## THE UNIVERSAL KEYING ADAPTER

When Dale Botkin, NØXAS, was about to start restoring his old Heathkit HW-16, he decided it was time to explore what would be needed to key this tube rig using an electronic keyer. He also remembered — not fondly — having been "bitten" a few times when he touched metal parts of the key. There was some substantial voltage on the key, and he wanted to avoid touching it again. The key jack of this rig has a negative voltage, something like –85 V or more. Even the 2N7000 output of a solid-state keyer, rated at 60 V, would be no match for that. The Universal Keying Adapter (UKA) shown in **Fig 19.39** bridges the gap between a modern keyer and a classic tube-type transmitter, and it can also be used to key older tube-type amplifier TR switching lines with solid-state transceivers that can't handle the voltage or current requirements.

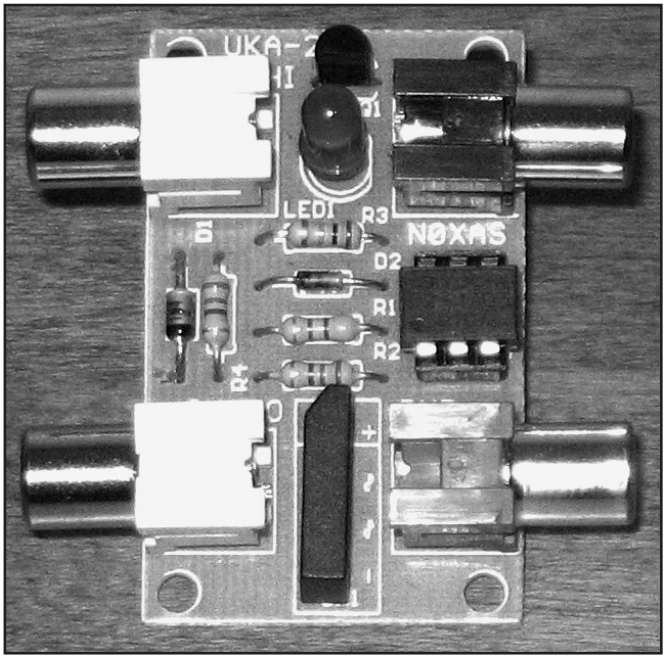



**Fig 19.39 — This version of the Universal Keying Adapter 2 is available as a kit from www.hamgadgets.com. Parts count is low, and it can easily be built on a small project board.**

### KEYING SCHEMES

Older gear generally uses one of two keying schemes, grid-block or cathode keying. Grid-block keying requires that your key handle fairly high negative bias voltages, often in the 150 V range. Cathode keying is more demanding, with voltages up to +350 V or so. Most modern solid state keyers use a simple transistor output circuit suitable only for low-voltage, positive keying. Obviously, neither grid-block nor cathode keyed transmitters should be connected to such an output! At the very least it's going to damage the keyer.

Most grid-block keying adapters use one or two bipolar transistors and are designed specifically to key grid-block rigs. This is fine as far as it goes, but also requires that you have one setup for solid state rigs, another for grid-blocked rigs, and still another if you have a cathode keyed boat anchor as well. It's not an optimum solution. Of course one could use a relay to key just about anything, but relay contact noise would quickly get really irritating. Relays also eventually wear out, contacts get dirty and the coils can use quite a bit of current, meaning battery powered keyers will suffer from very limited battery life.

### Solid-State Relays

Solid state relays exist, but they can be expensive. The author finally hit upon what seems to be an ideal solution. It's cheap, small, relatively low current, uses low voltage control and is capable of switching fairly high ac or dc voltages. Perfect! Crydom, NEC, Fairchild, Omron and other manufactures make very similar small, inexpensive MOSFET solid state relays. Suitable model numbers include the NEC PS7142 and PS7342, Fairchild HSR412, Omron G3VM-401B and others. Depending on the part selected they can handle up to a couple hundred milliamps and will switch up to 400 V ac or dc. All of this in a 6-pin DIP form factor, and for just a few bucks!

The MOSFET solid-state relay (SSR) is very similar to an optoisolator, but somewhat more versatile. Ac or dc loads can be switched, and the allowable load voltages are much higher than regular optoisolators. Driving the relay input involves supplying a few mA of current to turn on an LED inside the device. This requires about 1.4 V at a recommended forward current of 10 to 30 mA. The output is a pair of MOSFETs with common sources and a photo gate rather than a hard-wired gate. Turn on the LED and the MOSFETs conduct, turn off the LED and the MOSFETs shut off. Just like a relay, it's simple and elegant.

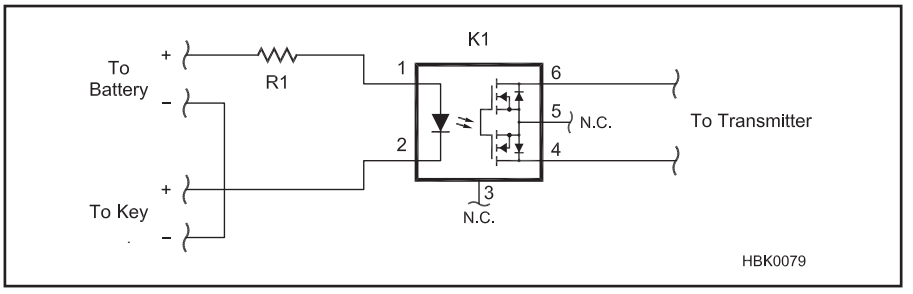



**Fig 19.40 — The original Universal Keying Adapter circuit used a solid-state relay and a battery for power.**

**K1 — Optically coupled solid-state relay, Fairchild HSR412 or equivalent.**
**R1 — ¼ W resistor, varies with supply voltage (see text). Use 150 or 220 Ω for two AA cells; 1 kΩ for 13.8 V dc power source.**

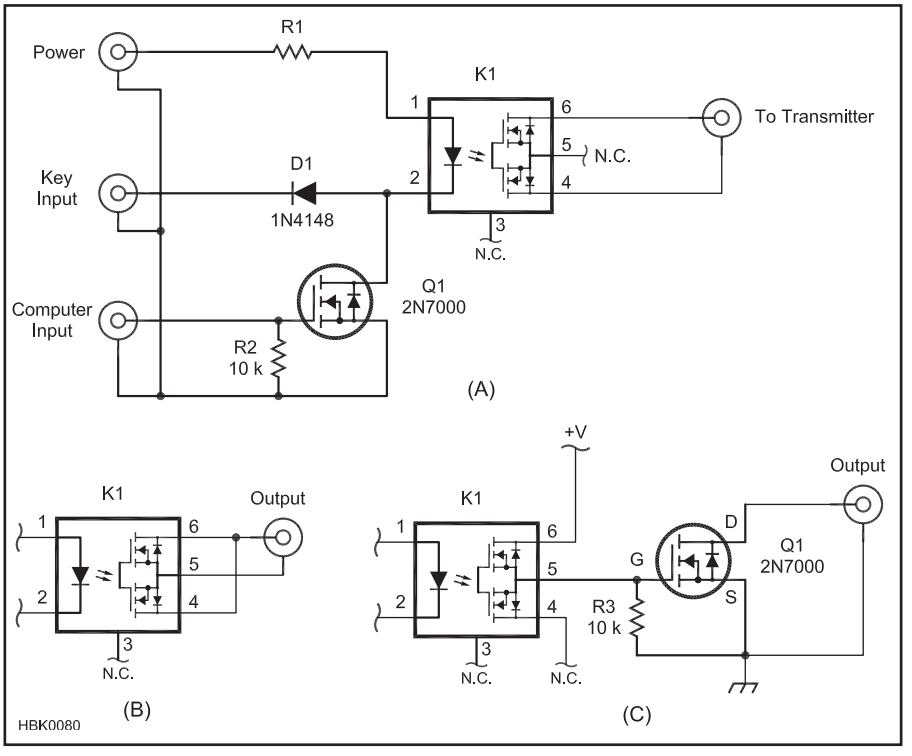



**Fig 19.41 — The Universal Keying Adapter circuit with provisions for using computer keying in parallel with a hand key or keyer. Two methods of increasing the load current capacity are shown at B and C (see text for discussion).**

**K1 — Optically coupled solid-state relay, Fairchild HSR412 or equivalent.**
**R1 — ¼ W resistor, varies with supply voltage (see text). Use 150 or 220 Ω for two AA cells; 1 kΩ for 13.8 V dc power source.**

### KEYING ADAPTER CIRCUITS

For a simple keying adapter arrangement, all that is needed is the MOSFET solid-state relay, one resistor, and a dc power source such as a battery. See **Fig 19.40**. The keying input from your hand key or electronic keyer completes the input circuit through the current limiting resistor and the input side of the SSR, turning the output on. In this example, the value of R1 is determined using Ohm's Law to give between 10 and 30 mA of current at the desired input voltage. For example, for use with two AA alkaline batteries, a range of 100 to 300 Ω is okay; 150 or 220 Ω will work reliably with NiCd or NiMH cells as well. If you plan to use a 13.8 V dc power supply, a 1 kΩ resistor should be fine for R1.

It soon became apparent that other uses existed in addition to just isolating the key or keyer from a transmitter. The addition of a simple transistor inverter allows the use of computer keying in parallel with input from a straight key, bug or keyer. This is handy, for example, to contesters using computers for keying who may need to send some information by hand from time to time. See **Fig 19.41**. The use of a 2N7000 MOSFET instead of the common NPN transistor makes it easier to accommodate both serial and parallel port use, since the gate will withstand up to 20 V positive or negative and does not need to be current limited. In this example, the value of R1 should be determined as mentioned earlier. R2's purpose is to keep the MOSFET gate from floating, so its value is not critical but 10 kΩ or 100 kΩ are good values.

The design eventually evolved to include a full-wave bridge rectifier allowing either ac or dc input, a Zener diode for voltage regulation, and an LED keying indicator. The result was the Universal Keying Adapter 2, which is also available in kit form (see **www.hamgadgets.com**). The UKA-2 can accept any dc or ac power source up to about 30 V, and is adaptable to lower power battery operation by substituting or eliminating some of the power supply parts.

### Other Configurations

It is worth noting that if only positive or only negative voltages will be used, the output current capacity can be greatly increased and the on-state resistance greatly decreased by connecting the two MOSFET drain outputs in parallel rather than serial. An example of this is shown in Fig 19.41B. For the HSR412, maximum load current increases from 140 mA for series output to 210 mA for parallel. An added feature of this arrangement is the presence of the intrinsic "body diodes" of the MOSFETS. If you are keying an amp that has an internal keying relay, this can serve to absorb some of the back EMF when the relay releases. Note that this arrangement requires that pin 5 of the IC be at a lower voltage than the other two pins — in other words, ground for positive keying, or –V for negative keying. Since the output is completely isolated from the input, the polarity of the output connector can be changed without the risk of exposing your other gear to dangerous voltages.

Although the IC solid-state relays are good for a wide range of uses, there are applications that present more of a load than the device is able to safely handle even with the outputs in parallel. For loads of more than the rated device current, an external MOSFET switch can be used. Again, the resulting output is optically isolated from the input. Resistor R3 shown in Fig 19.41C keeps the gate of the 2N7000 MOSFET low until the input is activated, so its value is not critical. The gate voltage +V needs only to be within the safe range for the device selected; in most cases 12 V will do fine.

The UKA design works well with both grid-block and cathode keyed rigs, as well as solid state. It's been tested with a TS-930SAT, Heath HW-16, FT-817, Rock-Mites, FT-480R and more. It has also been used with cathode keyed rigs such as the Heath DX-40, and many more examples of this circuit are in use keying various "boat anchor" rigs and amps. It works quite well to key older tube power amplifiers with solid-state transceivers that are not equipped with suitable keying relays or circuits. The input works well with any rig, key, electronic keyer, serial or parallel port tried so far.

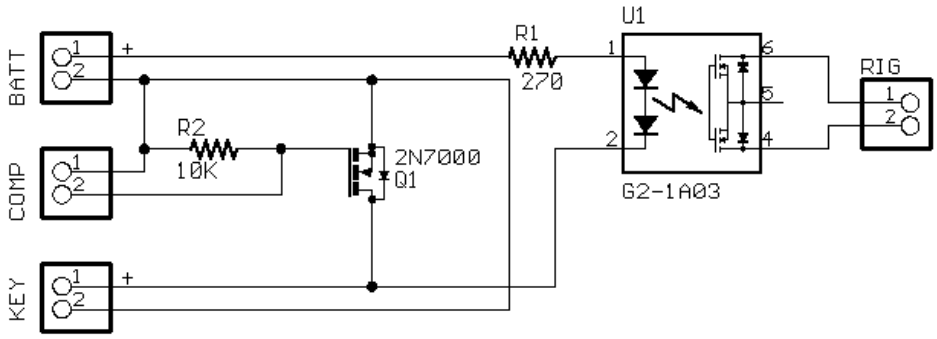
# NØXAS Universal Keying Adapter

The Universal Keying Adapter kit will allow you to key nearly any transmitter or transceiver with a straight key, electronic keyer, computer serial or parallel port or nearly any positive or negative logic signal. Inputs are provided for a key or keyer as well as computer control.

## Features of the UKA Kit:

- Keys solid state, grid block or cathode keyed transmitters or transceivers up to 400 V AC or DC
- Optical isolation between rig and key input
- Works with any electronic keyer, bug or straight key
- Computer input for use with contest software such as NA or CT
- Connects to parallel or serial port
- Self contained and self powered
- Compact size ideal for integration into other equipment

## Schematic:




## Parts List:

| Part | Value |
|---|---|
| U1 | Optically isolated, MOSFET Solid-State Relay |
| Q1 | 2N7000 MOSFET |
| R1 | 100 Ohm 1/4W resistor (Brown-Black-Brown ***OR*** Brown-Black-Black-Black) |
| R2 | 10K Ohm 1/4W resistor (Brown-Black-Orange ***OR*** Brown-Black-Black-Red) |
| | 2x AAA Battery Holder |
| | Printed Circuit Board |

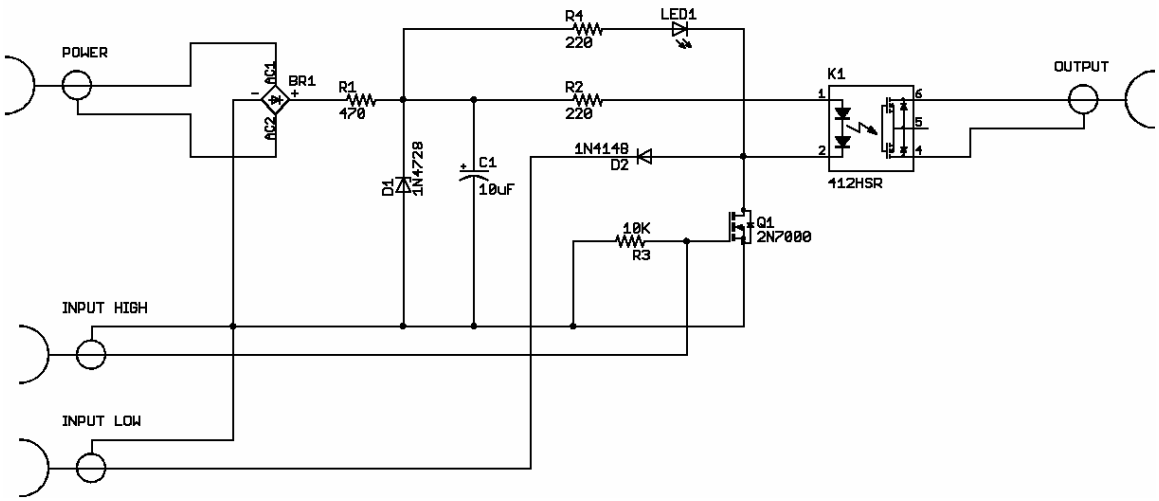
# NØXAS Universal Keying Adapter 2

The Universal Keying Adapter Version 2 kit will allow you to key nearly any transmitter or transceiver with a straight key, electronic keyer, computer serial or parallel port or nearly any positive or negative logic signal. It can also be used as a rig-to-amplifier interface. Inputs are provided for a key or keyer as well as computer control.

## Features of the UKA Kit:

- Keys solid state, grid block or cathode keyed transmitters or transceivers up to 400 V AC or DC, positive or negative
- Optical isolation between rig and key input
- Works with any electronic keyer, bug or straight key
- Computer input for use with contest software such as NA or CT
- Connects to computer parallel or serial port
- Self contained with provision for AC or DC power
- LED indicator shows active state
- Compact size ideal for integration into other equipment

## Schematic:



## Parts List:

| Part | Value |
|---|---|
| K1 | Optically isolated, MOSFET Solid-State Relay (6-pin DIP package) |
| Q1 | 2N7000 MOSFET |
| C1 | 10 uF, 16V electrolytic capacitor |
| R1 | 470 Ohm 1/4W resistor (Yellow-Violet-Brown) |
| R2, R4 | 220 Ohm 1/4W resistor (Red-Red-Brown) |
| R3 | 10K Ohm 1/4W resistor (Brown-Black-Orange) |
| D1 | 4.7V Zener diode (the larger of the two diodes) |
| D2 | 1N4148 diode (the smaller of the two diodes) |
| J1-J4 | PCB mount RCA phono jacks |
| BR1 | Diode bridge rectifier |
| PCB | Printed Circuit Board |
| | 1N4007 Diode |

## Assembling the Kit:

Always use good static prevention practices when working with static sensitive parts. This means you should wear a grounding strap when possible, or work on a static-dissipative work surface. Use a grounded tip soldering iron if possible. When soldering small parts it is a good idea to use a fine-tipped, small pencil-type soldering iron of no more than 25W or so. Use pliers, clamps or alligator clips as heat sinks to prevent heat damage to parts while soldering. If you are not fairly experienced with soldering small parts, you may want to practice on some scrap parts first or get some help from a more experienced builder.

All parts should be installed from the top (white printed) side of the printed circuit board. As you install each component, bend the leads slightly if needed to help hold the part in place. It's a good idea to use pliers, an alligator clip or some other heat sink to keep from damaging components with too much heat from soldering. Solder the leads in place, being careful not to use too much solder. Using a pair of fine-tipped diagonal cutters, neatly clip the component leads close to the solder joint.

□ 1. Install the 470 Ohm resistor in location R1.

□ 2. Install one 220 Ohm resistor in location R2.

□ 3. Install the 10K Ohm resistor in location R3.

□ 4. Install the remaining 220 Ohm resistor in location R4.

□ 5. Install the 1N4732A Zener diode in location D1. If you can't read the part number on the diode, D1 is larger than D2. Make sure the dark band on one end of the diode is oriented as shown on the circuit board.

□ 6. Install the 1N4148 diode on location D2. Make sure the dark band on one end of the diode is oriented as shown on the circuit board.

□ 7. Install the 2N7000 MOSFET transistor in the location marked Q1. Be sure to orient the flat side of the transistor as indicated on the circuit board.

□ 8. Install the red LED in the location marked LED. Be sure to orient the flat side of the LED as indicated on the circuit board. Some LEDs do not have a flat side; the shorter of the two leads goes toward the flat side marked on the PCB.

□ 9. Install the 10 uF electrolytic capacitor in the location marked C1. Make sure the capacitor is oriented properly, with the positive (longer) lead on the side marked "+".

□ 10. Install the 6-pin socket in location K1. Make sure to orient the socket with the notch as shown on the PCB outline. After installing the socket, insert the 6-pin chip K1 in the socket, again making sure the notch in the end is toward the center of the PCB.

□ 11. Install the four RCA jacks in the four locations marked on the circuit board. The red jack is used for PWR, the black is for OUT, the yellow is for IN HI and the white jack is for IN LO.

□ 12. Install the bridge rectifier BR1 in the location marked on the circuit board. Make sure the beveled end denoting the + output is oriented correctly.

□ 13. Check the board for stray leads, solder bridges or other problems and fix as needed.

## Operation of the UKA:

The IN LO input is used for most keys, electronic keyers, amplifier keying relays or transistors, foot switches, etc. It is in series between the input side of the solid-state relay and ground, so shorting the IN LO input activates the output of the solid state relay U1, keying the attached transmitter or transceiver. The current through the IN LO connector will be limited to no more than 20 to 25 milliamps.

The IN HI input is normally used for computer keying, but can be used for any signal that goes to a high level when keying. This input is pulled low by 10K Ohm resistor R2. Applying a positive voltage (3V or higher) to the IN HI input turns on Q1, which turns on U1's output and keys the rig. The MOSFET gate-source voltage is rated for plus or minus 20 Volts maximum, meaning it will easily tolerate computer parallel or serial port voltages.

Many programs use the standard computer port setup established by NA and CT. When using a program such as this, the **IN HI** signal should be a positive logic signal to key the rig. Here's a table showing connections for various types of serial and parallel port connectors:

| | **LPT** | **25-Pin Serial** | **9-Pin Serial** |
|---|---|---|---|
| **IN HI center pin** | 17 | 20 | 4 |
| **IN HI shield** | 18 | 7 | 5 |

Power can be supplied by any AC or DC power source from 10 to 14 Volts. If you are using a power supply significantly higher or lower than 12V you will need to change the value of R1 to compensate. Here are a few example recommended values to be used with different power supply voltages:

| Supply voltage | Recommended R1 value | Recommended R2/R4 value |
|---|---|---|
| 3V | None (jumper with wire) | 100 Ohms |
| 5V | 470 (omit Zener diode D1) | 220 Ohms |
| 6V | 100 Ohms | 220 Ohms |
| 9V | 220 Ohms | 220 Ohms |
| 16V | 560 Ohms 1/2W | 220 Ohms |

## Support:

Should you need support, have questions, have feature requests or bug/problem reports, please feel free to contact me via email at **n0xas@botkin.org** or **n0xas@arrl.net**. I will make every effort to respond as quickly as possible.

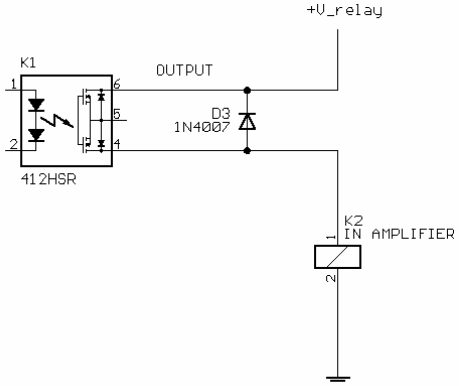
## Warranty:

All parts in your kit are guaranteed against defects for 90 days from date of purchase. This warranty does not cover damage due to incorrect assembly, improper soldering or wiring, overvoltage, static damage or other misuse or abuse. If you have problems, please contact me via email to arrange for an exchange or replacement part. If you accidentally damage a part, don't panic – just contact me, replacements are not expensive. Unfortunately I cannot offer assembly or repair service, but you should be able to find someone local to help out in the event of problems with assembly.

# Specifications:

| | |
|---|---|
| Input power: | 12V DC or AC |
| Input current: | 25 mA max |
| IN HI voltage: | -20 to +20 Volts max |
| IN HI impedance: | 10K Ohms |
| IN LO voltage: | +40 to 0 Volts |
| IN LO current: | -22 mA max |
| Output voltage: | 400V max AC or DC |
| Output current: | 120 mA max |
| Output ON resistance: | ~10 Ohms Typical, 27 Ohms max |
| Turn-ON time | 2 ms max |
| Turn-OFF time | .5 ms max |

**A note about driving relays with your UKA-2:** Some older amplifiers such as the 30L-1 use a solenoid relay to key the amplifier. When using your UKA-2 to drive a relay coil, the back EMF generated by the coil as it is de-energized may damage the UKA-2 output. An extra 1N4007 diode is included with this kit. This diode is the black epoxy encapsulated diode. If you plan to drive a relay coil, please install this diode so it is reverse biased in parallel with the UKA-2 output as shown in the following example. If you are driving an AC load or are not driving a relay coil, this extra diode is not needed.



## Assembling the Kit:

Keep all semiconductor parts in the anti-static packing material until you are ready to use them. Always use good static prevention practices when working with static sensitive parts. This means you should wear a grounding strap when possible, or work on a static-dissipative work surface. Use a grounded tip soldering iron if possible. When soldering small parts it is a good idea to use a small, pencil-type soldering iron of no more than 25W or so. Use pliers, clamps or alligator clips as heat sinks to prevent heat damage to parts while soldering. If you are not fairly experienced with soldering small parts, you may want to practice on some scrap parts first or get some help from a more experienced builder.

All parts should be installed from the top side of the printed circuit board. The top side is the side with the white silkscreen printing showing the component names and outlines. Start by installing the six pin IC socket on the printed circuit board. Insert the socket with the notch oriented as indicated on the PCB. After the socket is soldered in place, install the 100 Ohm resistor in location R1, followed by the 10K Ohm resistor in location R2. If you're not certain about the color bands, use a meter to measure the resistance of the two parts. Now install the 2N7000 MOSFET as indicated in location Q1. Make sure to orient the flat side of the transistor as shown.

Now connect the battery holder. The red lead should be soldered to the pad marked "+" and the black wire connected to the other pad. You may want to trim the leads shorter than the supplied 6". You can mount the PCB to the back of the battery holder with some double-sided foam tape if you wish. Now install the solid-state relay chip in the socket. Note that Pin 1 of the chip is marked by a small dot. Make sure to properly orient the chip with the Pin 1 end toward the notch in the socket. Once the chip is in the socket, just install two AAA alkaline batteries in the battery holder and you're done!

## Operation of the UKA:

Power for the LED side of U1 is supplied by the battery through the key. The KEY input is in series between the LED and ground, so shorting the KEY + pad to ground turns on the LED and activates the output of the solid state relay U1, keying the attached transmitter or transceiver. Resistor R1 limits U1's LED current to about 10 to 15 mA. Since the circuit is complete only when one of the inputs is active, there is no need for a power switch.

Optionally a computer or other active-high input may be connected to the gate of Q1, which is pulled low by 10K Ohm resistor R2. Applying a positive voltage to the COMP + input pad turns on Q1, which turns on U1's internal LED and keys the rig. The MOSFET gate-source voltage is rated for plus or minus 20 Volts, meaning it will easily tolerate computer parallel or serial port voltages.

Many programs use the standard computer port setup established by NA and CT. When using a program such as this, the **COMP +** signal should be a positive logic signal to key the rig. Here's a table showing connections for various types of serial and parallel port connectors:

| | **LPT** | **25-Pin Serial** | **9-Pin Serial** |
|---|---|---|---|
| **COMP+** | 17 | 20 | 4 |
| **COMP-** | 18 | 7 | 5 |

Power can be supplied by two AAA cells or any a smooth, regulated DC power source. The LED forward voltage is about 1.4V and should get 10 to 20 milliamps when active, so if you are using a power supply significantly higher or lower than 3V you will need to change the value of R1. Here are a few example recommended values to be used with different power supply voltages:

| **Supply voltage** | **R1 value range** |
|---|---|
| 5 | 270 – 500 Ohms |
| 6 | 300 – 470 Ohms |
| 9 | 500 – 760 Ohms |
| 12 | 700 – 1060 Ohms |
| 15 | 900 – 1360 Ohms |

## Support:

Should you need support, have questions, have feature requests or bug/problem reports, please feel free to contact me via email at **n0xas@botkin.org** or **n0xas@arrl.net**. I will make every effort to respond as quickly as possible.

## Warranty:

All parts in your kit are guaranteed against defects for 90 days from date of purchase. This warranty does not cover damage due to incorrect assembly, improper soldering or wiring, overvoltage, static damage or other misuse or abuse. If you have problems, please contact me via email to arrange for an exchange or replacement part. If you accidentally damage a part, don't panic – just contact me, replacements are not expensive. Unfortunately I cannot offer assembly or repair service, but you should be able to find someone local to help out in the event of problems with assembly.

# Notes: