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Meta title: AIDC Data-Center Full-Chain Power Magnetics Map: Transformers & Inductors from 10kV to Board VRM | ProMagTech
Meta description: A complete map of the magnetics along the AI data-center power chain: 10kV grid → 0.4kV distribution → SST solid-state transformer → 800V bus → BBU storage → rack 800V/48V → server 48V/12V → board VRM. Core material, topology, parameter ranges and selection rules per stage, including ProMagTech's high-frequency power-magnetics focus. Figures are public reference values, confirm per project.
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TECHNICAL OVERVIEW / AIDC FULL-CHAIN POWER MAGNETICS

AIDC Data-Center Full-Chain Power Magnetics Map

From the 10kV grid to the board VRM — the transformers and inductors along one power chain

How to read this article: This article maps the complete AI data-center power path, from the utility feed to the chip core, and the magnetics at each stage. To keep the picture honest, two labels are used throughout:

○ Industry-chain background — the magnetics at this stage belong to the high-voltage / line-frequency domain (e.g. silicon-steel distribution transformers), supplied by power-equipment makers. Covered here for context only; ProMagTech does not supply them.

● ProMagTech focus area — high-frequency isolation transformers and power inductors across every level: this is where ProMagTech (flat-wire power magnetics) concentrates.

1. Core Conclusion

AIDC power steps down from a 10kV utility feed all the way to a 0.7–1.8V chip core, crossing five to six voltage levels, each dependent on a transformer or an inductor. Understanding this chain is a prerequisite for judging magnetics selection. Three core conclusions:

In one line: 1. Clear division of labor: the high-voltage line-frequency section uses silicon-steel transformers/reactors (power-equipment domain); from SST downward, the high-frequency section uses high-frequency isolation transformers + power inductors (ProMagTech domain).

2. Frequency dictates material: from 50Hz line frequency (silicon steel) → 20–120kHz (nanocrystalline/ferrite) → 150kHz–2MHz (powder-core flat wire); the higher the frequency, the more it relies on high-frequency power magnetics.

3. The value concentrates at high frequency: the five magnetics categories with the largest overseas AIDC growth and the highest barriers all fall in ProMagTech's high-frequency focus (see Section 8).

The stages below follow the power chain in order. All parameters are public-industry or typical engineering reference ranges, used to convey the magnitude and selection direction of each stage; they do not represent any specific product's rating and must be confirmed per project.

2. Full-Chain Overview

The table is a single-view map of the complete power chain, marking each stage's voltage, frequency, main magnetics and domain:

Table 2-1 AIDC full-chain power magnetics overview

Stage	Voltage	Frequency	Main magnetics	Domain
10kV grid	10kV AC	50Hz	Silicon-steel distribution transformer/reactor	Background
0.4kV distribution	400V AC	50Hz	Silicon-steel isolation transformer/reactor	Background

Stage	Voltage	Frequency	Main magnetics	Domain
SST solid-state transformer	→800V DC	20–100kHz	HF isolation transformer + resonant/PFC inductor	ProMagTech
BBU storage	800V DC	20–80kHz	Bidirectional DC/DC storage inductor	ProMagTech
Rack 800V→48V	→48V DC	80–120kHz	HF isolation transformer + step-down inductor	ProMagTech
Server 48V→12V	→12V DC	150–250kHz	Flat-wire power inductor (no transformer)	ProMagTech
Board 12V→core	→0.7–1.8V	500kHz–2MHz	TLVR/VPD high-current inductor	ProMagTech

(Voltage/frequency are typical reference ranges per stage; they vary with architecture and must be confirmed per project.)

3. High-Voltage & Line-Frequency Distribution

○ **Industry-chain background** The 10kV and 0.4kV stages below belong to the high-voltage / line-frequency power-equipment domain; ProMagTech does not supply them — included for chain completeness.

The grid side centers on 10kV line-frequency distribution: the distribution transformer performs the first step-down, while current-limiting, filtering and zero-sequence reactors handle short-circuit limiting, harmonic mitigation and three-phase balancing, protecting downstream precision equipment such as the SST. These devices use cold-rolled grain-oriented silicon steel and are built for high-voltage, line-frequency, high-short-circuit-withstand outdoor distribution, supplied by specialist power-equipment makers. The 0.4kV low-voltage stage is analogous, using silicon-steel isolation transformers and low-frequency reactors for isolation, inrush buffering and reactive compensation.

For a magnetics engineer, the value of understanding these two stages is this: they set the power quality (voltage stability, harmonic level) that enters the SST high-frequency section. Harmonics and surges not cleaned up at line frequency will flow back into the SiC high-frequency system, causing abnormal device heating and false triggering. The chain is one system.

4. SST Solid-State Transformer High-Frequency Stage

● **ProMagTech focus area** High-frequency isolation transformers and the accompanying resonant/PFC inductors are a core ProMagTech capability area.

The SST (solid-state transformer) replaces the bulky line-frequency transformer with high-frequency conversion, transforming a 400V AC / 10kV input into an 800V-class HVDC bus — the core of next-generation efficient AIDC distribution. Its magnetics all operate in the 20–100kHz SiC high-frequency domain:

Table 4-1 SST-stage magnetics (reference ranges)

Magnetic device	Core material	Frequency ref.	Core function
SST HF isolation transformer	Nanocrystalline/ amorphous/power ferrite	40–100kHz	HF isolation, efficient step up/ down, replaces line-frequency transformer
Front-end PFC boost inductor	HF powder core/ nanocrystalline	20–60kHz	Power-factor correction, boost storage, input-ripple suppression
LLC resonant inductor	Nanocrystalline/power ferrite	40–100kHz	SiC soft switching with the transformer, cutting switching loss
800V output filter inductor	High-sat powder-core flat wire	—	Filters HF ripple, delivers clean HVDC
SST EMI common-mode inductor	—	—	Suppresses HF common-mode noise, prevents harmonic backflow

(SST unit power, withstand voltage and efficiency vary widely with architecture and must be confirmed per project; no specific figures are committed here.)

5. BBU Rack-Level Storage Backup Stage

● **ProMagTech focus area** The 800V bidirectional DC/DC storage inductor is a key application of ProMagTech flat-wire power inductors.

The BBU (battery backup unit) operates on an 800V DC storage bus, using bidirectional DC/DC to charge and regulate under normal mains and to release very large current the instant mains drops, keeping GPU compute uninterrupted. Its magnetics are characterized by high current, high saturation and fast transient:

Table 5-1 BBU-stage magnetics (reference ranges)

Magnetic device	Core / structure	Core function
Bidirectional DC/DC storage inductor (primary)	High-sat powder core / nanocrystalline flat wire	Charge regulation + very large current release on mains loss, keeping compute alive
BBU input filter inductor	—	Isolates SST HF ripple, prevents HF polarization heating/ aging of the battery
Parallel current-sharing inductor	—	Shares current across paralleled racks, preventing single-unit overload/thermal runaway
HV EMI common-mode inductor	—	Eliminates HVDC ground-loop noise

(The bidirectional, asymmetric duty of a storage inductor makes saturation-margin assessment the hard part — see our dedicated article on bidirectional DC/DC inductor saturation margin. Parameters to be confirmed per project.)

6. Rack First Step-Down: 800V DC → 48V DC

● **ProMagTech focus area** 800V/48V high-frequency isolation transformer and step-down inductor — a ProMagTech focus area.

The rack stage uses full-bridge LLC isolation plus synchronous rectification to step 800V HVDC down to a 48V regulated bus, with switching frequency entering 80–120kHz. This is a key link in AIDC central distribution:

Table 6-1 Rack 800V→48V stage magnetics (reference ranges)

Magnetic device	Core / frequency	Core function
800V→48V HF isolation transformer	Power ferrite/ nanocrystalline, 80–120kHz	HV/LV isolation + high-to-mid-voltage conversion
800V HV input filter inductor	Nanocrystalline/ferrite	Suppresses bus spikes, protects SiC HV switches
LLC main resonant inductor	80–120kHz	Enables soft switching, raises DC-DC efficiency
48V output smoothing inductor	High-flux powder-core flat wire	Delivers ultra-low-ripple clean 48V bus

7. Server & Board: 48V→12V→Core Voltage

● **ProMagTech focus area** Flat-wire power inductors (48V→12V) and TLVR/VPD high-current inductors (board VRM) are ProMagTech's highest-volume, highest-value areas.

The server PSU uses a multiphase parallel Buck (no transformer) to step 48V down to a 12V main bus at 150–250kHz; the board VRM then uses a 12–20-phase Buck to step 12V down to a 0.7–1.8V chip core at up to 500kHz–2MHz. Both stages rely entirely on power inductors:

Table 7-1 Server and board stage magnetics (reference ranges)

Magnetic device	Frequency ref.	Core function
48V→12V main step-down flat-wire inductor (flagship)	150–250kHz	Energy freewheeling, supports hundreds of amps of stable server output
48V input common/differential inductor	—	Filters bus crosstalk and circulating-current interference
TLVR ultra-low-loss high-current inductor	500kHz–1MHz	Ultra-fast transient response, very low loss, for liquid-cooled AI server boards
VPD high-density power inductor	—	CPU/memory/high-speed-signal supply and filtering

(The 48V→12V edge-wound flat-wire inductor and the board TLVR/VPD inductor are the fastest-growing AI-server categories today. Per-phase current, saturation current, DCR etc. to be confirmed per project.)

8. Full-Chain Selection Rules

Grouping the chain's magnetics by frequency makes the selection rule very clear:

AIDC full-chain magnetics selection rules (by frequency)

▶ **10kV/0.4kV line-frequency (50Hz)** — Silicon-steel line-frequency transformer + silicon-steel reactor [Background]

▶ **SST core stage (20–100kHz)** — Nanocrystalline/ferrite HF transformer + high-power HF inductor [ProMagTech]

▶ **Rack stage (80–120kHz)** — HF isolation transformer + flat-wire high-power inductor [ProMagTech]

▶ **Server PSU stage (150–250kHz)** — No transformer; flat-wire powder-core inductor (highest volume) [ProMagTech]

▶ **Board VRM stage (500kHz–2MHz)** — No transformer; TLVR/VPD premium inductor (highest value) [ProMagTech]

The five high-barrier overseas AIDC magnetics categories: The five magnetics categories with the largest growth and highest barriers in overseas AI data centers today — SST HF isolation transformer, 800V→48V rack transformer, BBU bidirectional storage inductor, three-stage step-down flat-wire inductor, and TLVR high-current inductor — all fall within high-frequency power magnetics, which is exactly ProMagTech's focus.

9. FAQ

Q1: Which magnetics on this chain can ProMagTech supply?

ProMagTech focuses on high-frequency power magnetics: SST HF isolation transformers, PFC/LLC resonant inductors, BBU bidirectional storage inductors, rack 800V→48V isolation transformers and step-down inductors, server 48V→12V flat-wire power inductors, and board TLVR/VPD high-current inductors. The 10kV/0.4kV line-frequency distribution transformers and reactors belong to the high-voltage power-equipment domain, supplied by specialist makers, and are outside ProMagTech's scope — we map the full chain to help you understand where magnetics sit along the whole power path.

Q2: Why does the core material change completely as frequency rises down the chain?

Because core loss correlates strongly with a material's usable frequency. The line-frequency stage (50Hz) uses silicon steel for low loss and high saturation; the HF isolation stage (tens to hundreds of kHz) uses nanocrystalline/ferrite balancing loss and power; the HF power-inductor stage (hundreds of kHz to MHz) uses powder cores for soft saturation and strong DC-bias capability. Frequency dictates material, material dictates structure — the underlying logic of full-chain selection.

Q3: Can the parameters in the tables be used directly for my selection or spec sheet?

The values are public reference ranges, for judging magnitude and direction per stage; they cannot be used directly as spec-sheet figures. Each stage's final parameters depend on your specific architecture, power, frequency and cooling, and must be confirmed under real conditions. Writing reference ranges into a spec as ratings creates risk at the validation stage.

10. Related Resources & Contact

Related technical resources

Topic	Link
800V HVDC bus inductor design guide	aidc-800v-hvdc-bus-inductor-design-guide
AI PSU LLC resonant planar transformer guide	ai-psu-llc-planar-transformer-guide
Why the core loss on the datasheet is wrong for your operating point	core-loss-datasheet-vs-real-operating-point

Contact ProMagTech: SHENZHEN PROMAGTECH CO.,LTD. focuses on custom high-frequency power magnetics for AIDC: SST HF isolation transformers, 800V bus and storage inductors, and flat-wire power inductors plus TLVR/VPD high-current inductors across the rack, server and board levels.

If your project sits in these high-frequency stages, send your voltage, power, frequency, current and cooling conditions, and we will provide a custom magnetics solution with achievable parameters. Line-frequency high-voltage distribution equipment is outside our scope, but we are glad to discuss the magnetics division of labor across the whole chain.

Web: www.promagtech.com

Disclaimer: All voltage, current, power, frequency, efficiency and temperature-rise figures in this article are public industry ranges or typical engineering reference values, not ratings or performance commitments of any specific product. The 10kV/0.4kV line-frequency distribution equipment belongs to the power-equipment domain and is not supplied by ProMagTech; it is covered here for chain context only. Final magnetics specifications must be confirmed per project under real operating conditions.