

Magnetic Integration Technology

Core Integrated Transformer and Resonant Inductor Design Guide

PROMAGTECH Standard Technical Article | Magnetic Component Design Material

MAGNETIC INTEGRATION INNOVATION

Higher Efficiency · Smaller Size · Better Performance

BEFORE: SEPARATE TRANSFORMER AND RESONANT INDUCTOR

- Separate Structure**
Transformer and resonant inductor are independent, occupying more space.
- Lower Efficiency**
Magnetic components are separate, leading to higher energy loss.
- Complex Process**
More assembly steps and lower production efficiency.

AFTER: CI (CORE INTEGRATED) TRANSFORMER

- Core Integrated Design**
Transformer and resonant inductor are integrated, significantly reducing volume.
- High Efficiency**
Optimized magnetic circuit, lower core loss, improving system efficiency.
- Process Simplification**
Fewer parts and steps, improved reliability and consistency.

VALUE DELIVERED

- Smaller Size**
Saves PCB space
- Higher Efficiency**
Lower energy loss
- Improved Reliability**
Reduces component failure risk
- Cost Advantage**
Simplified process, lower cost

APPLICATIONS

- Power Adapter
- Charger
- LED Driver
- Industrial Power Supply
- Communication Equipment

Dedicated to magnetic integration technology innovation, providing more efficient, reliable and compact magnetic components solutions. | www.promagtech.com

Website illustration: Separate transformer and resonant inductor vs. core integrated transformer

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Table of Contents

Section	Page
1. Source and Article Positioning	3
2. What Magnetic Integration Means	3
3. Separate Magnetic Design: Strengths and Limits	4
4. Design Review Focus for Core Integrated Transformers	5
5. Applications Suitable for Magnetic Integration	5
6. Customer Parameter Checklist	6
7. Technical FAQ	7
8. PROMAGTECH Support Scope	7
9. Technical Keywords and Evidence Checklist	7

Technical material note: This article is expanded from a PROMAGTECH technical resource page. Any statements about efficiency, volume, temperature rise, cost, isolation voltage, or reliability should be treated as project-specific design targets and must be confirmed by approved drawings, sample testing, thermal testing, electrical testing, and converter-level validation.

1. Source and Article Positioning

Item	Content
Source page	https://www.promagtech.com/technical-resources/magnetic-integration-core-integrated-transformer.html
Original topic	Magnetic Integration Technology: Combining Transformer and Resonant Inductor into One Core Integrated Magnetic Component
Target readers	Power supply engineers, sourcing engineers, R&D managers, and project teams working on AI server power supplies, OBC, energy storage, telecom power, and high-frequency converters
Article objective	Help engineers understand how PROMAGTECH can review and develop core integrated transformers, resonant inductor integration, and LLC/CLLC magnetic components

This material does not simply describe putting two magnetic parts into one package. It explains magnetic integration as an engineering design strategy. When a power converter needs higher power density, fewer magnetic components, a compact layout, and a more controlled thermal path, the transformer and resonant inductor can be reviewed as one integrated magnetic assembly.

Evidence boundary: Magnetic integration may improve component count, occupied PCB area, assembly complexity, and thermal path control. These potential benefits should not be published as universal guarantees. They must be confirmed for the specific project through drawings, sample records, temperature-rise tests, electrical tests, and converter-level validation.

2. What Magnetic Integration Means

In LLC, CLLC, and related isolated DC/DC converters, the high-frequency transformer and resonant inductor are often implemented as separate components. The transformer provides energy transfer and isolation, while the resonant inductor participates in the resonant tank. Magnetic integration reviews these functions within a more unified magnetic circuit, winding structure, insulation system, and mechanical package.

Concept	Engineering Meaning	Risk That Must Be Reviewed
Separate magnetics	Transformer and resonant inductor are designed, sourced, and assembled separately	PCB area, part count, assembly steps, and thermal paths may increase
Integrated magnetic component	Transformer function and resonant inductor function are reviewed within one magnetic assembly	Magnetic circuit, leakage inductance, parasitic capacitance, insulation, and temperature rise become more coupled
Core objective	Reduce magnetic part count, optimize space, simplify part of the assembly, and improve system layout	Real benefit depends on topology, frequency, power level, and mechanical boundary conditions

One-sentence definition: Magnetic integration is not a mechanical merge of two parts. It is a system-level tradeoff among topology, resonant parameters, magnetic circuit, winding structure, insulation, thermal path, and production process.

3. Separate Magnetic Design: Strengths and Limits

A separate transformer plus a separate resonant inductor is a mature and flexible route. It is useful when project parameters are still changing because engineers can adjust the transformer and resonant inductor independently during early debugging.

Review Dimension	Strength of Separate Design	Limit of Separate Design
Design tuning	Transformer and resonant inductor can be adjusted separately	Final power-stage layout is more distributed
Supply chain	Separate parts may provide more replacement options	Material count, inspection items, and inventory complexity increase
PCB layout	Functional boundaries are clear	Board area and high-frequency current-loop area may increase
Thermal design	Hotspots are easier to locate part by part	Multiple heat sources and thermal paths must be managed separately
Production management	Mature process and lower trial-production risk	More assembly steps and consistency control points

4. Design Review Focus for Core Integrated Transformers

The key question is not whether the magnetic component looks smaller. The key question is whether the required resonant inductance can be integrated into the transformer structure or coupled magnetic assembly without creating unacceptable loss, insulation, thermal, or EMI risk.

Design Item	What Must Be Reviewed	Information Needed from the Customer
Power range	Confirm against topology, cooling method, frequency, insulation requirement, and package size	Input/output voltage, current, peak load, and power level
Switching frequency	Review core loss, AC copper loss, skin effect, proximity effect, and resonant tank behavior	Operating frequency range, control method, and efficiency target
Resonant inductance	Confirm whether it can be integrated into the transformer structure or still requires a separate inductor	Lr target, Lm target, leakage inductance target, and resonant tolerance window
Isolation system	Confirm creepage, clearance, insulation stack, and hi-pot requirement	Safety standard, hi-pot test, insulation class, and pollution degree
Thermal performance	Validate winding temperature, core temperature, airflow, potting, and PCB thermal path	Allowed temperature rise, ambient temperature, airflow, potting, and heat-sink condition

Manufacturability	Review winding process, terminals, assembly, tolerances, and outgoing inspection	Sample quantity, annual volume, reliability test scope, and production schedule
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Engineering judgement: If the customer only provides power and size, the information is not enough to decide whether magnetic integration is suitable. Topology, frequency, resonant parameters, insulation, thermal path, and mechanical boundaries must be clarified.

5. Applications Suitable for Magnetic Integration

Magnetic integration is more suitable for projects with tight space, higher operating frequency, sensitivity to magnetic part count, or demanding thermal design. It should not be treated as the default answer for every power supply. If the project is extremely cost-sensitive, the parameters change frequently, or the frequency is relatively low, a separate magnetic design may be more practical.

Application	Why Magnetic Integration May Be Worth Reviewing	Review Focus
AI server power supply	Isolated DC/DC stages often face high power density, airflow sensitivity, and height constraints	Temperature rise, leakage inductance, batch consistency, and terminal layout
Telecom power / 48 V system	Rack space is limited and modularization is important	High-frequency loss, insulation, thermal path, and long-term supply consistency
Battery charger / power adapter	Part count and assembly efficiency can affect production cost	Cost boundary, safety requirement, temperature rise, and volume
LED driver	Isolated resonant power stages may need compact magnetics	Frequency, leakage inductance, EMI, and component height
PV / energy-storage auxiliary power	Magnetic volume and thermal control can affect converter reliability	Insulation, ambient temperature, and long-term operating temperature rise

6. Customer Parameter Checklist

To evaluate whether magnetic integration is suitable, customers should not only ask for an integrated transformer. The following information makes engineering review faster and more reliable.

- Converter topology: LLC, CLLC, flyback, forward, phase-shifted full bridge, or another topology.
- Input voltage range, output voltage, output current, peak load, and continuous power.
- Switching frequency range, resonant tank target values, control method, and efficiency target.
- Transformer turns ratio, magnetizing inductance, leakage inductance, resonant inductance, and allowable tolerance.
- Isolation requirement, creepage, clearance, insulation class, and hi-pot test requirement.
- Mechanical size, terminal layout, PCB mounting method, airflow, potting, or heat-sink condition.
- Sample quantity, annual volume, qualification documents, reliability testing, and production timeline.

Information Completeness	What PROMAGTECH Can Do	Risk
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Power and size only	Initial direction check only	Large design deviation; quotation or structure confirmation is not reliable
Topology, frequency, voltage, and current	Initial core and winding direction review	Insulation, temperature rise, and mechanical conditions are still
Complete electrical, mechanical, and thermal data	Sample design and DFM review can begin	Sample testing and converter-level validation are still required

7. Technical FAQ

Q1: Is an integrated magnetic transformer always better than two separate magnetic components?

No. Magnetic integration is valuable only when topology, frequency, power, size, thermal path, and resonant parameters are suitable. It may reduce part count and PCB footprint, but it can also increase magnetic circuit, winding, insulation, and validation complexity. For early-stage designs with frequent parameter changes, extreme cost pressure, or low-frequency high-power conditions, separate magnetics may be more stable.

Q2: Why is transformer and resonant inductor integration often discussed in LLC converters?

In an LLC converter, the transformer and resonant inductor both influence the resonant tank and energy-transfer behavior. If the magnetic circuit and winding structure are suitable, part of the resonant inductance function can be integrated into the transformer structure or coupled magnetic assembly. L_r , L_m , leakage inductance, parasitic capacitance, and temperature rise must still be validated together.

Q3: Does magnetic integration automatically improve efficiency?

No. It may reduce duplicated core material, some winding paths, and assembly interfaces, but it can also introduce new AC copper loss, leakage flux, temperature-rise issues, or distributed capacitance problems. Any efficiency improvement must be confirmed through loss breakdown, sample temperature-rise testing, waveform measurement, and converter-level efficiency testing.

Q4: How does magnetic integration affect EMI?

The effect can go in both directions. A more compact magnetic circuit and winding layout may help control high-frequency current paths, but distributed capacitance, leakage flux paths, or terminal layout may create new common-mode noise. Leakage inductance, parasitic capacitance, shielding, grounding, PCB layout, and filtering must be reviewed together.

Q5: What information is needed before evaluation can begin?

At minimum, the review needs topology, input and output range, power, switching frequency, resonant parameter targets, isolation requirement, size limit, temperature-rise target, cooling condition, and sample or production demand. Schematic constraints, PCB limits, existing sample data, or thermal images can improve review speed and accuracy.

Q6: What support can PROMAGTECH provide?

PROMAGTECH can review custom projects involving integrated transformers, resonant inductor integration, planar magnetics, flat-wire transformers, high-current inductors, PFC inductors, and common mode chokes. A typical workflow includes requirement review, core selection, winding design, insulation stack, DCR target, thermal path, prototype sampling, and project-level testing.

8. PROMAGTECH Support Scope

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 applications.

- Core integrated transformers
- Resonant inductor integration
- Planar transformers
- High-frequency transformers
- Flat-wire transformers
- High-current inductors
- PFC inductors
- Common mode chokes
- AI server magnetics
- EV charger magnetics
- ODM/OEM custom magnetic components

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9. Technical Keywords and Evidence Checklist

Technical Keyword	Description
Core integrated transformer	Primary technical keyword
Resonant inductor integration	LLC/CLLC resonant tank keyword
Integrated magnetic component	System-level magnetic integration keyword
LLC transformer	Application-related keyword
AI server power supply magnetics	Application-related customer keyword
EV charger magnetics	Application-related customer keyword
PROMAGTECH	Brand entity keyword

Recommended evidence to add later: To make this technical material stronger, add redacted sample photos, magnetic core and winding structure diagrams, test equipment photos, temperature-rise record templates, OQC inspection items, and a customer parameter input form. Before those records exist, do not publish fixed efficiency improvement, fixed volume reduction, or fixed cost reduction as guaranteed results.