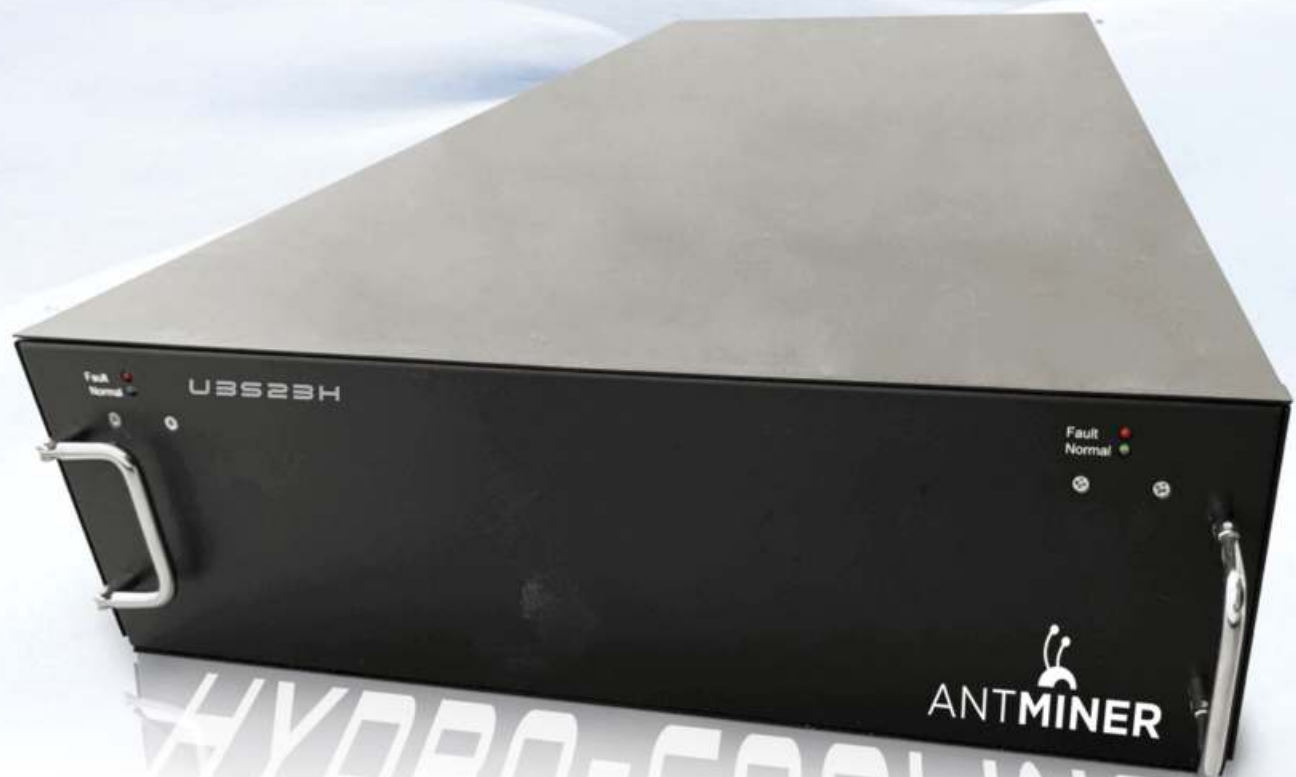


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GUIDE VS



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SINCE 2019





Electrical Infrastructure

Component	Bitcoin Mining Facility	AI Data Center
Medium Voltage Switchgear	Required on larger sites	Required
Pad Mount Transformer	Required	Required
Main Switchboards	1-2 Sections	IT Load: 7-10 Sections Mechanical Load: Dedicated Boards
Automatic Transfer Switch (ATS)	Not Common	Required
Uninterruptible Power Supply (UPS)	Not Required	Required
Panelboards	Required	Required
Remote Power Racks (rPDU)	Required	Required

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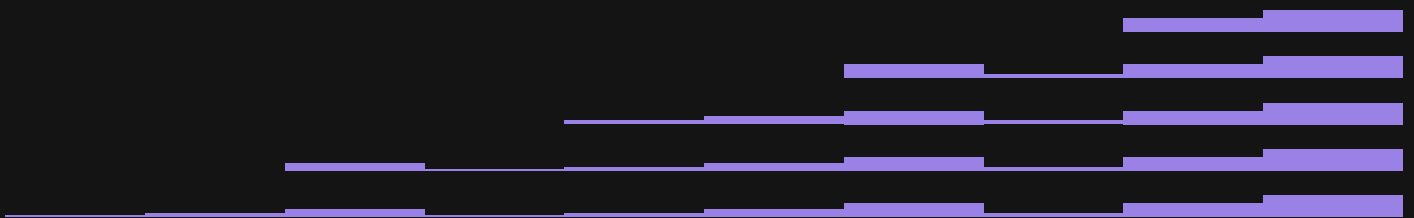




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THE FIRMWARE WARS

SOFTWARE. PERFORMANCE. PROFITABILITY.
THE **NEW** MINING FRONTIER.

How Software Became One of Bitcoin
Mining's Biggest **Competitive Advantage**



WHY HARDWARE
IS NO LONGER
ENOUGH



THE HIDDEN BATTLE
INSIDE EVERY
ASIC



AUTO-TUNING,
UNDervOLTING &
AI OPTIMIZATION



HOW SOFTWARE
IS REWRITING
MINING
PROFITABILITY

```
chip[57] temp: 63.2c
chip[58] temp: 62.7c
chip[59] temp: 61.9c
chip[60] temp: 63.1c
chip[61] temp: 62.3c
chip[62] temp: 62.0c
chip[63] temp: 61.7c
```

```
freq: 612
voltage: 0.82v
fan: 78%
power: 3250w
hashrate: 106.7 TH/s
efficiency: 33.6 J/TH
```

AUTO-TUNING...

```
optimizing each chip
analyzing stability
finding sweet spot
maximizing profit
```

```
status: optimal
profitability: +8.7%
```

HASHRATE
106.7 TH/s

POWER
3250 W

EFFICIENCY
33.6 J/TH



How Software Became One of Bitcoin Mining's Biggest Competitive Advantages

For years, Bitcoin mining was a hardware arms race. The conversation revolved around chip design, manufacturing processes, power efficiency, and hashrate. Every new generation of ASIC miners promised more terahash, lower joules per terahash, and better profitability.

The assumption was simple:

Better hardware wins.

But something unexpected happened. Software entered the fight. Today, some of the biggest performance gains in Bitcoin mining no longer come from buying a new machine. They come from unlocking more performance from the machine you already own.

Welcome to the **Firmware Wars.**

THE MOST OVERLOOKED LAYER

Yet one of the most important profitability variables sits inside every machine:

Most miners focus on:



ASIC model



Electricity cost



Bitcoin price



Network difficulty

FIRMWARE

Firmware controls:

- Frequency
- Voltage
- Fan behavior
- Thermal management
- Power consumption
- Chip tuning
- Stability



Two identical miners can produce dramatically different results depending on the software they're running.

**SAME HARDWARE.
DIFFERENT PROFITABILITY.**

Every Chip Is Different

One of the biggest misconceptions in mining is that all ASICs of the same model perform identically. They don't. Chip manufacturing is never perfect.

Every ASIC chip has slightly different electrical characteristics. Some chips run cooler. Some tolerate higher frequencies. Some require less voltage.

Some are simply better than others. Factory firmware generally treats these chips as if they are all the same. Aftermarket firmware often doesn't.

Modern tuning software can analyze individual chips and

optimize them independently. Instead of forcing every chip to operate at the same settings, the firmware attempts to find the sweet spot for each one.

This process is often called:

- **Auto tuning**
- **Per-chip tuning**
- **Dynamic tuning**

The result is a machine operating closer to its actual potential.

Why Manufacturers Play It Safe

Factory firmware exists for one purpose:

Reliability.

Manufacturers must ship software that works across:

- Hot climates
- Cold climates
- High humidity
- Low humidity
- Clean environments
- Dusty environments
- Strong chips
- Weak chips

The safest approach is conservatism. The goal is stability. Not maximum performance. That leaves room for firmware developers to push the hardware further. The manufacturer builds the machine. The firmware community attempts to unlock it.

The Three Paths

Most firmware strategies fall into three categories.

More Hashrate

This is the most obvious goal. Increase frequency. Push chips harder. Generate more terahash. More terahash means more potential revenue. At least in theory.

The challenge is that higher performance also creates:

- More heat
- More power consumption
- More stress

Performance is never free.

Better Efficiency

Sometimes the goal isn't more hashrate. It's lower operating cost. Efficiency-focused tuning attempts to reduce voltage and optimize chip behavior

while maintaining acceptable performance.

The result may be:

- Slightly lower hashrate
- Significantly lower power draw

For miners paying high electricity rates, efficiency often beats brute force.

Maximum Stability

Large operators often prioritize uptime over everything else. A machine producing slightly less hashrate but running continuously may outperform a faster machine that constantly crashes, overheats, or requires intervention.

For industrial fleets, reliability is revenue.



The Rise of Undervolting

One of the most important developments in modern mining has been the rise of undervolting. It sounds counterintuitive. Instead of increasing power, operators reduce it.

The goal is simple:

Find the minimum voltage required for stable operation. When successful, the machine consumes less electricity while maintaining much of its original performance. During bull markets, many miners chase hashrate. During bear markets, they chase efficiency.

Undervolting became especially popular during difficult mining conditions because every watt saved improves profitability. Sometimes the fastest miner is not the most profitable miner.

Chasing the Redline

At the opposite end of the spectrum sits overclocking. Overclocking pushes machines beyond factory specifications.

- Higher frequency.
- Higher power draw.
- Higher heat.
- Higher hashrate.

When conditions are favorable, the gains can be substantial. But so are the risks. Every increase in performance creates additional stress on:

- Chips
- Fans
- Power supplies
- Cooling systems
- Hashboards

Mining veterans often compare overclocking to driving a sports car.

The closer you get to the redline, the more attention maintenance requires.

Some operators love living at the edge. Others prefer longevity.

The Economics of Firmware

One of the most fascinating aspects of the firmware industry is its business model. Many platforms don't sell software in the traditional sense.

Instead, they charge a performance fee. The software developer earns a small percentage of mining time or revenue. The arrangement only works if the firmware creates more value than it extracts.

For miners, the calculation is straightforward:

If software increases profitability by more than the fee costs, everybody wins. This model transformed firmware from a hobbyist niche into a serious segment of the mining industry.

Fleet Management Changes Everything

The economics of firmware look different at scale. A home miner may focus on maximizing one machine.

A professional operator may manage thousands. At that scale, firmware becomes infrastructure.



Questions change. Instead of asking:

“How much more hashrate can I get?”

Operators ask:

How many failures will this create?

How much downtime will this reduce?

How much maintenance will this require?

How does this impact fleet efficiency?

A one percent improvement across thousands of machines can represent millions of dollars over time. Firmware becomes a strategic decision. Not just a technical one.

The Hidden Arms Race

Most of the industry’s firmware competition happens quietly. There are no massive product launches.

No flashy unveiling events. No dramatic keynote presentations. Instead, there is a constant battle happening behind the scenes.

Developers are competing to:

- Improve tuning algorithms
- Increase efficiency
- Reduce power consumption
- Improve thermal behavior
- Increase uptime
- Detect failures earlier

The competition never stops. Because every improvement creates a potential advantage. And in mining, small advantages compound.

Software Eats Hardware

A phrase often repeated in technology circles is:

“Software is eating the world.”

Bitcoin mining may be experiencing its own version of that reality. The hardware still matters. It always will.

But increasingly, the difference between a good operation and a great one comes from how effectively that hardware is managed.

Two operators can own the exact same machines. One may outperform the other dramatically. Not because of hardware. Because of software.

The Future of Mining Software

The next generation of firmware will likely become even more sophisticated.

Expect to see:

- ▲ AI-assisted tuning
- ▶ Predictive failure detection
- ◻ Dynamic power optimization
- ▲ Automated chip diagnostics
- ▶ Real-time profitability adjustments

The future ASIC may spend as much time optimizing itself as it does hashing. The industry is moving toward machines that continuously adapt rather than simply operate.

The Bottom Line

Bitcoin mining began as a hardware business. Today, it is increasingly a software business too. The machine is only the foundation. Firmware determines how effectively that machine performs.

Some miners use software to chase maximum hashrate. Others use it to maximize efficiency. The best operators understand that profitability lives somewhere in the middle.

Because in modern mining, the race is no longer just about who owns the best hardware. It’s about who unlocks the most from it.

And that battle is being fought one firmware update at a time.

That was 12 of 60 pages.

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