FSCV System Manual

User Manual

v2.0

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Table of Contents

Introduction

This describes all parts and instructions necessary to assemble a 16 channel fast scan cyclic voltammetry system. Please note that this manual is periodically being updated with more through instructions and pictures and therefore some sections are incomplete.

System Setup

Computer and LabVIEW

Parts List

VENDOR	PART NUMBER	DESCRIPTION	QUANTITY	UNIT COST
National Instruments	781100-01	PCIe-7841 R Series Card	2	$3,539.00
National Instruments	776249-03	RTSI Bus Cables	1	$54.00
National Instruments	189588-02	SHC68-68-RMIO Multifunction Cable for R Series - 2 meters	2	$170.00

Power

The isolation transformer helps to diminish external line noise and leads to a cleaner overall signal. The power supply unit provides power to the headstages, which routes through the Breakout Box.

Parts List

VENDOR	PART NUMBER	DESCRIPTION	QUANTITY	UNIT COST
CDW	184802	Tripp Lite Isolation Transformer 1000W	1	$293.99
Digikey	BK1672-ND	B&K Precision 1672 Power Supply	1	$489.00
Digikey	501-1583-ND	Green Banana Plug Cable, 4"	2	$5.29
Digikey	501-1044-ND	Red Banana Plug Cable, 18" (choose best length for lab's setup)	1	$5.89
Digikey	501-1043-ND	Black Banana Plug Cable, 18" (choose best length for lab's setup)	1	$5.89

Assembly Instructions

Step 1: Plugging in the Isolation Transformer and Power Supply

Plug the isolation transformer into a standard 120V wall socket. Next, plug the power supply into one of the isolation transformer's sockets.

Step 2: Connecting the Banana Cables and Setting the Voltage

Replicate the banana plug cables and labeling as seen in Figure 1. Before powering up, set all four dials to their furthest counterclockwise position. Power up the unit and slowly increase each current knob until the respective red CC light turns off and the green CV light turns on. Next, set both voltage dials such that the display reads 15.0V, then power off the unit. Mark on the case where the dials line up with 15.0V (optional).

Figure 1 - Power supply configuration.

Breakout Box

Brief description here

Parts List

The quantities listed below are for making a single breakout box.

VENDOR	PART NUMBER	DESCRIPTION	QUANTITY	UNIT COST
National Instruments	777145-02	CB-68LPR Unshielded 68-pin I/O Connector Block	2	$129.00
Grainger	1ME96	#4-40 x 3/ 8” Screw	1 pk	$2.07 (pk)
Mouser	650-M27500-20SD1T23	20AWG Wire	30 ft	$1.24 (ft)
Digikey	225FE-ND	Female D-Sub 25-pin Connector	1	$1.57
Digikey	377-1210-ND	Shielded Box	1	$113.00
Digikey	ARF1063-ND	Co-Axial (BNC) Connector	2	$5.33
Digikey	367-1169-ND	D-Sub Jack Screw	2	$1.40
Digikey	J151-ND	Red Banana Test Connector	1	$0.93
Digikey	J152-ND	Black Banana Test Connector	1	$0.77
Digikey	399-14006-ND	0.1uF Ceramic Capacitor	1	$6.40
Newark	41K9059	1kΩ Metal Film Resistor	1	$2.16
Digikey	BC4461CT-ND	3kΩ Film Resistor	1	$0.29
Digikey	HM1481-ND	Bumper Feet*	1 pk	$9.06 (pk)
Grainger	1VE49	#6 x 1/4" Sheet Metal Screw*	1 pk	$3.50 (pk)

*Optional purchase

Required Tools:

- Soldering iron, solder, and flux (Grainger #1UYJ2)
- Wire strippers (22 AWG) and cutters
- Dremel (or other rotary saw capable of cutting metal)
- Drill with metal compatible bits (1/8”, 1/2”, and 9/16”)
- Phillips screwdriver (P1)
- Flathead screwdriver (3mm)

Optional Tools:

- Heat gun and heat shrink tubing (recommended sizes: 3/32” and 1/8”) or liquid insulation (GC-Electronics #10-1762)
- Label maker
- Precision knife (for removing tubing)
- Helping hands, clamps, pliers (for holding and manipulating wires while soldering)

Channel Mapping

Board 0		
Screw Terminal (J#)	**DB25 Pin**	**Channel Number**
J68	DB-6	1
J66	DB-8	2
J65	DB-18	3
J63	DB-20	4
J62	DB-1	5
J60	DB-2	6
J59	DB-3	7
J57	DB-4	8

Board 1		
Screw Terminal (J#)	**DB25 Pin**	**Channel Number**
J68	DB-10	9
J66	DB-11	10
J65	DB-12	11
J63	DB-13	12
J62	DB-15	13
J60	DB-16	14
J59	DB-17	15
J57	DB-19	16

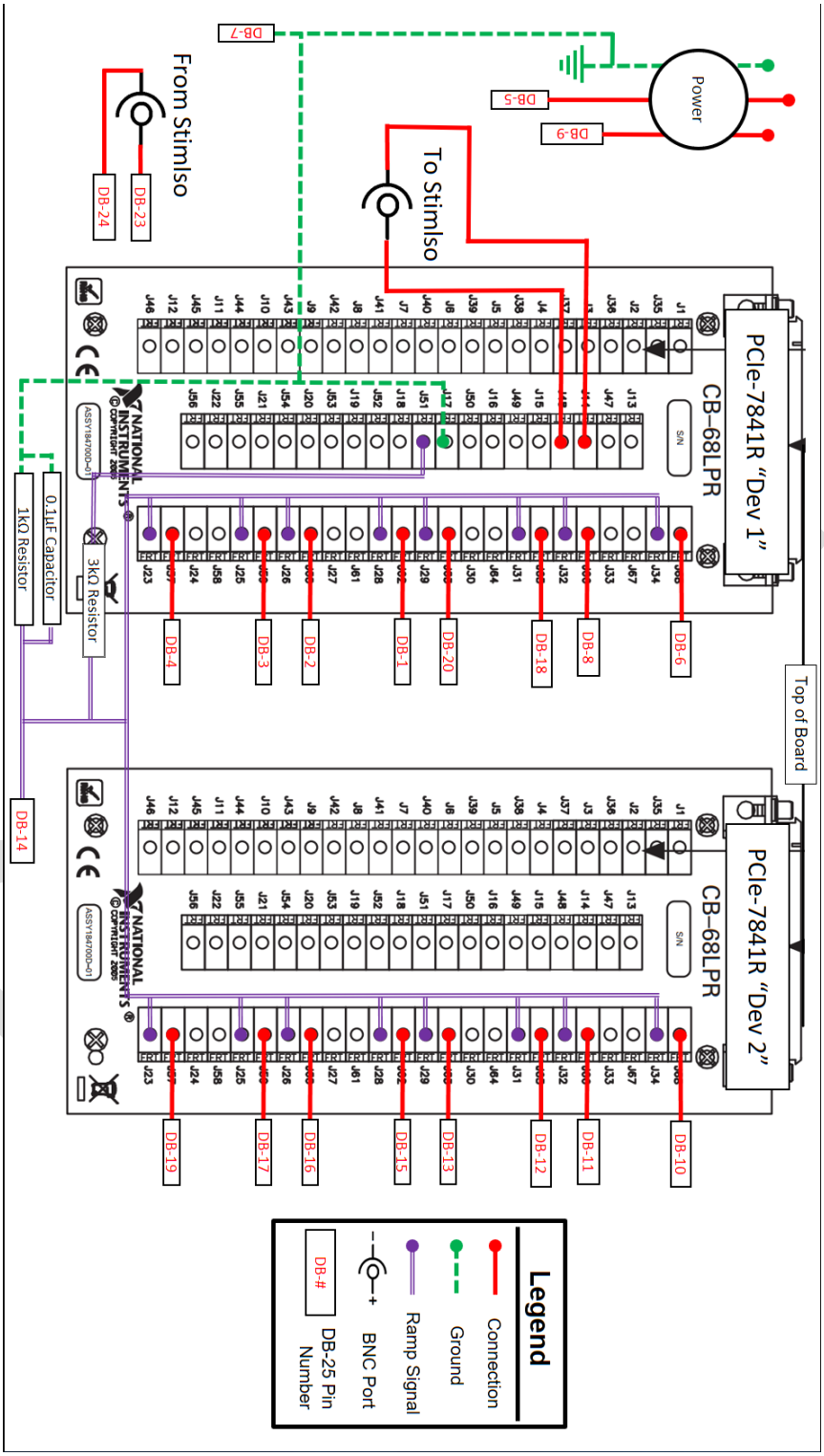
Wire Labels

Below is a sheet of wire labels that may be helpful in keeping wires organized while building. The labels are written such that the route of the wire is readily available (i.e. the label “B0 J68 | DB-6” would indicate the wire’s path from block 0, terminal J68 to the 6 pin on the DB25 port).

B0 J68	DB-6		B1 J68	DB-10
B0 J66	DB-8		B1 J66	DB-11
B0 J65	DB-18		B1 J65	DB-12
B0 J63	DB-20		B1 J63	DB-13
B0 J62	DB-1		B1 J62	DB-15
B0 J60	DB-2		B1 J60	DB-16
B0 J59	DB-3		B1 J59	DB-17
B0 J57	DB-4		B1 J57	DB-19
B0 J51	3 kΩ RESISTOR		FROM STIM (+)	DB-23
B0 J48	TO STIM ISO (+)		FROM STIM (-)	DB-24
B0 J14	TO STIM ISO (-)		V- (-15V)	DB-9
B0 J17	GND		V+ (+15V)	DB-5
B0 J17	FILTER		IN (RAMP)	DB-14
R2 (GND)	DB-7			

Wiring Diagram

This diagram can be taped to the inside of the lid of the box for quick reference



Assembly Instructions

Step 1: Cutting the Box

The box design that will be shown in this manual will follow this layout, with gray areas representing the vertical walls of the shielded box, and the connector blocks and power on the same side of the box as the pre-drilled vents (Figure 2). This layout is not mandatory, however this guide will focus on the design below.

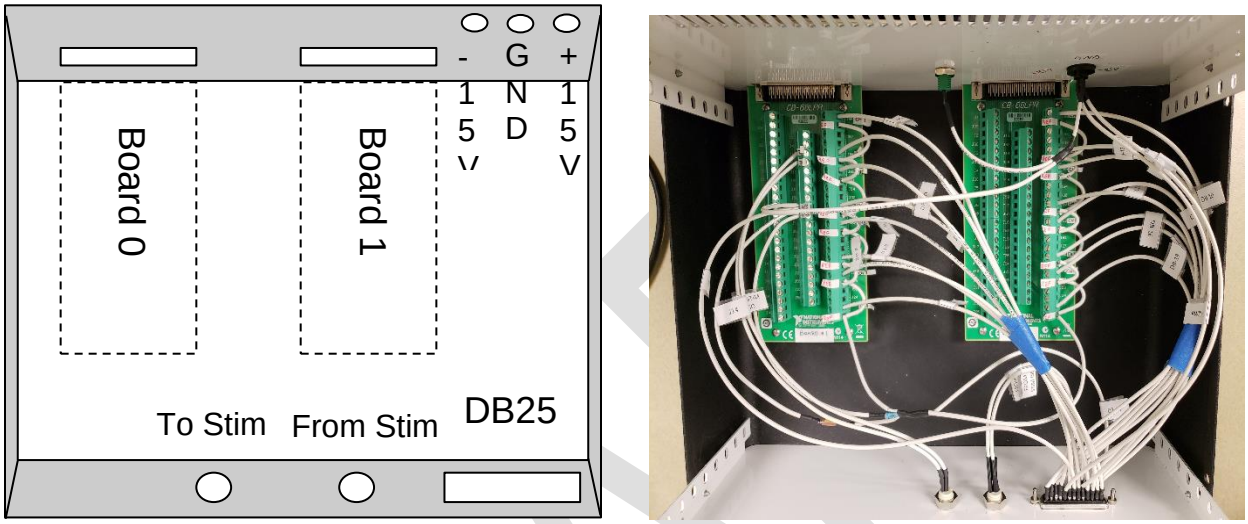


Figure 2 - Layout schematic (left) and resulting box (right).

Tips for cutting the box:

- Remove the panel from the box and prop on between steady surfaces (i.e. wood blocks) as the metal is malleable and will bend under the pressure of the drill/dremel.
- Trace out the cuts directly on the panels for precise cuts. Clean the box with IPA to remove any stray marks later.
- Be aware of how high the cuts need to be as the NI connector blocks may sit at different heights depending on what size standoffs are used.
- Hand turn a larger drill bit on drilled holes to clean up the edges and allow for connectors to sit flush with the box.

Connector Blocks: Cut a 6.5cm x 1cm hole with additional 7mm x 2mm linear cut on the bottom edge to allow for the connector to latch to the box without adding additional stress to the connector block. The NI connector blocks have a groove on the top edge of the connector (Figure 3). By feeding this through the hole and latching it, the connector blocks will stay in place and make for an easier and more secure connection (Figure 3).

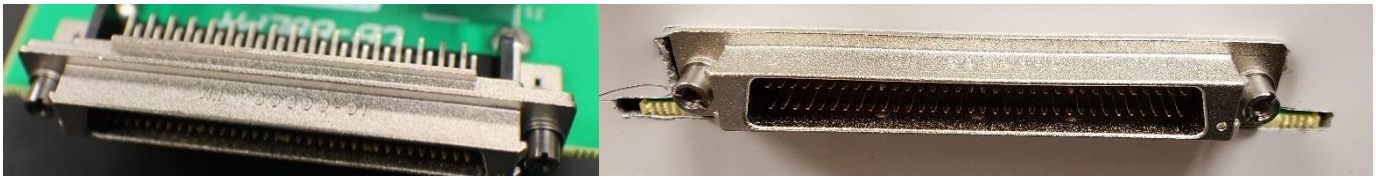


Figure 3 - Connector block with groove (left). Connector block in place in the box (right). Note that the linear cuts allow for the PCB to sit flush with the box without additional stress on the connector block.

The bottom of the box also needs to be drilled in order to hold the NI Connector Blocks firmly in place. Drill 4 holes (using 1/8" drill bit) for each connector block so that the middle of the standoffs (that should have been included with the NI Connector blocks upon arrival) will match. To mark the area to drill, secure the panel with the connector block holes cut out in place. Then latch the connector block in the hole and mark around the base of the standoffs with a pencil to mark the drill hole placement. (see Appendix for a template that can be aligned under the connector block and taped in place for easy drilling).

Once the holes have been drilled, use the #4-40 screws to secure both connector blocks (Figure 4). The box is shipped with 4 self-adhesive bumper feet, adding those to the bottom of the box at this point will prevent the screws from scratching work surfaces and allow for a steady surface to work with when soldering.

Figure 4 - All 8 screws have been placed and are securing the connector blocks. In the upper part of the image you can see 2 of 4 bumper feet that are attached to the bottom of the box at this point.

DB25: Cut a 4cm x 1cm hole.

Banana Jacks and Stim Iso Ports: Cut a 1cm radius hole for each.

NOTE: One banana jack is used to ground the box. This can also be accomplished by directly grounding to the box; however, the metal of the box will need to be exposed from under the paint via use of a dremel or sand paper for a proper connection.

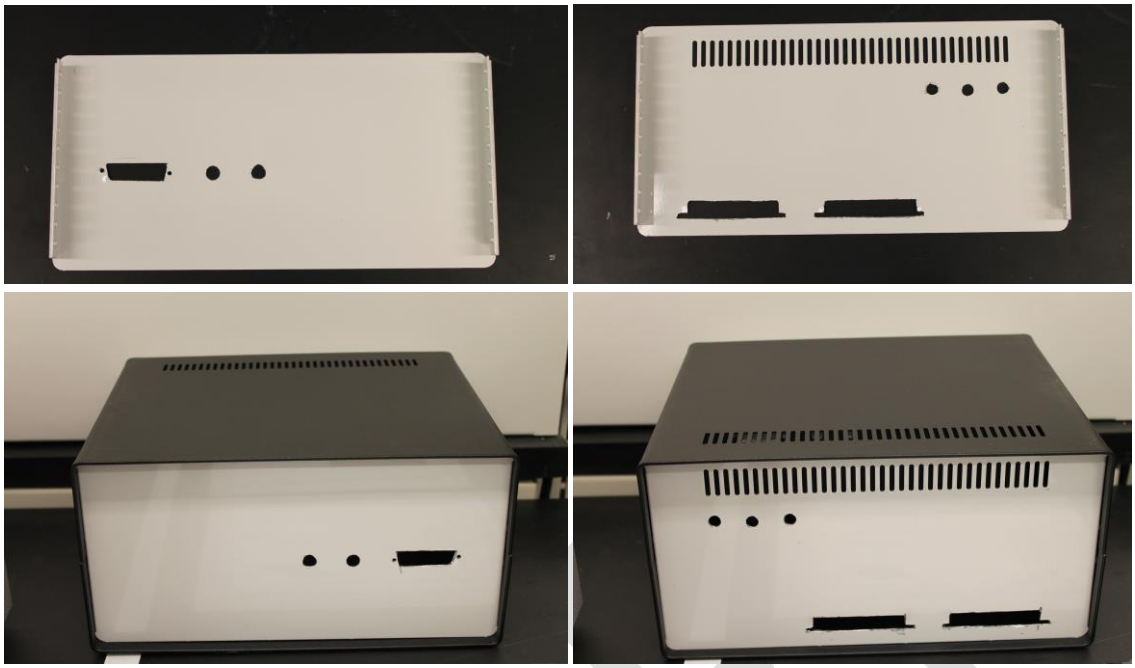


Figure 5 - Front panel (top left) and back panel (top right) with holes cut out. Front panel (bottom left) and back panel (bottom right) secured within the box.

Step 2: Soldering DB25 Port

Measure out 22 pieces of 30cm of wire for each DB25 connection that will be able to reach its designated screw terminal. Labeling the wires at this point will help to keep the box organized. Strip the insulation and shielding from the tips of the wires. It's recommended to strip the outside insulation 3/8" and the inner insulation 1/8". Solder a wire in place for every DB25 pin that is designated on the Wiring Map. As a quick reference all pins except 21, 22, and 25 will be assigned a wire. While not required, 10-15mm length of shrink tubing (3/32") or liquid insulation can be used on these connections if so desired.

IMPORTANT: Do not tin both ends of these wires at this point. Wires that will terminate at the connector block screw terminals should not be tinned as the screw terminals will put additional stress on tinned wires and may cause them to break over time.

Step 3: Soldering the Power, Banana Jack, and Stim Iso Ports

Secure the BNC connectors for the Stim Iso ports, banana jack, and DB25 connector in place within the box. Keeping the panels separated from the box will make soldering easier. Solder the connections on the Stim Iso ports as described in Figure 6. Use 1/8" shrink tubing on the Stim Iso ports and the banana jacks to insulate the wider connections and 3/32" shrink tubing to insulate the thinner connections.

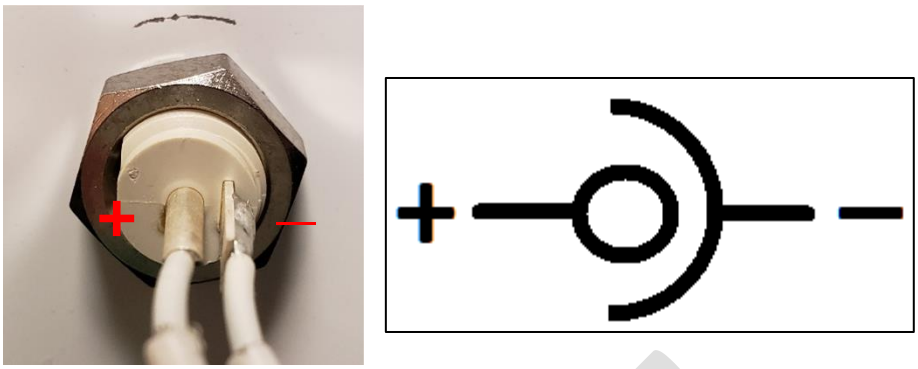


Figure 6 - Each Stim Iso Port is one BNC connector with the center (tip) pin shown on the chart as the positive terminal, and the ring (ground) tab as the negative terminal. Soldered BNC (left) and schematic (right).

It is recommended to color code the banana jacks with red being for positive, black for negative, and green for the ground. The ground wire will be routed to the banana jack and block 1 terminal J17. The positive jack will be routed to DB25 pin 5 and the negative jack will be routed to DB25 pin 9 (Figure 7).

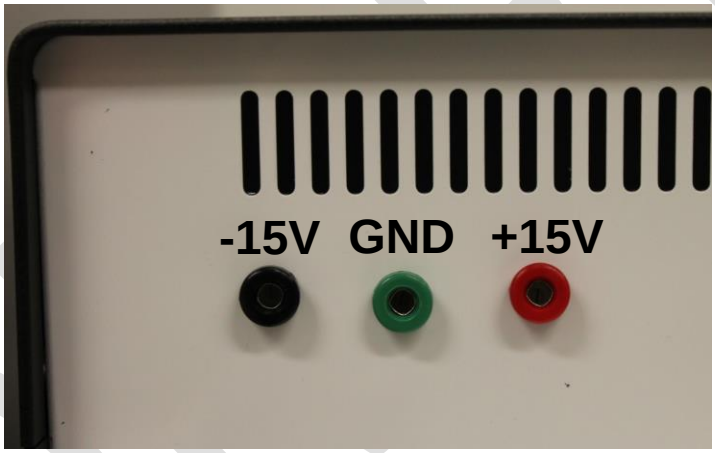


Figure 7 - Banana jacks from outside of the box.

Step 4: Creating the Reference Wire

Cut eight 8cm and six 5cm pieces of wire; these will reach between the reference terminals on the connector blocks and route by following the wiring diagram. Use longer pieces between terminals that are further apart and shorter pieces for terminals that are closer to each other. Because multiple wires will be assigned to the same terminal, stripping a longer length of the outer insulation away from the wire than the inner insulation will allow for more wires to fit in with minimal stress to the wire tips (Figure 8).

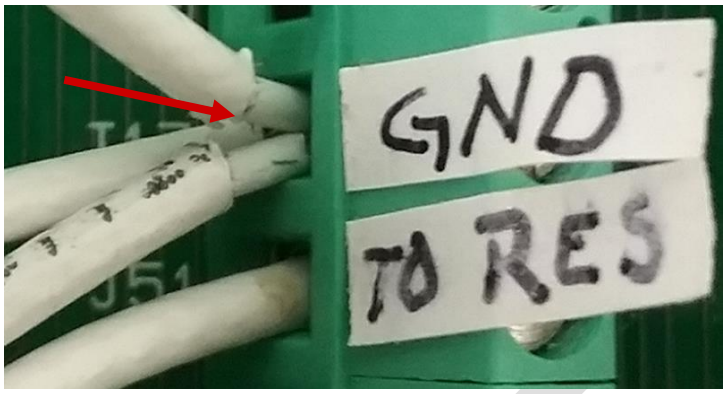


Figure 8 - Three wires are able to fit in the ground terminal because of the outside insulation being stripped back from the inner wire as indicated by the red arrow.

Step 5: Wiring the DB25 to the Connector block

Route each wire from the DB25 connector to its respective terminal on the connector block. Bundling wires that go to the same connector block will help keep them sorted and out of the way while matching them to their respective terminals. In this guide, blue masking tape was used for easier visibility in this guide (Figure 9).

IMPORTANT: It is not recommended to solder or tin wires going into the screw terminal, as the pressure exerted by the screw will cause the solder to flow over time and may cause the wires to become brittle and break.

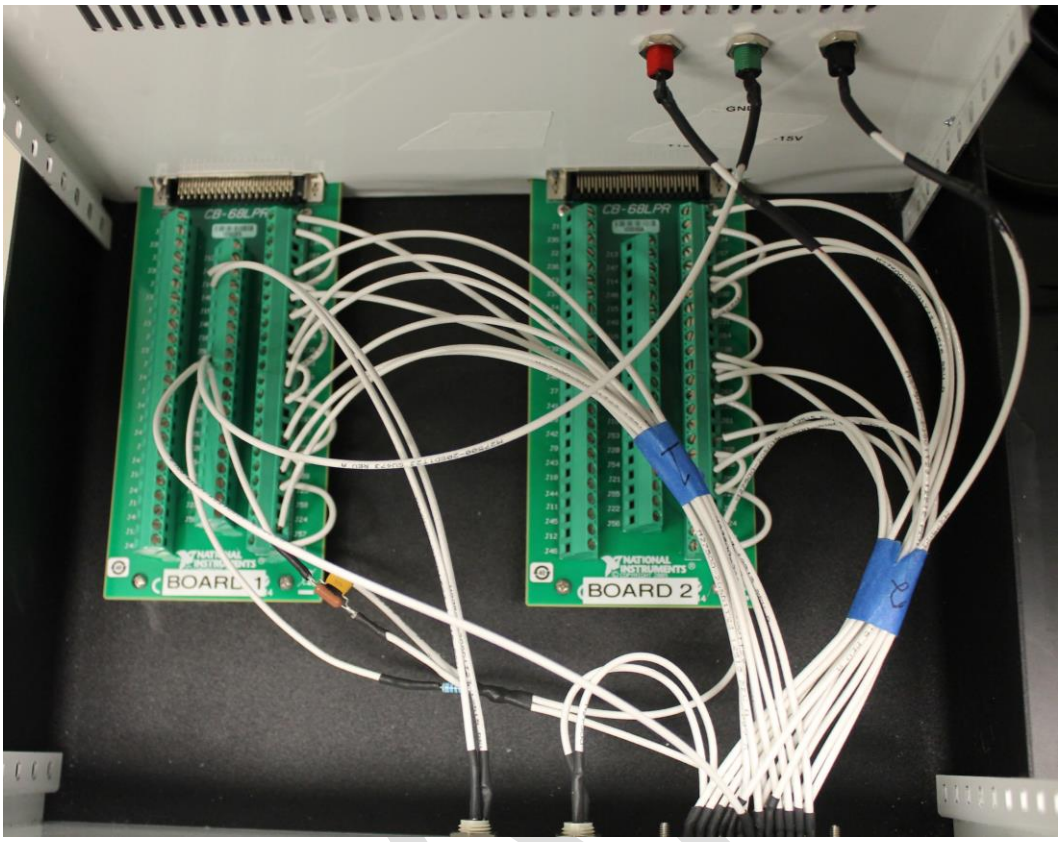


Figure 9 - Larger image of the final box with all components in place.

Step 6: Building the Analog Filter

The analog filter is constructed using a 1kΩ resistor soldered in parallel with a 0.1µF capacitor. Assembling the filter (Figure 10) outside of the box and then making the final solder to DB25 pin 14 before routing the rest of the wires to their appropriate terminals will make this step much easier and lessen the chances of burning insulation off of other wires. Four 20cm lengths of wire should be enough to reach each screw terminal on both boards. A shorter length, 5-7cm, will be enough to make the connection between the 3kΩ resistor and the analog filter.

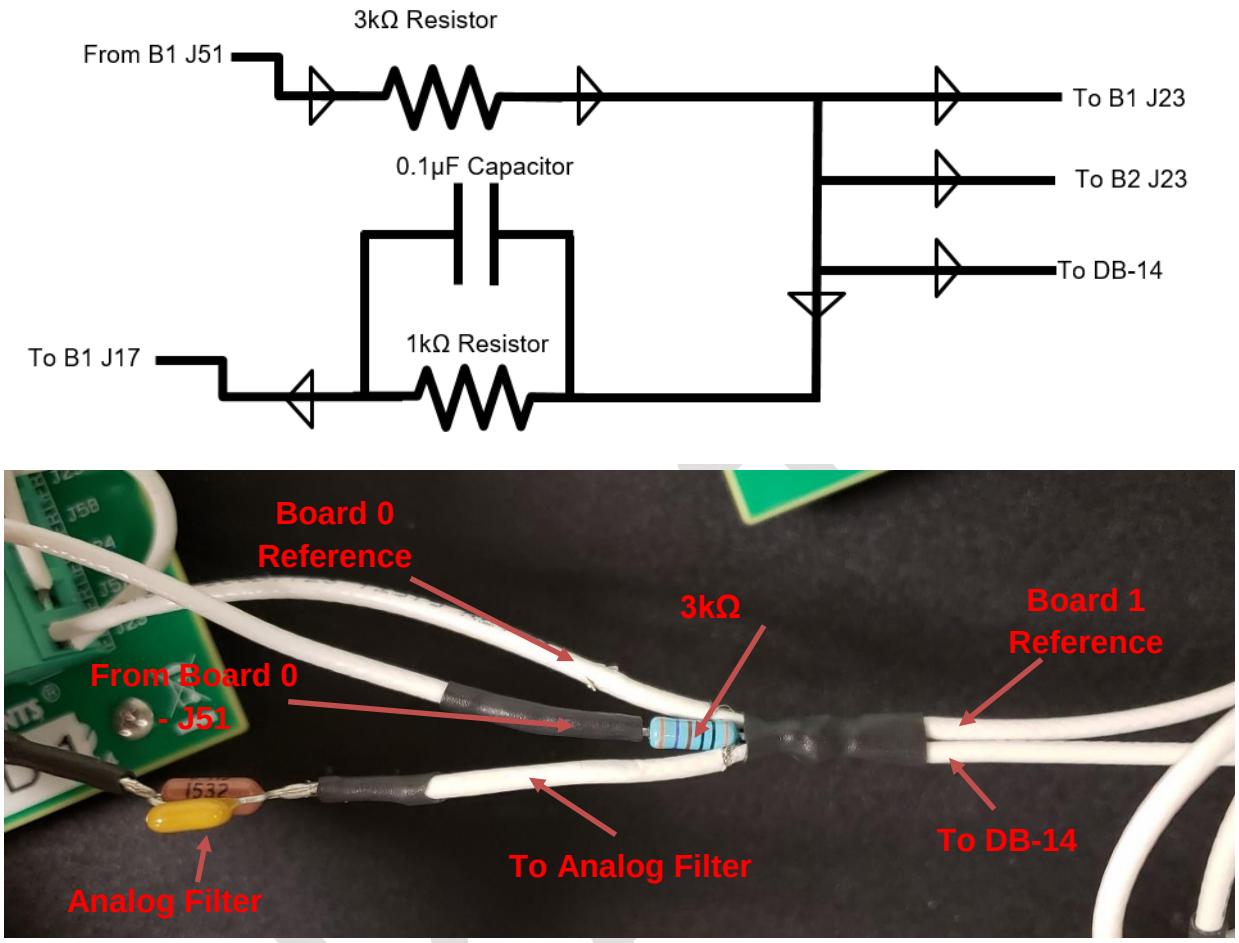


Figure 10 - Schematic showing the path to and connection between each component of the analog filter (top). (Bottom) Full circuit with wires and annotations.

Final Touches

Below are some suggestions to finish off the box:

- Label ports inside/outside the box (channels, polarity of ports, etc.)
- Tie wire bunches together to keep them together
- If not done so already add bumper feet to keep the box elevated so the screws on the bottom do not drag on surfaces.
- If shrink tubing was used, be sure to check that all junctions with the tubing have been properly shrunk to size.

Breakout Box to Headstage Cable

This cable connects the breakout box to the headstage. It carries the signals for the 16 individual channels, supply voltage, reference (GND), and input (Ramp). In addition, it can carry the stimulation signal supplied by an external source that routes through the breakout box.

Parts List

The quantities listed below are for making a single cable.

VENDOR	PART NUMBER	DESCRIPTION	QUANTITY	UNIT COST
Digikey	225ME-ND	Male D-Sub 25-pin Connector	1	$1.42
Digikey	925UAE-ND	D-Sub Enclosure	1	$10.93
Digikey	MB24S-50-ND	24 Conductor Wire Bundle (50')	1	$147.01
Grainger	22KY60	1/16” ID Heat Shrink Tubing (25’)	1	$11.45
Omnetics	A79029-001	36 Position Dual Row Female Nano-Miniature with 18.0" 34 AWG Lead-Wire - Omnetics Breakout‡	1	$104.44
Mouser	992-DB25F-TERM	DB25 Female Breakout Board	1	$15.74

‡Typically has a 6-8 weeks lead time. Prices are based on the minimum quantity needed to reach the vendor’s $200 per part minimum order. Contact vendor directly for the most up to date pricing.

Required Tools:

- Razor blade
- Small pointed scissors (Grainger #22UN25 or similar)
- Wire strippers (28 AWG) and cutters
- Source of fire (candle, blowtorch, Bunsen burner, etc.) or hot-tweezers
- Fine tip soldering iron, solder, and flux
- Multimeter capable of detecting continuity/shorts
- Heat gun

Optional Tools:

- Interface Board
- Wooden block
- Removable mounting putty
- Hot glue gun

Cable Mapping

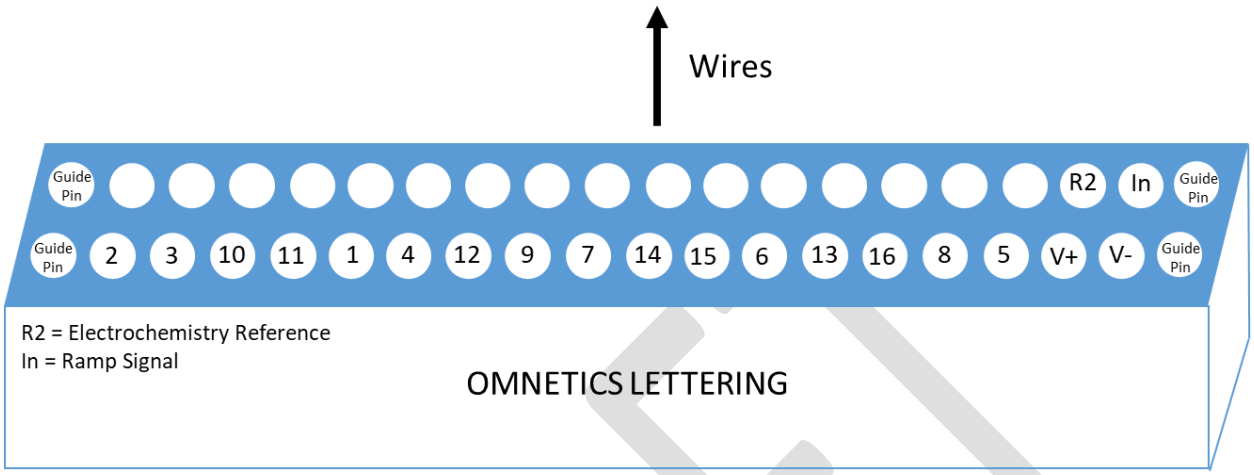
Below is the standard wire mapping for the cable. This mapping does not include the colors from the Omnetics connector cable as there are repetitions in the colors. How to properly map and connect this the Omnetics cable will be covered in the assembly instructions.

System Channel	24 Wire Bundle Color (Major – Minor)	DB25 Pin
5	Black – Blue	1
6	Red – Blue	2
7	Black – Red	3
8	Blue – Black	4
V+ (+15V)	Blue – Red	5
1	Black – Green	6
R2 (GND)	Red – White	7
2	Brown – Black	8
V- (-15V)	Yellow – Black	9
9	White – Black	10
10	Black – Yellow	11
11	Green – Red	12
12	Green – Black	13
In (Ramp)	White – Red	14
13	Red – Black	15
14	Black – White	16
15	Orange – Black	17
3	Brown – Red	18
16	Red – Brown	19
4	Red – Green	20
–	–	21
–	–	22
From Stim +	Yellow – Red	23
From Stim -	Red – Yellow	24
–	–	25

Un-used wires: Black – Orange and Black – Brown.

Omnetics Breakout Connector Mapping

Below is the mapping for the Omnetics breakout connector. The numbering and lettering correspond to the system channels column in the Cable Mapping table (page 23).



Assembly Instructions

Step 1: Preparing the 24 Wire Bundle

First, cut the 24 wire bundle to the overall desired length. From one end remove 4cm of primary insulation (razor blade), braided mesh (scissors), and foil (scissors). Separate the wires and strip away 4-5mm of insulation from each individual wire. Cut away the black-orange and black-brown wires (major-minor colors). If the stimulation signal is not going to be routed through the cable then the yellow-red and red-yellow wires can be cut away. After stripping the insulation, tin the exposed wire by twisting the ends, dipping them into flux, and applying a small amount of solder (Figure 11).

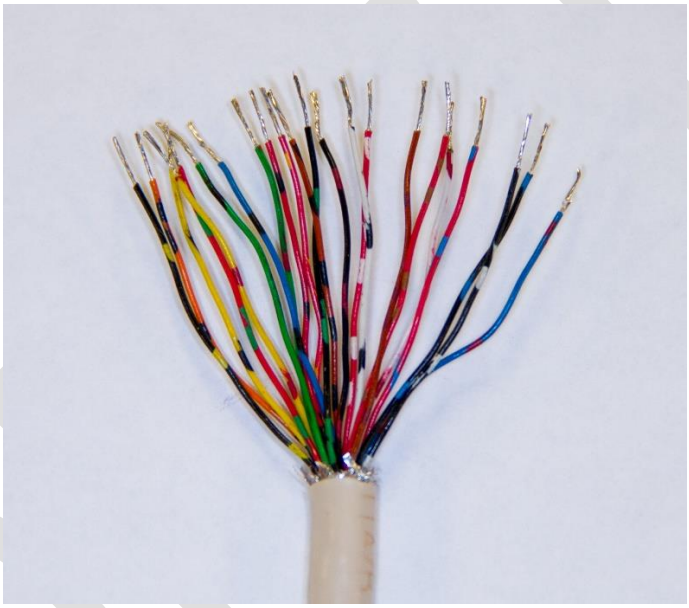


Figure 11 - Cut, stripped, and tinned wires for DB25 connector end.

At the other end of the 24-wire bundle, remove the desired length of primary insulation, braided mesh, and foil. For freely moving animal experiments we recommend exposing 8-12" as this minimizes the amount of torque on the animal. Separate the wires, **but leave the red-white & white-red pair twisted**, and strip away 4-5mm of insulation from each individual wire. Cut away the black-orange and black-brown wires (major-minor colors). If the stimulation signal is not going to be routed through the cable then the yellow-red and red-yellow wires can be cut away. After stripping the insulation, tin the exposed wire by twisting the ends, dipping them into flux, and applying a small amount of solder (Figure 12).

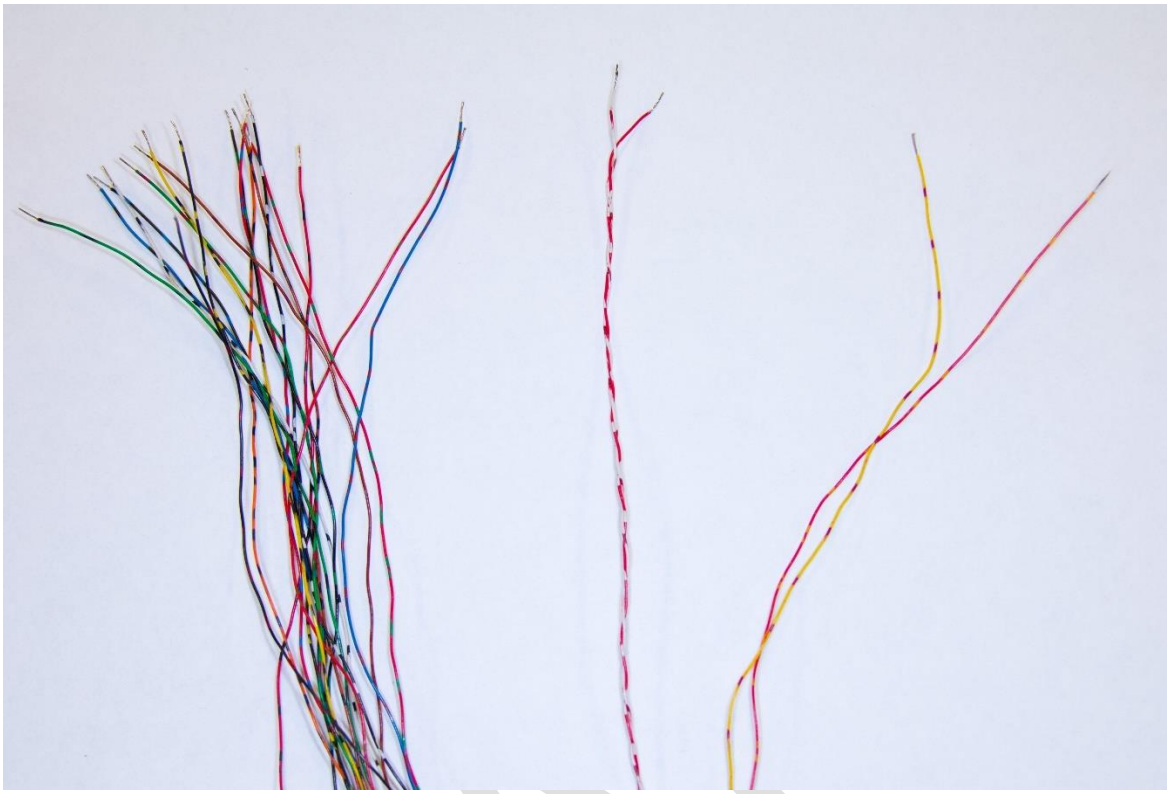


Figure 12 - Cut, stripped, and tinned wires for "headstage" end. Wires carrying channels 1-16, V+, and V- (left), twisted red-white and white-red wires carrying R2 (GND) and In (Ramp) (middle), and From Stim +/- wires (right).

Step 2: Preparing the Omnetics Breakout Wires

To prepare the Omnetics breakout wires, first remove the unused wires. Flipping the connector to the backside (no lettering showing) remove all but the two left most wires (Figure 13). Save these cut wires to use for practice when removing insulation. Lastly, trim the remaining wires to the desired length. For freely moving animal experiments, we recommend leaving the wires at their original length as this minimizes the amount of torque on the animal.

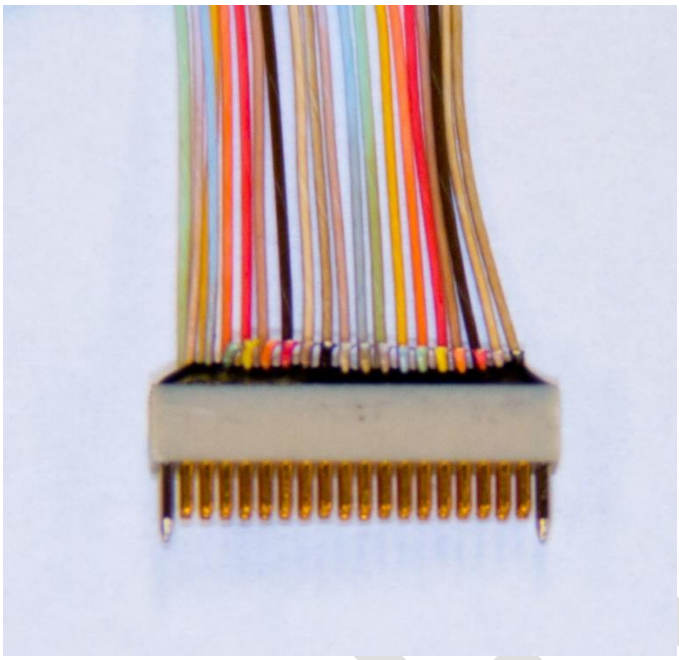


Figure 13 - Omnetics breakout connector with removed wires.

To remove the insulation from the Omnetics breakout wires a flame is the quickest method. This can be a small blowtorch, candle, Bunsen burner, etc.; the key requirement is that it is hands free once lit. Using the saved wires from before, practice removing the insulation by passing the wire through the flame. The extreme heat will cause the insulation to contract. Once 4-6mm can be consistently exposed, apply this technique to the actual bundle (Figure 14). Alternatively, use a set of hot-tweezers to strip away the insulation.

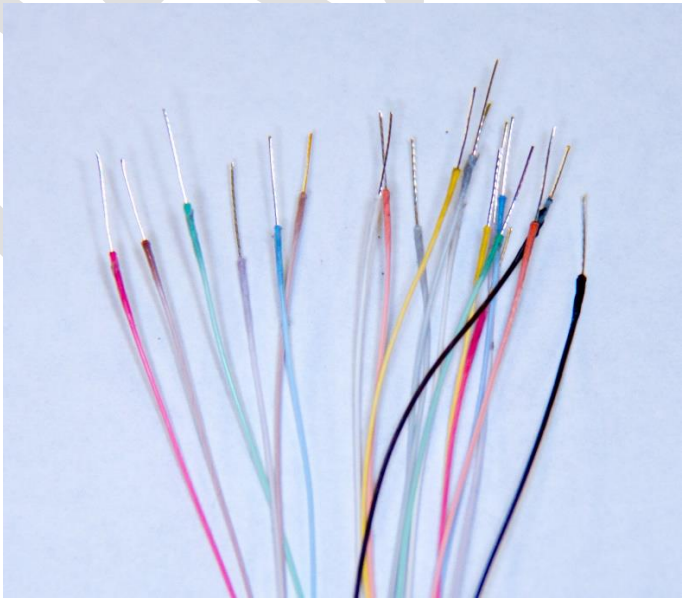


Figure 14 - Exposed Omnetics wires.

Step 3: Soldering the 24 Wire Bundle to the Male DB25 Connector

Before soldering the wires to the DB25 connector, thread on the D-sub enclosure's cable slot entry tab (Figure 15, red arrow). Using the Cable Mapping table (page 23), solder each colored wire to the corresponding DB25 connector pin. A wooden block with putty can help during soldering (Figure 15).

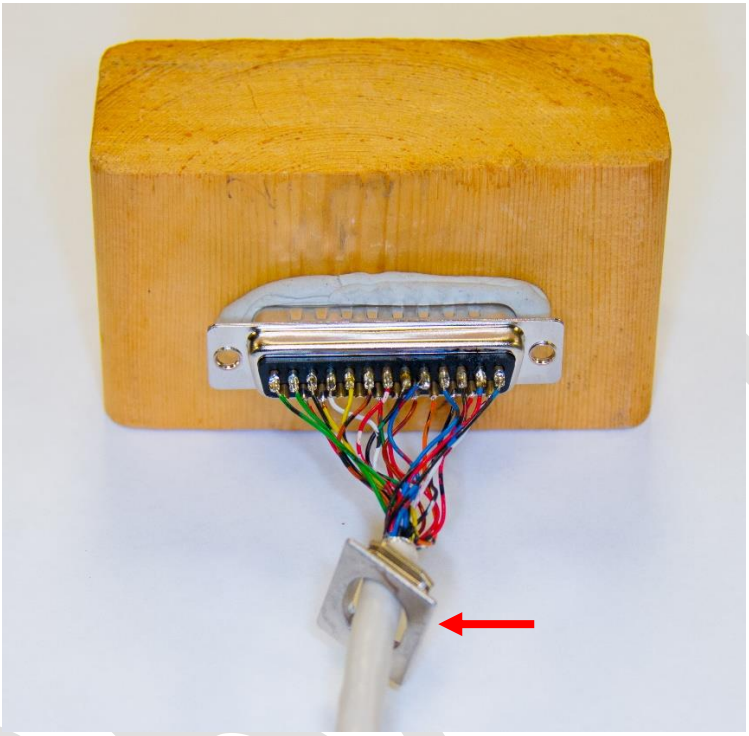


Figure 15 - Wires soldered to DB25 connector with threaded cable slot entry tab (red arrow).

Step 4A: Soldering System Channels 1-16, V+, and V-

Plug the DB25 male connector into the DB25 female breakout board, which will make checking for continuity easier. If the Interface Board is available, then plug the Omnetics breakout connector into that (lettering on both connectors should be facing in the same direction). For connections, reference the Cable Mapping table (page 23) and interface board or the Omnetics Breakout Connector Mapping diagram (page 24) if the interface board is not available.

Pre-thread all wires (except for red-white and white-red wires) with 2cm pieces shrink tubing. If the wires are too short to do this without the tubing coming off, then thread each wire just before soldering.

Starting with the Omnetics wires, isolate system channel 2 wire. From the 24-wire bundle isolate the brown-black wire. Solder these two wires together (Figure 16). Using the multimeter's continuity setting (see the multimeter's manual for this information), check the continuity by touching one probe to the female breakout board's pin 8 and the

other probe to the interface board's via labeled 2 (Figure 17). Alternatively, touch the probe directly to the corresponding Omnetics pin. If touching just one Omnetics pin is problematic, then insert a 30GA needle into the pin and then touch the probe to the needle. If the meter beeps, then continue connecting the wires using the Cable Mapping table (page 23) and interface board or the Omnetics Breakout Connector Mapping diagram (page 24) if the interface board is not available. DO NOT solder R2 (GND) and In (Ramp), red-white and white-red, respectively. If the multimeter does not have a continuity setting, then measure the resistance and look for values less than 0.5Ω.

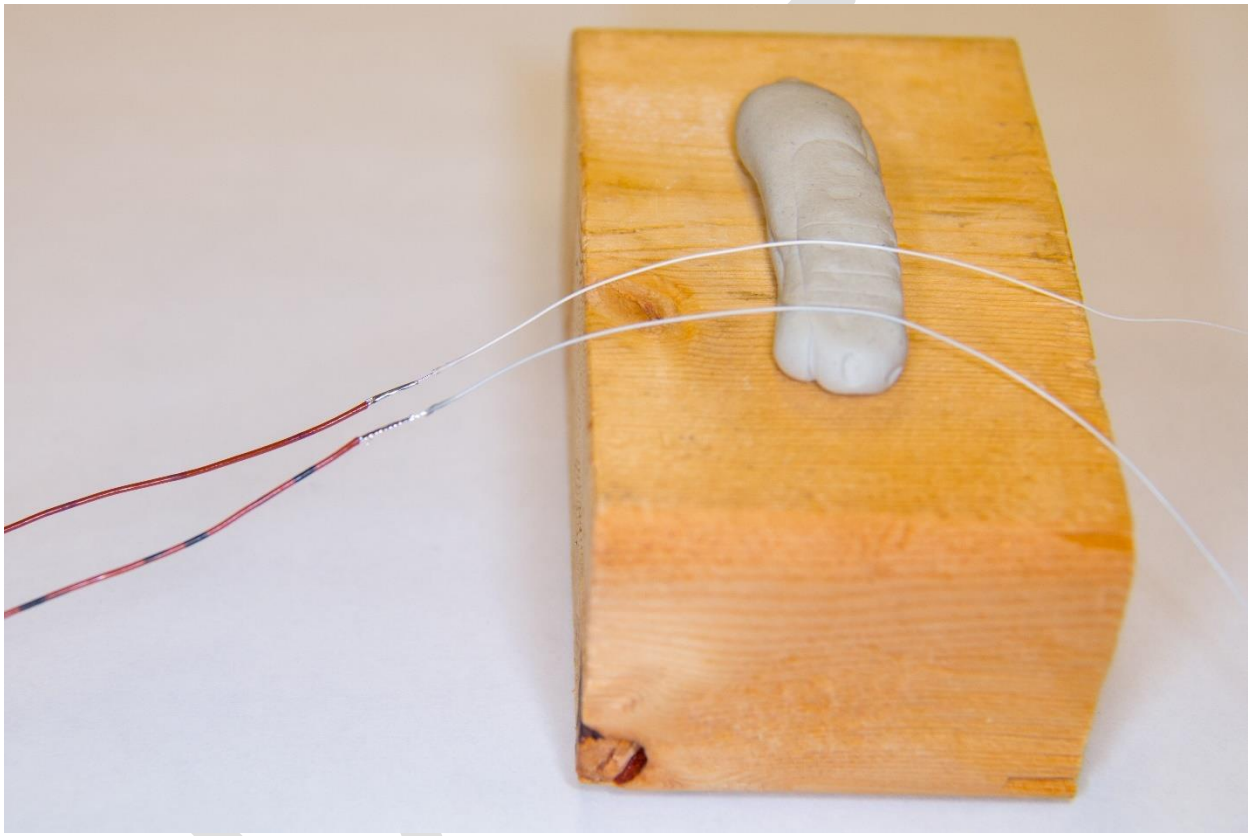


Figure 16 - System channels 2 and 3 connected to brown-black and brown-red wires, respectively. Once soldered, the Omnetics wires can be removed from the putty. Not shown, already threaded shrink tubing.

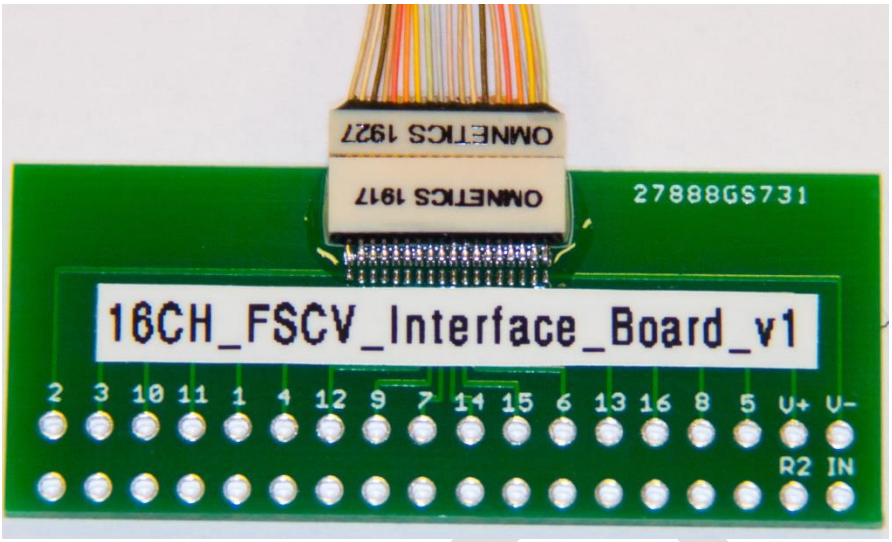


Figure 17 - Interface board attached to Omnetics connector.

Step 4B: Soldering System Channels R2 (GND) and In (Ramp)

Before connecting R2 (GND) and In (Ramp), the Omnetics wires for these signals need to be twisted together (Figure 18). This helps to reduce noise.

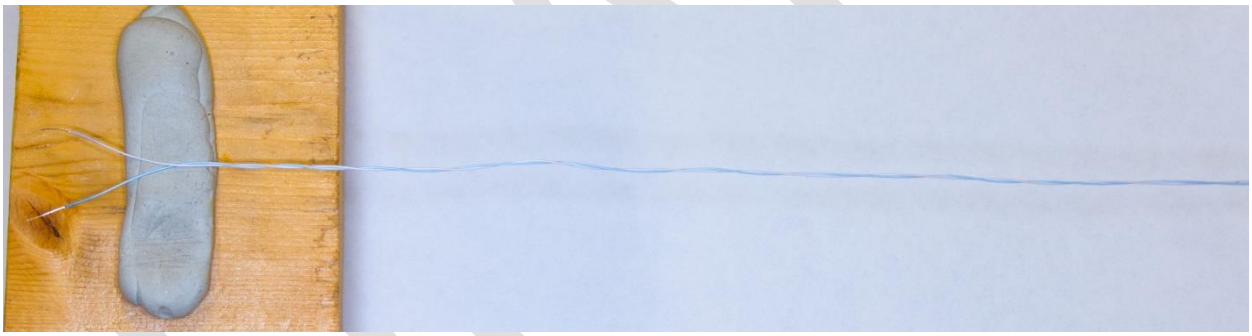


Figure 18 - R2 (GND) and In (Ramp) Omnetics wires are twisted together before connecting to red-white and white-red wires, respectively.

Once the Omnetics wires are twisted together, thread the shrink tubing on the red-white and white-red wires, and make the appropriate solder connections.

Step 5: Attaching a Stimulation Electrode

If using a stimulation electrode follow the same procedure in the previous steps. Make sure the stimulation electrode reaches beyond the end of the Omnetics connector by about 2-3” to account for the height of the headstage. If necessary, add in additional wire (cut away black-brown and black-orange can be used here).

Step 6: Shrink the Tubing

After all continuity checks have been made, shrink the tubing around the solder joints using a heat gun (Figure 19).

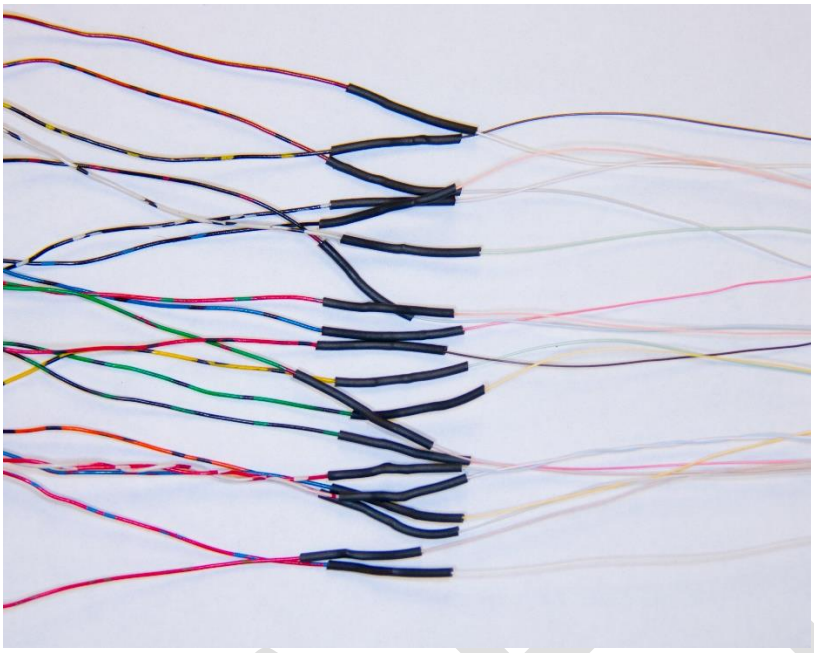


Figure 19 - All connections have been made and tubing shrunk.

Step 7: Testing the Cable

Test the cable functionality by using a dummy cell. If everything checks out, proceed to the next step. If not, double-check the connections which might require cutting away the tubing and re-soldering.

Step 8: Finalizing the Cable

After the cable has gone through the final checks, the ends can be secured with hot glue. At the DB25 end, after securing the cable slot entry tab in its slot and pushing the wires away from the screw holes, apply hot glue (Figure 20). Wait for the glue to harden before letting go of the cable. Before securing the cover, drop in the cable slot block tab and jackscrews. In this as0sembly, the strain relief screws and spring are not used, as this is accomplished by the hot glue.

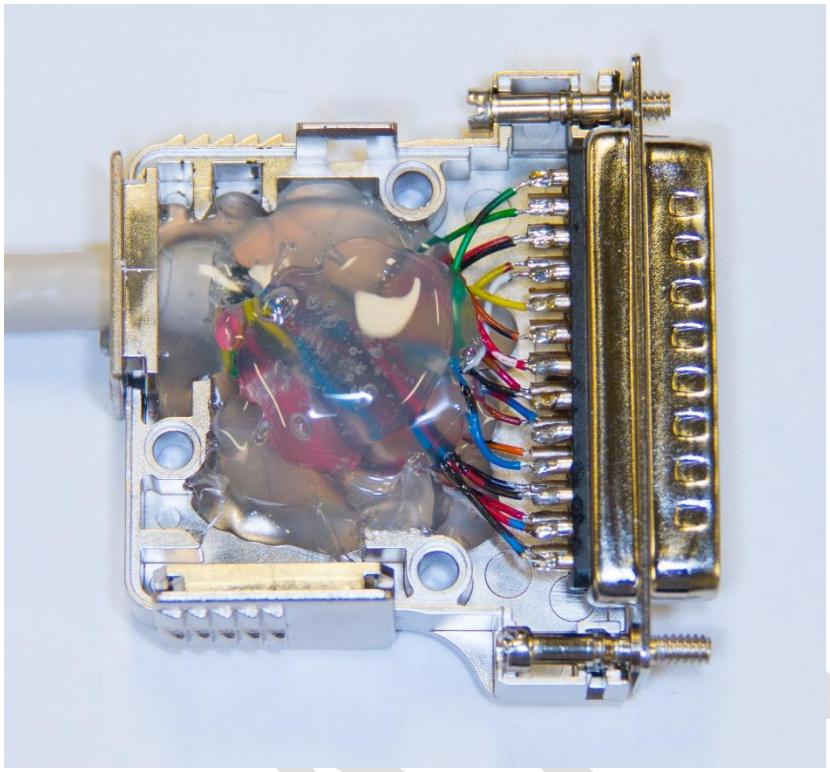


Figure 20 - Wires secured in D-Sub enclosure using hot glue. Also note the addition of the cable slot block tab (bottom left) and jackscrews (threaded through the DB25 connector).

After closing the housing, more hot glue can be applied where the cable exits, for additional reinforcement (Figure 21).

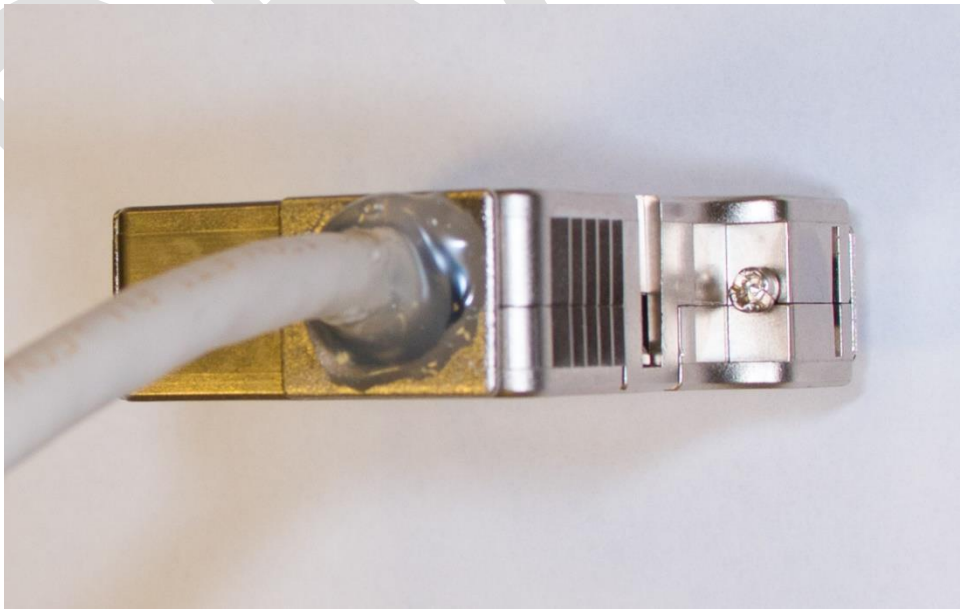


Figure 21 - Hot glue applied to cable slot entry tab for additional reinforcement.

At the Omnetics end, hot glue can be applied to provide both strain relief and a grasping point when handling the cable (Figure 22).

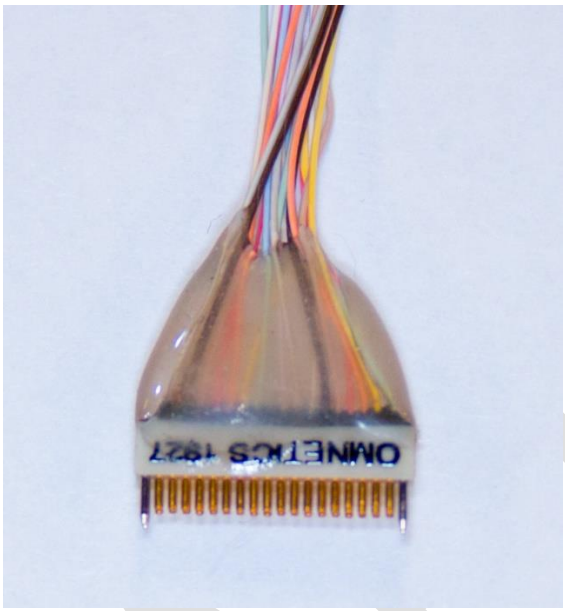


Figure 22 - Hot glue applied to Omnetics end of the cable to provide strain relief and a grasping point.

Interface Board

This optional board is used to test electrical connections when assembling the Breakout Box to Headstage Cable.

Parts List

The quantities listed below are for making a single board.

VENDOR	PART NUMBER	DESCRIPTION	QUANTITY	UNIT COST
	Custom PCB	16CH_FSCV_Interface Board_v1 (click link to access files)	1	Will vary by manufacturer
Omnetics	A79024-001	36 Position Dual Row Male Nano-Miniature Connector ‡	1	$62.75

‡Typically has a 6-8 weeks lead time. Prices are based on the minimum quantity needed to reach the vendor's $200 per part minimum order. Contact vendor directly for the most up to date pricing.

Required Tools:

- Soldering iron with a fine tip (0.1-0.2mm), solder, and flux (Grainger #1UYJ2)
- 2-part epoxy (Grainger #1FBG8)
- 1mL syringe with a 23G needle or a cotton tip applicator

Optional Tools:

- 100% isopropyl alcohol (IPA)
- Cleaning brush cut to ~5mm (Digikey #473-1048-ND)
- Forceps

Assembly Instructions

Step 1: Soldering the Omnetics Connector

Apply a small amount of solder to the lower row's (corresponding to the Omnetics connector's outer/top pins) two corner pads that lead to channel 2 and V-. Position the Omnetics connector on top of the soldered pads and reapply head to solder the pins to their respective pads. Solder the remaining outer pins to their respective pads.

To solder the inner pins, first place some solder on the iron's tip. Then gently push the iron tip through the outer pins to reach the inner pins. Repeat this process for the remaining inner pins. If an outer pin bends out of place, reposition it using a pair of forceps. Clean the pins and pads with 100% IPA.

Step 2: Securing the Omnetics Pins

Mix up some of the 2-part epoxy. Pull the mixture into a 1mL syringe, wipe the excess from the tip and threads, and firmly attach a 23G needle. Gently push the epoxy out through the needle and apply it to the Omnetics pins at both ends (Figure 23, red arrow). Applying too much force will cause the needle to come off the syringe. Alternatively, use the wooden end of a cotton tip applicator to apply the epoxy. Let the epoxy cure overnight.

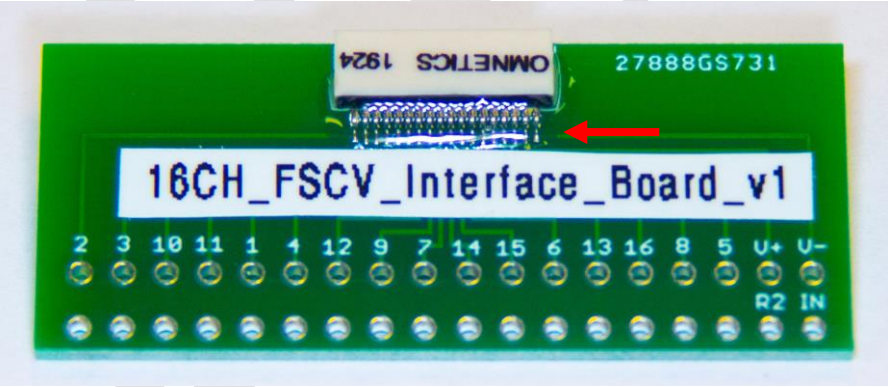


Figure 23 - Interface board with Omnetics pins secured with 2-part epoxy.

Headstage

This headstage connects to the array on one end and to the Breakout Box to Headstage Cable on the other end.

Parts List

The quantities listed below are for making a single headstage.

VENDOR	PART NUMBER	DESCRIPTION	QUANTITY	UNIT COST
	Custom PCB	16CH_FSCV_Headstage_v13 (click link to access files)	1	Will vary by manufacturer
Omnetics	A79024-001	36 Position Dual Row Male Nano-Miniature Connector ‡	1	$87.18
Omnetics	A79041-001	18 Position Dual Row Female Nano-Miniature Connector ‡	1	$34.63
Digikey	ADA4062-4ACPZ-R7CT-ND	4 Channel J-FET Amplifier Circuit	4	$3.21
Digikey	490-3104-6-ND	6pF Capacitor	16	$0.77
Digikey	541-4.99MLCT-ND	4.99MOhm Resistor	16	$0.33
Digikey	490-10430-1-ND	0.1uF Capacitor	2	$0.056
Newark	82K7797	Gold Pin	1 pk	$9.89 (pk)

‡Typically has a 6-8 weeks lead time. Prices are based on the minimum quantity needed to reach the vendor's $200 per part minimum order. Contact them directly for the most up to date pricing.

Required Tools:

- Soldering iron, solder, and flux (Grainger #1UYJ2)
- 2-part epoxy (Grainger #1FBG8)
- Stiff wire no larger than 0.5mm in diameter. An ideal source are the resistor and capacitor lead trimmings from the Dummy Cell assembly.
- Wire cutters
- 1mL syringe with a 23G needle or a cotton tip applicator

Optional Tools:

- Helping hands soldering aid
- Forceps

Assembly Instructions

Step 1: Inspecting the Headstages

After receiving the headstages back from the assembly house, check that the pins of the Omnetics connectors are properly soldered to the board. This can be done by gently pushing against the pins using a pair of forceps. If any of the pins are loose, try to repair the solder joint using a soldering iron. It is critical that the iron is applied to the pins for a minimal amount of time as excess heat can travel to the amplifiers and damage them.

After checking the solder joints, an optional check on the quality of the assembly is to connect the headstages to the FSCV system with a dummy cell. This test can sometimes, but not always, point to which channels are problematic and can be potentially fixed by repairing a poor solder connection. As the Omnetics pins have not been secured with epoxy at this stage, connecting and disconnecting of the headstage should be done with extreme care. In addition, the internal reference switch on the dummy cell should be utilized during this test as the external reference pin has yet to be attached.

Step 2: Securing the Omnetics Pins

Mix up some of the 2-part epoxy. Pull the mixture into a 1mL syringe, wipe the excess from the tip and threads, and firmly attach a 23G needle. Gently push the epoxy out through the needle and apply it to the Omnetics pins at both ends (Figure 24, red arrows). Applying too much force will cause the needle to come off the syringe. Alternatively, use the wooden end of a cotton tip applicator to apply the epoxy. Let the epoxy cure overnight.

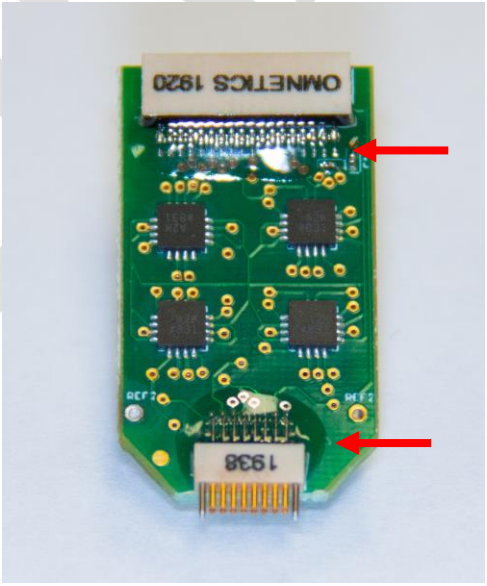


Figure 24 - Headstage with Omnetics pins secured with 2-part epoxy.

Step 3: Assembling and Attaching the Reference Pin

Insert a small piece of wire into the reference pin and solder the two together (Figure 25).

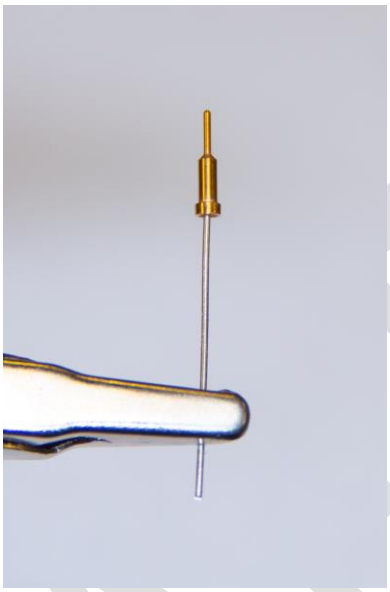


Figure 25 - Soldered reference pin and wire.

Next, insert the reference pin and wire assembly into either of the holes marked REF2 at the bottom of the headstage (Figure 26). Solder the assembly to the board from the underside and cut away the excess wire.

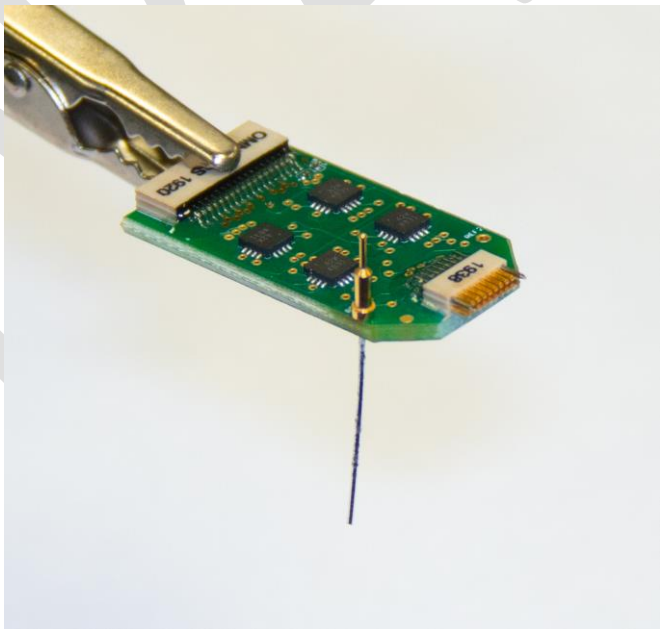


Figure 26 - Reference pin assembly attached to the headstage.

Dummy Cell

Brief description here

Parts List

The quantities listed below are for making a single dummy cell.

VENDOR	PART NUMBER	DESCRIPTION	QUANTITY	UNIT COST
	Custom PCB	16CH_FSCV_Dummy_Cell_v2 (click link to access files)	1	Will vary by manufacturer
Omnetics	A79040-001	18 Position Dual Row Female Nano-Miniature Connector ‡	1	$35.08
Digikey	CKN10721CT-ND	Slide Switch SPDT	1	$0.81
Digikey	CF14JT33K0CT-ND	33kΩ Resistor	16	$0.40
Digikey	BC1072CT-ND	1000pF Capacitor	16	$0.167
Newark	82K7797	Gold Pin	1 pk	$9.89 (pk)

‡Typically has a 6-8 weeks lead time. Prices are based on the minimum quantity needed to reach the vendor's $200 per part minimum order. Contact them directly for the most up to date pricing.

Required Tools:

- Soldering iron, solder, and flux (Grainger #1UYJ2)
- 2-part epoxy (Grainger #1FBG8)
- Wire cutters

Optional Tools:

- Helping hands to hold PCB during assembly

Assembly Instructions

Reference Jumper Wire

The reference jumper wire connects the headstage's reference pin to an implanted reference electrode or to the reference pin on a Dummy Cell. The pins on both the headstage and reference electrode or dummy cell should be the type listed below.

Parts List

VENDOR	PART NUMBER	DESCRIPTION	QUANTITY	UNIT COST
Digikey	A3049R-100-ND	26AWG Wire	1	$42.46
Grainger	22KY60	1/16" ID Heat Shrink Tubing (25'),	1	$11.45
Newark	82K7797	Gold Pin	1 pk	$9.89 (pk)

Required Tools:

- Soldering iron, solder, and flux (Grainger #1UYJ2)
- Wire strippers (26 AWG) and cutters
- Heat gun
- Super glue
- Forceps or needle nose pliers

Optional Tools:

- Wooden block
- Removable mounting putty

Assembly Instructions

Step 1: Preparing the Wire

First, cut the wire to the overall desired length, typically 6-7cm is enough. From each end, strip away 3-4mm of insulation. After stripping the insulation, tin the exposed wire by twisting the ends, dipping them into flux, and applying a small amount of solder (Figure 27). If the putty and wooden block are available, place the wire in the putty as this will be helpful for subsequent steps. A benefit to using the putty and wooden block is that multiple wires can be prepared simultaneously. Alternatively, use a set of helping hands, provided nothing cuts through or "bites" into the wire.

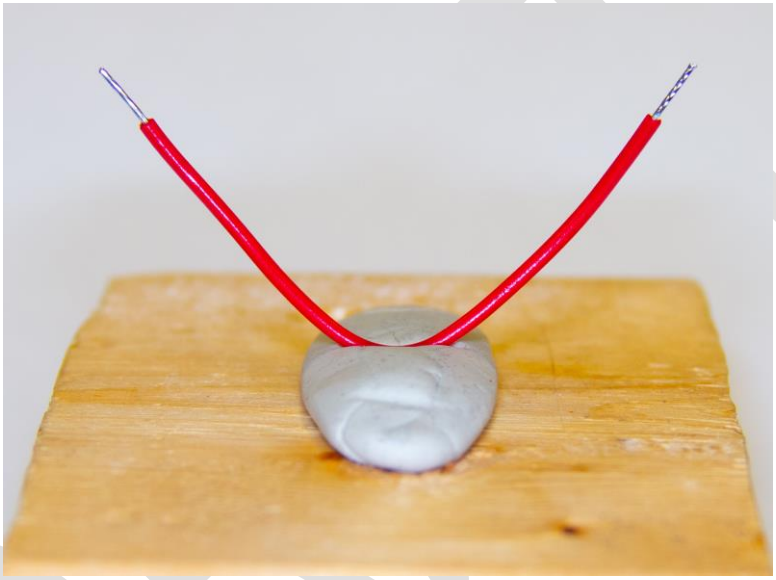


Figure 27 - Wire stripped of insulation and tinned ends.

Step 2: Attaching the Gold Pins

Dip the tips of the gold pins into flux and attach one pin to each end of the wire using additional solder (Figure 28).

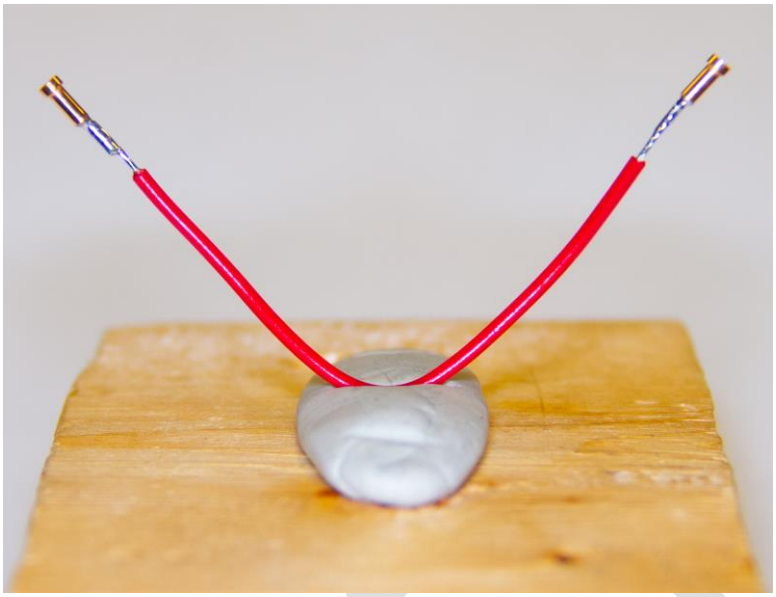


Figure 28 - Wire with soldered pins.

Step 3: Heat Shrink Tubing

Slip 1.5-2cmm lengths of heat shrink tubing over each end of the wire/pin assembly to cover the solder joints. Make sure the end of the tubing and the circular/open portion of the pin are flush if not a bit lower than the opening (Figure 29, red arrows). Use the heat gun to shrink the tubing. Next, apply a small drop of super glue to the transition where the tubing ends and the exposed insulation begins (Figure 29, blue arrows). The glue will help to ensure that the tubing does not shift or loosen over time.

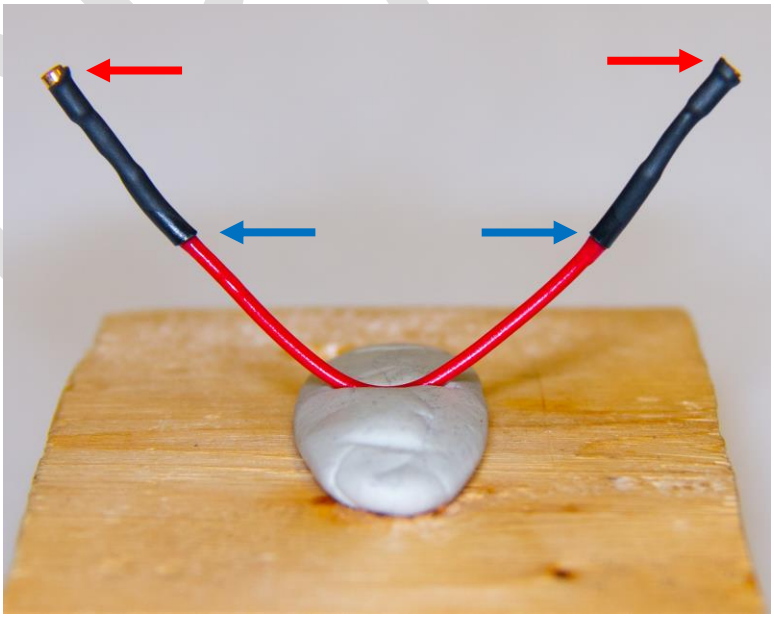
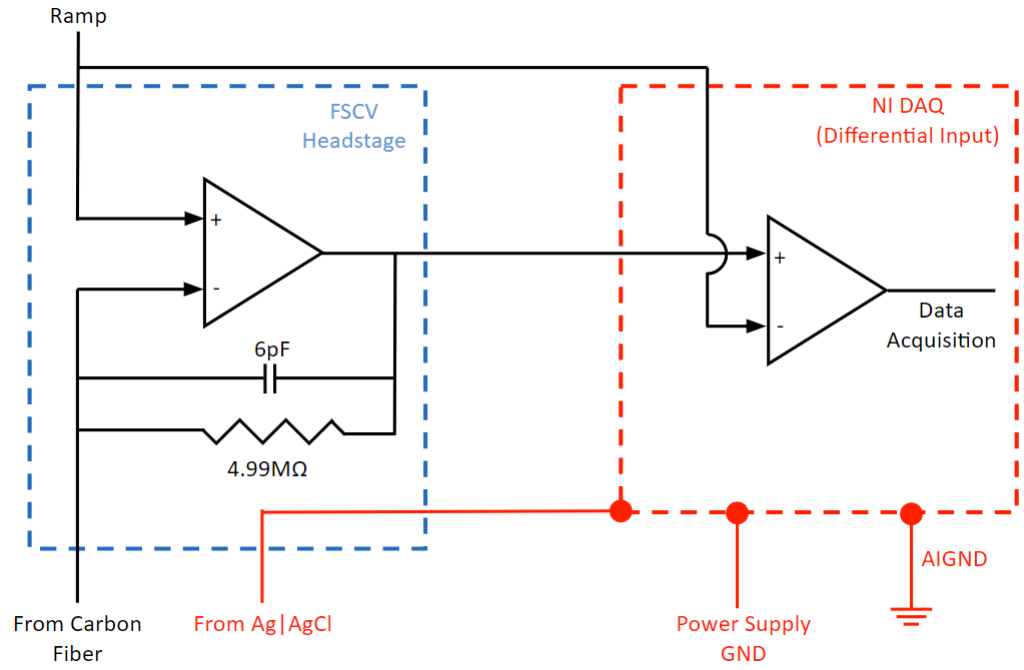


Figure 29 - Wire with shrink tubing and super glue.

Appendix

FSCV Circuit Diagram



Drilling Template