Channel Mapping Guide

TDT Headstages and Adapters

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Notices

The latest versions of TDT documents are always online at https://www.tdt.com/docs/

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Channel Mapping

This document will show you how to make a successful channel map in Synapse for your TDT headstage, adapter (if applicable), and vendor probe and connector pinout. While this document may not *include* your specific combination of hardware, all the steps outlined can be used to make the map you need.

Important resources for making a channel map are the TDT hardware page for Headstages & Adapters, the Synapse manual and Mapper gizmo, and your probe vendor's documentation.

You do not always need a channel map. Some vendor probes have electrode sites which are already in linear order and who's pinouts are made to connect to TDT headstages. We recommend that you read through the first few sections of this guide and have relevant hardware documents available in order to determine whether a map is needed.

When do we Need a Channel Map?

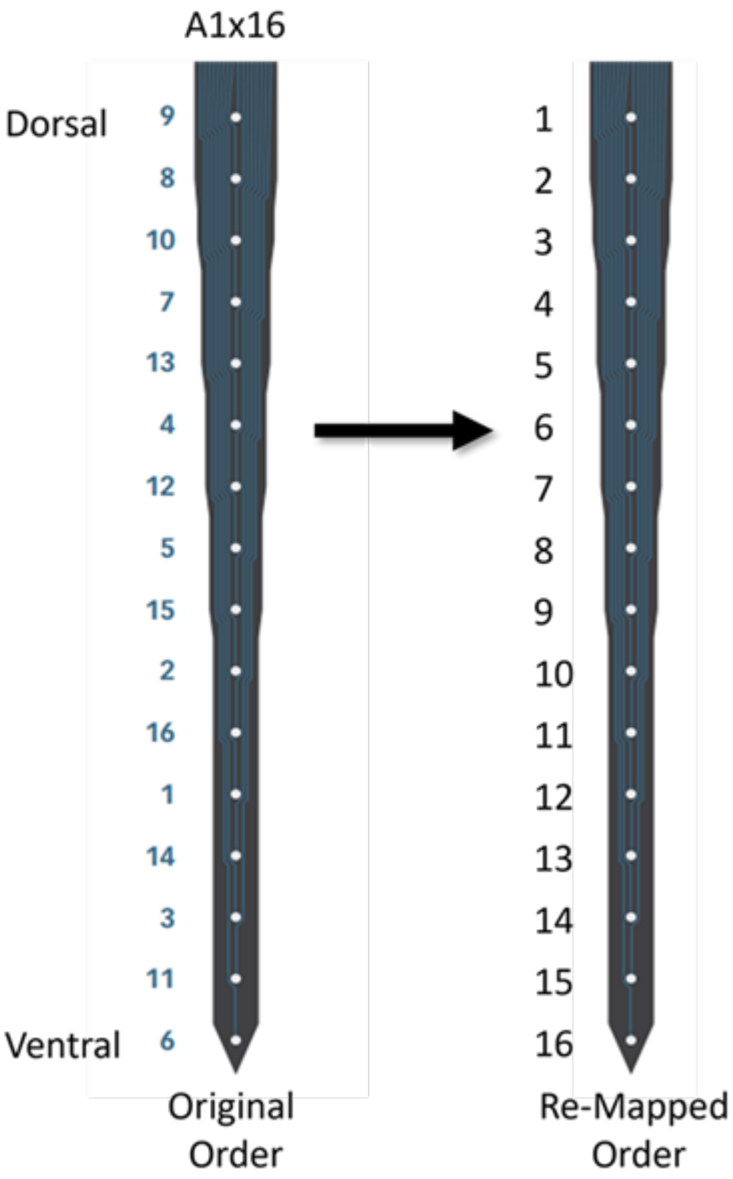
There are two cases in which you would need a channel map:

1. You have a probe and want to re-order the electrode site numbers
2. The channel pinout of your probe or adapter do not match one-to-one with your TDT headstage.

Both of these might apply to your setup, in which case the appropriate steps in tracing the route would need to be combined.

Electrode Site Re-Ordering

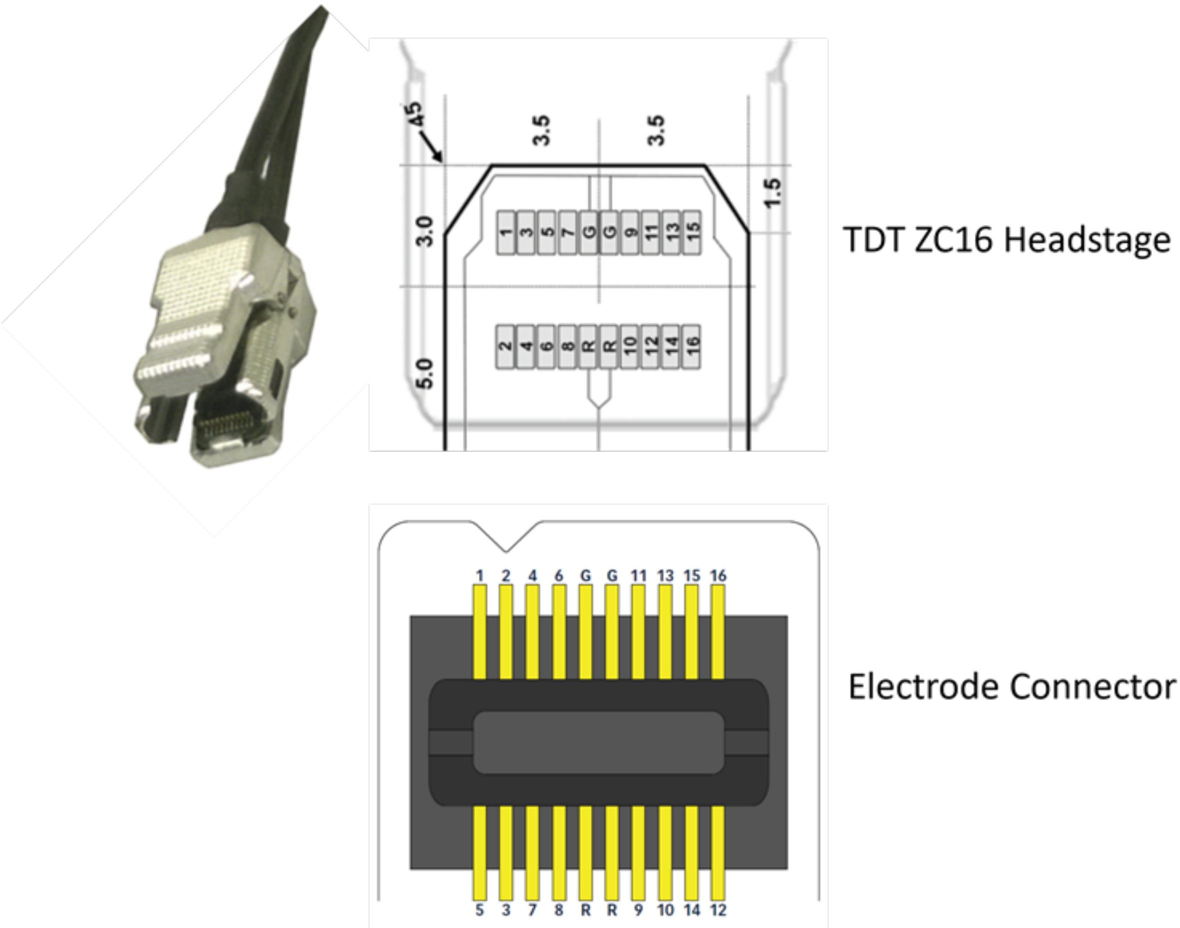
Below is an example electrode probe where the electrode sites are arranged non-linearly in the dorsal-ventral axis. For ease of observation and analysis, it would be desirable to re-order the electrode sites linearly from 1-16 in either direction.



A16: A1x16 probe, credit NeuroNexus

Pinout Mismatch

All TDT Headstages & Adapters have specific pinouts that reflect the preamplifier channel to which they connect. So, without remapping, whatever is connected to channel 1 on your Zif Clip® headstage or any other headstage is recorded as channel 1 in Synapse. However, might not reflect the channel pinout of your vendor probe, as you can see in the below example:



Z16 Pinout, credit NeuroNexus

The ZC16 headstage at the top has odd numbers in the top row and even numbers in the bottom. This is not the case for the vendor pinout, where channel 2 on the probe, for example, connects to channel 3 on the headstage. Left unchanged, we would record electrode site 2 as channel 3 in Synapse.

The same is true for TDT adapters when they connect to vendor probes. The adapter pinouts reflect the pinouts when connected properly to TDT **analog** headstages.

Important

TDT adapter pinouts reflect the pinouts when connected properly to TDT **analog** headstages. When using Zif Clip® digital headstages with 64 channels or greater (i.e ZD64, ZD96, or ZD128 headstage) you must remap based on the headstage. [link to ZD section in] (tracing-the-route.md)

Steps to Making a Successful Map

1. Have an up-to-date TDT pinout for your headstage and adapter (if using one) from our online hardware documentation.
2. Have the vendor probe and connector pinout. This has to be specific and correct to your probe! If you are unsure or cannot find it online, please email your vendor.
3. Always know the proper orientation for connecting your headstage and adapter.
4. Choose your desired electrode site ordering.
5. Follow the electrode output from the vendor probe through the vendor connector to the TDT headstage or adapter + headstage. We call this 'tracing the route.' This step is the essence of your channel map.
6. Make a single final map in the TDT mapper gizmo. Save your map.
7. Verify your map. TDT cannot verify your maps, and any map TDT has helped with should be checked by the end user.

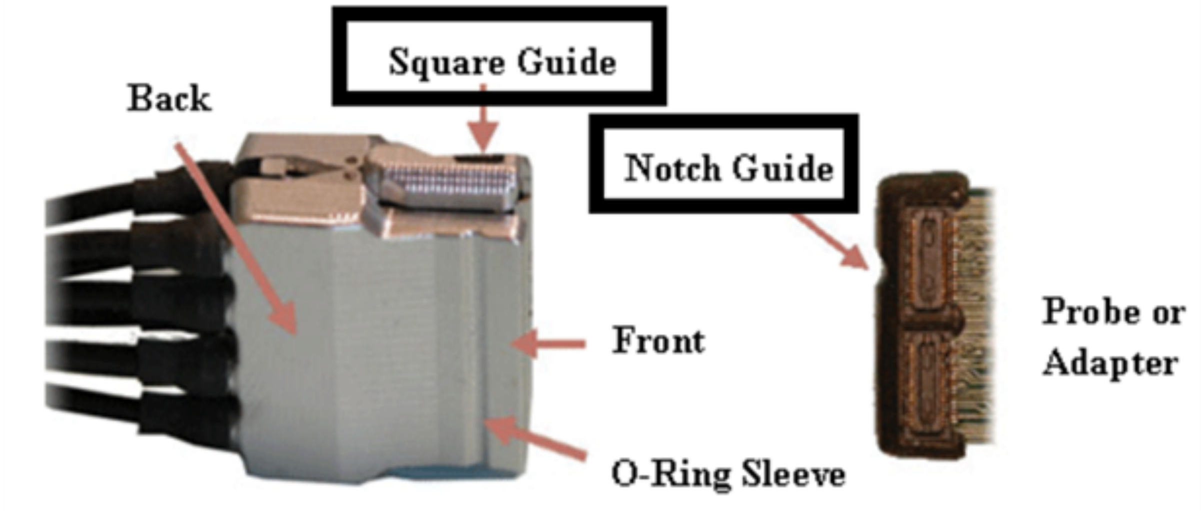
Connecting Your Headstage and Adapter

TDT headstage and adapters have specific connection orientations that must be followed for the pinouts listed in the documentation to be correct. If you connect a headstage or adapter backwards, your map will be wrong.

This page will list out a few of the many possible headstage and adapter connections. Be sure to carefully consider your equipment and verify that the connections you make for your specific setup are correct.

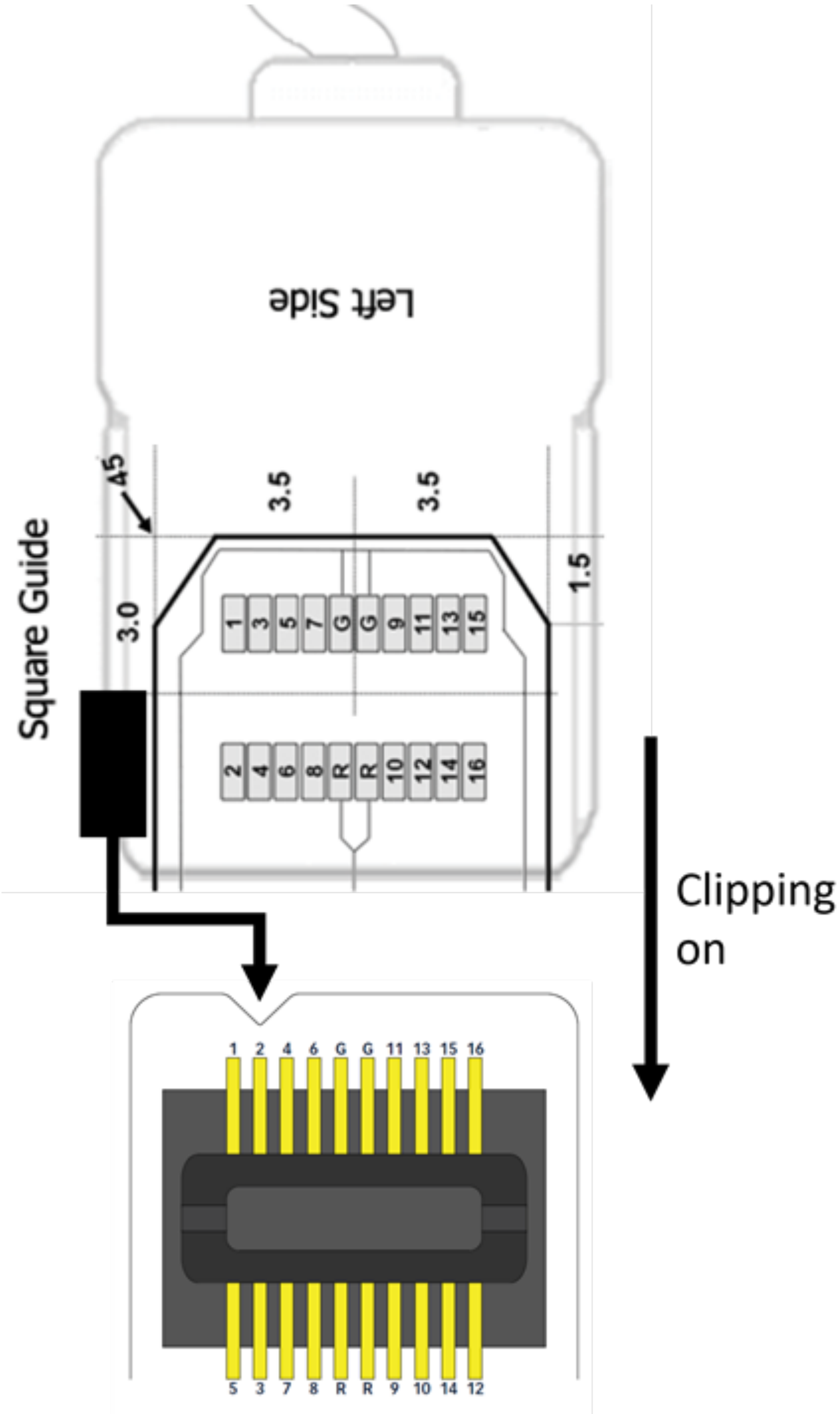
Zif Clip® Headstage Connections

TDT Zif Clip® headstages use visual indicators on the headstage and probe adapter to mark proper connection orientation. The headstage has a **black rectangle** on one side that you must align with a **notch cutout** on the probe or adapter. You can find this information on our ZC headstages page as well as below. The ZC headstages page also includes important instructions for proper headstage handling when connecting to the probes or adapters not covered here.



In the image above, you can see the black rectangle on the headstage and the notch cutout on the probe or adapter. Please take a moment to notice these on your own physical hardware if you have it with you. If you are teaching students or lab colleagues, please point this out to them.

Below is the same concept but with a ZC16 headstage pinout and an Neuronexus electrode probe pinout.



Notice in the ZC16 headstage webpage that the image actually shows the headstage horizontal instead of vertical. These types of schematic pinouts are what you will need to use to trace out your full mapping route. You might find it helpful to screenshot or print the connectors for ease of visualizing the connections.

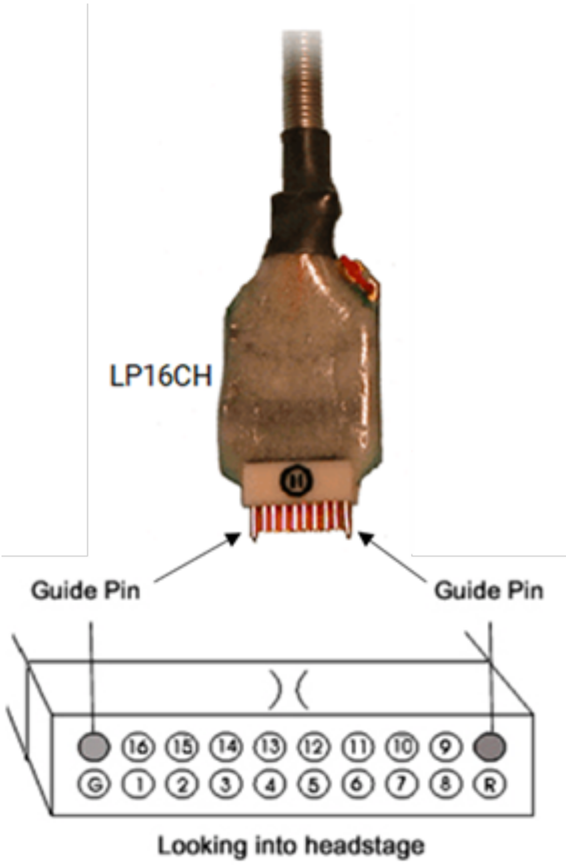
Note

You can use Microsoft Paint or some other image editing tool to crop and rotate headstage, adapter, and probe images to align them with how you would see them visually. You can also physically print out the images, cut them out of the paper, and align them on a table.

Omnetics Headstage and Adapter Connections

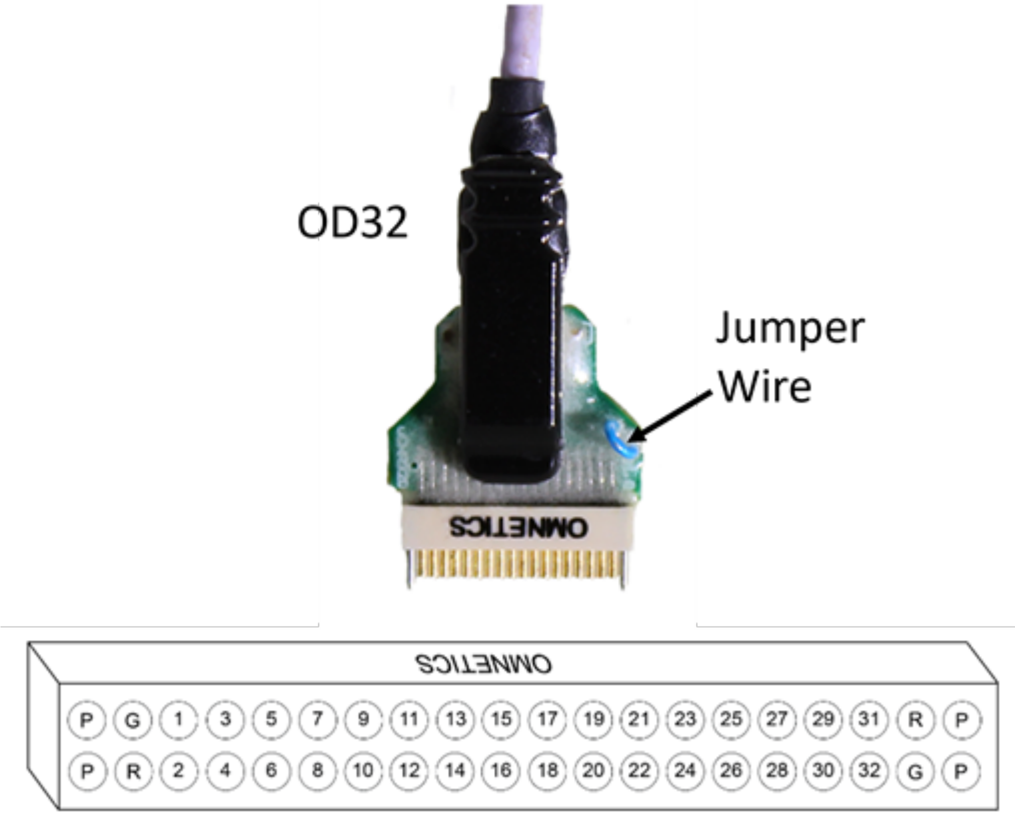
Omnetics connectors are very popular in neuroscience and TDT uses them for both headstages and adapters. Many vendors use Omnetics connectors for their probes as well.

Some Omnetics connectors, like the 16 channel ones used on the LP16CH headstage or ZCA-OMN16 are polarized, which means they can only connect in one orientation. This is because the guide pins on the Omnetics connector are asymmetrical and, because they are bigger than the channel pins, you physically cannot flip around the connection.



The guide pins are the larger silver pins in the image. These would connect to the edges of one row only on a mating adapter or probe. The connector pinout are the headstage channel numbers if you were to look at the headstage with the pins closest to your face. These pinout channels are the preamplifier recording channels.

Higher channel count Omnetics connectors might not have asymmetrical guide pins, as you can see with the OD32 or the LP32CH



P=Guide Pins **R**=Reference **G**=Ground

Because you can make the connection in two ways, it is important to note which side is the 'front' and which is the 'back.' Generally, the Omnetics label on the connector will be the front, but always compare to the online images for other visual references like GND and REF jumper wires to verify the orientation.

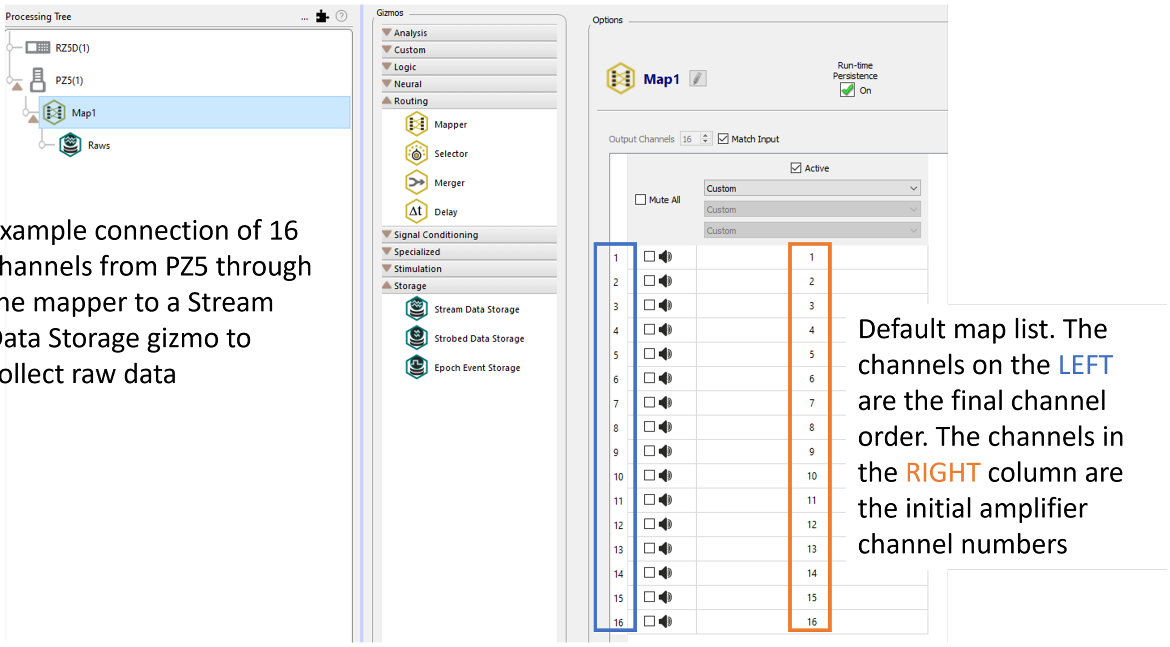
> **Important**
>
> Please compare your headstage or adapter with the images available in the hardware documentation to see the correct orientation. If you are unsure, please ask support@tdt.com

The Mapper Gizmo

You can learn about all the details of the Mapper Gizmo on the Synapse Manual page.

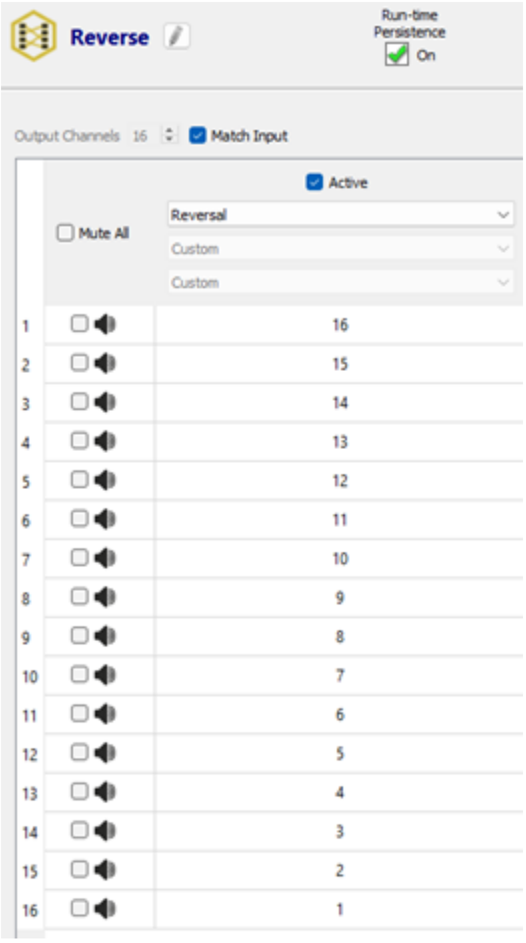
Overall, the Mapper mainly is used to take multi-channel inputs, which come in ordered a certain way, and transform them into a re-ordered output. The mapper will generally connect upstream to a preamplifier gizmo, like the PZ5 or PZA and connect downstream to a storage gizmo or a filtering gizmo or PCA sorter.

Note the mapping convention where the number listing on the left will be the final channel order and the numbers input in the cells are what you remap to that final output.

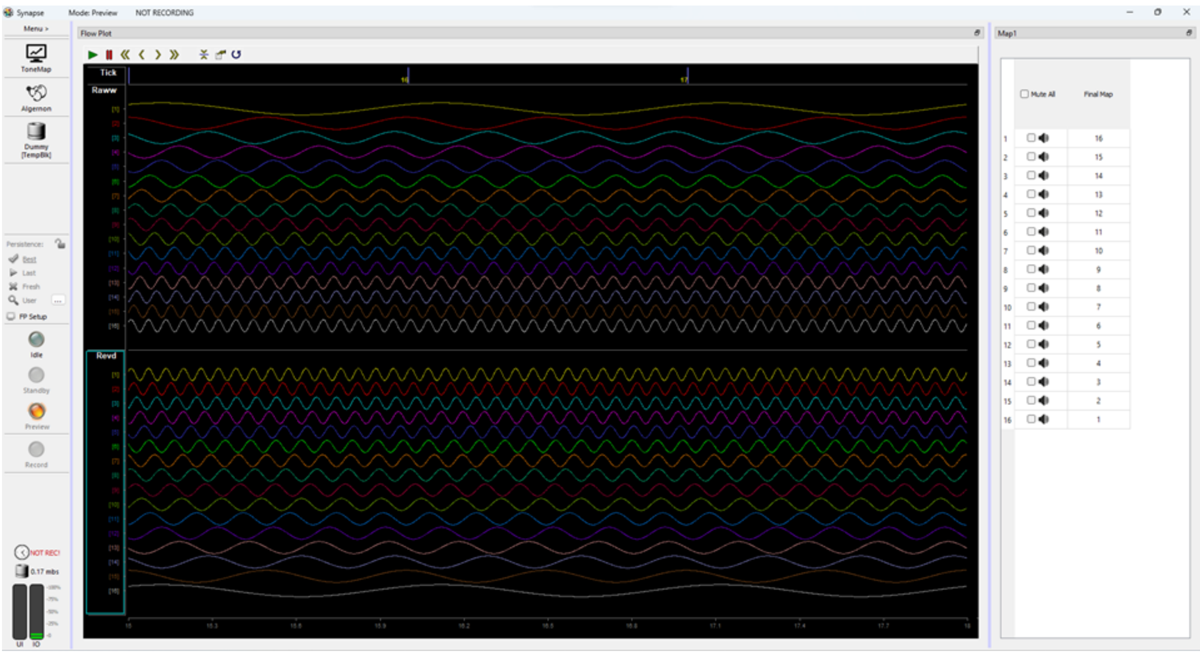


If I wanted to completely flip the order of my channels, I would enter a '16' in row 1, '15' in row 2, etc. Here is a simple example using a tone generator that makes a tone of increasing frequency for every channel in linear order from 1 Hz to 16 Hz.

:material-download: Download Experiment File



The mapped outcome compared to a raw output is below. You can see the mapper gizmo final map at runtime. Note that the channel colors are for ease of viewing and do not mean anything - pay attention to the sinusoidal frequency for channel identification.

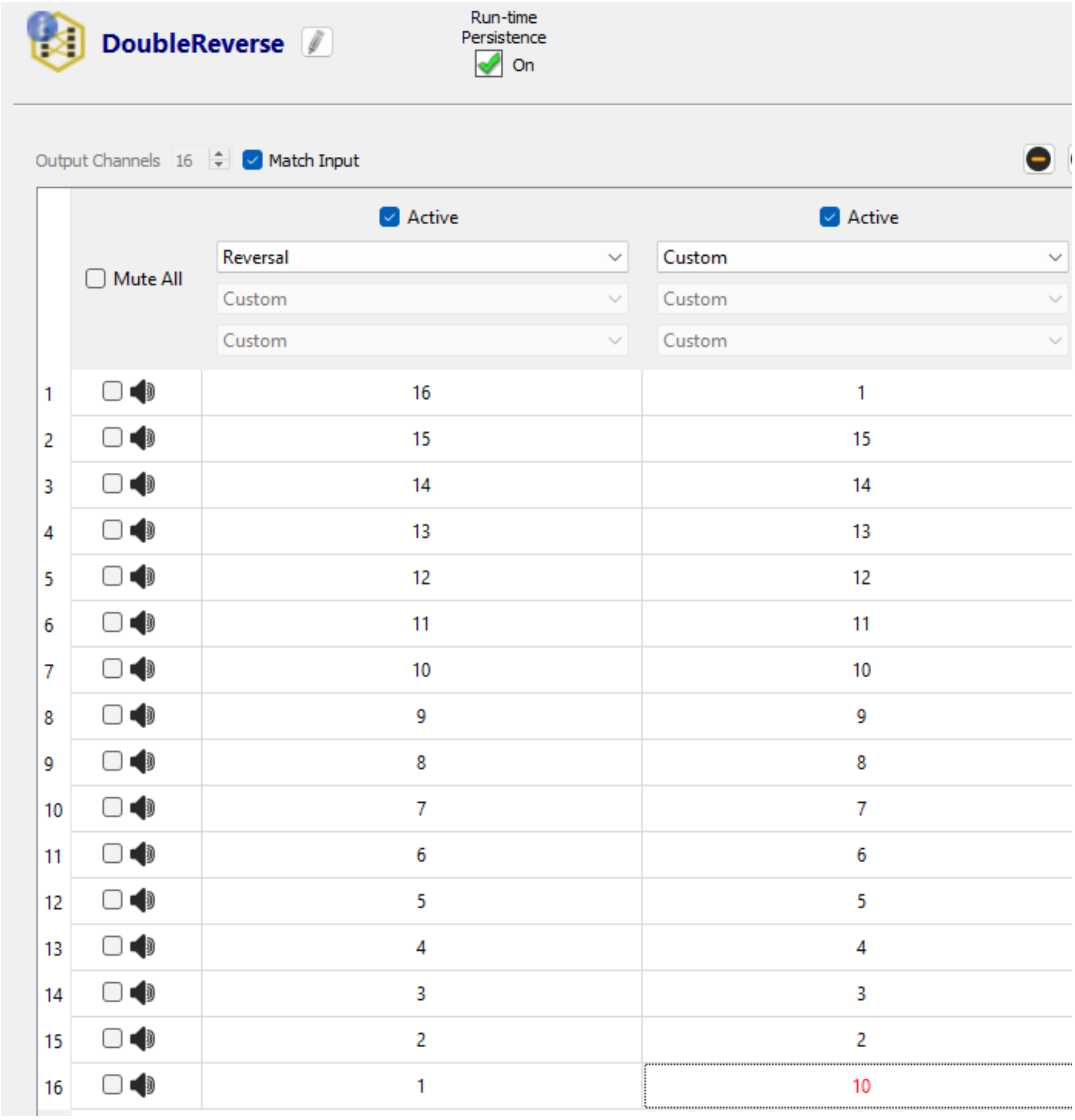


The Final Map

This guide focuses on making a single final map from Tracing a route that you then save and use again later on. One single map column is easier for most people to understand if the entire route is traced and written out.

Saved maps can be accessed from the dropdown menu. The dropdown directory is here `C:\TDT\Synapse\MapFiles`

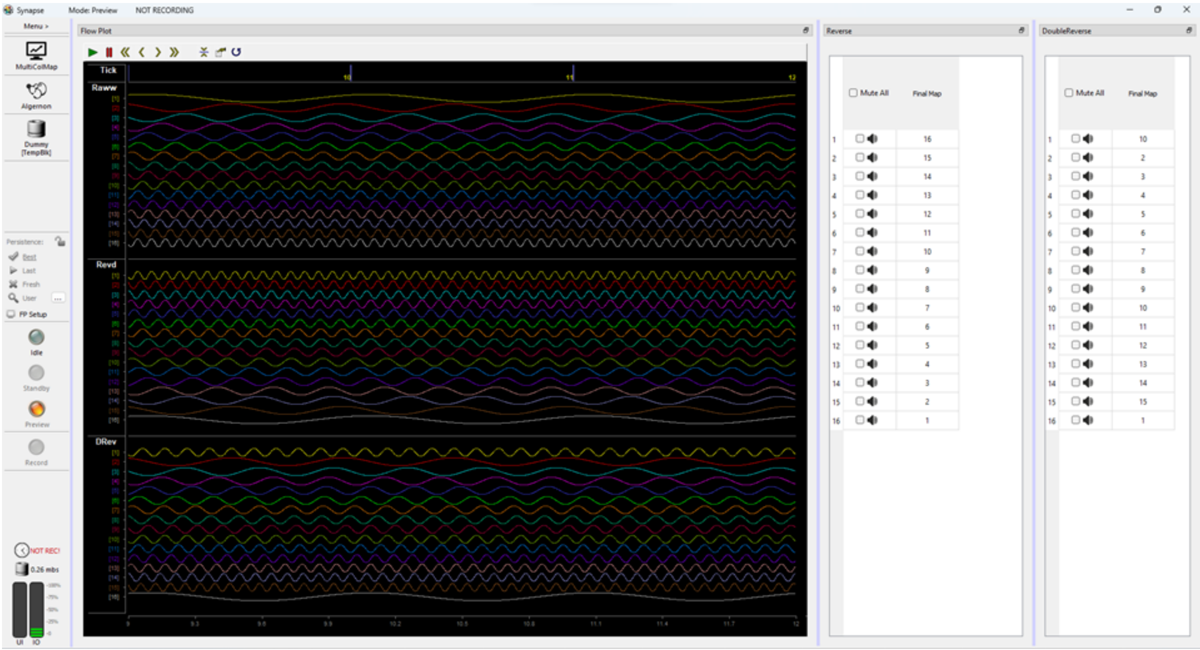
You can, however, make a multi-column map instead of a single final map, if you wanted.



The left hand side is once again the final order, i.e what you want to map everything to. The final map is done by taking each active column from right and following the re-order. In the example, we are double-reversing our tone generator, but with a key difference of swapping 1 Hz for channel 16 and 10 Hz for channel 1. If it was a true double-reverse, we would end up back to the original 1 Hz -> 16 Hz order.

Look at the highlighted 10 in the right-hand column. We are taking the original input from channel 10 (10 Hz) and mapping it to channel 16 by placing it in row 16. Then, in the middle column 'Reversal' we take row 16 and map it to channel 1. Thus, we end up with 10 Hz in channel 1.

Likewise, on the right channel 1 is 1, then we ask channel 16 to be 1, so we end up with 1 Hz on channel 16.

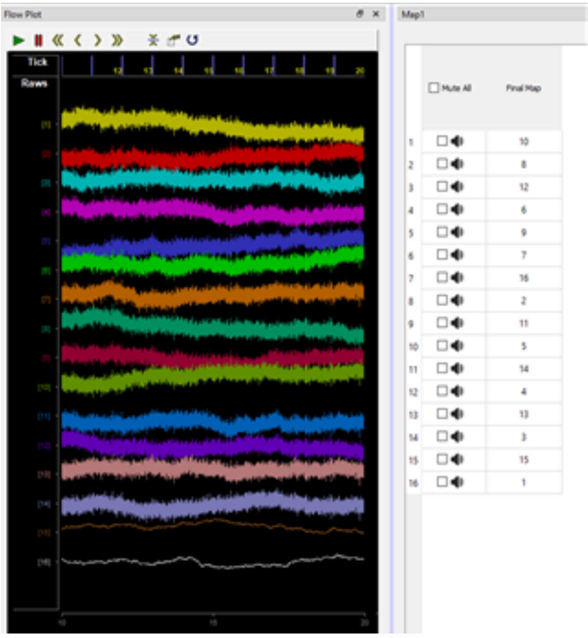


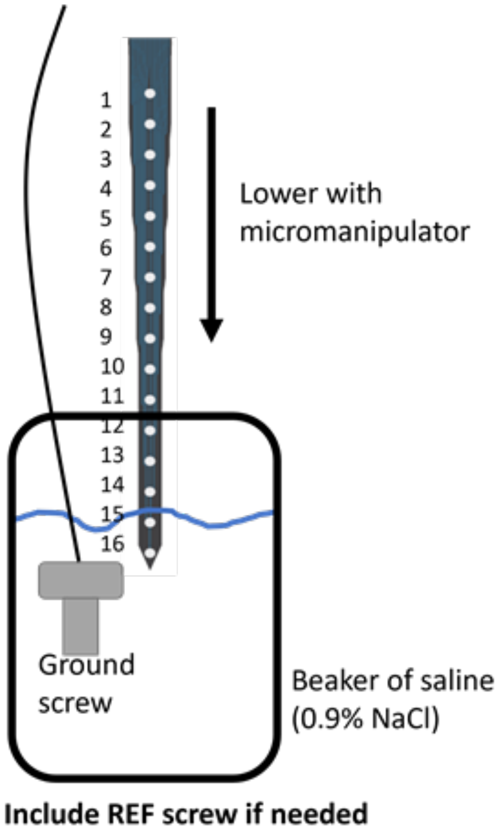
:material-download: Download Experiment File

Verify Your Map

The only way to properly verify your map is correct for your probe is to test it. This should be done in vitro with 0.9% NaCl (saline) solution. The saline is your subject. Connect everything the way you would for a normal recording procedure and use a micromanipulator so you can precisely control the depth of your probe.

As you lower the probe into the saline, the channels that get submerged will complete the circuit with the GND screw and become less noisy. This should show you from ventral to dorsal whether you made the map correctly. Here we verify the map made in Electrode Re-Order with Pinout Correction





Make sure you have a **ground screw** and a ref screw (if applicable) in the solution.

Tracing the Route

This is how you make your map.

Write out the connection route and new channel number of each site in the following format: “We want electrode site N to be mapped as channel X. Electrode site N on the probe + connector goes to pin number M on the TDT headstage, so Channel X in the mapper gizmo gets a value of N.” In other words, we remap preamplifier channel M as X in the mapper.

Once you go through every pin, double check that your Map in the Mapper Gizmo is correct and saved.

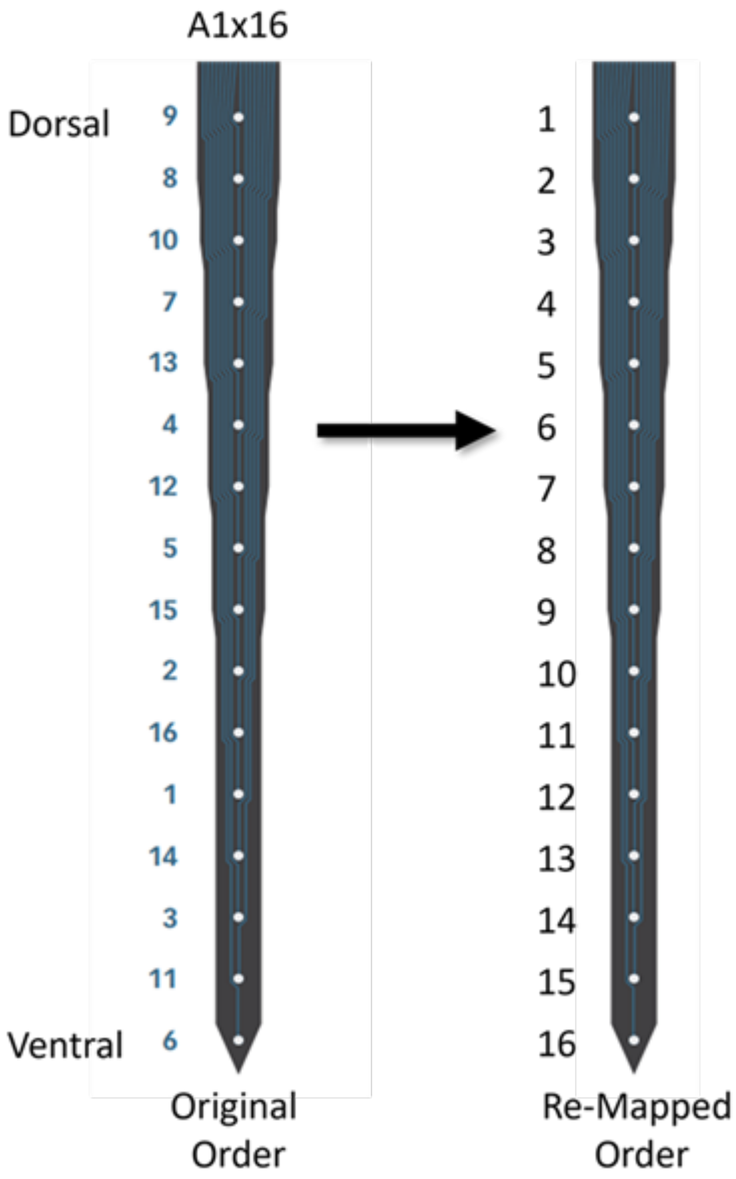
Remember to Verify your map when you can do a saline test.

Just Electrode Site Re-Ordering

This section is for TDT headstages and vendor probes that have matching pinouts. In this case, you do not need to worry about remapping the connections between the headstage and probe.

In the below example, we use the TDT RA16AC and NeuroNexus A16: A1x16 to demonstrate electrode site re-ordering. This headstage + probe pair have matching pinouts, so all we need to do is remap existing headstage channels in a new order in Synapse.

We want to re-order the original electrodes so that from top to bottom the channels read from 1 -> 16.



A16: A1x16 probe, credit NeuroNexus

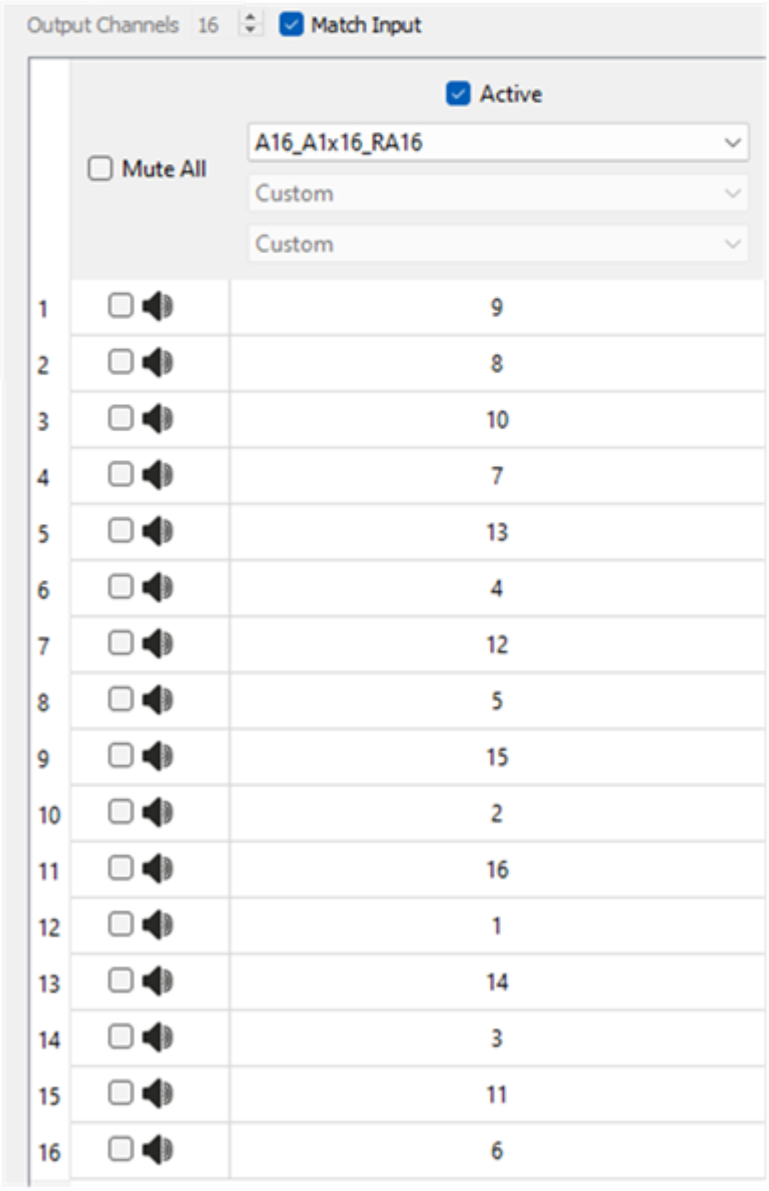
Because the headstage and probe pinouts match, we know any given channel N goes to pre-amplifier channel N in Synapse. All we need to do is use the Mapper gizmo to change the order in which our channels are saved.

The Trace: We want electrode site 9 on the probe to be mapped as channel 1 in Synapse. Electrode site 9 goes to pin 9 on the TDT headstage. So channel 1 in the mapper gizmo gets a value of 9. In other words, we remap the preamplifier channel 9 as channel 1 using the mapper.

Next channel: We want electrode site 8 on the probe to be mapped as channel 2 in Synapse. Electrode site 8 goes to pin 8 on the TDT headstage. So channel 2 in the mapper gizmo gets a value of 8. We remap preamplifier channel 8 as 2 in the mapper.

Last channel: We want electrode site 6 on the probe to be mapped as channel 16 in Synapse. Electrode site 6 goes to pin 6 on the TDT headstage. So channel 16 in the mapper gizmo gets a value of 6.

The final map for this example would be

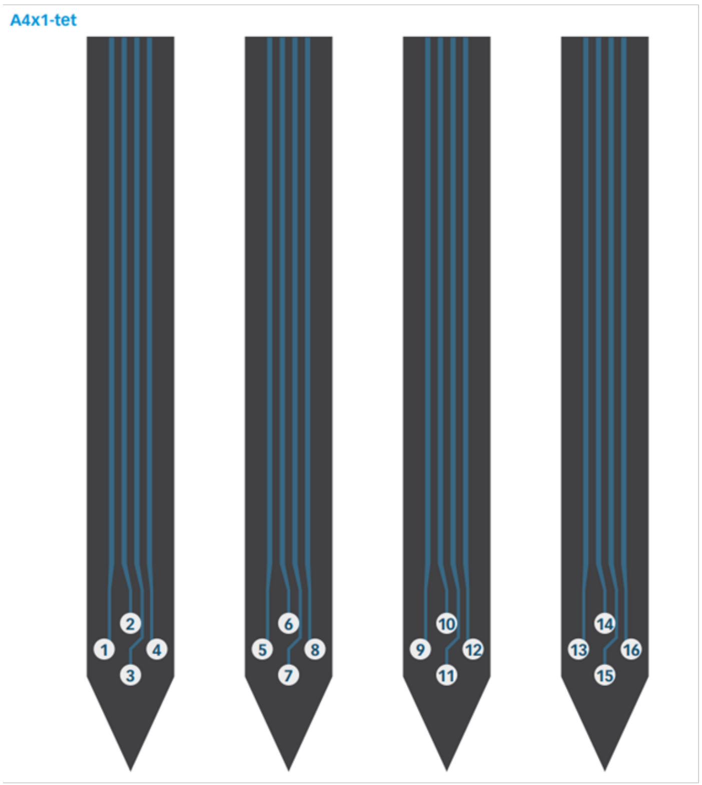


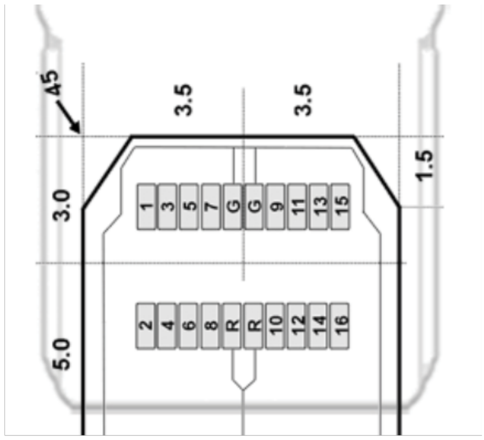
The TDT headstage pinout reflects the PZ amplifier pinout. So whichever headstage channel an electrode site initial routes to is its default saved channel number

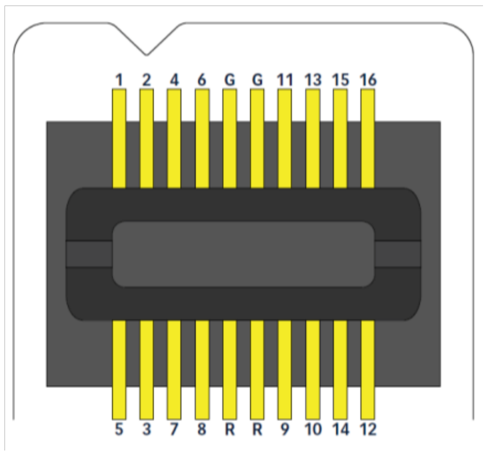
Just Pinout Correction

This section is for if you have electrode probes with the order you want, or you don't want to remap them, but your TDT headstage or TDT adapter pinout and the probe pinout do not match. In this case, you need to make a map to correct this mismatch so your electrode sites can be identified properly in the recorded data.

The below image is an A4x1 tetrode Z16 probe from Neuronexus that has electrode pads in an order we want. However, the Zif Clip® pinout on the probe (top right) does not match the ZC16 headstage pinout (bottom left). We will make sure that each electrode get saved as its proper number using the Mapper.







The Trace: We want electrode site 1 to be mapped as channel 1 in Synapse. Electrode site 1 goes to pin 1 on the TDT headstage. So channel 1 in the mapper gets a value of 1.

We want electrode site 2 to be mapped as channel 2 in Synapse. Electrode site 2 goes to pin 3 on the TDT headstage. So channel 2 in the mapper gets a value of 3. In other words, we remap the preamplifier channel 3 as channel 2 using the mapper.

We want electrode site 16 to be mapped as channel 16 in Synapse. Electrode site 16 goes to pin 15 on the TDT headstage. So channel 16 in the mapper gets a value of 15.

The final map for this example would be:

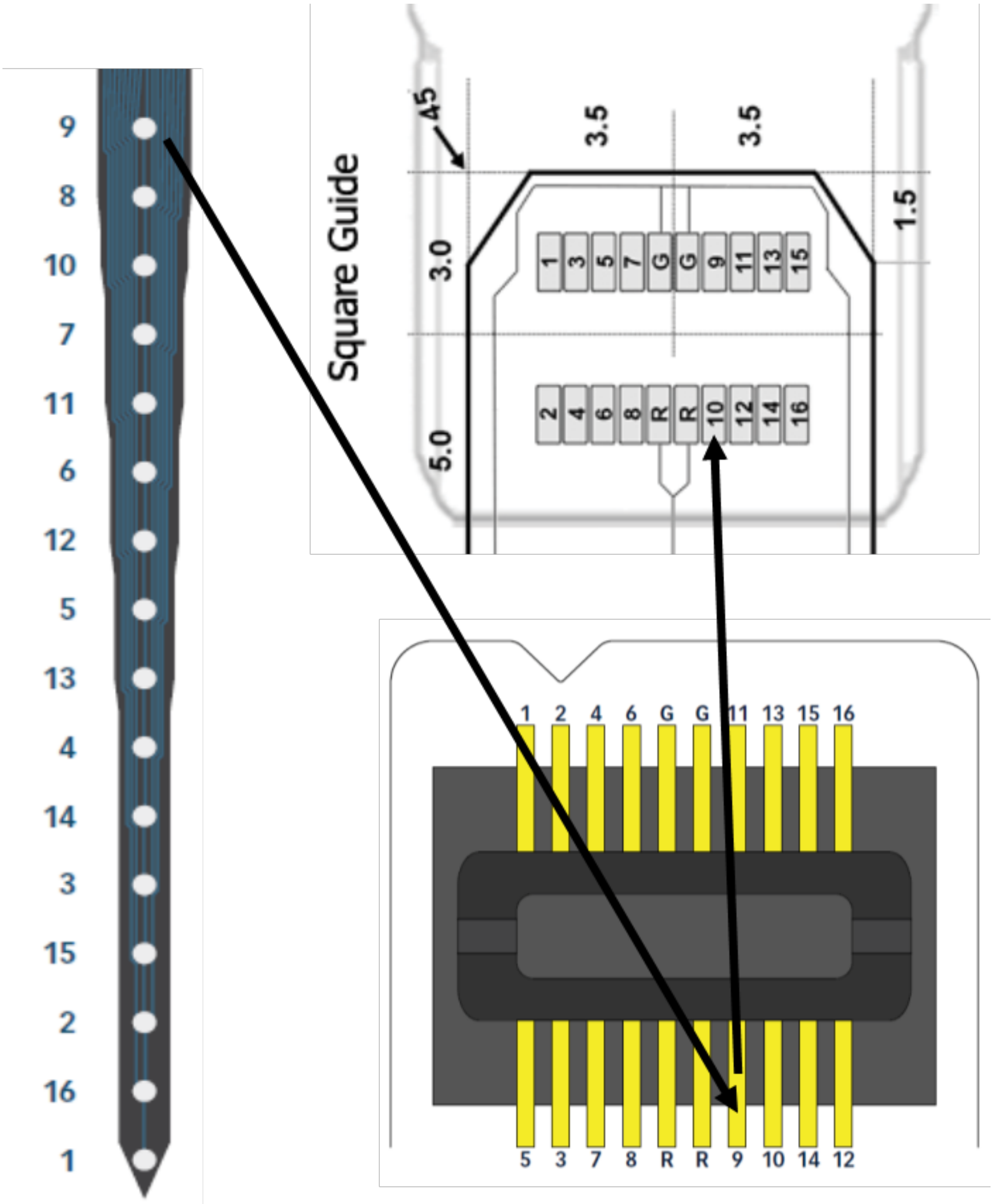
	Mute All	Active A1x4Tet Custom Custom
1		1
2		3
3		4
4		5
5		2
6		7
7		6
8		8
9		10
10		12
11		9
12		16
13		11
14		14
15		13
16		15

Remember that this same technique applies to adapters.

Electrode Re-Order with Pinout Correction

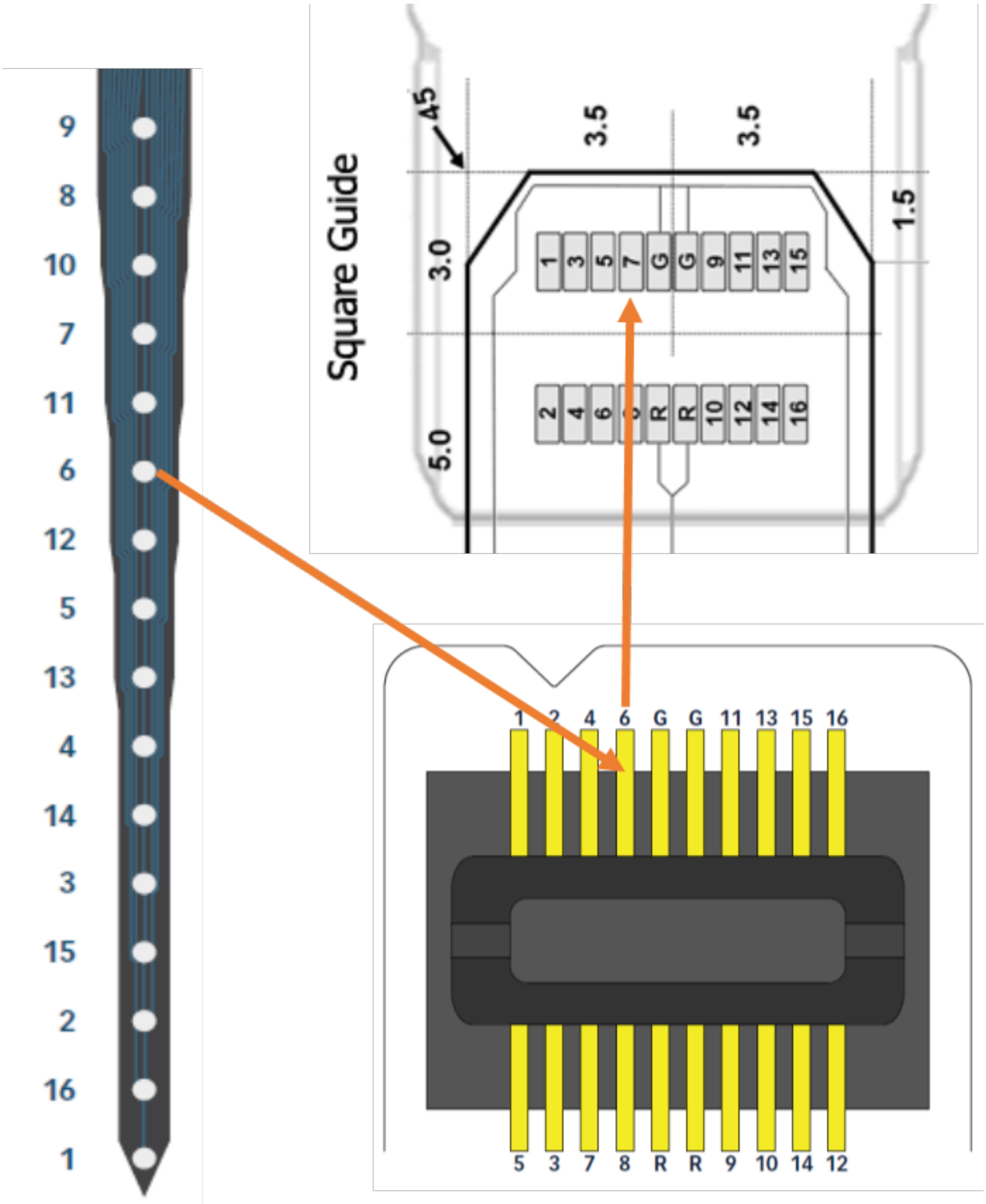
This section is for if you have electrode ordering that you want to re-arrange and your probe pinout does not match the TDT headstage or adapter you are using.

This example uses a Neuronexus A1x16 Z16 probe that has a non-linear electrode order on the Dorsal-Ventral axis and who's pinout does not match the ZC16 analog headstage that could be used for recording. We will visually map out the trace using all the diagrams we have available.



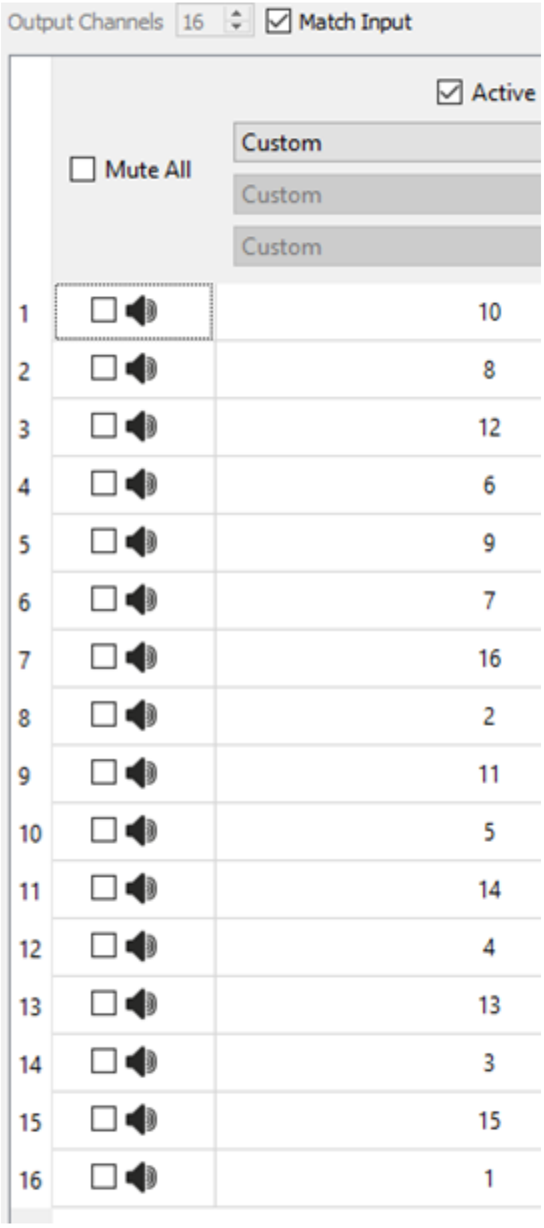
The Trace: We want electrode site 9 to be mapped as channel 1 in Synapse. Electrode site 9 goes to pin 10 on the TDT headstage. So channel 1 in the mapper gets a value of 10. In other words, we remap the preamplifier channel 10 as channel 1 using the mapper.

Jumping ahead by a few channels:



The Trace: We want electrode site 6 to be mapped as channel 6 in Synapse. Electrode site 6 goes to pin 7 on the TDT headstage. So channel 6 in the mapper gets a value of 7.

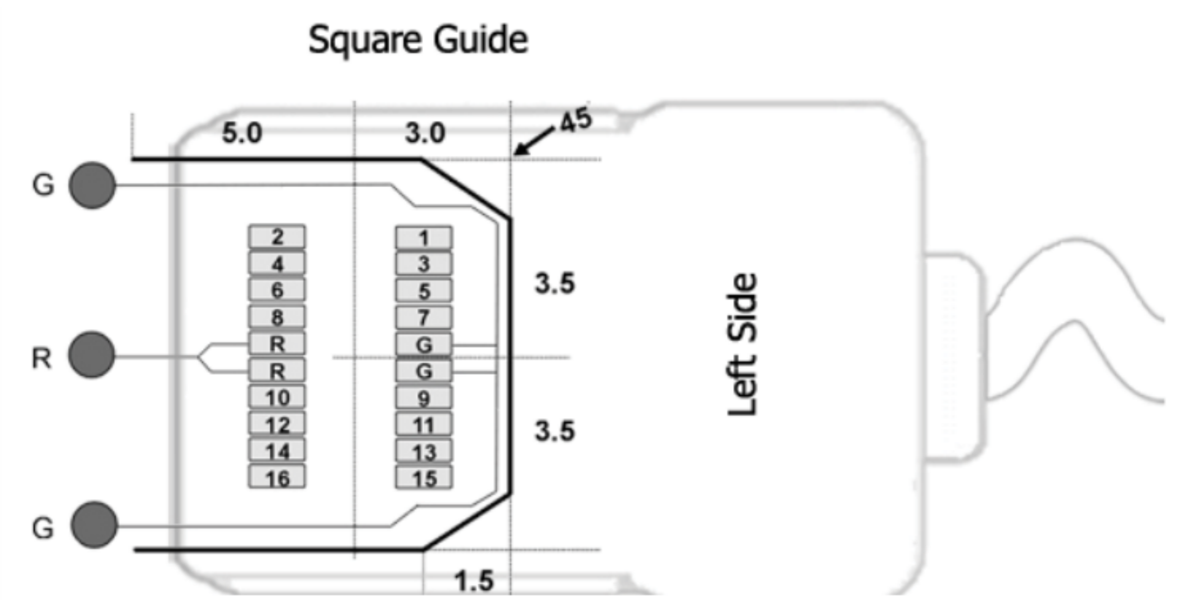
Here is the final map

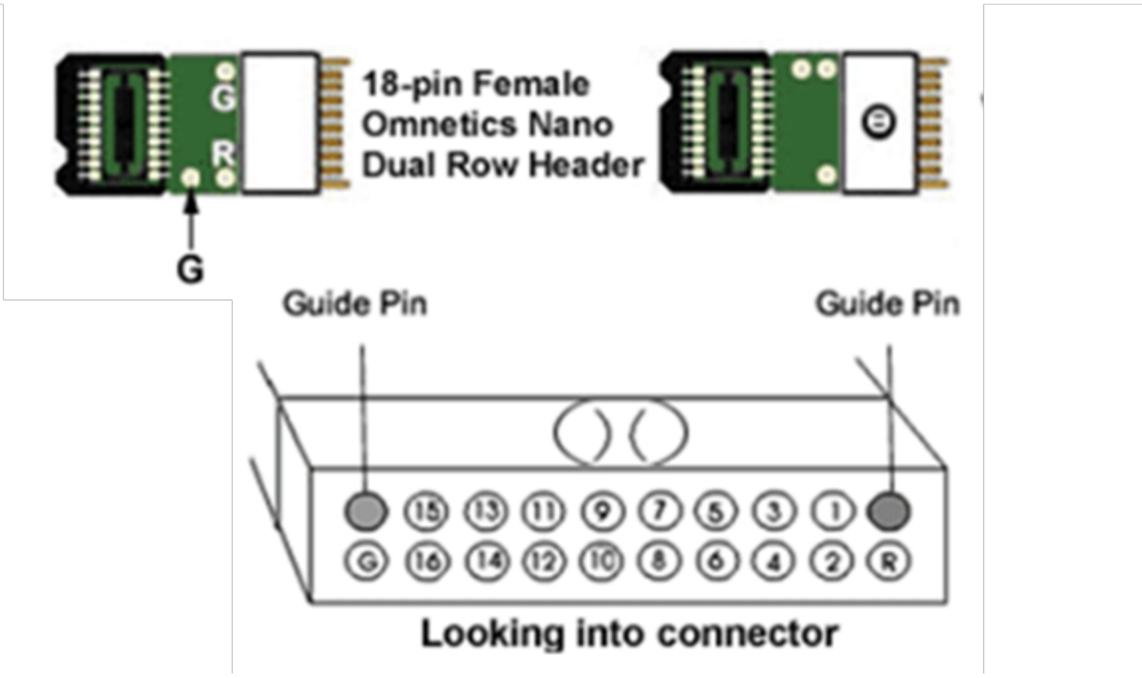


Electrode Re-Order with Pinout Correction: Omnetics Example

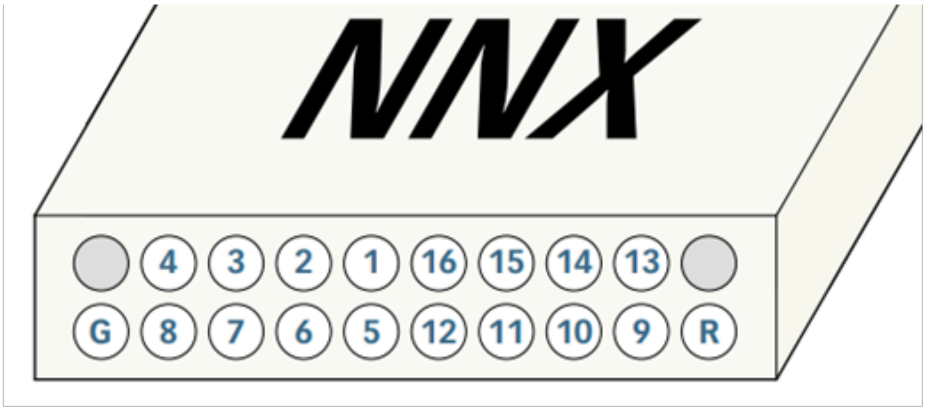
We are going to do another example of electrode site re-ordering with a TDT pinout mismatch, but this time we will be using an Omnetics adapter in between.

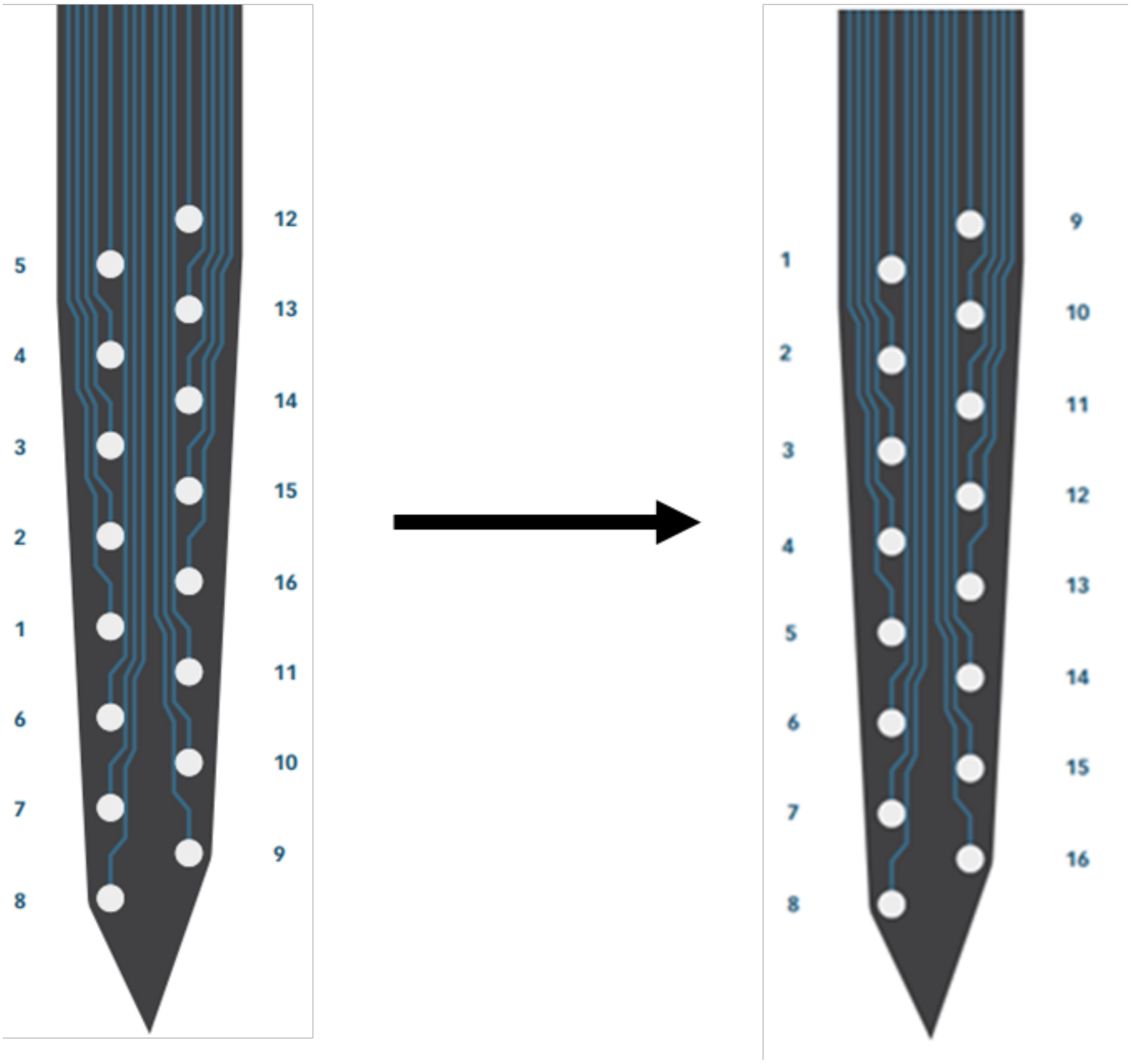
We will use a ZC16 headstage and a ZCA-OMN16 adapter. Recall that, for all analog headstages, the adapter pinout reflects the pinout for the TDT headstage.





Our probe will be a Neuronexus V1x16-Poly2 that we want to remap as such:



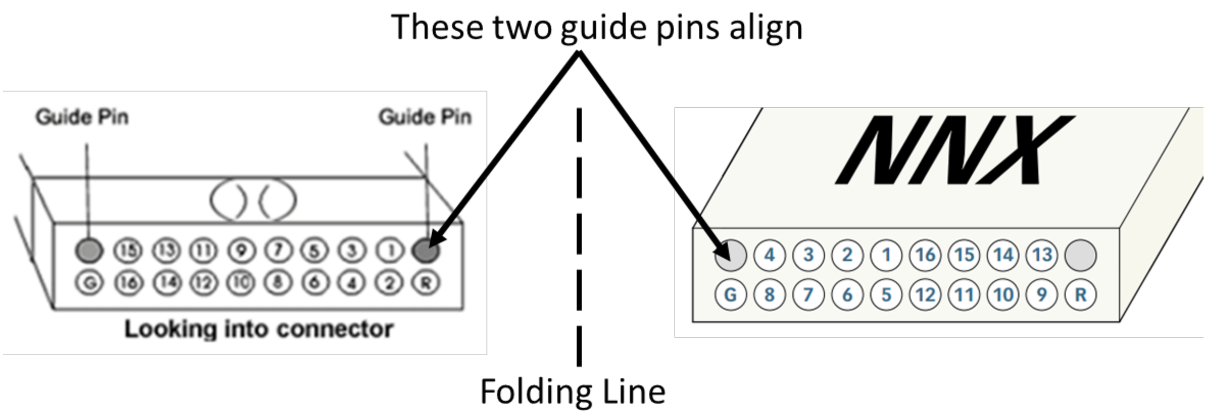


The physical alignment of the female ZCA-OMN16 adapter and the male Omnetics connector on the probe is determined by the guide pins. You can see that the guide pins only connect on one row. To mate the two connectors, you can visualize a vertical line in between them and folding the page in half along the line.

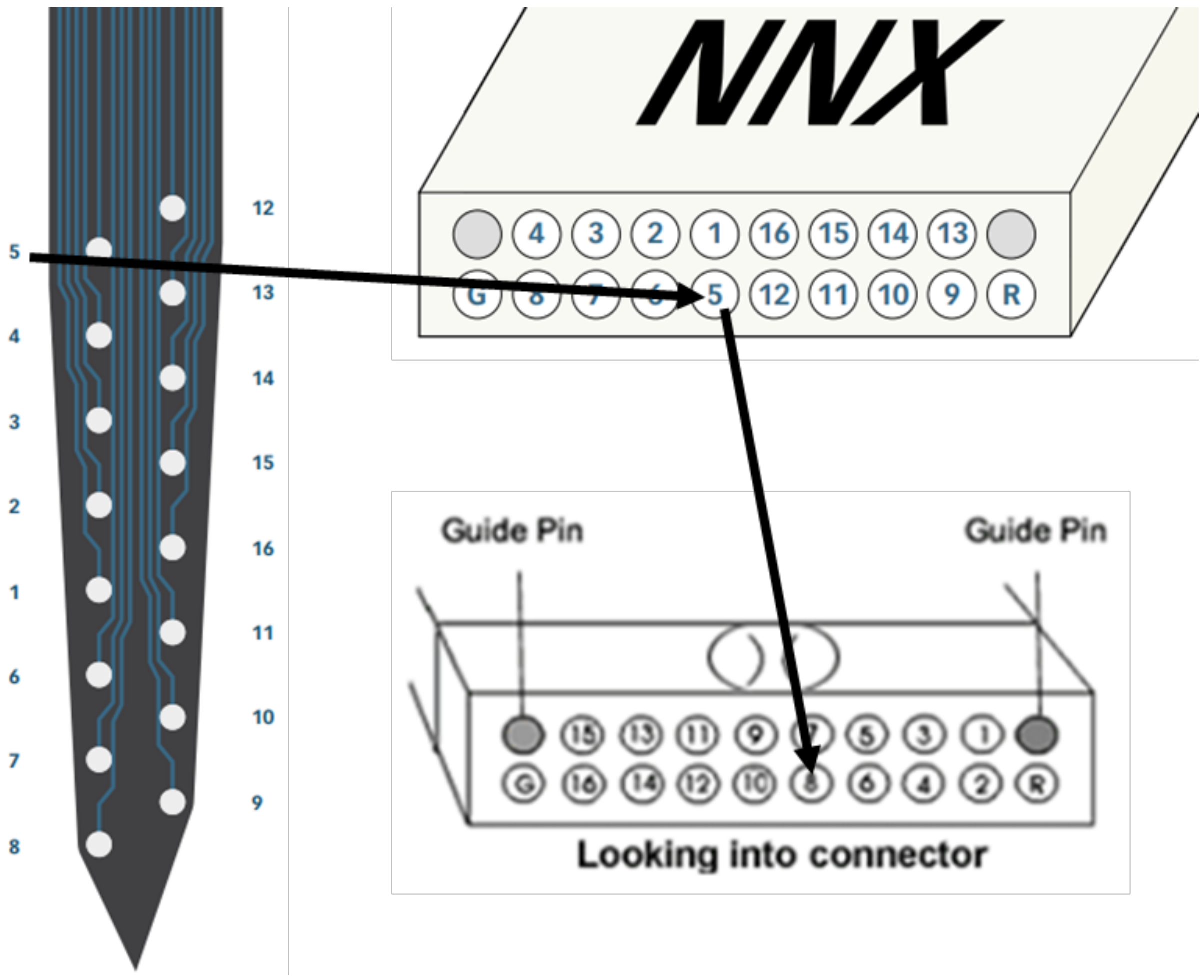
If you follow the 'G' and 'R' pins, which are 'ground' and 'reference,' respectively, you will notice they do not align. We cannot remap these in Synapse because they are inherit to how the signals get created on the headstage. This is not a problem, however, because we can record using a 'single-ended' configuration.

Note

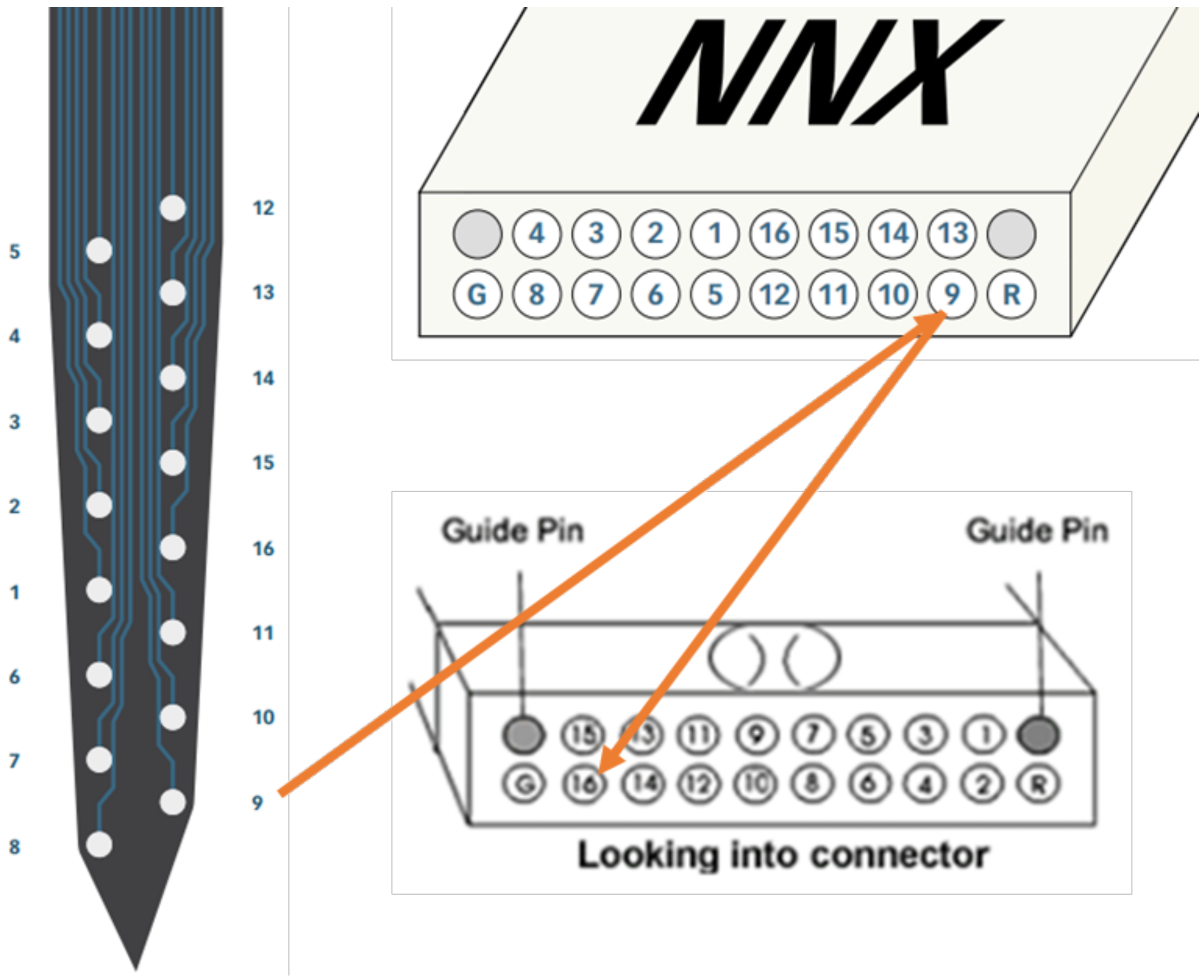
A single-ended recording configuration will leave the G-R jumper on your TDT headstage uncut to keep GND and REF shorted together. A single-ended recording configuration is often desirable for single-unit electrophysiology.



The Trace: We want electrode site 5 to be mapped as channel 1 in Synapse. Electrode site 5 goes to pin 8 on the TDT headstage. So channel 1 in the mapper gets a value of 8.



The Trace: We want electrode site 9 to be mapped as channel 16 in Synapse. Electrode site 9 goes to pin 16 on the TDT headstage. So channel 16 in the mapper gets a value of 16.

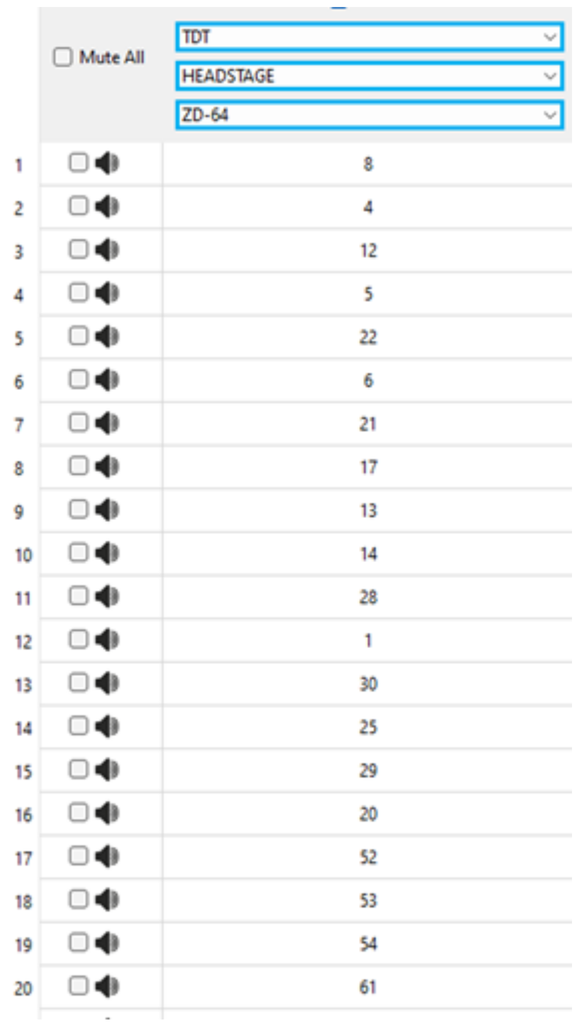

5
4
3
2
1
6
7
8
12
13
14
15
16
11
10
9
NNX
4 3 2 1 16 15 14 13
G 8 7 6 5 12 11 10 9 R
Guide Pin
Guide Pin
15 13 11 9 7 5 3 1
G 16 14 12 10 8 6 4 2 R
Looking into connector

1	8
2	1
3	3
4	5
5	7
6	6
7	4
8	2
9	10
10	15
11	13
12	11
13	9
14	12
15	14
16	16

Using a ZD64 or Greater Digital Headstage with a TDT Adapter (No Electrode Site Re-Ordering)

TDT digital headstages (ZD64, ZD96, ZD128) have a different pinout than their analog counterparts. As such, they need to be remapped to correct for the pinout mismatch because TDT adapters use assumed analog headstage connections for their channel number pinouts.

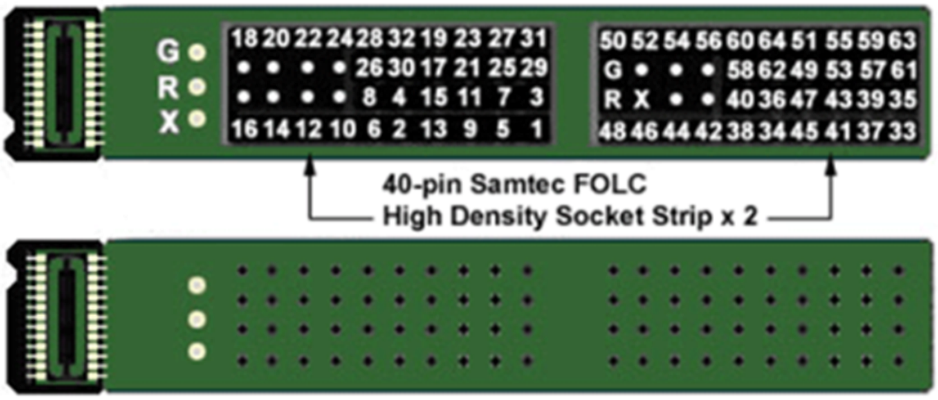
There is a built-in map in the Mapper gizmo for the digital headstages that you can use for the adapters. Make sure to select TDT > Headstage > and whichever ZD channel number your headstage uses.



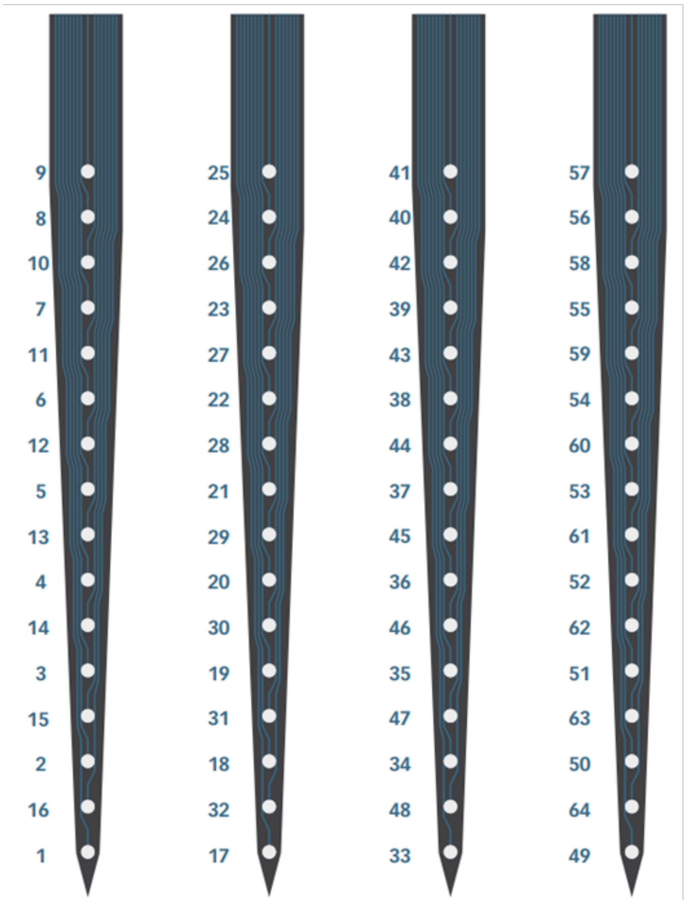
As an exercise, you can look at the ZD64 pinout and the ZC64 pinout to rationalize the map in synapse.

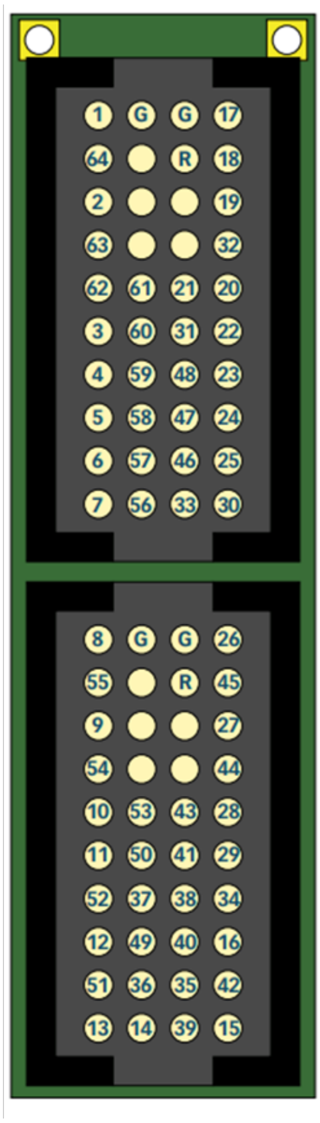
Using a ZD64 or Greater Digital Headstage with a TDT Adapter (with Electrode Site Re-ordering)

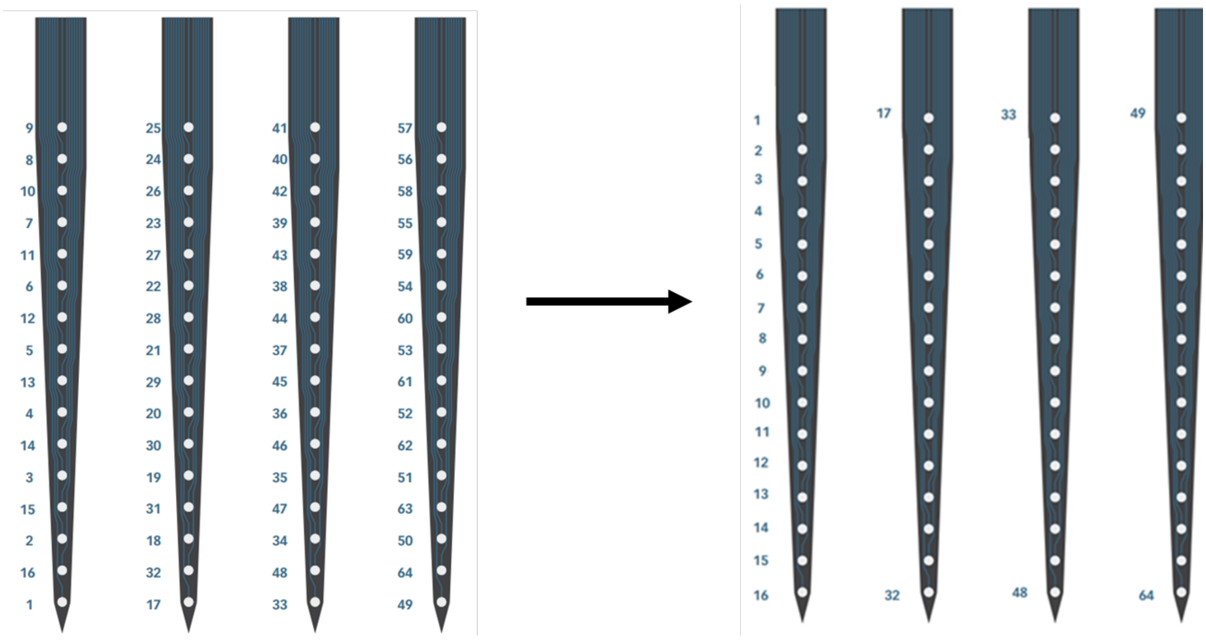
This is the hardest map you can make. In this example, we will use a ZD64 with a ZCA-NN64 adapter that connects to a NeuroNexus A4x16 probe



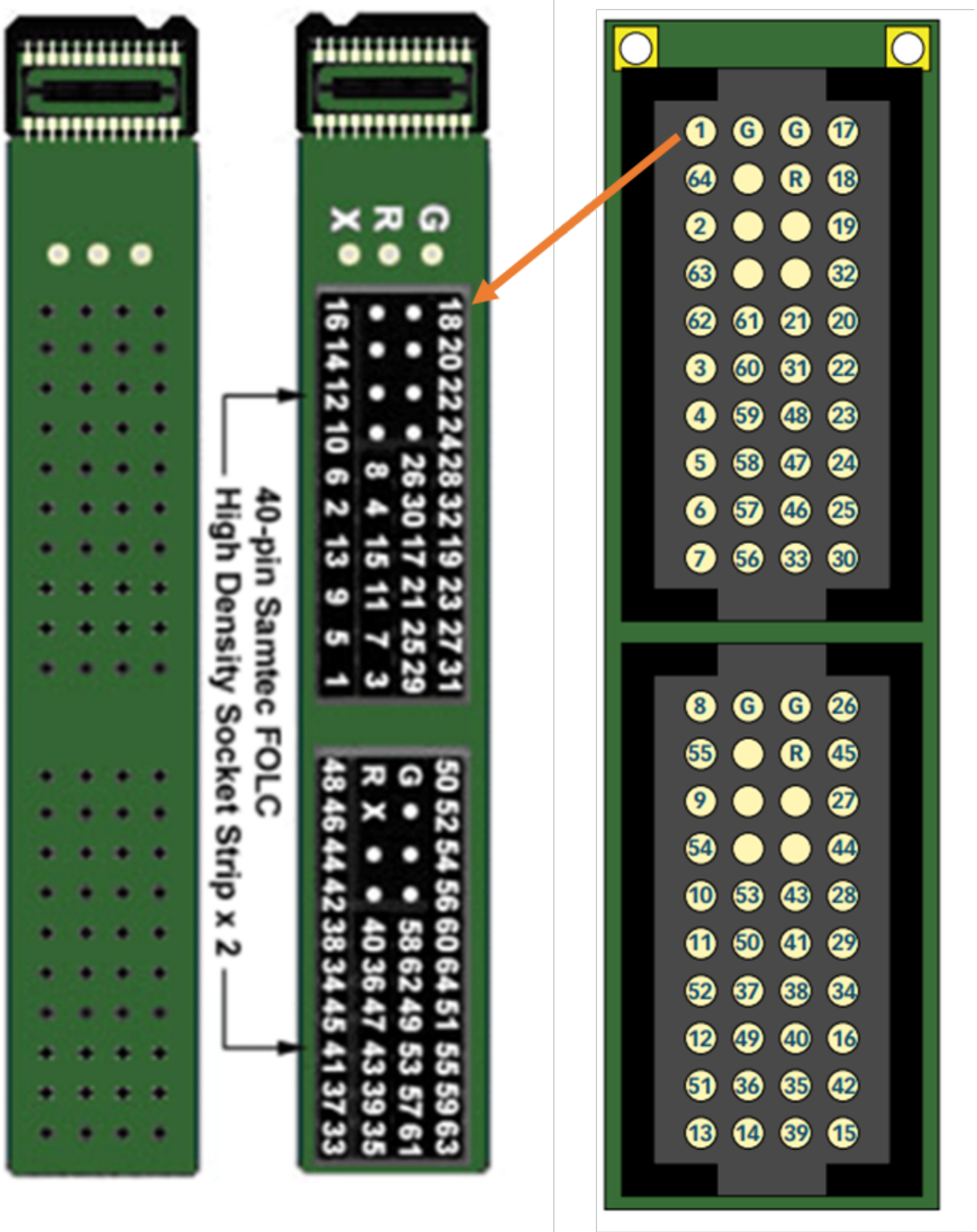
Pinouts are looking into the connector and reflect the preamplifier channels.







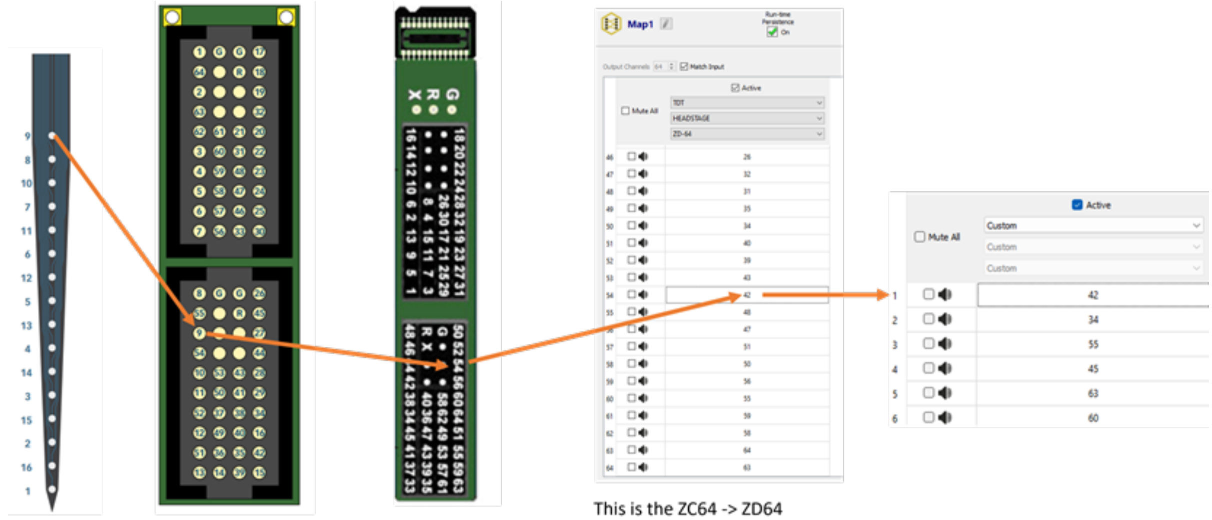
To visualize the connection, imagine the probe connector flipped 180 degrees into the page when connecting to the ZCA-NN64 TDT adapter. Channel '1' on the probe connector mates to channel 18 on the TDT adapter.



Remember that in this example we are also using the ZD64 headstage. This means that, when tracing our route, we must also account for the mismatch between the ZCA-NN64 and the

ZD64. The image below traces the route through to the final map. Note the use of the ZD64 Mapper map at the second to last step to help the translation of analog to digital mapping.

The Trace: We want electrode site 9 to be mapped as channel 1 in Synapse. Electrode site 9 goes to pin 54 on the TDT adapter which goes to pin 42 on the ZD64 headstage. So channel 1 in the mapper gets a value of 42.



This is the ZC64 -> ZD64 conversion map, NOT the final remap for this probe

The Trace: We want electrode site 10 to be mapped as channel 3 in Synapse. Electrode site 10 goes to pin 60 on the TDT adapter which goes to pin 55 on the ZD64 headstage. So channel 3 in the mapper gets a value of 55.