Building The Keyall Discrete kit
and from Jackson Harbor Press
Using: a high voltage keying interface

The Keyall Discrete is an accessory for a keyer , hand key or bug which will allow operation with nearly any transmitter. The circuit is a solid state relay which will key solid state (nominal 12 V / 13.8V), cathode keyed tube rigs (high positive keying voltage) or grid block tube rigs (high negative keying voltage). The Keyall Discrete will even key transmitters like the original Tuna Tin 2 which requires a keying output which is isolated from ground. The Keyall Discrete output can be made fully optically isolated from the keyer input. The Keyall Discrete can even be used as a conventional solid state relay for DC or AC loads - appropriate protection devices such as an MOV and a series fuse should be added by the builder for these non-ham applications.

The Keyall and Keyall HV kits have been popular. But I realized that the way they work is apparently mysterious to some hams. The Keyall Discrete is an attempt to make the inner workings of the design literally visible while adding a bit of fun. The Discrete in the name refers to the use of basic components such as resistor, capacitor, LEDs and MOSFETs rather than the "integrated" componentry of the original designs.

Circuit Explanation: The kit uses fourteen (12 red and 2 blue) LEDs to take the place of the PVI (Photo-Voltaic Isolator) IC used in the Keyall and Keyall HV kits. Half of the LEDs are used as conventional LEDs that light up when the key (or keyer) is pressed. The other half of the LEDs are used as photo-diodes (aka solar cells) to generate a DC voltage when the key is pressed. These generated voltages are used to turn on (or off) the MOSFET transistors. The light source + solar cell combination provides isolation between the key and the potential high voltage of the transmitter. The pair of MOSFET output transistors allow the kit to switch DC (either polarity) or AC loads, doesn't matter which output is connected to which load polarity. This is just like a mechanical relay so this configuration is known as a solid state relay or SSR. The third MOSFET is a depletion mode transistor which for the purposes of the kit means that if the gate voltage is zero (with respect to the source) the transistor is ON. If the gate voltage is made negative then the transistor turns OFF. This allows the pair of blue LEDs to control the third MOSFET by allowing it to short out the gate capacitance of the output transistors when the LEDs are off and allow the gate capacitors of the output transistors to charge up when the LEDs are on.

General notes about building: The components should be inserted a few at a time, soldered in place and then the leads are clipped. The pads and traces are small and delicate - a small tipped, low power (25 watts or less) soldering iron should be used.

The three transistors used in this kit are all MOS devices. This means that they should be handled as little as possible to prevent static damage. The builder should use a grounding strap and anti-static mat if available or at the very least, work on a grounded metal surface and be sure to touch ground prior to touching the transistors.

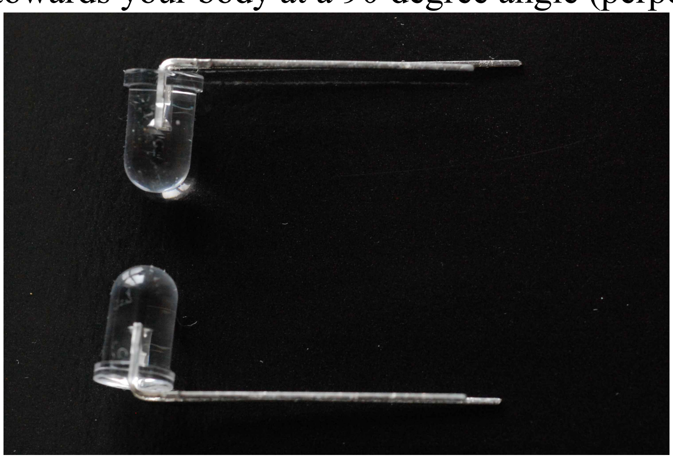
Building the kit - Step 1) Get the parts together: All of the necessary board mounted components have been supplied. You will still have to provide off-board items from the stocklist to fully implement the kit including the enclosure, input and output jacks, battery holder (or power jack) and mounting hardware.

Step 2) Identify and orient the components: The components should be easy to identify and place. The LEDs are on paper strips and should be marked with the color. The cathode (negative side) of the LED has a flat side, also the lead is shorter than the anode (positive side).

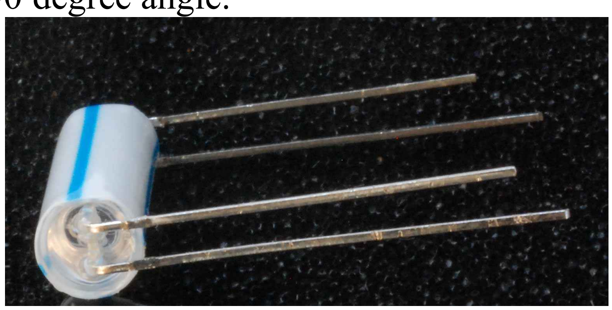
Step 3) Mount and solder the components on the board: Use the parts placement diagram along with the parts list (back of this manual) for the placement and orientation of the parts.

Here is a suggested sequence:

1) Start by cutting the soda straw into seven pieces, each 20 mm long (a little more than ¾ inch) – the exact dimension isn't super critical.
2) Then without cutting the leads, remove the two blue LEDs from the cardboard
3) While holding one of the LEDs in your left hand with the flat side up bend the leads towards your body at a 90 degree angle (perpendicular).



4) Then hold the other LED in your left hand with the flat side up and bend the leads away from your body at a 90 degree angle.



5) Now insert the LEDs into one of the soda straw pieces, they should fit snugly.
6) Then with the short leads on the right, insert the straw/LED assembly into the rightmost rectangle on the circuit board (labeled blue) – note that the + sign near the left holes is for the anode of the LED, the cathode (the long lead).
7) Double check the orientation with the parts placement diagram then solder in place.
8) Leave the leads unclipped for now.

9) Steps 2-7 should be repeated for a pair of red LEDs to the left of the blue pair (marked red on the board), again leave the leads unclipped.
10) Take R3, the 10 meg ohm resistor (brown-black-blue-gold), form the leads as shown on the middle detail picture of the parts placement diagram and then solder to the unclipped leads of the blue/red LEDs as shown. The leads can now be clipped.
11) Steps 2-7 should be repeated for the 5 remaining pairs of red LEDs (at the spots marked red on the board – the leads may be clipped as needed).
12) Take R2, the 120 ohm resistor (brown-red-brown-gold), form the leads, insert as indicated on the silk screen at the bottom left of the board and solder in place.
13) Take R1, the 10k ohm resistor (brown-black-orange-gold), form the leads, insert as indicated on the silk screen at the bottom right of the board and solder in place.
14) Take C1, the .01 uF disc ceramic capacitor, insert as indicated on the silk screen at the top center of the board and solder in place. C1 can be bent to lower the profile of the board if desired.
15) Take Q1, the LND150 TO-92 MOSFET transistor, insert as indicated on the silk screen with the flat side towards the top edge of the board and solder in place.
16) Form the leads of Q2 and Q3 to fit as indicated on the silk screen. If possible, avoid bending them at a sharp angle, a gentle bend is better as the leads can be brittle and break with repeated bending. Insert and solder in place.

Finally, make sure that all the connections are soldered and clip the leads.

Step 4) Check your work: Before proceeding, take the time to check the bottom of the board for solder bridges. Use the Bottom view diagram as a guide to visually check for these shorts. It may help to clean the flux from the board and then use a strong light in conjunction with a magnifying glass to see these problems. After you are convinced that the board is OK, solder up the connections to the power/key and output jacks as shown on the hookup diagram.

Operation: With the power to the Keyall Discrete connected, a VOM can be connected (in current measuring mode) in series with the positive lead to measure the active current - this current should be in the range of 20 mA, a little lower or higher is OK, the prototype measured 17 mA at 13.8 volts with a 120 ohm resistor. Connect the input (keyer, key, bug) device to the Keyall Discrete input and the output to the transmitter. The polarity of the output isn't important, either one can be grounded and the other will switch positive, negative or AC voltages.

Construction Notes:

Manditory modification: as already mention in the build sequence it is ***mandatory*** that the builder solder R3, the 10 megohm resistor between the gate and source of Q3 (the LND150 MOSFET). R3 allows the gate capacitance of Q3 to discharge when the blue LED is off and thus discharge the gate capacitance of the output transistors. Otherwise the output transistors will go on and stay on for an extended period of up to several seconds after key-up.

The metal tabs on Q2 and Q3 are live, they are the drain connections and could be used to make the connection to the load if desired.

It may be prudent to use Nylon hardware to mount the board in a case to prevent shorting the transistor tabs to the case with metal hardware.

There are many modifications that could be made to this kit, here are a few ideas:

If the builder wants to completely isolate the keyer from the transmitter, do NOT ground either of the Keyall Discrete outputs to the case. (Also, use a battery to power the Keyall Discrete rather than a station supply which may be grounded.) Instead, use either a stereo 1/4 inch or 1/8 inch jack (connecting the Keyall Discrete outputs to tip and ring) OR use another output connector such as two insulated binding posts and connect the two Keyall Discrete outputs to the binding posts. An appropriate cable will then need to be made for this isolated output configuration. This type of isolated output is useful for transmitters like the original Tuna Tin 2 which has the key connection between the positive supply voltage and the transmitter power supply input. If the voltages being switched are for a tube rig, be sure to use a jack and plug that can operate safely at the high (greater than the common 13.8 volts) voltage.

For those who dislike the use of soda straws, heat shrink tubing or any other plastic tubing of appropriate size could be used – the LEDs are 5 mm in diameter but there is a small ridge at the base which is slightly larger – the main idea is to align the pairs of LEDs optically. Note that if heat shrink is used that over-enthusiasm should be avoided while doing the shrink so that no light is blocked at the LED tapers by the shrink tubing necking down into the gap.

A pair of 9 volt batteries in series could be used in place of the 13.8 volt supply but R2 should be increased to 300 ohms or so. R1 can probably be left at 10k ohms. OR, a 9 volt battery could be connected in series to three 1.5 volt cells to get roughly 13.5 volts which is close enough. I have also used ten Nimh cells in series to power the kit.

The 6 red LEDs will “drop” over 11.6 volts at 20 mA so any other power source than the 13.8 volts common in a ham shack should be at least 11.6 volts. A different resistor value can be calculated using this formula: $R2 = (V - 11.6) / .02$ Then the next higher standard value resistor can be used.

While I usually like to enclose my kits in a metal box, a translucent or transparent lidded box may be more fun since the LED light will be visible as keying occurs.

It is possible to key two separate positive loads with the kit such as a cathode keyed VFO along with the cathode keyed rig. OUT1 is connected to one load, OUT2 is connected to the other, the common ground connection for both is made to the unlabeled hole below C1. This is the common source connection for the three MOSFET transistors.

Different keying transistors may be used for either higher keying voltages than the stock 500 or 1000 volt MOSFET transistors OR for lower ON-resistance MOSFETs – note that these “better” transistors can be pricey. Also note that they often have larger gate capacitances which may affect the keying characteristics of the kit.

Notes:

The circuit of the Keyall Discrete optically isolates the load from the input and LED power. No tests have been conducted to rate the isolation potential but it certainly will prevent the “bite” encountered when a forearm accidentally is brushed across the terminals of a straight key.

Please feel free to email with any questions, comments, suggestions or problems with the kit - email to: wb9kzy at wb9kzy dot com

Best Regards and thanks for choosing the Keyall Discrete kit,
Chuck Olson, WB9KZY

Keyall Discrete Parts List

Qty	Ref	Part Name	Description
2	Q1,Q2	IRF820	500 V n-channel enhancement MOSFET, TO-220
1	Q3	LND150	High voltage n-channel depletion MOSFET, TO-92
1			circuit board
1	C1		.01 uF 1000 V ceramic disc capacitor
1	R1		10K ohm resistor - brown-black-orange-gold
1	R2		120 ohm resistor - brown-red-brown-gold
1	R3		10 megohm resistor - brown-black-blue-gold

The following items are ***NOT*** included with the kit:

1		mono input jack from key or keyer
1		battery holder or snap, 9 Volt or external power connector
1		Mono output jack to rig
		enclosure

The following items are available as an option for the kit:

2	Q1, Q2	IRFBG30 1000 V n-channel MOSFETs (instead of IRF820s)