

# PZ2 PreAmp

## PZ2 Overview

The PZ2 is a high channel count preamplifier suitable for extracellular recordings. The PZ2 preamplifier features a custom 18-bit hybrid A/D architecture that offers the advantages of Sigma-Delta converters at significantly lower power and a fast fiber optic connection capable of simultaneously transferring up to 256 channels. The extended bandwidth offered by this connection supports sampling rates up to ~50 kHz and improves signal fidelity, spike discrimination, sorting, and analysis. Used exclusively with Z-Series base stations, PZ2 preamplifiers are available in 32, 64, 96, 128, or 256-channel models.



**Note:** When sampling at a rate of ~50 kHz only the first 128 amplifier channels will be available.

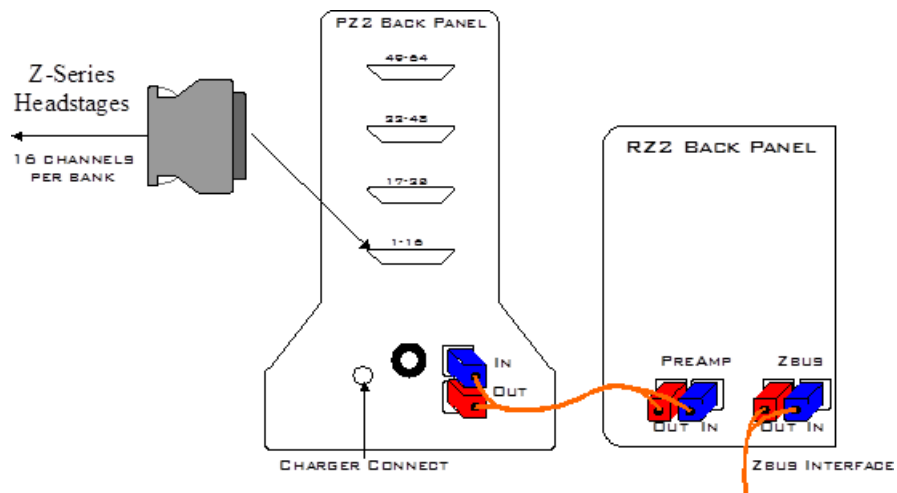
## System Hardware

All PZ2 channels are organized into groups of 16 channel **banks** with each bank corresponding to a rear panel headstage connector and front panel LED display. Recorded signals are digitized, amplified, and transmitted to the RZ2 base station via a single fiber optic connection for further processing. In addition, configuration information is sent from the RZ2 to the PZ2 preamplifier across the fiber optic connection.

A standard configuration for neurophysiology recordings includes electrodes (chronic or acute), one or more Z-Series high impedance headstages, a PZ2 preamplifier, and an RZ2 base station.

## Hardware Set-up

The diagram below illustrates the connections necessary for PZ2 preamplifier operation.



One or more Z-Series headstages can be connected to the input connectors on the PZ2 back panel. A 5-meter paired fiber optic cable is included to connect the preamplifier to the base station. The connectors are color coded and keyed to ensure proper connections. The PZ2 battery charger connects to the round female connector located on the back panel of the PZ2 preamplifier.

**Important!** To avoid introducing EMF noise, DO NOT connect the charger to the PZ2 while collecting data.

## Powering ON

To turn the preamplifier on, move the three position battery switch located on the front panel of the PZ2, to either the Bat-A or Bat-B position.

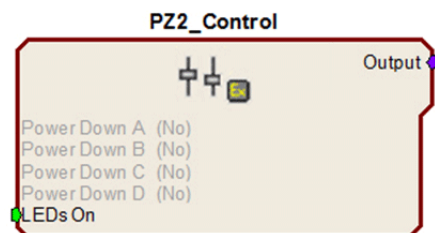
## Powering OFF

To turn the preamplifier off, move the three position battery switch located on the front panel of the PZ2, to the OFF position.

**Important!** Channels are grouped by 16-channel banks and each bank will only power up when a headstage is connected. This design helps to increase battery life.

## PZ2 Software Control

The preamplifier's hardware operation (power options and indicator LEDs) can be configured using the PZ2\_Control macro within the RpvdsEx control circuits running on the RZ2 base station.



Double-clicking the macro in RPvdsEx displays the macro properties and allows users to easily configure the macro. Additional information on using the macro is available in the macro properties dialog box.

This macro is not required for preamplifier operation but is recommended if the user requires more control over the amplifier power/up or power/down status or front panel LEDs. See the relevant sections below for more information about these features.

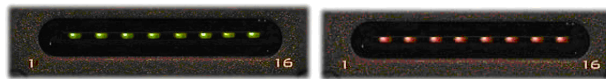
## PZ2 Features

### Clip Warnings and Activity Display

256 front panel LEDs can be used to indicate spike activity and/or clip warning depending on display mode and configuration. See “Display Button” and “Status LED” below for more information.

#### Recording Channel LEDs

When enabled, LEDs for each channel may be lit green to indicate activity or red to indicate a clip warning.



**Green: Activity | Red: Clip Warning**

Clip Warning	When the input to a channel is greater than $-3\text{dB}$ from the preamplifier's maximum voltage input the LED for the corresponding channel is lit red indicating clipping may occur.
Activity	Whenever a unit (spike) occurs (the sensitivity threshold can be configured with the PZ2_Control macro) the LED for the corresponding channel is lit green.

**Note:** The LED Indicators are also mirrored on the RZ2 LCD display.

#### Display Button

The Display button located on the front panel of the PZ2 toggles the clip warning and activity display LEDs between software control and standard operation.

#### To toggle between display modes:

- Press the **Display** button.

#### Status LED

When recording, the status LED located below the Display button indicates the current display mode of the LED Indicators.

Green	Software Control of LEDs Use the PZ2_Control macro to configure LED Indicators. LEDs are turned off until enabled through software control.
Orange	LEDs enabled for standard operation

In this mode, LEDs are automatically enabled for default activity and clip warning display as described above.

## External Ground

The external ground is optional and should only be used in cases where the subject must occasionally make contact with a metal surface that isn't tied to the animal ground, such as a lever press. When contact is made, a ground loop is formed that temporarily adds extra noise to the system. Grounding this metal surface directly to the TDT hardware removes this ground loop at the cost of raising the overall noise floor a small amount.

A banana jack located on the back of the PZ2 (directly to the right of the charger input) provides connections to common ground for the first bank of channels (1-16). A cable kit is also provided to ensure cables used with the external ground are suitable for this use. Each kit includes: one male banana plug to male banana plug pass through and one male banana plug to alligator clip pass through. These cables also include ferrite beads to remove any potential RF noise that might travel through the cable. For best results position the ferrite bead close to the source of the RF noise.

## Battery Overview

The PZ2 preamplifier features two Lithium ion batteries to allow for longer record times. A three-position switch selects the active battery between Bank-A, Bank-B, or both banks off.

### Maximizing Battery Life

To increase battery life, individual banks of channels will only power up when a headstage is connected to the corresponding input.

The PZ2\_Control macro can also be added to the circuit running on the RZ2 to further specify how PZ2 channel banks are powered. When a headstage is connected, banks may be powered on or off statically through the **Power Control** options within the macro or dynamically by using the **PZ2\_Control** macro inputs. See the internal macro help for more information.

### Battery Status LEDs



**Battery Level:** Eight LEDs indicate the voltage level of the selected battery. These LEDs can be found on the front of the PZ2 preamplifier by the heading Level. When the battery is fully charged, all eight LEDs will light green. When the battery voltage is low, only one green LED will be lit. If the voltage is allowed to drop further, the

last LED will flash red. TDT recommends charging the battery before this flashing low-voltage indicator comes on. While charging, the Level LEDs will flash green.

Status	Description
8 Green	Fully Charged
1 Green, 7 Unlit	Low Voltage
1 Flashing Red	Low Voltage - Charge Immediately!
8 Green Flashing	Charging in Progress

## Charging the Batteries

Operate the preamplifier with the charging cable disconnected. Connecting the PZ2 charger will simultaneously charge both batteries. TDT recommends putting the three-position switch in the **OFF** (middle) position while charging the PZ2.

### Charging Indicators

When powered on, the PZ2 battery status LEDs are also used for each battery to indicate which battery, if any, is charging. These LEDs are found next to the Level LEDs by the headings -A- and -B-. A green indicator denotes the battery bank is fully charged while a red indicator designates the battery is currently charging. When the device is in operation (charger is not connected) the -A- and -B- LEDs are not lit.

Status	Description
Red	Charging
Green	Fully Charged
Unlit	Operation Mode (charger not connected)

An external battery pack is also available to provide longer battery life for extended recording sessions. See “PZ-BAT External Battery Pack for the PZ Amplifiers” on page 6-23.

## PZ2 Technical Specifications

<b>A/D</b>	Up to 256 channels, 18-bit hybrid
<b>Maximum Voltage In</b>	+/- 10 mV
<b>Frequency Response</b>	3 dB: 0.35 Hz – 7.5 kHz 6 dB: 0.2 Hz – 8.5 kHz
<b>Anti-Aliasing Filter</b>	4th order Lowpass (24 dB per octave)
<b>S/N (typical)</b>	73 dB

<b>Distortion (typical)</b>	< 1%															
<b>A/D Sample Rate</b>	Up to 48828.125 Hz*															
<b>Sample Delay</b>	Dependent on Sample Rate and RPvdsEx input method <table border="1"> <thead> <tr> <th>Rate</th> <th>Pipe Input</th> <th>MC Input</th> </tr> </thead> <tbody> <tr> <td>6 kHz</td> <td>16 samples</td> <td>15 samples</td> </tr> <tr> <td>12 kHz</td> <td>17 samples</td> <td>16 samples</td> </tr> <tr> <td>25 kHz</td> <td>20 samples</td> <td>19 samples</td> </tr> <tr> <td>50 kHz</td> <td>26 samples</td> <td>25 samples</td> </tr> </tbody> </table>	Rate	Pipe Input	MC Input	6 kHz	16 samples	15 samples	12 kHz	17 samples	16 samples	25 kHz	20 samples	19 samples	50 kHz	26 samples	25 samples
Rate	Pipe Input	MC Input														
6 kHz	16 samples	15 samples														
12 kHz	17 samples	16 samples														
25 kHz	20 samples	19 samples														
50 kHz	26 samples	25 samples														
<b>Input Impedance</b>	10 <sup>5</sup> Ohms															
<b>Power Requirements</b>	2 Lithium Ion cells at 10 AmpHours each															
<b>Battery</b>	Eight hours to charge both cells Battery life between charges, per cell: 32 ch ~ 13 hrs 64 ch ~ 11 hrs 96 ch ~ 9.5 hrs 128 ch ~ 8 hrs 256 ch ~ 5 hrs															
<b>Charger</b>	External 6 V, 3 A power supply															
<b>Indicator LEDs</b>	Up to 256 status or clip warning, battery life, active battery bank															
<b>Input referred noise</b>	2 $\mu$ V rms typical 300- 7000 Hz, 8 $\mu$ V peak typical															
<b>Fiber Optic Cable</b>	5 meters standard, cable lengths up to 20 meters**															

\*Note: When sampling at a rate of 48.828 kHz the PZ2 preamplifier is limited to a maximum of 128 channels.

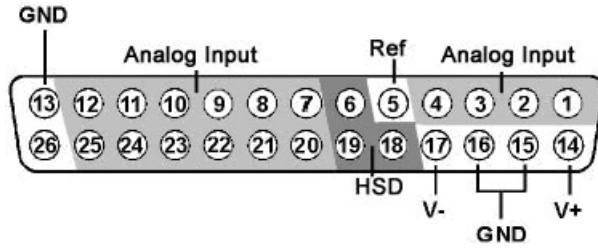
\*\*Note: If longer cable lengths are required, contact TDT.

## Input Connectors

PZ2 Preamplifiers have up to 16, 26-pin headstage connectors on the back of the unit. A1 – A16 represent the 16 channels coming from each connected headstage. The PZ2 channels are marked next to the respective connector on the preamplifier. So, for the connector for channel 1 – 16, A1 is channel 1 while on the connector for channels 17 – 32, A1 is channel 17.

**Important!** Each input connector uses its own unique ground and reference. When using multiple headstages, ground pins on all headstages should be connected together to form a single common ground. See “Headstage Connection Guide” on page 6-99.

**Pinout Diagram**



Pin	Name	Description	Pin	Name	Description
1	A1	Analog Input Channels	14	V+	Positive Voltage (+1.5V)
2	A2		15	GND	Ground
3	A3		16	GND	
4	A4		17	V-	Negative Voltage (-1.5V)
5	Ref	Reference	18	HSD	Headstage Detect
6	HSD	Headstage Detect	19	HSD	
7	A5	Analog Input Channels	20	A6	Analog Input Channels
8	A7		21	A8	
9	A9		22	A10	
10	A11		23	A12	
11	A13		24	A14	
12	A15		25	A16	
13	GND		Ground	26	

**Note:** TDT technical support (386-462-9622 or [support@tdt.com](mailto:support@tdt.com)) before attempting to make any custom connections to pins 6, 18, or 19.

