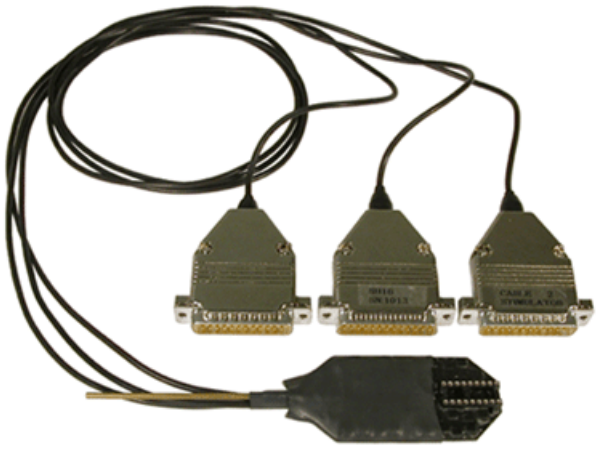
SH16 Switchable Headstages

SH16 - Switchable Acute Headstage



The SH16/SH16-Z/SH16-IZ is a 16 channel acute headstage containing recording circuitry that can be bypassed for selected channels and connected to the stimulus isolator. It features high voltage, low leakage solid-state relays to allow for remote switching.

Note: The SH16 provides unity gain (1x) for its recording channels.

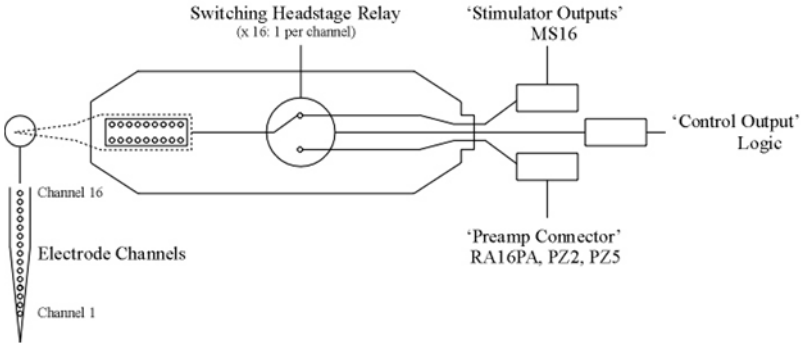
The minimum switching time for the SH16/SH16-Z is dependent on the length of time it takes to send the 24-bit serial control bit pattern (see "Creating the Serial Control Bit Pattern" on page 10-49, for more information) that defines which channels are switched plus an inherent 2 ms delay associated with the solid state relay switches.

The minimum switching time can be calculated as follows:

[Number of bits in serial control pattern (24)] ÷ [Serial data transfer Rate (939 Hz Max)] + 2 ms

Serial Transfer Rate (Hz)	Minimum SH16 Switching Time (ms)
939	28
469	53

The diagram below illustrates how the relays are used to switch channels for recording (to RA16PA) or stimulation (from MS16).



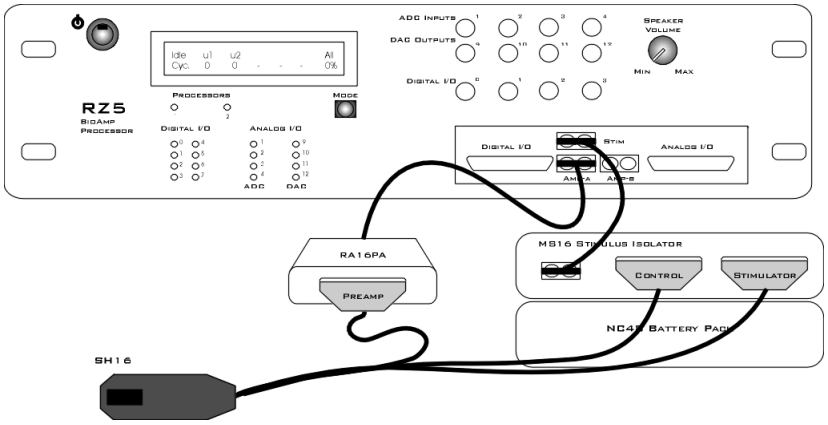
Switchable Headstage Diagram

The 16 channel switchable acute headstage has an 18-pin DIP connector that can be used with standard high impedance metal electrodes. The pinout of the SH16 matches the wiring of NeuroNexus electrodes, allowing direct connection to the headstage. TDT recommends connecting electrodes to an 18-pin DIP socket and then connecting the socket to the headstage to protect the headstage from unnecessary wear and tear.

Important! When using the headstage with the NeuroNexus probes, keep in mind that there may be several versions of the probe. Check the NeuroNexus Website for pin diagrams. Also, see MCMap for a description and examples on how to re-map channel numbers.

Connection Diagram

When using the SH16/SH16-Z with a microstimulator system, connect the system as shown. The diagram below shows a system configuration featuring the RZ5 BioAmp Processor, an MS16 Stimulus Isolator, and RA16PA Medusa PreAmp. Connections are much the same when using the RX7 in place of the RZ5.

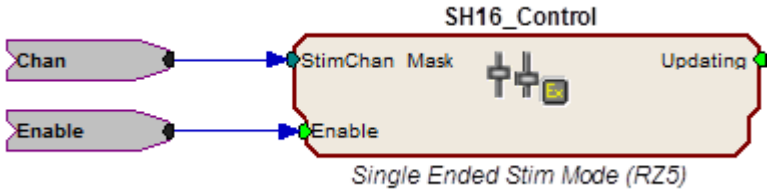


SH16 to MicroStimulator Connection Diagram

Switchable Headstage Operation

When using the SH16/SH16-Z switching headstage with an RZ5 or RX7 processor and an MS4/MS16 Stimulus Isolator, TDT recommends using the SH16_Control macro to set stimulation channels and mode of operation. Based on the macro settings, all necessary control signals are sent from the base station to the headstage via the MS4/MS16 Control output port.

Setup parameters determine which channels are used for stimulation and whether the headstage will be operated in single ended or differential mode.



See the Help text in the macro's properties dialog box for more information about this macro.

Note: The SH16/SH16-Z requires at least 10ms in order to initialize its control bits for use. If you are trying to trigger the enable input you must either use a trigger signal that is delayed 10ms from the point the circuit is run or use a manual trigger method to begin acquisition.

Operating the Switching Headstage without Using the Macro

The SH16_control macro (above) greatly simplifies control of the switching headstage. If the macro cannot be used, the SH16/SH16-Z can be controlled directly from RPvdsEx using the following information.

The SH16/SH16-Z is controlled using the digital I/O (digital control lines) on the MS4/MS16, which are in turn set by writing an integer value directly to memory (poke address values vary depending on the processor used). Channels 1 - 3 of the digital I/O (bits 0-2) are used to send a serial pattern that controls the state of all channels to the SH16/SH16-Z.

Transmitting this data to the headstage from the MS4/MS16 is accomplished using the following 3 digital output lines.

Bit Number	Name	Description	Pin # (Control DB25)
2	DO2	Serial Clock Line	19
1	DO1	Serial Data Line	6
0	DO0	Load/Latch Signal	18

DO0 (Bit 0) is the load/latch signal. This bit is pulsed for a minimum pulse width of 100 nanoseconds to latch the data to the relays on the headstage after the data has been transmitted.

DO1 (Bit 1) is the serial data line. The 24-bit mask must be sent most significant bit (MSB) first. In other words, bit 23 is sent first, then bit 22, bit 21, etc.

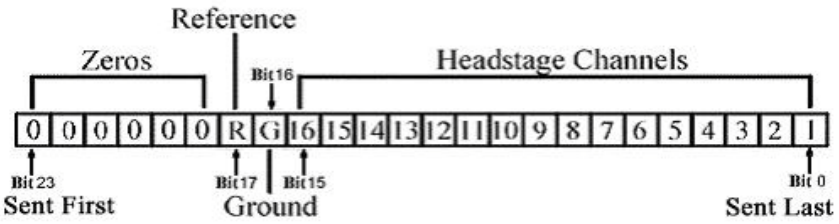
DO2 (Bit 2) is the serial clock signal. When the SH16/SH16-Z is being controlled through a System 3 device such as the MS4/MS16, then the maximum rate for serial data transfer is 939 Hz.

Creating the Serial Control Bit Pattern

Channel setup and control are programmed by serially transmitting a 24-bit pattern to the headstage on the serial data line (DO1). The first bits in the pattern control the

connection of a given channel to the Stimulus Isolator. Bit 16 controls the ground and bit 17 controls the record reference line. Bits 18-23 are not used and are always sent as zeros. By default, all channels are set in the record mode (disconnected from the stimulator). To connect a given electrode to the output of the stimulus isolator, send a binary '1' on the appropriate bit of the pattern. Sending a binary '0' on the appropriate bit will disconnect that electrode from the stimulus isolator and connect it to the recording preamp.

To disconnect the stimulator ground from the record ground during stimulation, a '1' is sent in the mask at bit location 16. To disconnect the record reference line from the headstage and leave it floating during stimulation, a '1' is sent at bit location 17.



Serial Control Bit Pattern

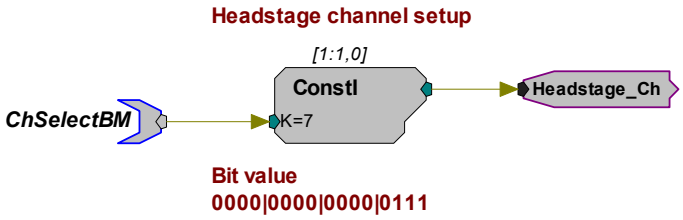
For example, to stimulate on channels 1 (1), 3 (4) and 4 (8), the following serial bit pattern with an integer value of 13 (1 + 4 + 8) should be sent to the headstage. Notice that bits 16 and 17 are not set (1), allowing non-stimulating channels to record using a preamplifier.

0000	0000	0000	0000	0000	1101

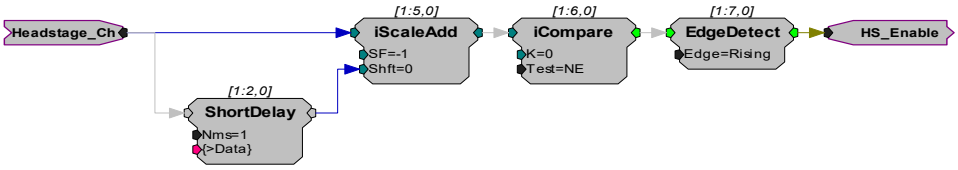
RPvdsEx Circuit

The following circuit illustrates the headstage channel setup and serial data load for the SH16/SH16-Z using an MS4/MS16 and RZ5 or RX7 processor.

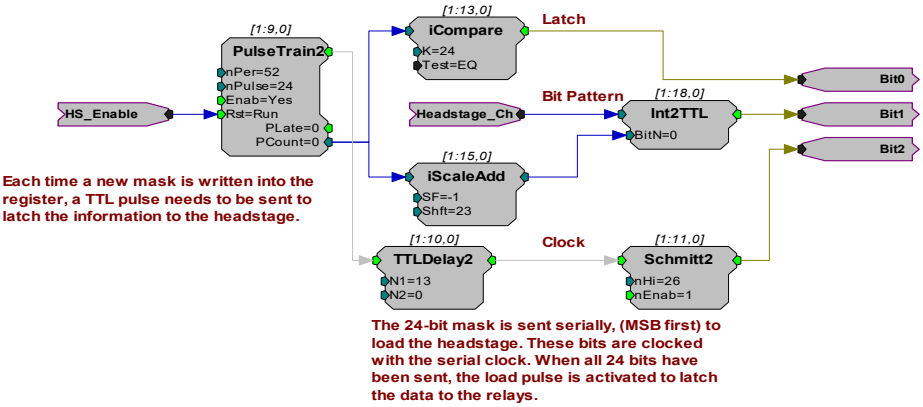
The first figure shows the headstage channel setup. The ChSelectBM parameter tag sets the value of the ConstI with an integer representing the serial control bit pattern discussed above.



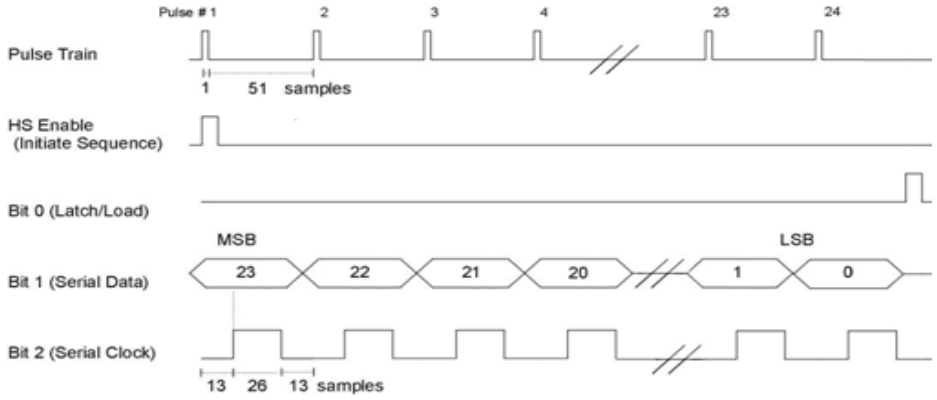
The next segment of the circuit detects a change to the headstage setup and generates a pulse that will reset the serial data transmission to send the new channel selection and control logic.



The third segment of the chain uses a pulse train to send the 24-bit pattern serially (MSB first) to the headstage. After all 24 bits have been sent; the data is latched to the relays.

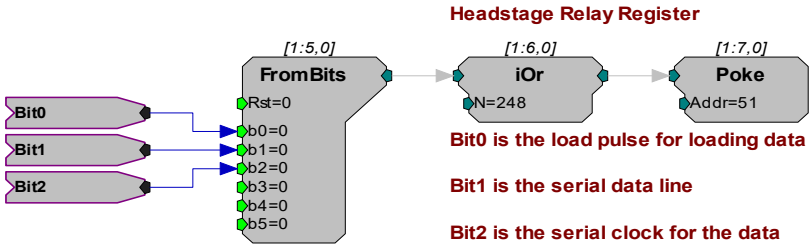


With the sampling rate set to 25 kHz in RPvdsEx and 'nPer' equal to 52 in the PulseTrain2 component, the serial clock (Bit 2) will run at 469 Hz. Setting 'nPer' equal to 26, will allow the clock to run at 939 Hz. The figure below (not to scale) shows the 25kHz pulse rate of 52 samples (1 sample high, 51 samples low) as well as the serial clock rate of 13 samples low, 26 samples high, and 13 samples low.



For headstages with serial numbers >2000, the headstage needs digital high voltages on the input lines of the control connector to power its circuits.

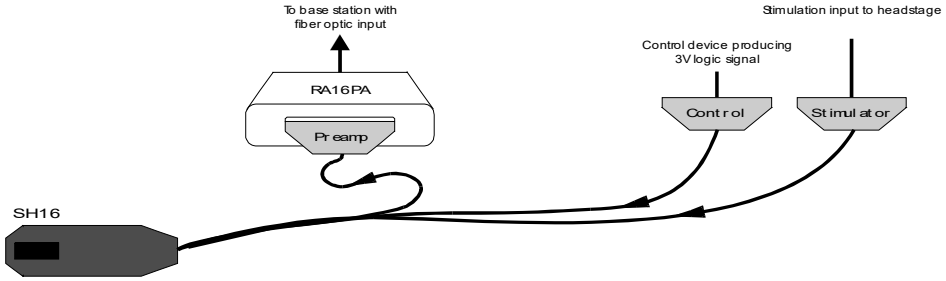
Power the headstage circuits by writing a logic '1' (high) to the MS16 control bitss 3-7). In the circuit segment below, the latch, data, and clock lines are fed directly to bits 0, 1, and 2 respectively on the FromBits component and bits 3-7 are set high by ORing the value from the FromBits component with the value 248 (binary: 0000 0000 1111 1000).



A poke component is used to send the resulting value to memory address 51 on the RZ5 processor or memory address 3 on the RX7. The Poke RPvdsEx component writes values to a specific device memory location and should be used with care.

Using the Switching Headstage with Other Devices

When using the SH16/SH16-Z with hardware other than a microstimulator system, connect as follows:



The Serial Control Bit Pattern that controls connection of a given channel to the Stimulus Isolator can be sent using any 3 digital logic lines that will produce a +3V logic signal. Circuit design is similar to the example above, designed for use with the RZ5 and RX7 processors, but must be modified by routing Bit 0, Bit 1, and Bit 2 to the appropriate digital outputs of the device (instead of using the Poke component).

Note: The serial clock (Bit 2) on the SH16/SH16-Z can be run at a maximum rate of 5 MHz for other devices.

Technical Specifications

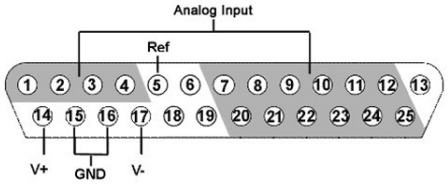
Headstage Gain	Unity (1x)
Input Impedance	10^{14} Ohms

SH16/SH16-Z Pinout Diagrams

PreAmp Connector

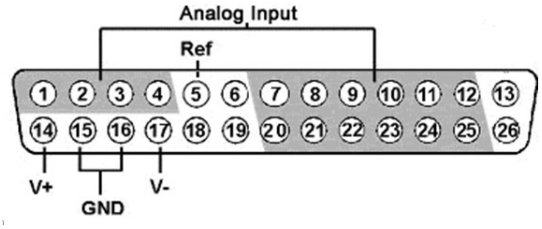
For SH16 headstages with serial numbers <2000, the DB25 connector labeled Preamp must be connected as it supplies power to the headstage. For headstages with serial numbers >2000, this connector does not need to be connected if the user is not recording on the non-stimulating channels.

DB25 Pinout Connections for use with Medusa PreAmps



Pin	Name	Description		Pin	Name	Description
1	A1	Analog Input Channel Number Ch 1-4		14	V+	Positive Voltage
2	A2			15	GND	Ground
3	A3			16	GND	Ground
4	A4			17	V-	Negative Voltage
5	REF	Reference Pin		18	NA	Not Used
6	NA	Not Used		19	NA	Not Used
7	A5	Analog Input Channel Number Ch 5, 7, 9, 11, 13, and 15		20	A6	Analog Input Channel Number Ch 6, 8, 10, 12, 14, and 16
8	A7			21	A8	
9	A9			22	A10	
10	A11			23	A12	
11	A13			24	A14	
12	A15			25	A16	
13	NA	Not Used				

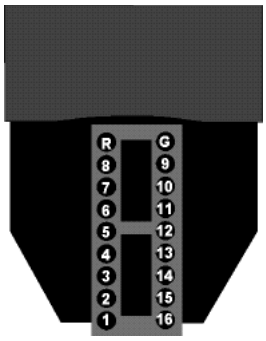
Mini DB26 Pinout Connections for use with PZ PreAmps



Pin	Name	Description		Pin	Name	Description
1	A1	Analog Input Channel Number Ch 1-4		14	V+	Positive Voltage
2	A2			15	GND	Ground
3	A3			16	GND	Ground
4	A4			17	V-	Negative Voltage
5	REF	Reference Pin		18	NA	Not Used
6	NA	Not Used		19	NA	Not Used
7	A5	Analog Input Channel Number Ch 5, 7, 9, 11, 13, and 15		20	A6	Analog Input Channel Number Ch 6, 8, 10, 12, 14, and 16
8	A7			21	A8	
9	A9			22	A10	
10	A11			23	A12	
11	A13			24	A14	
12	A15			25	A16	
13	NA	Not Used		26	NA	Not Used

Headstage Pinout

The numbers in the diagram to the right refer to the channel connections to the preamp connector or stimulator connector.



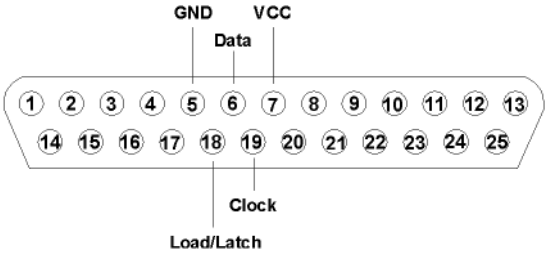
"G" on the diagram to the right is connected to the reference pin (Ref) on the stimulator connector and can also connect to the ground pin (GND) of the preamp connector through a switchable relay in the SH16/SH16-Z.

"R" on the diagram to the right is connected to a switchable relay that can connect to the "Ref" pin of the preamp connector.

The connector accepts 0.5 mm diameter male pins.

The headstage has sensitive electronics. Always ground yourself before handling.

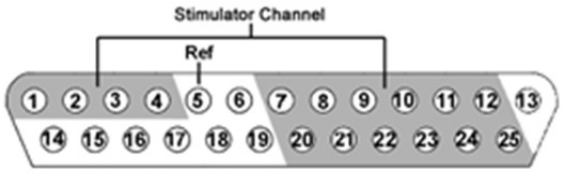
DB25 Control Connector



The connector can be connected to any control device that produces a 3 V logic signal. For headstages, serial numbers >2000, this connector supplies power to the headstage and must be connected.

Note: Pins that are not labeled are not connected.

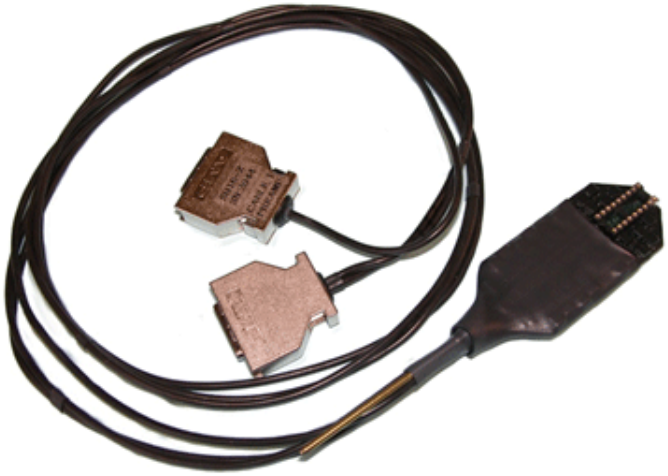
DB25 Stimulator Connector



Note: The global reference (Ref) is connected to the SH16/SH16-Z ground pin (G of headstage pinout).

Pin	Name	Description		Pin	Name	Description
1	S1	Stimulator Channels Ch 1-4		14	NA	Not Used
2	S2			15		
3	S3			16		
4	S4			17		
5	Ref	Reference		18		
6	NA	Not Used		19		
7	S5	Stimulator Channels Ch 5, 7, 9, 11, 13, and 15		20	S6	Stimulator Channels Ch 6, 8, 10, 12, 14, and 16
8	S7			21	S8	
9	S9			22	S10	
10	S11			23	S12	
11	S13			24	S14	
12	S15			25	S16	
13	NA	Not Used				

SH16-IZ - 16 Channel Switchable Acute Headstage



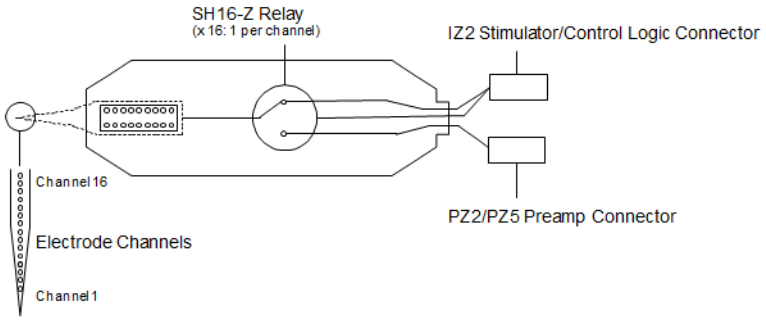
The SH16-IZ is a 16 channel acute headstage containing programmable relays that connect selected channels to the IZ2 stimulator and leave unselected channels connected to the PZ2. It features high voltage, low leakage solid-state relays to allow for remote switching.

Note: The SH16-IZ switching headstage provides unity gain (1x) for its recording channels.

Channel selection is handled within the IZ2_Control macro which generates a 24-bit serial control bit pattern to control SH16-Z channel switching. The minimum switching time is dependent on the length of time it takes to receive the control bit pattern plus an inherent 2 ms delay associated with the solid state relay switches. Typical switching times are shown in the table below.

Sampling Rate	Minimum SH16-Z Switching Time (ms)
50 kHz and above	28
25 kHz	53

The diagram below illustrates how the relays are used to switch channels for recording (to PZ2) or stimulation (from IZ2).



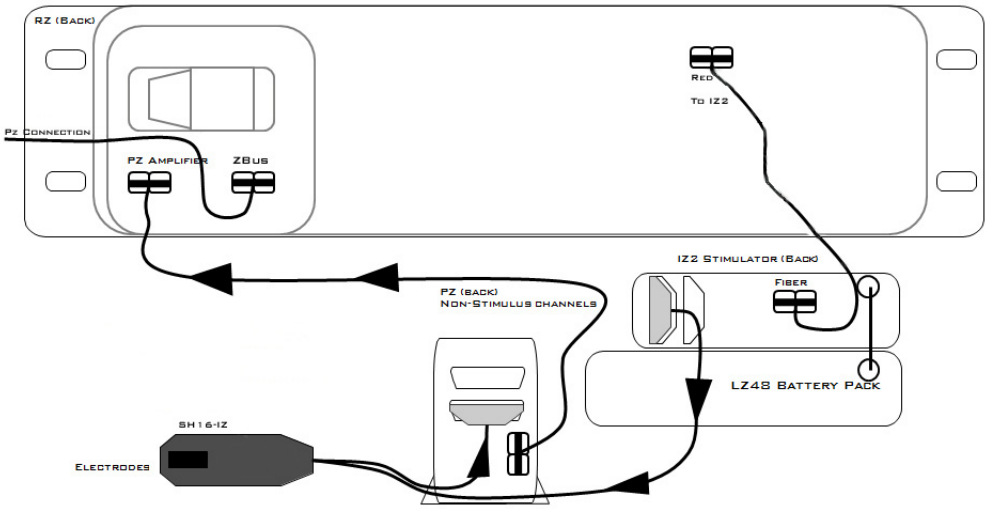
Switchable Headstage Diagram

The 16 channel switchable acute headstage has an 18-pin DIP connector that can be used with standard high impedance metal electrodes. The pinout of the SH16-IZ matches the wiring of NeuroNexus electrodes, allowing direct connection to the headstage. TDT recommends connecting electrodes to an 18-pin DIP socket and then connecting the socket to the headstage to protect the headstage from unnecessary wear and tear.

Important! When using the headstage with the NeuroNexus probes, keep in mind that there may be several versions of the probe. Check the NeuroNexus Website for pin diagrams. Also, see MCMap for a description and examples on how to re-map channel numbers.

Connection Diagram

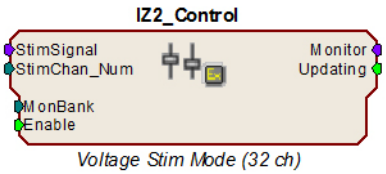
When using the SH16-IZ with a microstimulator system, connect the system as shown. The diagram below shows a system configuration featuring the RZ Processor, an IZ2 Stimulator, and PZ2 preamp or PZ5 digitizer. The IZ2 connects to the front panel of an RZ5D and the back panel of all other RZ devices.



SH16-IZ to MicroStimulator Connection Diagram

Switchable Headstage Operation

When using the SH16-IZ switching headstage it should be enabled in the IZ2_Control macro.



Voltage Stim Mode (32 ch)

The StimChan parameter input is used to set the stimulation channels. Based on the macro settings, you either specify a single channel to open for stimulation or send a channel mask if stimulating on more than one channel. All necessary control signals are sent from the base station to the headstage via the IZ2 output port. To use an electrode as the stimulus return path, make sure that channel is open for stimulation and send an inverted stimulus signal to that channel.

Multiple SH16-IZs can be used with a single IZ2. The MonBank input determines which SH16-IZ is updated when the StimChan value is changed.

See the Help text in the IZ2_Control macro's properties dialog boxes for more information about this macro.

Note: The SH16-IZ Headstage requires at least 10 ms to initialize its control bits for use. If you are trying to trigger the enable input you must either use a trigger signal that is delayed 10 ms from the point the circuit is run or use a manual trigger method to begin acquisition.

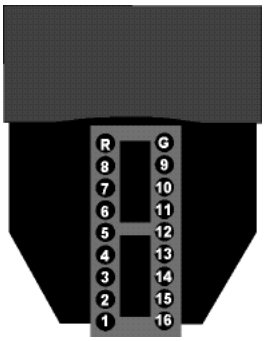
Technical Specifications

Headstage Gain	Unity （1x）
Input Impedance	10^{14} Ohms

SH16-IZ Pinout Diagrams

Headstage Pinout

The numbers in the diagram to the right refer to the channel connections to the preamp connector or stimulator connector.



"G" on the diagram to the right is connected to the ground pin （GND） on the stimulator connector and can also connect to the ground pin （GND） of the preamp connector through a switchable relay in the SH16-IZ.

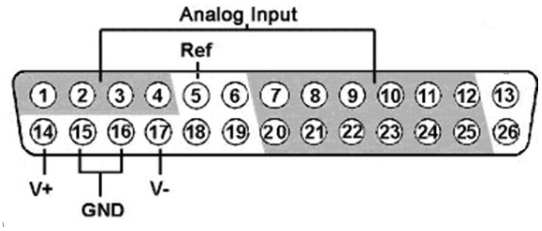
"R" on the diagram to the right is connected to a switchable relay that can connect to the "Ref" pin of the preamp connector.

The electrode connector accepts 0.5 mm diameter male pins.

The headstage has sensitive electronics. Always ground yourself before handling.

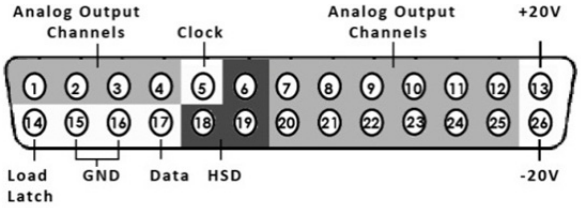
PreAmp Connector

For SH16-IZ headstages, this connector does not need to be connected if the user is not recording on the non-stimulating channels.



Pin	Name	Description		Pin	Name	Description
1	A1	Analog Input Channel Number Ch 1-4		14	V+	Positive Voltage
2	A2			15	GND	Ground
3	A3			16	GND	Ground
4	A4			17	V-	Negative Voltage
5	REF	Reference Pin		18	NA	Not Used
6	NA	Not Used		19	NA	Not Used
7	A5	Analog Input Channel Number Ch 5, 7, 9, 11, 13, and 15		20	A6	Analog Input Channel Number Ch 6, 8, 10, 12, 14, and 16
8	A7			21	A8	
9	A9			22	A10	
10	A11			23	A12	
11	A13			24	A14	
12	A15			25	A16	
13	NA	Not Used		26	NA	Not Used

DB26 Stimulator Connector



Pin	Name	Description		Pin	Name	Description
1	S1	Stimulator Channels Ch 1-4		14	LL	Load/Latch
2	S2			15	GND	Ground
3	S3			16	GND	Ground
4	S4			17	Data	Digital Data
5	Clock	Digital Clock		18	HSD	Stimulator Detect
6	HSD	Stimulator Detect		19	HSD	Stimulator Detect
7	S5	Stimulator Channels Ch 5, 7, 9, 11, 13, and 15		20	S6	Stimulator Channels Ch 6, 8, 10, 12, 14, and 16
8	S7			21	S8	
9	S9			22	S10	
10	S11			23	S12	
11	S13			24	S14	
12	S15			25	S16	
13	+20V	+20V		26	-20V	-20V