

120V / 40A / 66kHz Flat-Wire Inductor Design Case

Engineering Review Guide for
High-Current DC-DC Converter Magnetics

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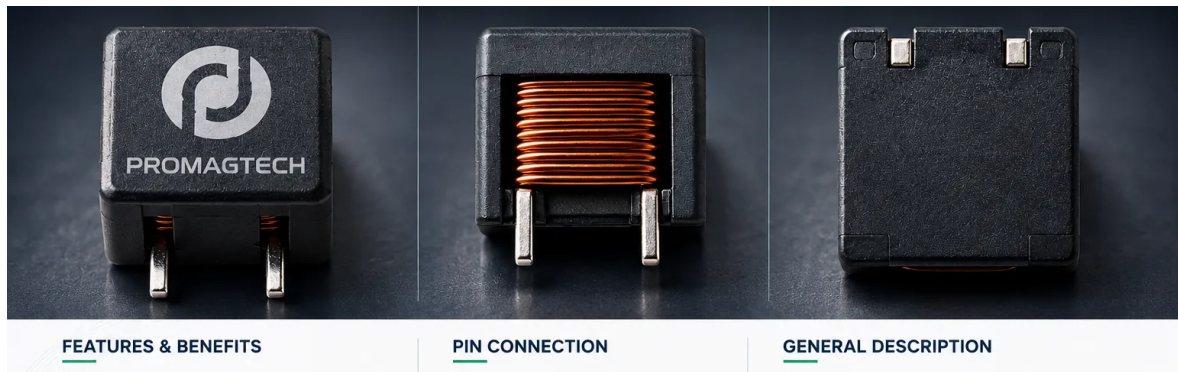


Figure: Product views from the anonymized 120V/40A/66kHz high-current flat-wire inductor case.

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Document note: This article is expanded from an anonymized PROMAGTECH engineering case. Buyer identity, project names, commercial information, external part numbers, contacts and internal approval fields have been removed. The electrical values are public-safe sample-stage design evidence. Final production values must be tied to approved drawings, sample records and test reports.

1. Case Background and Anonymization Boundary

This case reviews a high-current flat-wire inductor for a 120V output, 40A operating-current, 66kHz switching-frequency converter stage. The engineering question is not only the nominal inductance value. The selected core, turns count, winding cross-section, DCR target, insulation stack and mechanical envelope must remain credible at both the 40A operating point and the 60A saturation-current target.

For high-current inductors, no-load inductance only describes the initial condition. A proper review must also check inductance under DC bias, copper loss, thermal path, terminal strength, creepage/clearance margin and sample-stage validation items.

2. Design Input Requirements

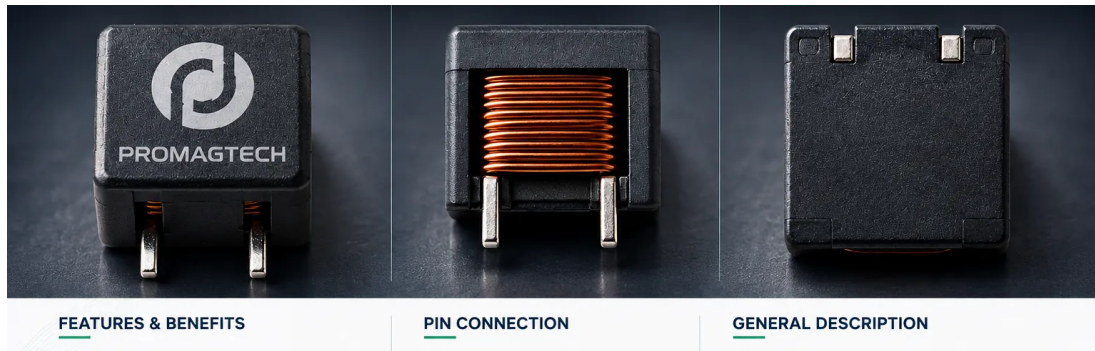
Item	Anonymized Design Input	Review Focus
Input voltage range	740-860 VDC	Confirm topology, voltage stress and insulation class
Output voltage	120 VDC	Review volt-second stress and ripple current
Output current	40 A	Rated operating current, not the same as saturation current
Saturation-current target	60 A	Must be checked with DC bias behavior and thermal conditions
Ripple-current review	20% in buck mode, 40% in boost mode	Affects RMS current and AC loss
DCR target	<10 mΩ	Directly affects copper loss and thermal design
Mechanical envelope	Approx. 35 mm diameter class, 40 mm height class	Check winding window, terminals and insulation margin
Winding	0.7 x 6.0 mm flat copper wire class	Review window fill, bend radius and terminal connection

3. 66kHz Design Snapshot

Parameter	Public-Safe Engineering Value	Comment
Switching frequency	66 kHz	Used for loss, temperature-rise and material review
Inductance at rated current	100 μH class at 40 A	More useful than no-load inductance for converter operation
No-load inductance reference	About 195 μH class	Sample-stage reference, not enough for selection alone
High-current checkpoint	70 μH class target at 60 A	Used for saturation-margin review
DCR	<10 mΩ target / 10 mΩ max class at 25°C	Hot DCR correction should be considered
Turns reference	38 turns class	Determined together with core μ _e , gap and winding space
Core reference	EQ32 Fe-Si core, μ _e 60 class	Anonymized material route, not a universal design rule

4. Mechanical Envelope and Construction Review

The mechanical review checks whether a flat-wire winding and rigid terminal structure can fit into a compact 35 mm diameter-class and 40 mm height-class package while maintaining terminal spacing, lead protection, insulation paper position and assembly repeatability.



FEATURES & BENEFITS

PIN CONNECTION

GENERAL DESCRIPTION

The image shows top, side and bottom terminal-layout views. For customer engineering teams, the value of this image is not decorative. It helps quickly review height, terminal direction, soldering or through-hole assembly method, winding window and possible mechanical interference.

Review Item	Why It Matters	Required Evidence
Height and diameter	Determine whether the component fits the available space	2D/3D drawing, PCB and mechanical constraints
Terminal layout	Affects soldering strength, creepage distance and assembly	Pin pitch, hole diameter and insertion direction
Flat-wire window	Affects DCR, temperature rise and winding manufacturability	Wire size, turns count and insulation thickness
Lead protection	Affects high-voltage safety and long-term vibration reliability	Sleeving material, fixing method and dielectric requirement

5. DC Bias and Saturation-Current Review

A common high-current inductor risk is that no-load inductance looks acceptable while inductance drops quickly under DC bias. Fe-Si 60u material shows permeability roll-off as DC magnetizing force increases. Therefore, the 40A and 60A checkpoints are more important than the nominal inductance value alone.

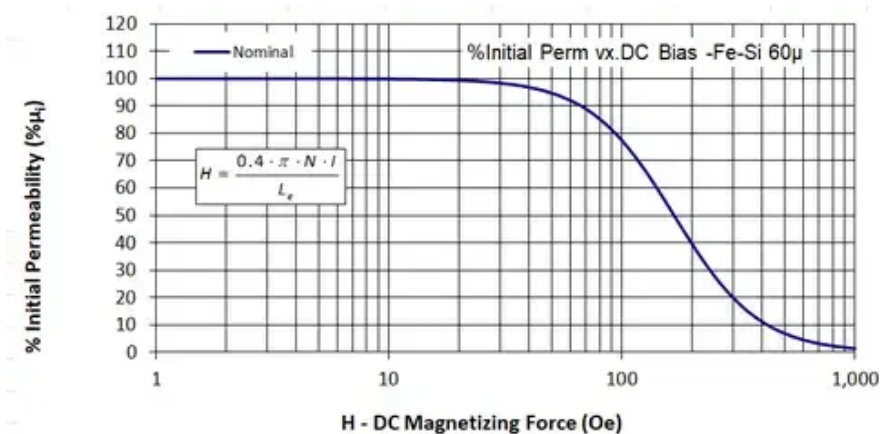


Figure: Fe-Si 60u initial permeability versus DC bias curve. It explains the review method and is not a universal guarantee for every custom design.

Current Point	Review Purpose	Engineering Judgment
No load	Confirm initial inductance and process consistency	Cannot replace high-current testing

40 A	Rated operating point	Check inductance, DCR loss and temperature rise
60 A	Saturation-current target	Confirm inductance retention and core margin
Hot condition	Material and copper resistance change with temperature	Close the loop with temperature-rise testing

6. Material, Insulation and Process Review

Item	Sample-Stage Reference	Notes
Core	EQ32 Fe-Si, μ e 60 class	Material and size must be reviewed per project
Winding process	Flat copper wire winding	Review wire edge, bend stress and layer insulation
Thermal class	Class H 180°C design reference	Does not prove system-level temperature-rise approval
Insulation stack	Nomex paper and Mylar sheet reference	Must match dielectric, creepage and safety requirements
Lead protection	High-voltage Teflon sleeving reference	Confirm length, fixing method and dielectric strength
Terminal finish	Lead-free matte tin reference	Must match customer soldering process

7. Quality Verification and Risk Boundary

The sample-stage quality scope typically includes inductance, DCR, appearance, dimensions and insulation-related checks. In this case, the public-safe specification reference included 1.5 kVAC / 60s dielectric strength between winding and core and insulation resistance at the 100 M Ω class. These values must not be copied to another project without confirming the customer insulation requirement and approved drawing.

Validation Item	Purpose	Delivery Recommendation
LCR inductance test	Confirm no-load and specified-current inductance	Record frequency, test condition and sample ID
DCR test	Estimate copper loss and consistency	Separate 25°C cold DCR from hot-condition correction
DC bias test	Confirm inductance retention under high current	Cover at least rated current and saturation target
Temperature-rise test	Validate thermal path and loss model	Record ambient temperature, airflow and mounting condition
Dielectric / insulation test	Verify electrical safety boundary	Run according to customer safety and drawing requirements

Boundary statement: This case proves that PROMAGTECH can convert a high-current converter requirement into a structured magnetic design review. It does not prove mass-production approval, buyer endorsement, universal temperature-rise performance or certification status.

8. Engineering Input Checklist and FAQ

Customer Input Parameter	Why It Is Needed
Converter topology	Buck, boost and bidirectional DC-DC stages stress the inductor differently
Input and output voltage range	Required for volt-second, insulation and magnetic operating-point review
Output current and ripple target	Required for RMS current, AC loss and temperature-rise review
Inductance at rated current and saturation-current target	Required to judge whether inductance remains usable under DC bias
Maximum DCR and temperature-rise limit	Required for copper-loss and thermal trade-offs
Size, terminal preference and cooling condition	Required for mechanical feasibility and assembly consistency

Q1: Why is no-load inductance not enough?

Because high-current inductors experience permeability reduction under DC bias. A no-load value can look acceptable while the 40A or 60A operating points no longer meet the converter requirement. The review must include rated-current inductance, inductance retention, DCR and temperature rise.

Q2: Is flat wire always better than round wire?

No. Flat wire can help reduce DCR, improve window utilization and create a better thermal path, but package space, bend radius, insulation structure and terminal process can change the result. The right choice depends on size, frequency, current and validation requirements.

Q3: Does DCR below 10 mΩ prove safe temperature rise?

No. DCR only explains part of copper loss. Hot resistance, core loss, mounting condition, airflow and nearby heat sources all affect temperature rise. Sample testing is required before publishing a thermal conclusion.

Q4: What support can PROMAGTECH provide?

PROMAGTECH can support core selection, flat-wire winding design, DCR target review, DC bias check, insulation-stack suggestion, prototype sampling and test-record preparation. Project conclusions should be tied to approved drawings and measured data.

9. PROMAGTECH Magnetic Component Solutions

SHENZHEN PROMAGTECH CO., LTD. provides engineering support for custom power magnetic components used in industrial power supplies, server power supplies, EV charging, energy storage, telecom power, and high-frequency power electronics.

- Planar transformers
- High-frequency transformers
- Flat-wire transformers
- PFC inductors
- Flat-wire inductors
- LLC magnetic integration
- AI server magnetics
- EV charger magnetics
- ODM/OEM custom magnetic components

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10. Technical Keywords and Evidence Checklist

Keyword	Engineering Meaning
120V 40A flat-wire inductor	High-current DC-DC converter magnetic design case
66kHz power inductor	Loss, DCR and temperature-rise review for a medium-frequency inductor
DC bias review	Check whether inductance remains usable under high current
Fe-Si magnetic core	One material route for compact high-current inductors
DCR <10 mΩ	Copper-loss and thermal design target, to be confirmed by sample testing
PROMAGTECH	Custom magnetic component engineering support brand

Evidence to add before stronger claims: anonymized sample photos, dimension drawings, winding structure diagrams, LCR records, DCR records, DC bias curves, temperature-rise records, dielectric-strength records, and a customer parameter input form. Do not publish fixed efficiency improvement, fixed temperature reduction, or lifetime improvement as guaranteed results without test records.