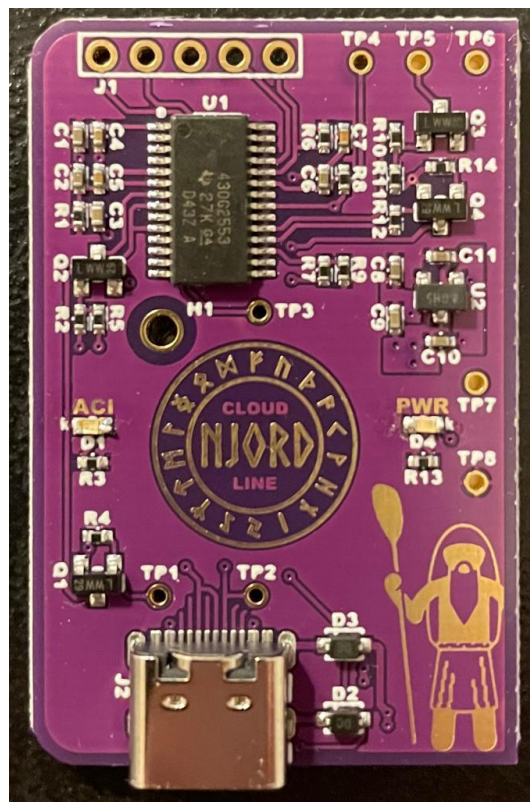


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# Njord Cloudline User Manual

## V1.0

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This is the user manual for the Njord Cloudline board. If you are installing the Njord Protean board, please refer to the “Njord Protean User Manual.”

## Warnings and Disclaimers



**CAUTION:** Using fan spoofer equipment like the Njord Cloudline board can increase the risk of overheating and damaging your miner. It is advised to monitor system temperatures closely to ensure they stay within safe limits.

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**WARNING:** Installing the Njord Cloudline board on your miner may void the miner's warranty. It is recommended to thoroughly research and evaluate the potential risks and benefits of using the Njord Cloudline board before installing it on your mining rig.

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## Product Overview

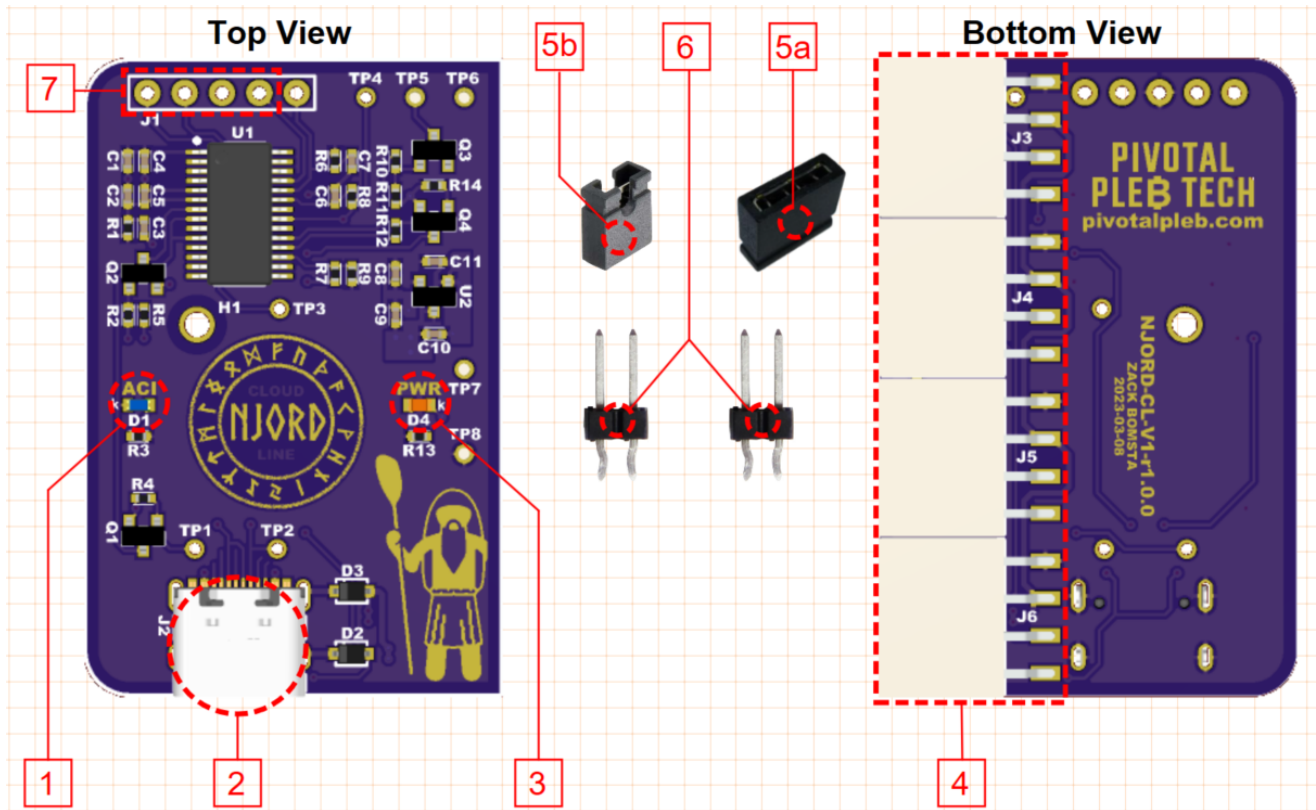
Off-the-shelf Bitmain mining rigs generate over 3 kilowatts of heat during normal operation and require efficient cooling to prevent overheating and damage. The miner uses multiple 12V DC fans governed by a central control board running a native temperature control algorithm to regulate its internal temperature and protect it from overheating. These fans are very loud and intrusive in residential mining environments.

The Njord Cloudline board enables Bitmain miners to control AC Infinity Cloudline fans that offer better cooling performance at lower sound pressure levels. Specifically, the Njord Cloudline board allows the miner to dynamically control an AC Infinity Cloudline fan's speed from the miner's control board using its native temperature control algorithm. Additionally, the Njord Cloudline board spoofs the original 12V DC stock fans. This allows the miner to run normally without the stock fans being connected to its control board.

The Njord Cloudline board utilizes AC Infinity's unique EC motor control protocol to interface directly with the Cloudline fan's integrated EC controller. The USB-C connector from the Cloudline fan plugs directly into the USB-C socket on the Njord Cloudline board. No high voltage AC connections to the Njord Cloudline board are required. See the "Installation Instructions" below for more details.

Finally, the Njord Cloudline board provides several preset operating modes to choose from that allow for optimal performance across different use cases. See the "Operating Mode Configuration" section below for more details.

## Expanded Product Components (For Reference in Installation and Configuration Instructions Below)



1. AC Infinity Plugged In Indicator LED
2. AC Infinity Cloudline Socket
3. DC Power Indicator LED
4. Fan Port Connectors

- 5a. 3-pin Jumper
- 5b. 2-pin Jumper
6. Press-to-Install Header Pins (2)
7. Header Pin Holes

The product components detailed above will be referenced throughout this document with the name followed by the corresponding number in square brackets [ ].

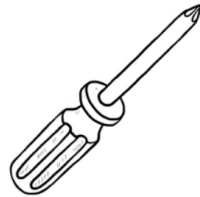
## Installation Instructions

The instructions in this section are for controlling an AC Infinity Cloudline fan through the “AC Infinity Cloudline Socket” [2].

These instructions assume that a compatible AC Infinity Cloudline fan has already been identified, selected, and acquired. See “Selecting Compatible Cooling Equipment” for more details. These instructions also assume that the fan has already been mechanically coupled to the mining rig.

### Required Tools for Installation

The following tools are recommended for installing the Njord Cloudline board.



#1 Phillips Screwdriver

### Installation Steps

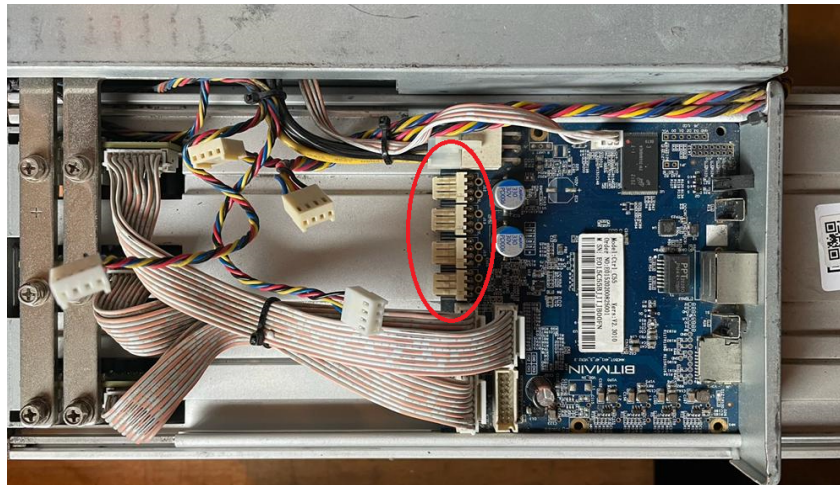
These installation steps assume that the AC Infinity Cloudline fan has a USB-C connector. Older Cloudline models that do not have a USB-C connector can be paired with the “MOLEX TO UIS PORT ADAPTER DONGLE, CONVERSION CABLE CORD” available for purchase from AC Infinity on their website.

#### **Step 1**

Power down and unplug all mining and cooling equipment. **DO NOT ATTEMPT TO INSTALL THE NJORD CLOUDLINE BOARD WHILE EQUIPMENT IS PLUGGED INTO AC MAINS.**

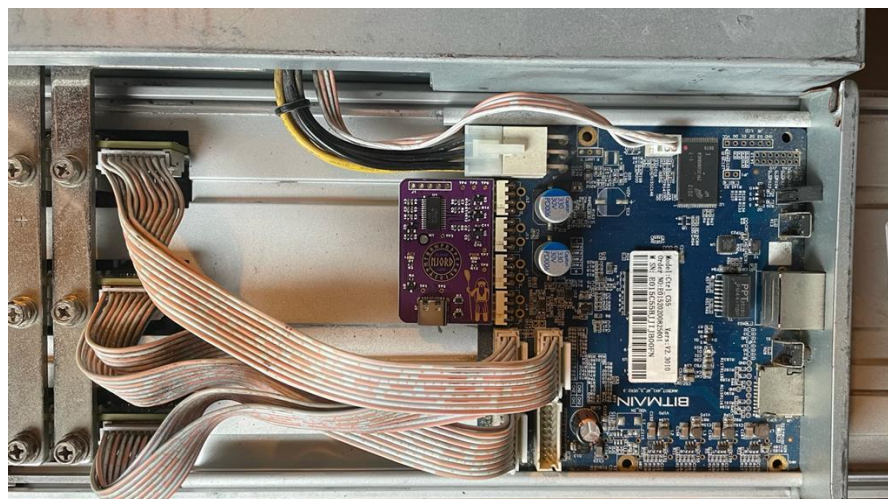
**Step 2**

Remove the miner's top cover and locate the miner's control board. Disconnect all 12V DC fans connected to the control board.



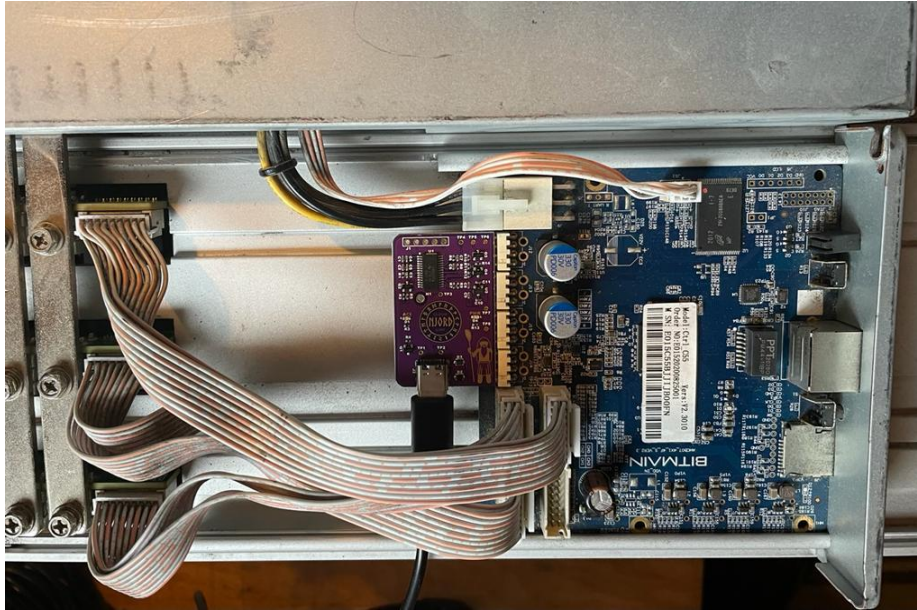
**Step 3**

Plug the Njord Cloudline board's "Fan Port Connectors" [4] into the 4 available fan headers on the control board. The top of the Njord Cloudline board should be facing up. Ensure that each fan header pin is properly aligned with the corresponding holes on the "Fan Port Connectors" [4] before connecting. If done properly, there shouldn't be any control board fan header pins exposed once the Njord Cloudline board is fully mounted.



**Step 4**

Locate the USB-C cable coming from the AC Infinity fan. Unplug the cable from the AC Infinity controller if needed. Plug the USB-C cable into the “AC Infinity Cloudline Socket” [2].

**Step 5**

Plug the AC Infinity Cloudline fan into AC mains.

**Step 6**

Power on the mining rig by plugging in the miner's power supply.

**Step 7**

Inspect and observe the Njord Cloudline board setup for proper operation. If everything was installed correctly and is working as intended, the orange “DC Power Indicator LED” [3] and the blue “AC Infinity Plugged In Indicator LED” [1] should light up immediately upon powering on the miner.

Note: If the miner is running 3rd party firmware, it may be best to change the Njord Cloudline boards operating mode. See the “Operating Mode Configuration” section below for more details.

## Operating Mode Configuration

The Njord Cloudline board provides 4 preset operating modes that can be helpful for tuning optimal performance across different mining environments and miner configurations. This section describes the preset operating modes, explains how to select each mode, and offers mode recommendations for common miner configurations.

Each preset operating mode consists of 2 settings: the “max fan speed” setting and the “PID” setting. The user cannot adjust these settings individually. Instead, they are adjusted based on the operating mode that the user selects with the configuration jumpers (see “Configuration Steps” and “Jumper Configuration Table”). Further details about these settings are given below.

### Max Fan Speed Setting

By default, the Njord Cloudline board will track the control board’s fan speed signal and allow the AC Infinity to run up to 100% if needed. It is often the case that the control board will set the fan speed to 100% for several minutes on boot up. This can be intrusive in environments that are sensitive to noise--especially if rebooting the miner happens often. Enabling the max fan speed setting limits the fan’s max speed to 70%. Careful consideration must be made before enabling this setting as it may cause the miner to overheat. For example, if the miner is being severely overclocked or hashing in high ambient temperatures, the miner may require more than 70% of the fan’s max speed to keep the miner’s temperature below the max temperature threshold. If this setting is enabled in this scenario, the fan will not be able to go above 70% of its max speed, and consequently, the control board may not be able to keep the miner’s temperature low enough for normal operation.

### PID Setting

The miner’s control board firmware uses a sophisticated temperature control mechanism called a PID controller to regulate miner temperatures in highly variable environments by controlling fan speeds. It’s beyond the scope of this document to give a detailed explanation of PID controllers, but there are a few key points to understand. First, when a PID controller is developed, it’s tuned to the specific system it’s deployed on. Modifying that system (i.e. changing the fans) may foul the PID controller and result in unwanted temperature and/or fan speed cycling. There are ways to make the PID controller more resilient to system changes, but the right way to do so depends on the PID controller’s design. This leads to the second important point. Each firmware supplier (i.e. Bitmain, Braiins, Luxor, Vnish, etc.) has developed its own PID controller with its own unique behavior, and there isn’t a single one-size-fits-all solution to make them all resilient to

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system changes. This is where the Njord Cloudline board's PID setting comes in. It selects between two PID buffering methods: the "mean reversion" method and the "slew" method. By default, the Njord Cloudline board uses the mean reversion method. This method works best with Bitmain and Braiins firmware. Conversely, the slew method works best on Luxor and Vnish firmware. The PID setting can be toggled by selecting different operating modes given below. It is beyond the scope of this document to make a PID mode recommendation for all possible firmware options. If running a firmware outside of the ones given above, the user is encouraged to try the two different PID modes and see which one they prefer for their setup.

### **Operating Modes**

There are 4 operating modes. Each operating mode is a unique combination of the max fan speed setting (max or limited) and the PID setting (mean reversion or slew).

**1. *Mean Reversion, Max Fan***

This is the default operating mode. It uses the mean reversion method to buffer the PID controller and does not limit the max fan speed. It may be the best option for mining rigs running Bitmain or Braiins firmware in environments that are not overly sensitive to noise. No configuration steps are needed to select this mode. It is enabled by default out of the box.

**2. *Mean Reversion, Limited Fan***

This mode uses the mean reversion method to buffer the PID controller and limits the max fan speed to 70%. It may be the best option for mining rigs running Bitmain or Braiins firmware in environments that are sensitive to noise. Selecting this mode requires specific configuration steps. See the "Configuration Steps" section and "Jumper Configuration Table" below for more details. **DO NOT SELECT THIS MODE IF YOU INTEND TO SEVERELY OVERCLOCK YOUR MINER OR RUN YOUR MINER IN HIGH AMBIENT TEMPERATURES.**

**3. *Slew, Max Fan***

This mode uses the slew method to buffer the PID controller and does not limit the max fan speed. It may be the best option for mining rigs running Luxor or Vnish firmware in environments that are not overly sensitive to noise. Selecting this mode requires specific configuration steps. See the "Configuration Steps" section and "Jumper Configuration Table" below for more details.



**4. Slew, Limited Fan**

This mode uses the slew method to buffer the PID controller and limits the max fan speed to 70%. It may be the best option for miners running Luxor or Vnish firmware in environments that are sensitive to noise. Selecting this mode requires specific configuration steps. See the “Configuration Steps” section and “Jumper Configuration Table” below for more details. **DO NOT SELECT THIS MODE IF YOU INTEND TO SEVERELY OVERCLOCK YOUR MINER OR RUN YOUR MINER IN HIGH AMBIENT TEMPERATURES.**

**Jumper Configuration Table**

Mode	Jumper Position	Miner Firmware	Max Fan Speed
Mean Reversion Max Fan	• • • • No Jumper	Bitmain Braiins	100%
Mean Reversion Limited Fan	• - • -   • 3 Left Pins	Bitmain Braiins	70%
Slew Max Fan	• - •   • • 2 Left Pins	LuxOS Vnish	100%
Slew Limited Fan	•   • - •   • 2 Middle Pins	LuxOS Vnish	70%

**Configuration Steps**

The configuration steps outlined here are general steps for selecting a preset operating mode. Specific preset modes are selected based on specific jumper configurations. See “Jumper Configuration Table” above to determine how to select a specific mode.

**Step 1**

Power down and unplug all mining and cooling equipment. **DO NOT ATTEMPT TO MODIFY THE PRESET MODE WHILE THE MINING EQUIPMENT IS PLUGGED INTO AC MAINS.**

**Step 2**

Locate the two “Press-to-Install Header Pins (2)” [6], the “3-pin Jumper” [5a], and the “2-pin Jumper” [5b].

**Step 3**

Locate the “Jumper Pin Holes” [7] and press the short, bent ends of the “Press-to-Install Header Pins” [5] into the four left most holes. If installed correctly, there should be one vacant header pin hole to the right of the header pins.

**Step 4**

Determine which pin jumper (“3-pin Jumper” [5a] or “2-pin Jumper” [5b]) should be used and which position it should be plugged in at based on the desired operating mode using the “Jumper Configuration Table” above.

**Step 5**

Plug the Njord Cloudline board into the miner’s control board if it was removed during the configuration process (see Step 3 of Installation Instructions for details).

**Step 6**

Plug the AC Infinity Cloudline’s USB-C connector into the Njord Cloudline board if it was unplugged during the configuration process (see Step 4 of Installation Instructions for details).

**Step 7**

Plug the AC Infinity Cloudline fan into AC mains.

**Step 8**

Power on the mining rig by plugging in the miner’s power supply.

**Step 9**

Inspect and observe the Njord Cloudline board setup for proper operation. If everything was installed correctly and is working as intended, the orange “DC Power Indicator LED” [3] and the blue “AC Infinity Plugged In Indicator LED” [1] should light up immediately upon powering on the miner. The fan’s selected operating mode will now take effect.

**Note:** Now that the “Press-to-Install Header Pins” [5] have been installed, changing the selected operating mode can be done by simply changing the pin jumper configuration. No miner power down or reboot is necessary.

## Selecting Compatible Cooling Equipment

The Njord Cloudline board was designed specifically to be able to control AC Infinity Cloudline fans. The AC Infinity Cloudline series uses an electronically commutated (EC) motor. It is possible to control other EC motors through the “AC Infinity Cloudline Socket” [2] if the EC motor has a pin compatible USB-C cable (matches the AC Infinity USB-C pinout) and follows the AC Infinity EC motor control protocol. See the “AC Infinity EC Motor Control Protocol” section for more details. At the time of writing, the Njord Cloudline board supports all Cloudline Lite Ax, Cloudline Lite Bx, Cloudline Sx, and Cloudline Tx models (AI-CLA4, AI-CLB4, AI-CLS4, AI-CLT4, AI-CLA6, AI-CLB6, AI-CLS6, AI-CLT6, AI-CLA8, AI-CLB8, AI-CLS8, AI-CLT8, AI-CLS10, AI-CLT10, AI-CLS12, AI-CLT12). Please note that the Njord Cloudline board will replace the stock AC Infinity controller. It’s not possible to use AC Infinity’s manual speed controller or their temperature and humidity controllers simultaneously with the Njord Cloudline board. If ambient temperature and humidity control is required, please consider alternative system designs.

## APPENDIX

### AC Infinity EC Motor Control Protocol

AC Infinity uses a modified PWM and Tach communication protocol, similar to the common 4-wire PC fan protocol, to control the Cloudline fan speed. Cloudline fans have an integrated, digital "EC motor controller" that relies on an input signal from one of several different human input device controllers (HID) to control the fan speed. The digital EC controller reads the duty cycle of a 0-10V, 5KHz PWM input signal from an HID controller to determine what the fan speed should be. The EC controller also provides a tach signal. The protocol is as follows:

- The EC controller provides 10V to the HID controller via VBUS of the USB-C connector
- The speed control input signal is between 0-10V
- The speed control PWM frequency is 5KHz except in the cases of the fan fully OFF or fully ON
- The PWM duty cycle sets the fan speed. Unless fully ON or fully OFF, the duty cycle ranges from 23.5% to 87.5%
- 0V (0% duty cycle) signals fan fully OFF
- 10V (100% duty cycle) signals fan fully ON
- The speed control input signal is pulled up to 10V by default by the EC controller (pull-up resistor)
- The HID controller pulls the speed control input signal low (open drain) to control the PWM
- HID controller unplugged defaults to fan fully ON because the PWM line is pulled up to 10V by EC controller
- The fan tach signal is between 0-5V
- The fan tach signal duty cycle is fixed at 50% except in the case of the fan fully OFF
- The fan tach signal frequency increases with fan speed (~35Hz to ~156Hz)
- The fan tach signal is 5V when the fan is fully OFF