# PTT Opto Isolator for IC-705 to KXPA100 Power Amplifier

(with Design Notes & Parts List)

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IC-705


PTT Opto Isolator


KXPA100

***K5PA Design Concepts***

November 2022

# Completed Unit

# Use-Cases

- IC-705 is a wonderful transceiver covering 160m-2m bands plus 440 MHz band and can easily battery operated at home or the field (it contains its own Lithium-ion battery, or it can use an external power source)
- Elecraft KXPA100 is a great fixed/portable amplifier capable of 100 W all modes 160-6m and operates from a 12-volt battery or AC/DC power supply
- Use-Case #1 – Home QTH
  - At home QTH, occasional power would be nice to have, but not always. KXPA100 is available so use it as needed to work the DX.
- Use-Case #2 – In-the-Field
  - In-the-field, QRP is great fun, but wouldn't it be nice to occasionally use higher power when conditions warranted it? Why not have the KXPA100 available when needed?
- Both Use-Cases can use battery power for portable applications or an AC/DC power supply.

# Design Goals

- Safely and Dependably Interface the ICOM IC-705 Portable QRP Transceiver to an Elecraft KXPA100 HF/6m Amplifier
  - Some general reports of problems when connecting to IC-705 SEND/ALC connector causing internal ICOM circuitry to fail
  - IC-705 SEND/ALC connector is designed to be either an input or output for keying the IC-705 or for the IC-705 to key an external amplifier
  - *Recent* IC-705 user manual has clarified the interface limitations (such as relay keying)
- My Design Goals
  - Provide an exceptional interface between the ICOM and Elecraft using an optical transistor device so connectivity is limited to one-way signal transmission of the PTT to the amplifier
  - Design a simple circuit that can be replicated by anyone with minimal skills
  - Provide approximately 5 mA of current into the IC-705 during PTT activation of the KXPA100
  - Provide a simple transistor switch closure to the KXPA100 that requires only 1 mA to activate the amplifier's keying circuit
  - Make the interface circuit small and light weight that can be used in the home or field location

# Interface Requirements

- Elecraft KXPA100 HF Power Amplifier
- User manual
  - E740199 KXPA100 Owner's Manual Rev A6.pdf
- Key In, P. 36
  - +5 Vdc open circuit on receive, closed to ground on transmit (1 mA maximum).
- Connections to an External Amplifier, p. 18
  - The Elecraft KX3 can accept up to 30 Vdc on the PA Key line and sink up to 100 mA when in transmit.
  - The KXPA100 PA Key limits depend upon the serial number:
    - Up to serial number 700, do not apply more than 5 Vdc.
    - Serial number 700 and above, do not apply more than 30 Vdc.

**Connections to an External Amplifier**

If you want to drive an external high-powered amplifier with your KXPA100, you must be careful to avoid exceeding the voltage and current limits of the KXPA100 PA KEY circuit. Figure 6 shows the PA Key connections to an external amplifier when using the KXPA100 connected to a transceiver with and without a control cable.

Typically external amplifiers have a voltage on their key input. The amplifier is enabled for transmit when the key input is grounded. The open-circuit voltage and the current that flows when the key input is grounded must not exceed the limits the KXPA100 can handle to avoid damaging the KXPA100. When no control cable is used, this voltage is also applied to the transceiver.

The Elecraft KX3 can accept up to 30 Vdc on the PA Key line and sink up to 100 mA when in transmit.

The KXPA100 PA Key limits depend upon the serial number:

- Up to serial number 700, do not apply more than 5 Vdc.
- Serial number 700 and above, do not apply more than 30 Vdc.

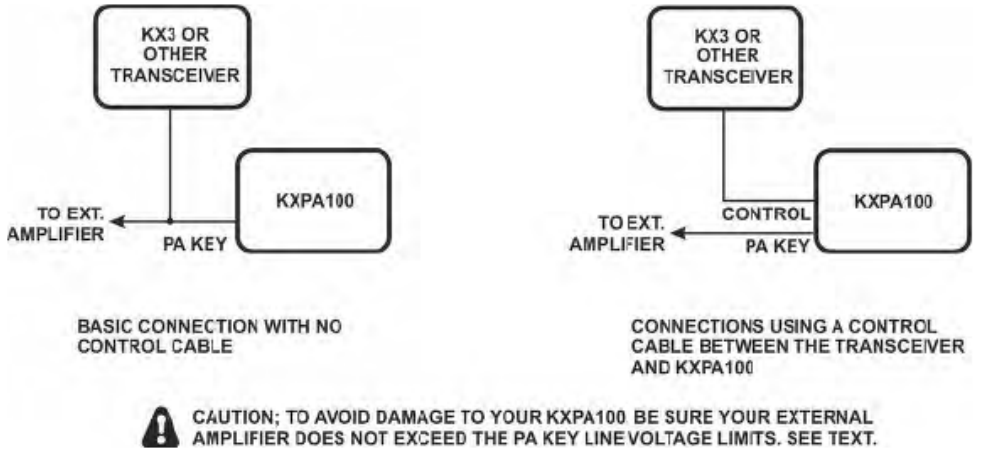



Figure 6. PA Key Connections to an External Amplifier.

## Specifications

**KXPA100 Amplifier**

| | |
|---|---|
| **Key In** | +5 Vdc open circuit on receive, closed to ground on transmit (1 mA maximum). |

# Interface Requirements

- ICOM IC-705 Portable QRP Transceiver
  - User Manual, Basic, Dated Sept. 2021, p. 13-3, [SEND/ALC]
- SEND Pin as Input
  - Transmit mode if -0.5 < Pin < +0.8 V
  - Receive mode if 2.0 < Pin < 20.0 V
  - 20 mA maximum current flow
- SEND Pin as Output
  - Pin voltage goes low when in transmit, e.g., when PTT is active in transceiver
  - Pin voltage when low < 0.1 V
  - Max. current when low < 200 mA

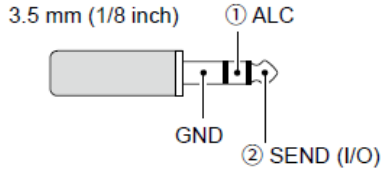
## [SEND/ALC]

①ALC

When operating with a non-Icom linear amplifier, input ALC voltage (–4 ~ 0 V) from the linear amplifier.

②SEND

- An external unit controls the transceiver. When this pin goes to ground, the transceiver transmits.
  - Input voltage (RX): 2.0 to 20.0 V
  - Input voltage (TX): –0.5 to +0.8 V
  - Current flow: Maximum 20 mA
- The pin goes low when the transceiver transmits.
  - Output voltage (TX): Less than 0.1 V
  - Current flow: Maximum 200 mA

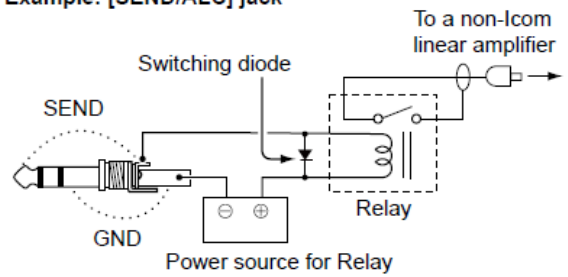



When the SEND terminal controls an inductive load, such as a relay, a counter-electromotive force can malfunction or damage the transceiver. To prevent this, we recommend adding a switching diode, such as a 1SS133, on the load side of the circuit to absorb the counter-electromotive force.

ⓘWhen the diode is added, a delay in relay switching may occur. Be sure to check its switching action before operating.

ⓘBe sure to connect the Negative terminal of the Power source for Relay to the [SEND/ALC] jack's GND terminal.

**Example: [SEND/ALC] jack**

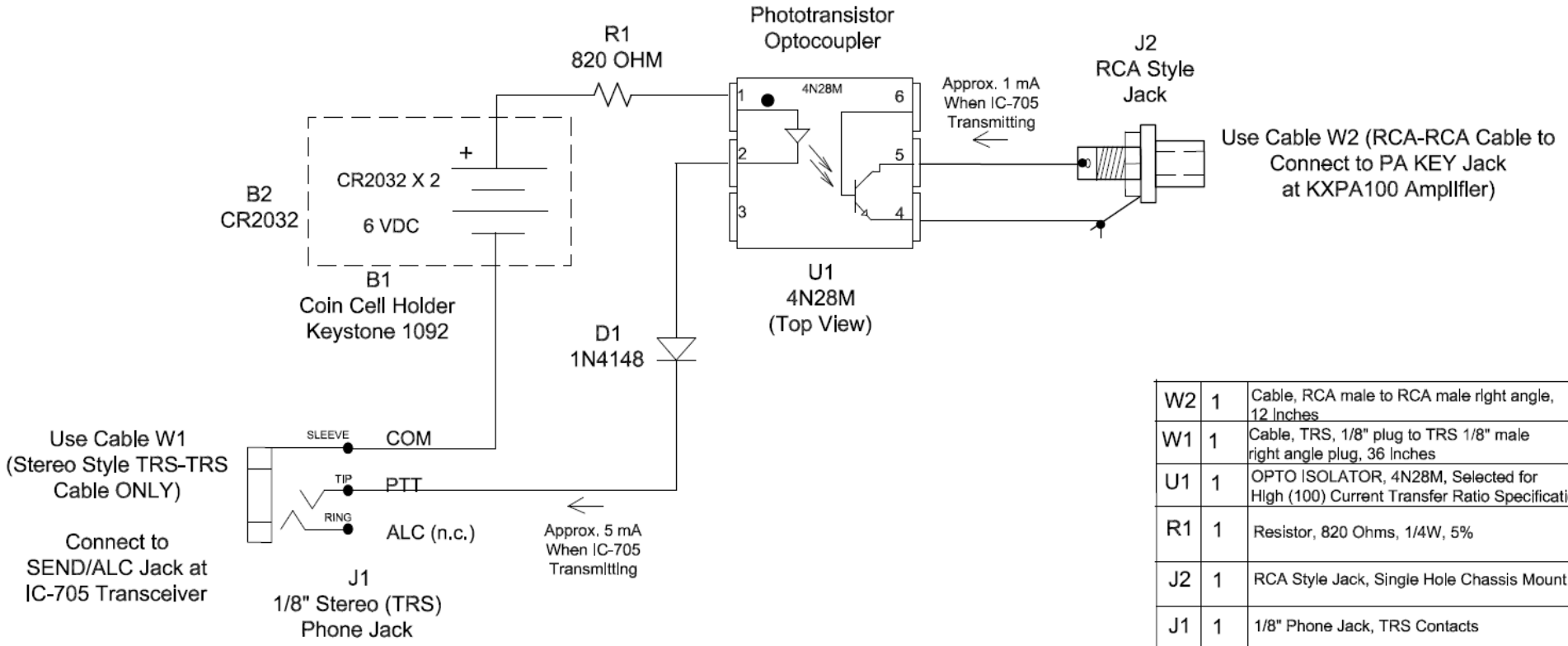


Notes:

1) Definition: n.c. means no connection

2) TRS cable means Tip-Ring-Sleeve (stereo style)

| CHANGE HISTORY | | |
|---|---|---|
| VERSION | DATE | DESCRIPTION |
| – | 11/19/2022 | Original |
| | | |
| | | |




| ITEM | QTY | DESCRIPTION |
|---|---|---|
| W2 | 1 | Cable, RCA male to RCA male right angle, 12 Inches |
| W1 | 1 | Cable, TRS, 1/8" plug to TRS 1/8" male right angle plug, 36 Inches |
| U1 | 1 | OPTO ISOLATOR, 4N28M, Selected for High (100) Current Transfer Ratio Specification |
| R1 | 1 | Resistor, 820 Ohms, 1/4W, 5% |
| J2 | 1 | RCA Style Jack, Single Hole Chassis Mount |
| J1 | 1 | 1/8" Phone Jack, TRS Contacts |
| D1 | 1 | Diode, 1N4148, or Equivalent |
| B2 | 2 | 3 Volt Coin Cell Battery, Type CR2032 |
| B1 | 1 | Dual Coin Cell Holder, Keystone Model 1092 for CR2032 Cells |



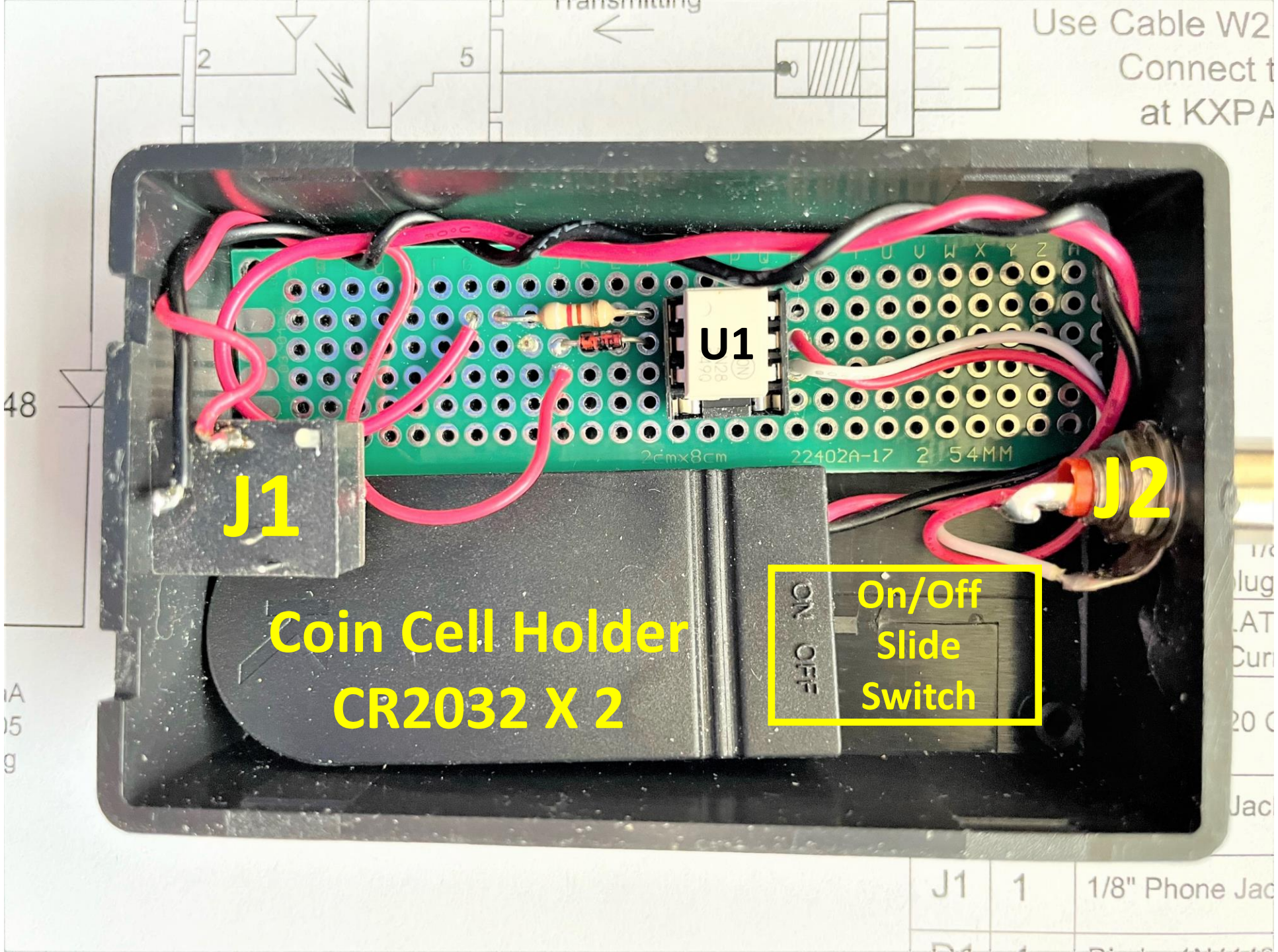
**K5PA Design Concepts**

TITLE: PTT OPTO ISOLATOR IC-705 TO KXPA100

| | | | | |
|---|---|---|---|---|
| gh | SIZE: A2 | CAGE CODE | DWG NO: 4000-0067 | REV: – |
| 11/19/2022 | SCALE | | SHEET: 1 of 1 | |

# Design Notes Of Interest

1) The photo transistor, U1 (4N28M), was chosen for its high current transfer ratio (no less than 100) specification and its electrical voltage and current parameters.
    1) The current transfer ratio describes the ratio of input current going through the photodiode to the collector to emitter current at the output transistor. The larger the ratio the less input current is required for a given output current capability.
    2) Be aware of making substitutions to this part without fully analyzing the changes.
2) The 2 internal Lithium-ion batteries, CR2032, are contained inside a dual battery holder that is specified in the parts list. There is a small on/off slide switch in the holder that can be used to turn off the battery voltage.
    1) If cable W1 pugged into J1 is disconnected from the unit, no current can flow through the circuit
    2) An on/off switch is not really needed.
3) The internal batteries were chosen to provide a 6-volt source to simplify the connections to the interface box. The current drain from the battery during transmit is about 5 mA so the batteries should last a long time, possibly over 100 hours of continuous FT8 transmissions.
    1) You can measure their voltage by using a digital voltmeter across the tip to sleeve of the input TRS stereo connector. If desirable, a separate voltage could be taken from the IC-705 power source to replace the internal battery.
    2) For a 12 V source, replace the 820-ohm resistor with a 1800-ohm resistor that will keep the optical diode current about the same.
4) The opto isolator, 2N28M, has an NPN transistor that is switched on and off with the internal optical emitter diode.
    1) The NPN transistor is selected to drive the KXPA100 amplifier input circuit that DOES NOT consist of a relay.
    2) If this circuit is modified to drive a small relay, then a snubbing diode needs to be added across the coil (see the prior page from the ICOM user manual).


U1
J1
J2
Coin Cell Holder
CR2032 X 2
ON OFF
On/Off
Slide
Switch

**Bill of Materials**
**Drawing 4000-0067**
**Rev --**

**PTT OPTO ISOLATOR IC-705 TO KXPA100**

| Item | Part No. | Part Description | Mfgr | Part No. | Vendor | URL of Vendor P/N | Qty | Item Cost | Extended Cost |
|---|---|---|---|---|---|---|---|---|---|
| B1 | 4000-0067 | Dual Coin Cell Holder, Keystone Model 1092 for CR2032 Cells | Keystone | 1092 | Mouser https://www.mouser.com | P/N 534-1092-CC | 1 | $ 3.54 | $ 3.54 |
| B2 | 4000-0067 | 3 Volt Coin Cell Battery, Type CR2032 | Panasonic | CR2032 | Mouser https://www.mouser.com | P/N 658-CR2032 | 2 | $ 0.48 | $ 0.96 |
| D1 | 4000-0067 | Diode, 1N4148, or Equivalent | Onsemi | 1N4148 | Mouser https://www.mouser.com | P/N 512-1N4148 | 1 | $ 0.10 | $ 0.10 |
| J1 | 4000-0067 | 1/8" Phone Jack, TRS Contacts | Amphenol | ACJS-MV35-3 | Mouser https://www.mouser.com | P/N 523-ACJS-MV35-3 | 1 | $ 1.07 | $ 1.07 |
| J2 | 4000-0067 | RCA Style Jack, Single Hole Chassis Mount | CUI Devices | RCJ-035 | Mouser https://www.mouser.com | P/N 179-RCJ-035 | 1 | $ 1.46 | $ 1.46 |
| R1 | 4000-0067 | Resistor, 820 Ohms, 1/4W, 5% | Ohmite | OK8215E-R52 | Mouser https://www.mouser.com | P/N 588-OK8215E-R52 | 1 | $ 0.13 | $ 0.13 |
| U1 | 4000-0067 | OPTO ISOLATOR, 4N28M, Selected for High (100) Current Transfer Ratio Specification | Onsemi | 4N28M | Mouser https://www.mouser.com | P/N 512-4N28M | 1 | $ 0.45 | $ 0.45 |
| W1 | 4000-0067 | StarTech.com 3 ft. (0.9 m) 3.5mm Audio Cable - 3.5mm Slim Audio Cable - Right Angle - Male/Male - Aux Cable (MU3MMSRA), Black | StarTech | MU3MMSRA, Right Angle to Straight TRS Plugs on Ends | Amazon | AMAZON LINK | 1 | $ 5.95 | $ 5.95 |
| W2 | 4000-0067 | CESS-167-1f RCA Right Angle to Straight Type Male to Male Preamp Jumpers Patch Cable, 2 Pack (1 Foot) | CNCESS | Model # s167 | Amazon | AMAZON LINK | 1 | $11.40 | $ 11.40 |
| -- | 4000-0067 | Project Box, Plastic Enclosure, Black, 80x50x26mm (3x2x1 inch LWH) O.D. (Zulkit, ABS Plastic) | Zulkit (for Qty 5) | | Amazon | Amazon | 1 | $ 6.99 | $ 6.99 |
| | | | | | | **Quantity 1 Kits** | | | **$ 32.05** |