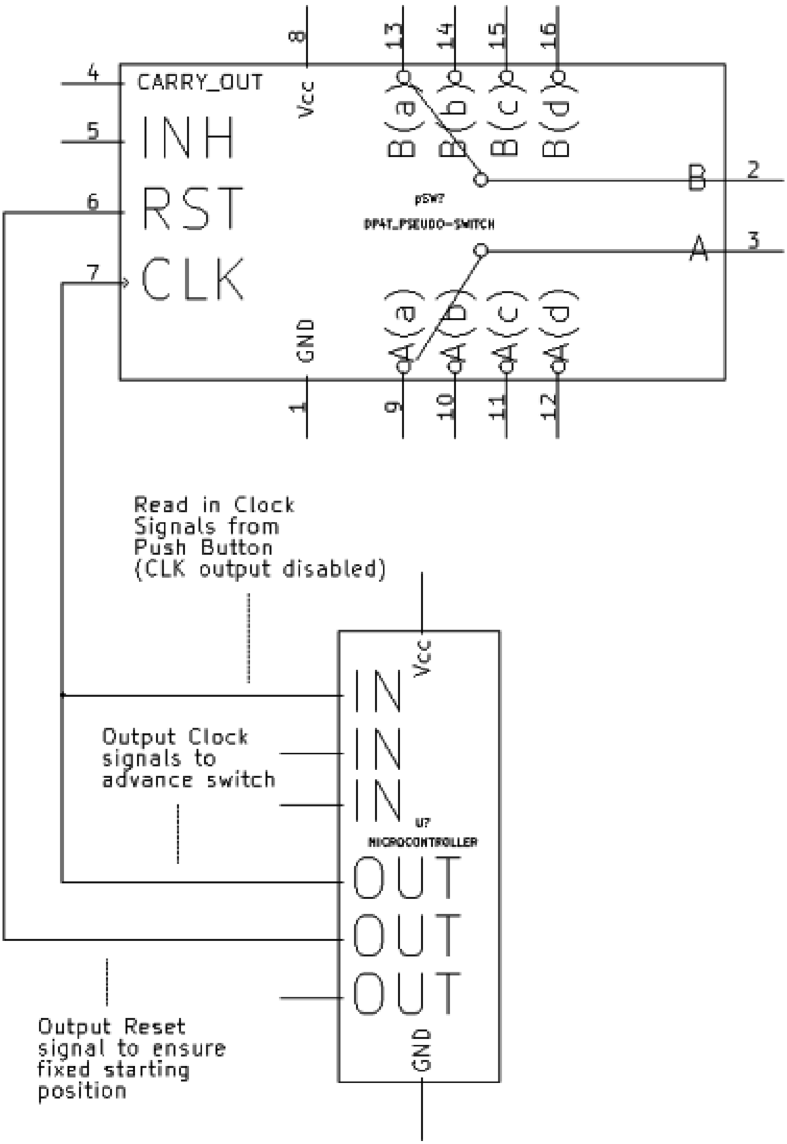


Example 5. Cascaded poles - 10 position.

The last two positions will take four Clock pulses to advance over. Alternatively, limit the second Pseudo-Switch to two positions for a total of eight.



Example 6. Cascaded poles - 16 position.



Example 7. Input readback.

Code Example

This is an example C function to advance the position of the switch a specified number of places, optionally resetting it beforehand to ensure the final position is correct regardless of whether the built-in push button has been pressed to advance the position manually. It also sets the state of the Inhibit function.

Fill in the missing definitions to suit your microcontroller configuration.

```
// Example Configuration function for Pseudo-Switch Analogue
   Switch Board from OmberTech
// 2018 OmberTech. No warranty. May be used for any purpose.

#define MICROSECOND                      // Approximate number of
                                         execution cycles required for
                                         CPU to complete "for" loop in
                                         microsleep function.

// Microcontroller outputs connected to Pseudo-Switch:
#define      CLOCK
#define      RESET
#define      INHIBIT


// Delay for specified number of microseconds (alternatively use
   hardware timer):
void microsleep (unsigned int microseconds)
{
       unsigned long i;
       while (microseconds--)
         for ( i = 0 ; i < MICROSECOND ; i++ );
}


// Modify Pseudo-Switch configuration:
void pseudosw ( unsigned int clk, // Number of switch positions
                                 to be advanced
                 char rst,        // If 1, reset switch position
                                 to "A" before advancing
                                 position
                 char inh )       // If 1, enable Inhibit mode
                                 (no switch contacts selected).
                                 If 0, disable Inhibit mode.
{
       INHIBIT = inh;
```

```
        if (rst)
                {
                  RESET = 1;
                  RESET = 0;
                    microsleep (5);//Ensure Reset has been disabled
                }

        for ( ; clk > 0 ; clk-- )
                {
                        CLOCK = 1;
                        CLOCK = 0;
                }
         microsleep (5); // Wait for switching time
}
```

The above code can be downloaded in text format, and without the wrapped comments, from:
http://www.computernerdkev.heliohost.org/pseudoswitch/

Using the above function, this would move the switch to the fourth position (D):

```
pseudosw (3,1,0);
```

While this would advance it two positions ahead of its previous position (the switch will loop back around if it reaches the last position):

```
pseudosw (2,0,0);
```

Finally, this turns on the Inhibit function of the Pseudo-Switch without changing its set position:

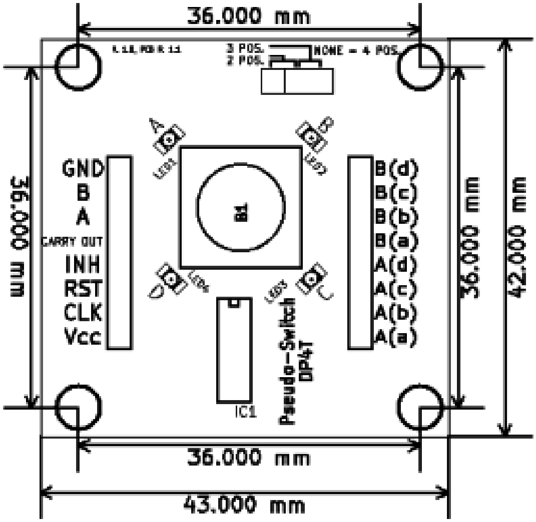
```
pseudosw (0,0,1);
```

Which is actually equivalent to:

```
INHIBIT = 1;
```

Mounting

The Pseudo-Switch board can be mounted to an instrument case using 3mm or 1/8 inch bolts and suitable spacers. If manual control is desired, a suitable hole should be placed to allow both access to the push button, and to leave the position indicator LEDs visible.

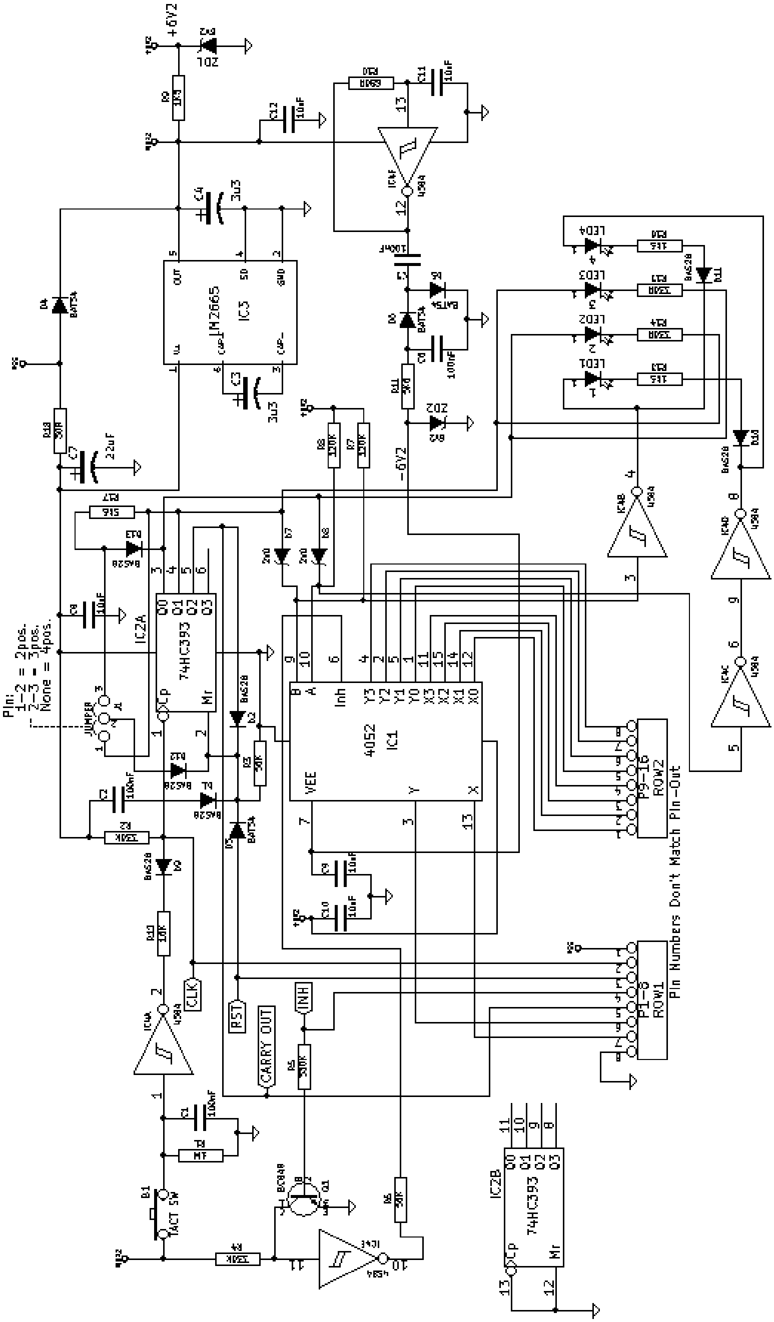


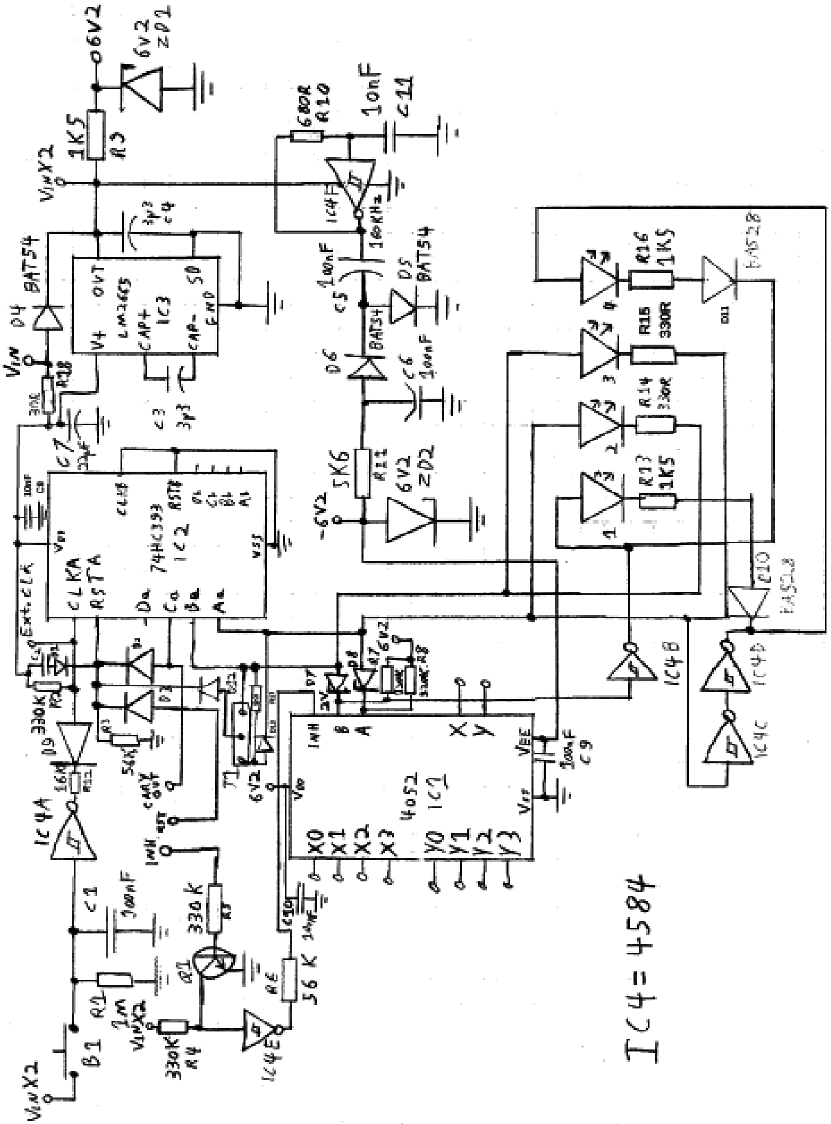
Dimensions

Circuit Description

The following schematic describes the circuitry that drives the Pseudo-Switch. To facilitate switching 5V signals from 3V circuits, and to allow negative voltages and AC signals, a voltage doubler and a voltage inverter are included. In total four internal power lines are used, along with Ground: Vcc (3V - 5V DC), VinX2 (the doubled output voltage from IC3), +6.2V, and -6.2V. Additionally, Vcc is supplied via a 30 ohm resistor to all connections except D4 in order to protect IC3, as described later.

CAD generated and hand drawn copies of the schematic are shown on the following pages.


Pin Numbers Don't Match Pin-Out
74HC393
IC2A
IC2B
4052
IC1
LM2665
IC3
ROW1
ROW2
CARRY OUT
RST
CLK
INH
TACT SW
+6V2
-6V2


IC4 = 4584
74HC393
IC2
LM2665
IC3
4052
IC1
Q1
B1
R1
C1
R3
1K5
6V2
ZD1
ZD2
R10
680R
C11
10nF
IC4F
100kHz
C5
100nF
D5
BAT54
D6
C6
100nF
-6V2
R11
5K6
D4
BAT54
C4
3p3
C3
3p3
C7
Ext.CLK
R18
D9
R12
16K
IC4A
IC4B
IC4C
IC4D
IC4E
R13
1K5
R14
330R
R15
330R
R16
1K5
D10
BAS28
D11
C9
100nF
R4
330K
R5
330K
R6
56K
INH
VIN
VINX2

Signal Control:

The switching of "switch positions" is achieved electronically using a 4052 analogue switch IC, controlled by the binary counter IC2A (74HC393) at pins 9 and 10 (inputs A and B). in addition the Inhibit input, pin 6, is controlled externally via IC4E and Q1 which together form a non-inverting buffer that also performs the required logic level conversion from the input voltage up to that of the internal 6.2V supply. R6 limits the current that may flow from IC4E to ZD1 via IC1's input protection diode when the supply voltage to IC4 is above that of the regulated 6.2V line powering IC1.

IC1 is conveniently designed to reference GND for its control inputs, with a separate connection for negative voltage to use with its internal analogue switching circuitry. This avoids the need for negative voltages to be supplied to the control inputs when they are brought Low.

The binary counter IC2A is powered from Vcc, and advances on the High to Low transition of its Clock input, pin 1. This pin is normally held High by R2 when not pulled down by an external circuit connection. When B1 is pressed, the input to IC4A (4584 Schmitt Inverter) is brought High, once de-bouncing capacitor C1 is charged. This produces a low output that pulls down the Clock input of IC2A via R12 (which prevents damage to an external circuit which may override the signal) and advances the switch position count. D9 prevents the boosted voltage of IC4's High output from being applied to IC2 or an external circuit.

IC2A's Reset input, pin 2, is pulled Low via R3 except for when one of the four diodes connected to it force it High. When the position jumper, J1, is in the "2pos." setting, this happens after the count advances to position 2 and IC2 pin 4 goes High. In the "3pos." setting, it is when both pin 3 and pin 4 are High. If neither of these positions are selected, D2 ensures a default maximum position by resetting the counter at position 4, which is when pin 5 goes High. D1 resets the counter when power is first applied, and D3 allows external reset control.

The LEDs showing the current switch position are arranged so that sufficient voltage to light them is only available when the output combination corresponding with their indicated position is at IC2A's outputs. Three more inverters from IC4 are used to achieve this. In order to drive the inputs to these inverters, and to IC1, 2V zener diodes D7 and D8, along with pull-up resistors R7 and R8, increase the High level voltage above the output of IC2A while ensuring that the Low voltage is still below the input threshold.

Power Supply

A positive and negative internal supply above the Vcc level is required to allow the switching of AC signals and to permit reverse current flow in analogue circuits at voltages that may be above the input supply. The first stage is IC3 (LM2665), which is a dedicated voltage doubler IC from Texas Instruments using the switched capacitor method. Internally it uses CMOS analogue switches to charge capacitor C3, then add the voltage over it to the charge of C4 at the output. The LM2665 actually takes the voltage supply for its own internal circuitry from the output. As a result, D4 is required in order for it to start when power is first applied.

Because CMOS inputs can be damaged if they are at a higher voltage than the supply, an issue is found if the voltage drop over D4 and the charge time of C4 results in the "V+" input being higher than the output at start-up. To avoid this, R18 limits the rate at which the supply voltage rises as it charges filter capacitor C7, while D4 connects directly to the input supply to make sure that C4 reaches full charge before this. D4 is also a schottky type diode, with a lower forward voltage than silicon types.

The output of the voltage doubler is regulated to 6.2V by ZD1 to power IC1 (4052) and other discrete circuit components. However the supply to IC4 (4584) taps in before this in order to receive the maximum voltage and current to power the negative voltage generator built with IC4F.

As a schmitt inverter, IC4F is able to be turned into an oscillator by simply adding a capacitor on its input with a resistor connecting it to the output. The resulting square wave, at roughly 160KHz frequency, is applied to C5. This forms the beginning of a conventional negative voltage generator circuit which is built using schottky diodes for minimum voltage drop. The output is regulated to -6.2V by ZD2 and connects with the VEE input of IC1 (4052).