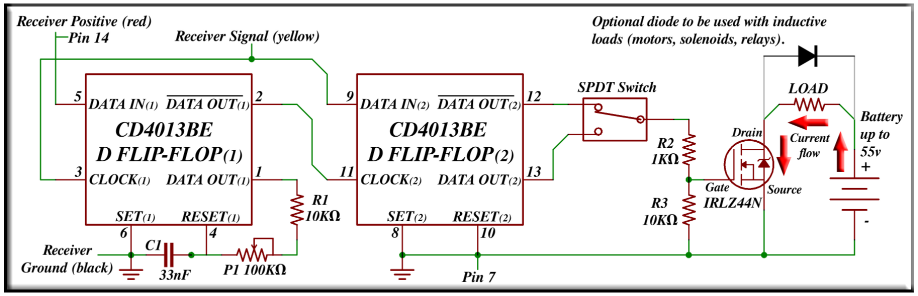


Electronic Receiver Switch Schematic Diagram

Thanks for purchasing this **Hansen Hobbies Receiver Switch Kit**! Please make sure you have everything:

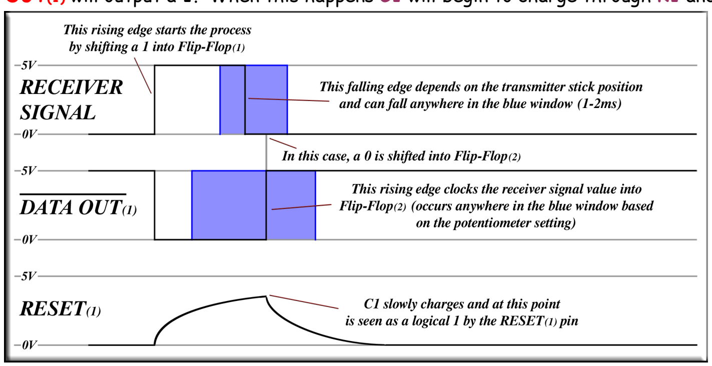
- .72x1.1" pcb	(1)	- CD4013BE chip	(1)	- IRLZ44N MOSFET	(1)
- SPDT switch	(1)	- 100KΩ pot	(1)	- 10kΩ resister	(2)
- 1KΩ resistor	(1)	- 33nF capacitor	(1)	- 8" receiver lead	(1)
- power wires	(4)	- solder 18"		- .75" clear heat shrink	

Circuit explanation:

The **CD4013BE** contains two D-type flip-flops. If you have no idea what a flip-flop is then you'll benefit from a little online research. Here's a quick review: a flip-flop has the ability to 'lock in' a logic value (**0** or **1**) and make that value present at the **DATA OUT** pin. The locked-in value is only allowed to change when the **CLOCK** pin rises from low to high (a rising edge). At that time the logic value present at the **DATA IN** pin is shifted in and the **DATA OUT** pin outputs that value. **Note: "DATA OUT" with a line over it is simply the inverted DATA OUT - always.** There are also **SET** and **RESET** pins that let us force the **DATA OUT** value 1 or 0 respectively whenever we want, simply by pulling one or the other high; the ones we aren't using are connected to ground.

Radio control receivers use **Pulse Width Modulation (PWM)** to communicate with a servo. The pulse occurs every **50ms** and is variable between **1ms** and **2ms** long as shown in the graph below – the width of the pulse tells the servo what position to be at. Our goal is to decode this signal into an **ON** or **OFF** state so we can turn peripheral devices **ON**/**OFF** during flight. The best approach is to create a signal in phase (rising edges occur at the same time) with the receiver signal, then compare this new signal width with the receiver signal width and turn the device **ON** if the receiver signal is longer, or **OFF** if it is shorter.

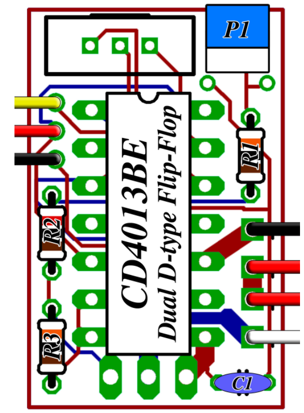
We create the comparison signal by connecting the **FLIP-FLOP(1)** (**FF1**) **CLOCK(1)** to the receiver signal, and the **DATA IN(1)** to **Vcc** (positive). Whenever the receiver signal rises, a **1** will be shifted into **FF1** and **DATA OUT(1)** will output a **1**. When this happens **C1** will begin to charge through **R1** and **P1** (this takes a certain amount of time) – when the voltage across **C1** gets high enough to be seen as a logical **1** on the **RESET(1)** pin then **FF1** will reset and **DATA OUT(1)** will output a **0**. This happens at every rising edge of the receiver signal and is shown in the graphs to the left.



We now have a **PWM**'d signal occurring at **DATA OUT(1)** and the width of its pulse is determined by the resistor-capacitor combination on **RESET(1)**. By adjusting **P1** we can change the length of the pulse from about **.5ms** to **2.5ms**, which will let us make it longer or shorter than any valid receiver signal. Now we'll use **FF2** to compare the two signals. Notice that the receiver signal is connected to **DATA IN(2)** and the inverted output from **FF1** is connected to **CLOCK(2)**. This gets a bit confusing, but the graphs above should help a lot. As you can see, the inverted **DATA OUT(1)** is normally high, and pulses low for a short period (as determined by **P1**). When it rises back up **FF2** shifts in the receiver signal value. If the **DATA OUT(1)** pulse is longer than the receiver signal pulse than **FF2** will shift in a **0**, otherwise it will shift in a **1**. This 'comparison' happens every **50ms** and affects the output of **FF2**. **DATA OUT(2)**, and its complement both connect to a switch that determines which one connects to the power **MOSFET**. By flipping the switch, we simply invert the **ON**/**OFF** operation of the peripheral device (much like a servo reverse).

Finally, we have an **IRLZ44N** power **MOSFET** which acts like a big switch to turn the **LOAD ON** and **OFF**. **MOSFET**'s do not require current to turn on, just a charge present at the gate. For this reason **R3** is placed between the gate and ground to guarantee that the **MOSFET** turns **OFF** when the receiver is turned off (the gate charge will sink into ground). **MOSFET**'s also have fairly high gate-capacitance, and we take advantage of this with **R2**, which makes the gate charge accumulate slowly when the **MOSFET** is to be turned on – this is like a "soft-start" feature.

Assembly instructions:

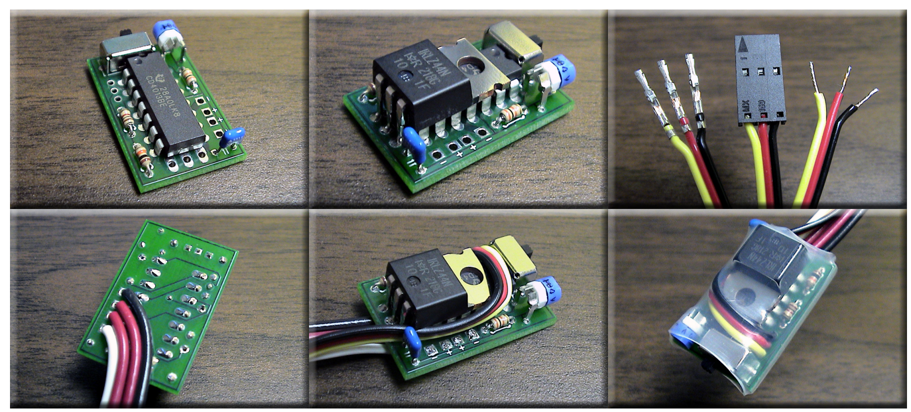


Use the printed circuit board (pcb) layout diagram to the right as well as the images below to place and solder your components. The solder in this kit has a water soluble flux that can be cleaned off with hot water and a brush. This results in a very clean looking solder job. Cleaning the flux off is not optional. If you prefer, use a standard rosin flux solder or no-clean solder instead that doesn't need to be cleaned. It is recommended that you solder the **CD4013BE** chip first, then move on to the resistors and capacitors. Before soldering the **MOSFET** in place, bend the legs **90 degrees** as shown below. Clip off the component leads as you go.

This kit used to require you to make a servo connector (hence the photo below), but now includes a completed lead. You may need to reshape the tinned strands with pliers to make them fit into the holes. Finally, solder the red, black, and white power wires in place. These should come up from the bottom of the pcb (opposite of all the other components) as shown below. If you look at the board you will find that the red wires don't actually have to be soldered to the board, since all that is achieved is that they are connected together. If you prefer, you can just connect the positive end of your load battery directly to your load, and you will have something that looks more like the battery, load, MOSFET circle on the far right side of the schematic.

After all the components are soldered in place (and leads clipped flush to the board) check over your circuit to make sure there aren't any bridged connections or misplaced components. If you're using the included solder wash the board in hot water and scrub with a brush. If available, do a final rinse with distilled water or isopropyl alcohol. Dry the board with a towel and let air dry, or use a heat gun/hair dryer. Water will not damage the circuit, but moisture in the switch and/or potentiometer could cause it to malfunction.

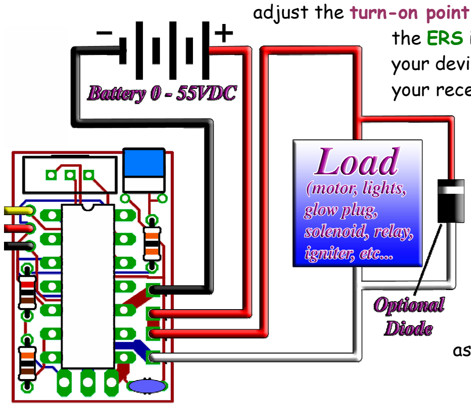
When you're satisfied that everything is working correctly, you can protect the circuit with the supplied heat shrink tubing. We recommend you route the receiver lead wires as shown - the wires will be clamped down among the pcb, components, and heat shrink to prevent strain on the solder joints.



Operating Instructions:

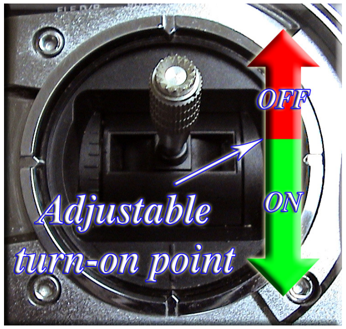
This device is designed to allow **ON**/**OFF** control of onboard devices like lights, glow plug drivers, motors, smoke systems, rocket boosters, solenoids, relays, and whatever else you can think up. You can safely power a device with a DC supply ranging up to **55V** at up to **5A**.

Hook up: Setting up your **ERS** is very easy – you'll need something that you can visibly turn **ON**/**OFF** so you can adjust the **turn-on point** – a small light bulb or LED will work fine for this. First plug the **ERS** into the receiver channel that you want to use to activate your device. Next connect your power source (any battery – can be your receiver battery) to the red and black wires, and the device to be powered to the red and white wires as shown (it doesn't matter which red wire goes where, as they are internally connected). If your device needs to have special orientation make sure its positive terminal connects to a red wire, and the negative terminal to the white wire. Also, if your device is a motor, relay, solenoid, electromagnet, etc… a diode (included) needs to be connected across its terminals as shown to the left. This will protect the **ERS** from reverse high-voltage spikes associated with inductive devices.



Adjusting: Move the transmitter stick (or switch) to the position where you want the device to turn **ON**, then slowly turn the potentiometer on the **ERS** until you see your device turn **ON**/**OFF**. Your device will always be **ON** either above or below this point, as shown to the right. Flipping the small slide switch on the ERS will cause the **ON** and **OFF** regions to switch (like a servo reverse).

Notes: You can use this device to power electric motors, however we don't recommend it for use in place of a speed control to power flight motors because it doesn't have the safety features that most Electronic Speed Controls have built-in.



If you have any questions or comments about this kit please email chris@hansenhobbies.com.

www.hansenhobbies.com