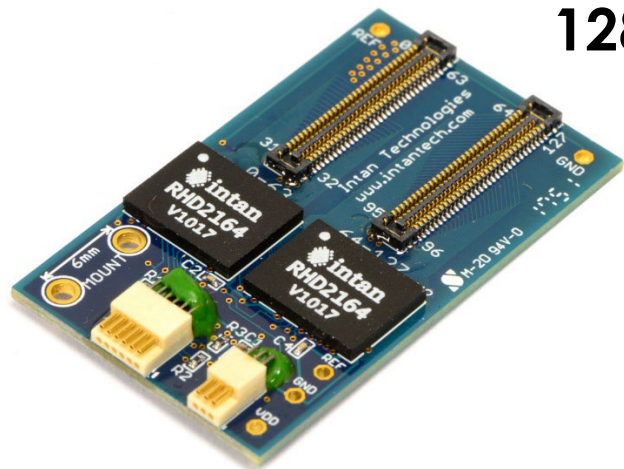


## RHD

# 128-Channel Headstage



24 February 2015; updated 7 August 2025

## Features

- ◆ Small (35 mm x 21 mm x 4 mm), lightweight (2.05 g) circuit board containing two RHD2164 64-channel amplifier chips from Intan Technologies
- ◆ Waveforms from 128 electrode channels (electrodes not included) are digitized and transferred over a single serial peripheral interface (SPI) cable
- ◆ Integrated electrode impedance measurement capability
- ◆ Dual mounting holes for mechanical stability

## Applications

- ◆ High density neural recording
- ◆ High-channel-count electrode characterization

## Description

The RHD 128-channel headstage is the highest density recording module available from Intan Technologies. It is compatible with the RHD Recording System, which can support multiple boards operating simultaneously. Each 128 channel headstage requires only one serial peripheral interface (SPI) cable to provide power and data communication with an RHD controller. (Although the RHD

USB interface board has four SPI interface connectors, it can support only two of these 128-channel headstages due to the 256-channel count limit imposed by the bandwidth limit of the USB 2.0 connection to the host computer. The 512-channel RHD recording controller can support four of these headstages; the 1024-channel RHD recording controller can support eight.)

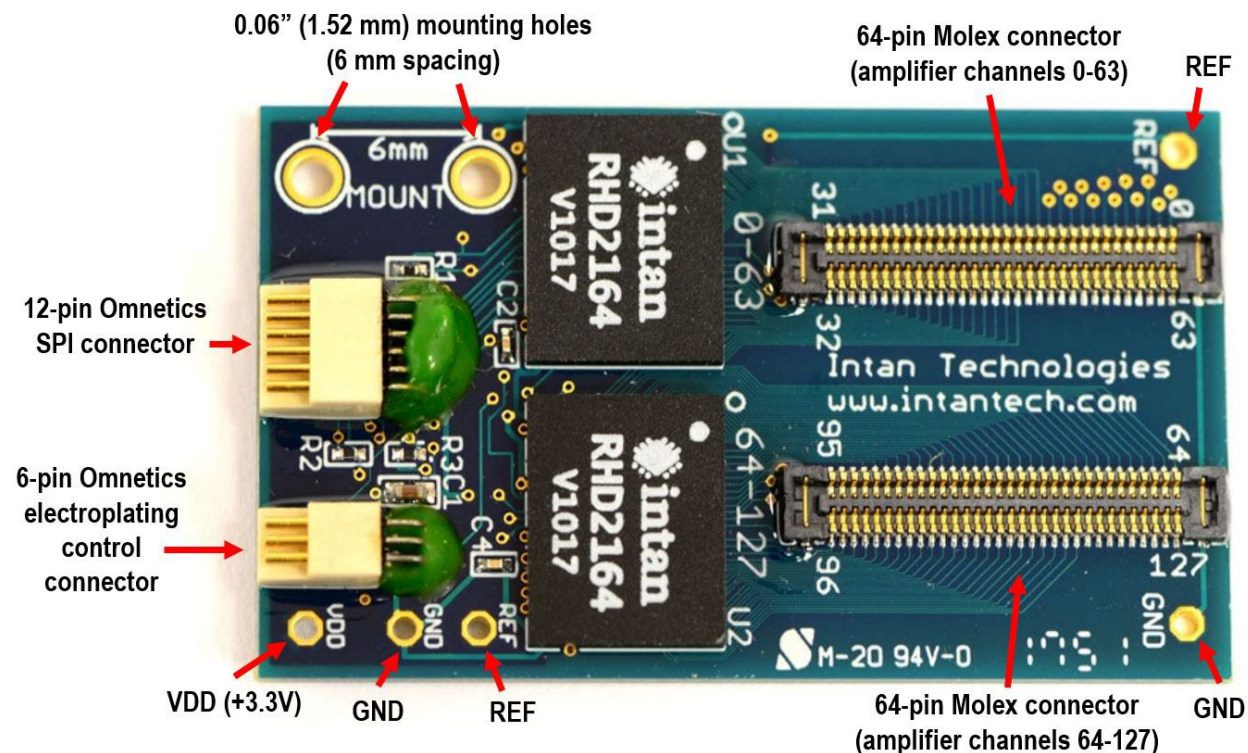
This 35 mm x 21 mm x 4 mm device weighs 2.05 grams and contains two Intan Technologies RHD2164 64-channel digital electrophysiology interface chips. These chips amplify, filter, and digitize microvolt-level waveforms from 128 electrode channels, serialize this data, and transfer it over a thin SPI cable where it can be viewed and recorded using open-source software from Intan Technologies. The chips also permit *in situ* measurements of all electrode impedances.

Two standard 64-pin Molex connectors provide connection points for an electrode array. (See diagram on next page.) Reference and/or ground electrodes may be connected to one of two solder holes on the board. A 12-pin Omnetics connector at the rear of the board provides a connection point for a standard Intan SPI interface cable. Two mounting holes with a center-to-center spacing of 6.0 mm provide a mechanical connection point. These holes each have a diameter of 60 mils (1.52 mm).

A six-pin Omnetics connector near the SPI connector once connected to the optional RHD Electroplating Board, but this board was discontinued in 2022. The Electroplating Board allowed users to plate silicon probes that were once distributed by the Masmanidis lab at UCLA, but these probes are no longer available. We now recommend using commercially available pre-plated silicon probes with this headstage.

# RHD 128-Channel Headstage

## Top View

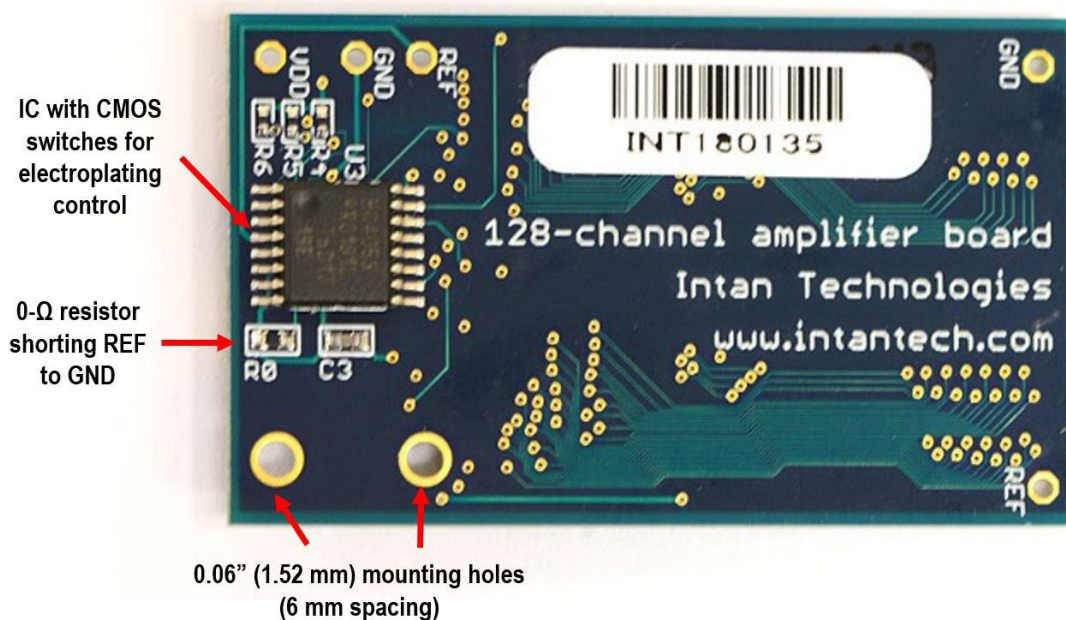


The RHD 128-channel headstage is shown here with key components labeled. Two 64-pin Molex connectors are used for electrode connections. The amplifier channel order (indexed from 0 to 127 to remain consistent with Intan data acquisition software) is marked on the circuit board at the four corner pins of each connector. The connectors used on the headstage are Molex SlimStack board-to-board connectors with 0.4-mm pitch and a height of 1.0 mm (Molex part number 502426-6410; Digi-Key part number WM24076-ND). The corresponding mating connectors to be used on an electrode board are Molex part number 502430-6410 (Digi-Key part number WM24084-ND; Mouser Electronics part number 538-502430-6410). The center-to-center spacing of these two connectors is 8.8646 mm (0.349 inches). A printed circuit board with 2-mil (50  $\mu\text{m}$ ) traces and 2-mil spacing is required to route signals from the RHD2164 chips to these connectors.

**It is important to note that these Molex connectors, like virtually all small, dense connectors on the market today, are only rated for a small number of plug-unplug cycles (i.e., 15-20). These numbers cited by the manufacturer are typically very conservative, and Intan adds epoxy to the ends of these connectors to further strengthen them. Still, it is recommended to minimize the number of plug-unplug cycles on these connectors in order to maximize the life of the headstage.**

# RHD 128-Channel Headstage

## Bottom View



The bottom of the RHD 128-channel headstage contains a 74HC4053 integrated circuit containing three CMOS switches once used for electroplating control. It also contains part R0: a zero-ohm jumper that shorts the reference electrode (REF) to ground (GND). **Note that this part must remain in place during electroplating.** This jumper may be removed for recordings if an independent reference is desired, but most users of Intan headstages obtain excellent recording quality with this part in place (i.e., the reference electrode shorted to ground). Soldering tweezers are the best tool for de-soldering or re-soldering this part.

The RHD 128-channel headstage contains solder holes for connecting reference and/or ground electrodes. A low-impedance reference electrode (typically a platinum or Ag/AgCl wire) should be used for all recording configurations. If R0 has been removed, then the tissue should also be connected to ground (GND) somehow (e.g., a skull screw). During electroplating, the ionic plating solution bath must be connected to REF, **not** to GND. For more information, see the RHD Electroplating Board datasheet.

The power supply voltage of approximately +3.3V is available at the VDD solder hole. This can be used to add an LED or other active device to the headstage, though devices that pull large amounts of current may cause excessive voltage drops over long SPI cables. For more information, see the **RHD Application Note: Adding an LED to headstages**.

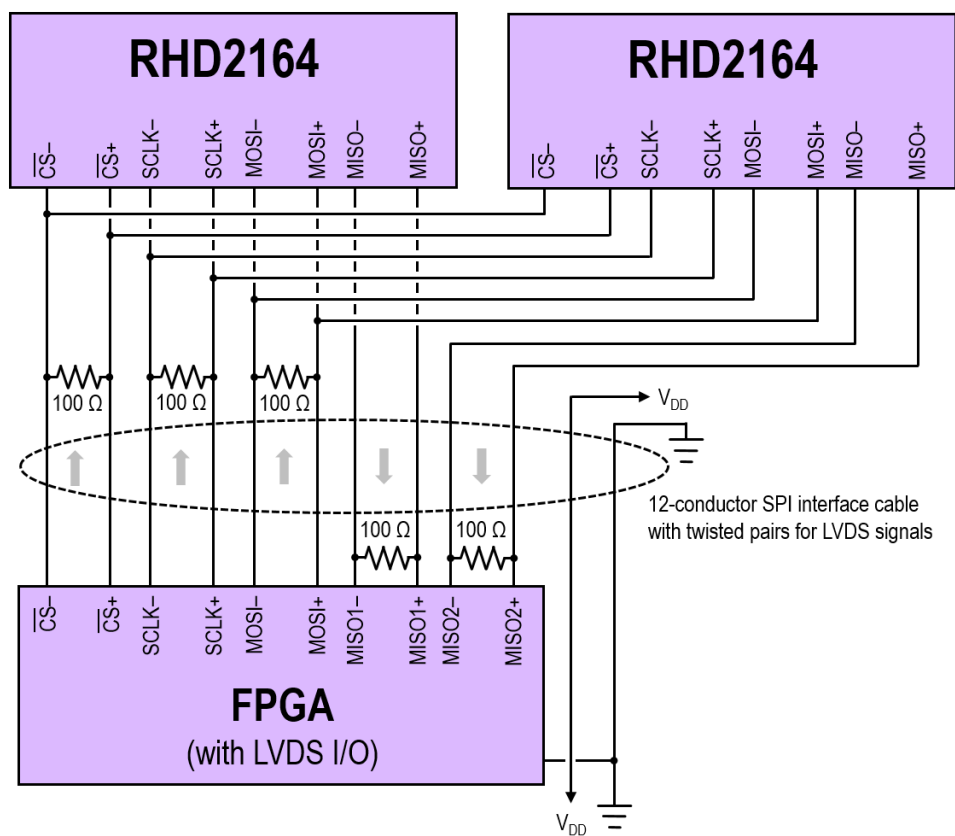
Two mounting holes are available for mechanical attachment. Although they are metal plated, they are electrically isolated from the circuitry in the board.

# RHD 128-Channel Headstage

## Circuit Design

### Serial Peripheral Interface

The RHD 128-channel headstage uses all 12 wires in the SPI interface cable to power and communicate with two RHD2164 chips. The diagram below shows a simplified version of the LVDS (low voltage differential signaling) SPI buses used on the board. Both chips receive the same commands, but they send data back on two MISO (master in, slave out) paths. More information on this communication method may be found in the **RHD2000 Series Datasheet**, the **RHD2164 Datasheet**, and the **RHD SPI cable/connector specification**. All documents may be found on the Downloads page at the Intan Technologies website.



# RHD 128-Channel Headstage

## Related RHD System Documentation

The following supporting datasheets may be found at <http://www.intantech.com/downloads>:

- ◆ RHD2000 Series Digital Electrophysiology Interface Chips
- ◆ RHD2164 Digital Electrophysiology Interface Chip
- ◆ RHD Recording System User Guide
- ◆ RHD USB/FPGA Interface: Rhythm
- ◆ RHD SPI Cable/Connector Specification

Application Notes:

- ◆ RHD Application Note: Data File Formats
- ◆ RHD Application Note: I/O Voltage Level Shifting
- ◆ RHD Application Note: Adapting SPI Cables to a Commutator
- ◆ RHD Application Note: Adding an LED to Headstages

Schematics of all circuit boards are available from Intan Technologies.

## Contact Information

This datasheet is meant to acquaint engineers and scientists with the RHD 128-channel headstage developed at Intan Technologies. We value feedback from potential end users. We can discuss your specific needs and suggest a solution tailored to your applications.

For more information, contact Intan Technologies.



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