

# How to use TTL In/Out with JAGA

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## 1. TTL In/Out board:

- The JAGA TTL In/Out board has four TTL BNC pins (BNC1, BNC2, BNC3, BNC4).
- These four ports can be plugged into a USB port on your computer via an FTDI adapter.
- These four TTL BNC pins, for now, can be designated as either all TTL Input or all TTL output pins.

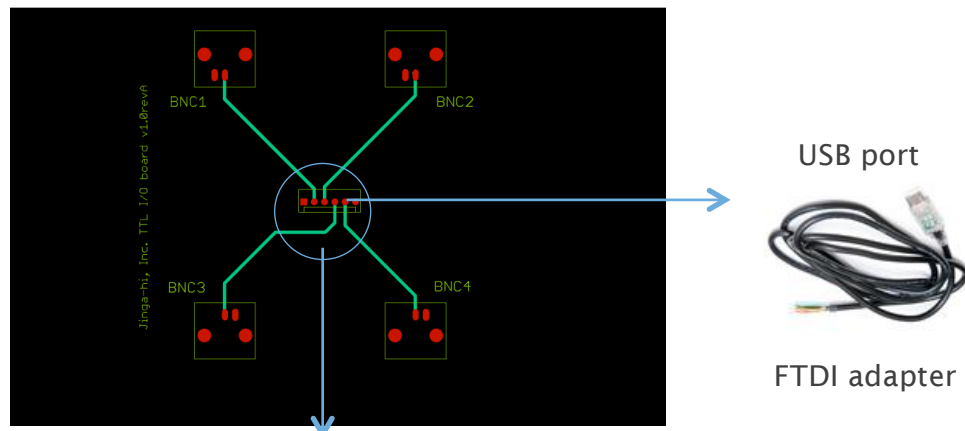
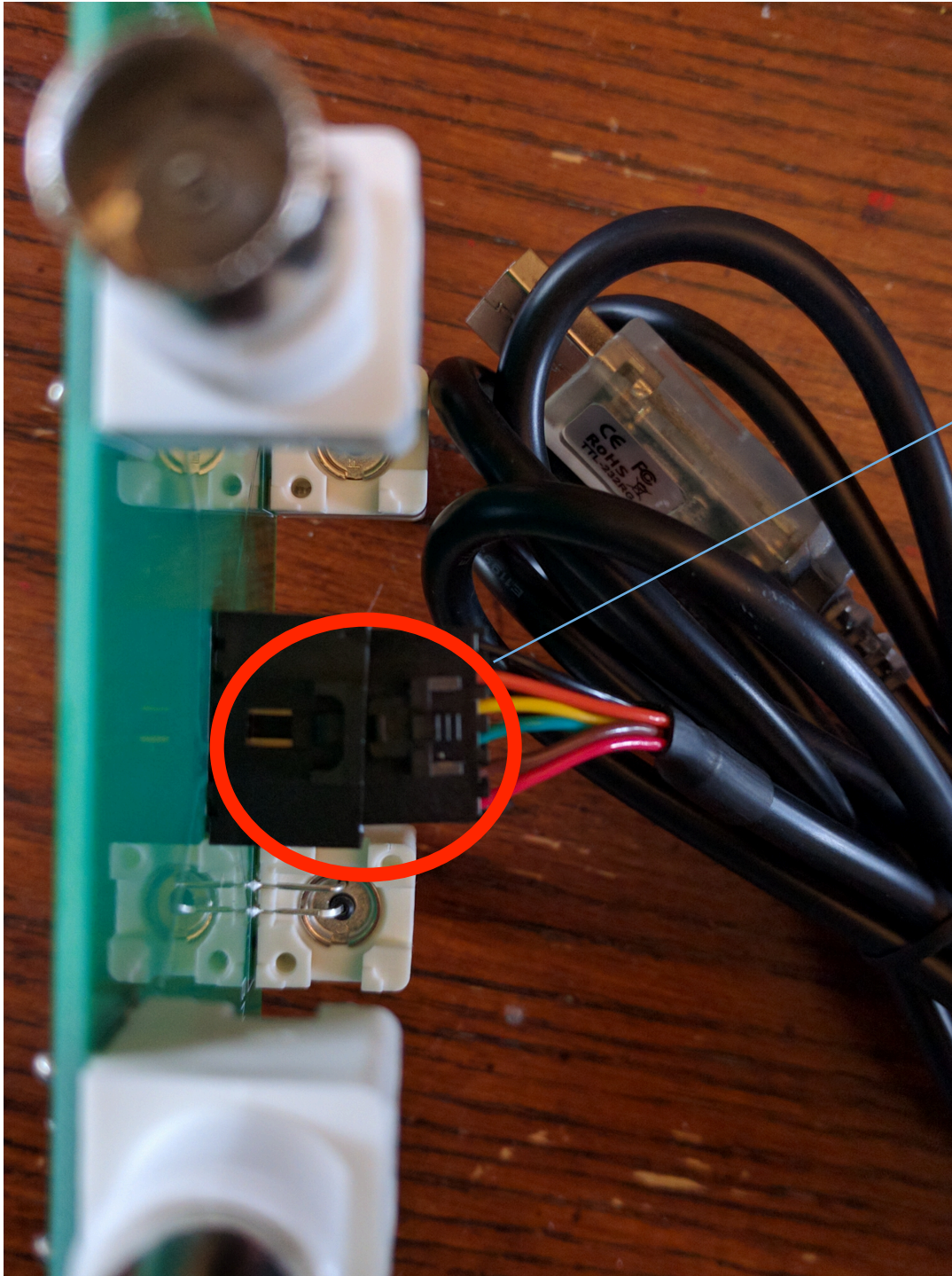


Fig.1 The center pins on the board is connected to the FTDI connector. The pins are from left to right: Black (GND), Orange (BNC1), Yellow (BNC2), Green (BNC3), Brown (BNC4), Red ((+5V)

- For TTL input applications, our GUI software NeuroPhys has an integrated interface. TTL information is saved synchronized with neural recording data (see 2.1).
- If you want to have TTL input first and trigger TTL out later based on the criteria of your experiment, you can insert your own code in our GUI software NeuroPhys (see 2.2).
- For TTL output applications, we have an open-source program with which users can write their own code to trigger out TTL (See 3).

## 1.1 How to connect the JAGA board for TTL In with FTDI adapter cable:

- Make sure that you combine the correct side of the black connector on the TTL board and the FTDI adapter cable shown below. You may accidentally flip the side of the connector and they won't get connected properly.



Make sure you see this latch. Once you insert this, you will need to press this to get the cable out again.

## 2. How to use JAGA board for TTL In:

### 2.1. How to recognize the TTL In device in NeuroPhys

- Plug in the TTL\_In/Out board into your computer
- Click on the USB icon in the top tool bar (see figure below).
- “Jinga-Hi interface” will automatically show in NeuroPhys. Click “Rescan Devices” if the message does not appear.

Fig.2 Click on USB

Fig.2 If you want to see recording and TTL together, you can change *Tabbed view* into *Paneled View*

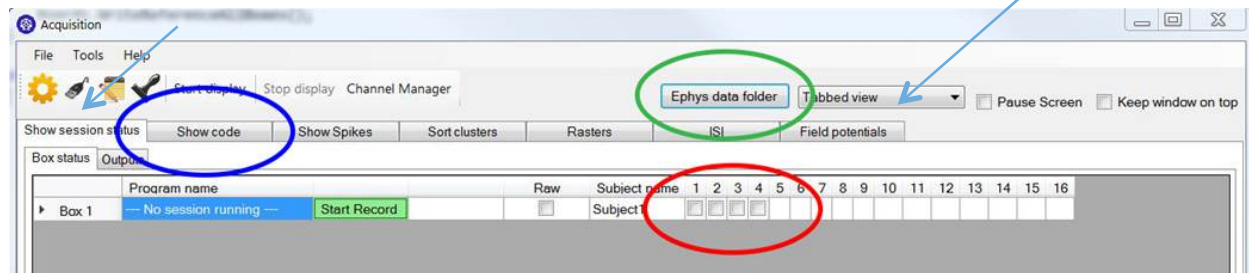
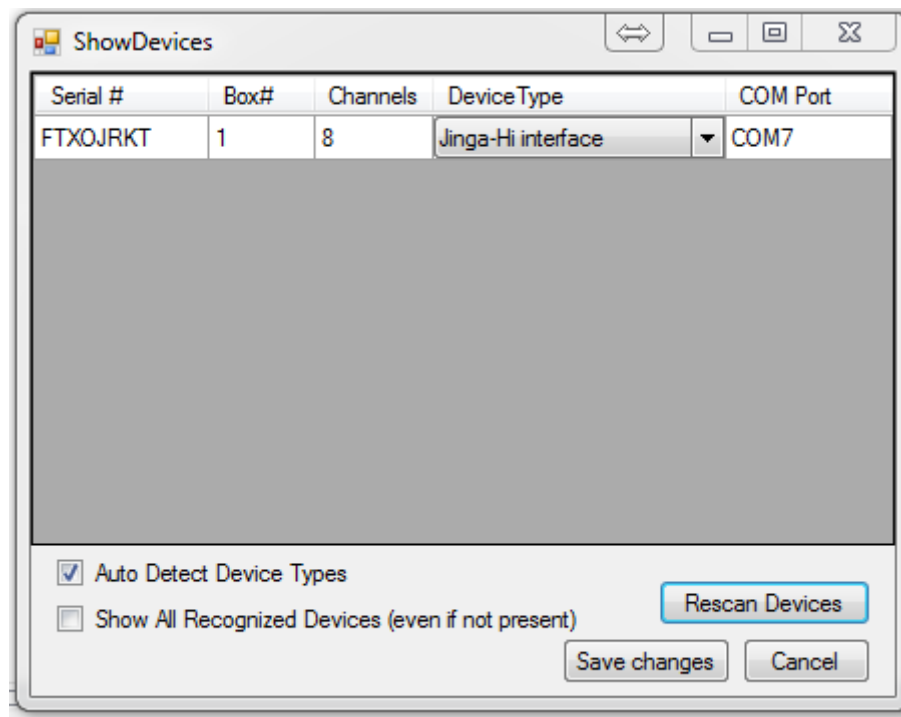


Fig.2 These four squares will appear indicating TTL input channels

Fig.3 Jinga-Hi interface pops up automatically.



- Click on the tab “Show session status”.
- Find four square TTL boxes (see red oval in fig.2). The boxes are not checked – checks will display in real time during neural recording.
- Switch to “Paneled view” in the tool bar for better monitoring your experiment (see red arrow in fig.2).
- TTL information will automatically be saved as “Event” with INPUT\_ON/OFF\_#BNC pin number with the time counter (see figure below for example). You can also convert the file into a csv format using NeuroSorter.

### Example of how TTL data is saved

```
=====
Data type, Timestamp, Channel ID, Unit/Name
=====
Spike, 128, 1, unsorted, 392, 300, 165, 17, -80, -159, -301, -466, -560, -601, -639, -703, -820, -962, -1068, -1142, -1202, -1265, -1347, -1446, -1549, -1652
Spike, 268, 1, unsorted, 413, 312, 178, 33, -65, -145, -265, -408, -526, -618, -693, -765, -855, -948, -1008, -1053, -1113, -1201, -1326, -1468, -1598, -1701
Spike, 409, 1, unsorted, 216, 146, 105, 53, -24, -135, -269, -406, -531, -619, -690, -781, -888, -983, -1074, -1177, -1290, -1401, -1505, -1600, -1678, -1712
Spike, 550, 1, unsorted, 285, 187, 96, 5, -97, -220, -374, -525, -610, -660, -752, -866, -926, -972, -1093, -1255, -1361, -1439, -1570, -1724, -1820, -1867
Spike, 689, 1, unsorted, 339, 272, 191, 56, -99, -209, -281, -348, -427, -531, -645, -737, -815, -896, -987, -1084, -1183, -1280, -1372, -1454, -1536, -1634
Spike, 830, 1, unsorted, 221, 130, 51, -22, -98, -178, -255, -337, -435, -547, -664, -785, -911, -1036, -1155, -1255, -1305, -1339, -1417, -1525, -1611, -1682
Spike, 970, 1, unsorted, 401, 259, 139, 36, -75, -190, -279, -360, -474, -598, -673, -727, -826, -959, -1079, -1182, -1273, -1364, -1467, -1575, -1664, -1740

Event, 14952, 153, TTL_Input_On_4
Event, 131449, 153, TTL_Input_On_4
Event, 259462, 153, TTL_Input_On_4
Event, 101992, 203, TTL_Input_Off_4
Event, 224944, 203, TTL_Input_Off_4
Event, 363298, 203, TTL_Input_Off_4

|
EEG/LFP, 6141,
0, -1760, 4, 1708, 975, -1169, -1747, 27, 1761, 1054, -1097, -1711, 28, 1755, 1063, -1091, -1743, -18, 1752, 1098, -1062, -1747, -41, 1734, 1103, -1060, -1777, -79, 1739, 1161, -
1004, -1763, -106, 1701, 1138, -1006, -1771, -113, 1729, 1202, -966, -1782, -160, 1677, 1178, -963, -1790, -193, 1658, 1188, -964, -1838, -256, 1634, 1212, -918, -1812, -251, 1
644, 1242, -886, -1812, -268, 1657, 1297, -833, -1792, -279, 1649, 1321, -797, -1785, -301, 1633, 1325, -801, -1821, -366, 1585, 1314, -798, -1835, -389, 1582, 1352, -743, -181
0, -380, 1619, 1422, -687, -1809, -419, 1580, 1411, -677, -1810, -445, 1555, 1418, -669, -1833, -494, 1532, 1437, -634, -1824, -511, 1511, 1440, -624, -1853, -571, 1475, 1445, -
611, -1854, -583, 1478, 1486, -561, -1845, -611, 1452, 1493, -526, -1821, -616, 1452, 1513, -517, -1854, -674, 1404, 1508, -499, -1857, -696, 1412, 1564, -424, -1805, -683, 141
5, 1585, -402, -1810, -717, 1383, 1593, -373, -1809, -750, 1345, 1575, -377, -1833, -787, 1346, 1628, -305, -1790, -773, 1357, 1656, -283, -1799, -828, 1286, 1618, -294, -1825, -
883, 1245, 1620, -261, -1805, -872, 1281, 1700, -174, -1760, -878, 1258, 1696, -173, -1785, -927, 1205, 1667, -180, -1803, -967, 1186, 1699, -125, -1769, -960, 1189, 1726, -86
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, 66, -1732, -1158, 990, 1762, 99, -1714, -1164, 980, 1771, 112, -1715, -1192, 943, 1765, 138, -1697, -1205, 938, 1793, 192, -1661, -1205, 931, 1823, 234, -1649
EEG/LFP, 13309,
0, -1233, 894, 1815, 253, -1648, -1256, 880, 1836, 291, -1621, -1265, 857, 1840, 329, -1587, -1265, 829, 1820, 317, -1621, -1327, 786, 1820, 340, -1614, -1345, 757, 1828, 384, -1
599, -1388, 703, 1813, 409, -1572, -1384, 700, 1828, 436, -1566, -1412, 665, 1822, 458, -1553, -1437, 611, 1790, 445, -1578, -1475, 592, 1804, 488, -1546, -1478, 577, 1833, 548, -
1502, -1480, 556, 1821, 566, -1474, -1470, 566, 1877, 643, -1429, -1477, 520, 1828, 622, -1443, -1515, 485, 1832, 655, -1419, -1520, 469, 1847, 700, -1404, -1554, 426, 1833, 70
8, -1393, -1569, 406, 1843, 745, -1361, -1560, 388, 1839, 749, -1182, -998, 1216, 2867, 1839, -435, -955, 763, 2203, 1158, -1075, -1537, 270, 1812, 870, -1299, -1731, 118, 1736,
863, -1297, -1771, 61, 1710, 879, -1266, -1745, 65, 1714, 901, -1248, -1757, 41, 1720, 936, -1236, -1803, -15, 1692, 941, -1222, -1803, -38, 1676, 952, -1198, -1800, -43, 1705, 1
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```

## 2.2. How to receive first TTL in, then trigger TTL out later

If you want to read TTL in and control TTL out in a programmable way based on your TTL in, you can write your code under “show code” (See blue oval in Fig.2).

### 3. Use JAGA board for TTL Out

You can also trigger TTL out with our open source code without using NeuroPhys. See [Jaga\\_TTL\\_out.m4v](#) .