



CSC

Soft Magnetic Powder Cores



Chang
Sung
Corporation

CSC

INDEX

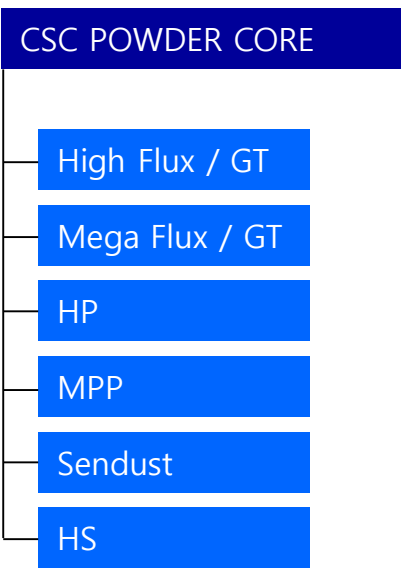
- SECTION 1. CSC POWDER CORE
- SECTION 2. CSC SPECIAL SHAPE CORE
- SECTION 3. NEW CORE MATERIAL
- SECTION 4. APPLICATION INTRODUCTION

SECTION 1.

CSC Powder Core

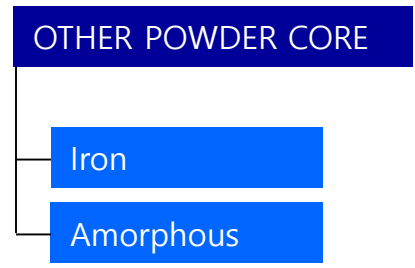

MATERIAL CLASSIFICATION

• SOFT MAGNETIC CORE MATERIAL



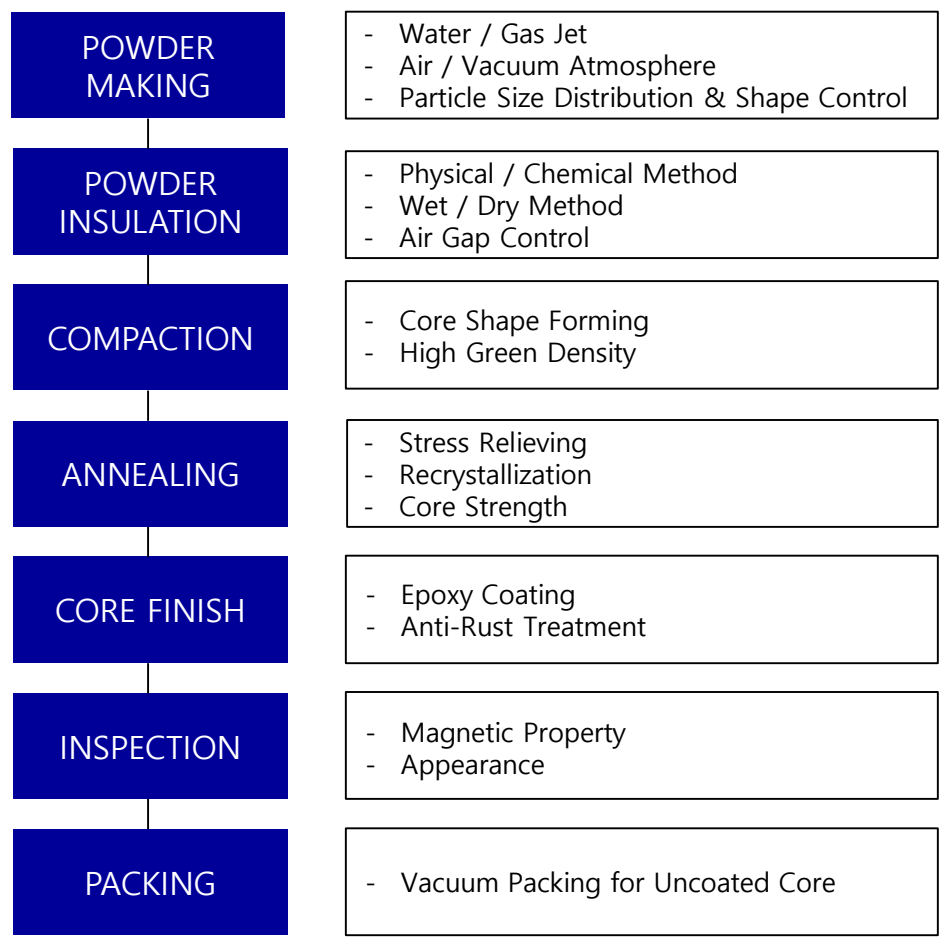
CSC Core Features


- **Various Shape**
 - Toroidal & Other Special Shape
- **Evenly Distributed Air Gap**
 - Excellent Insulation from Eddy Current
 - Soft Saturation DCB Curve
 - Nearly No Leakage Flux
- **Low Core Loss**
 - Minimized Temperature Rising under Operation
- **High Curie Temperature & Stability**
 - Available in Harsh Environment (AEROSPACE, AIRCRAFT, MILITARY, MEDICAL)




MANUFACTURING PROCESS

• PROCESS FLOW CHART




INCHEON, KOREA HEADQUARTER 

- Sales and Marketing
- R&D Center

PYEONGTAEK, KOREA FACTORY 

- MPP
- **Specialized for Customized & Special Production**

WEIHAI, CHINA FACTORY 

- High Flux, Mega Flux, Sendust, HP, HS
- Core Finish Line
- **Specialized for Mass Production**

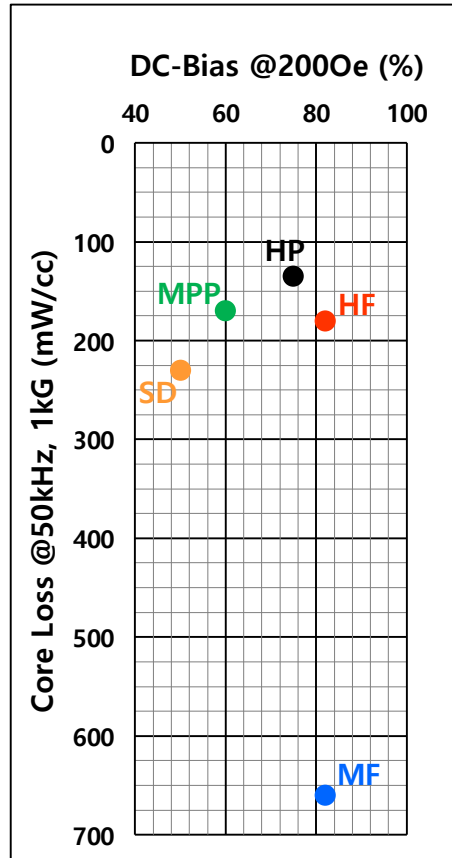


CORE MATERIAL

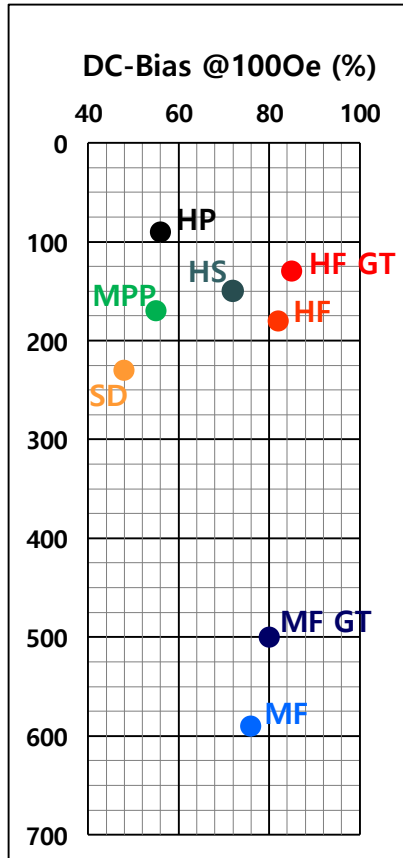
- CSC MATERIAL REFERENCE

Material	Perm.	Bs (kG)
High Flux Titanium	60	15
High Flux	26-160	15
Mega Flux Titanium	60	17
Mega Flux	19-90	17
MPP	26-200	10
Sendust	26-125	10
HP	19-60	8.5
HS	60	13

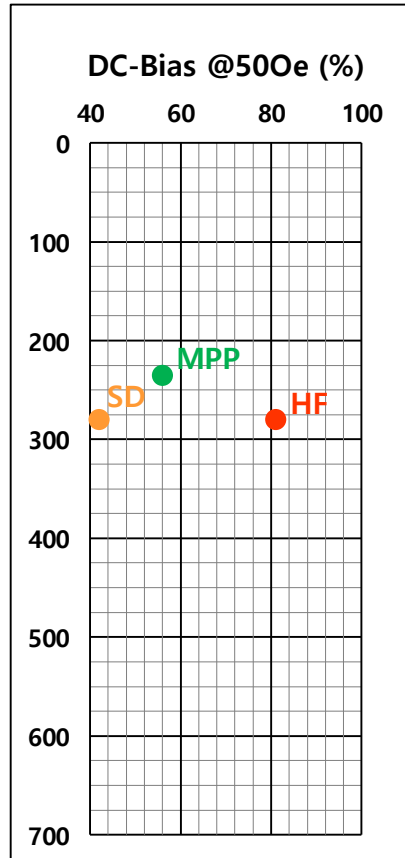
26μ



60μ



125μ

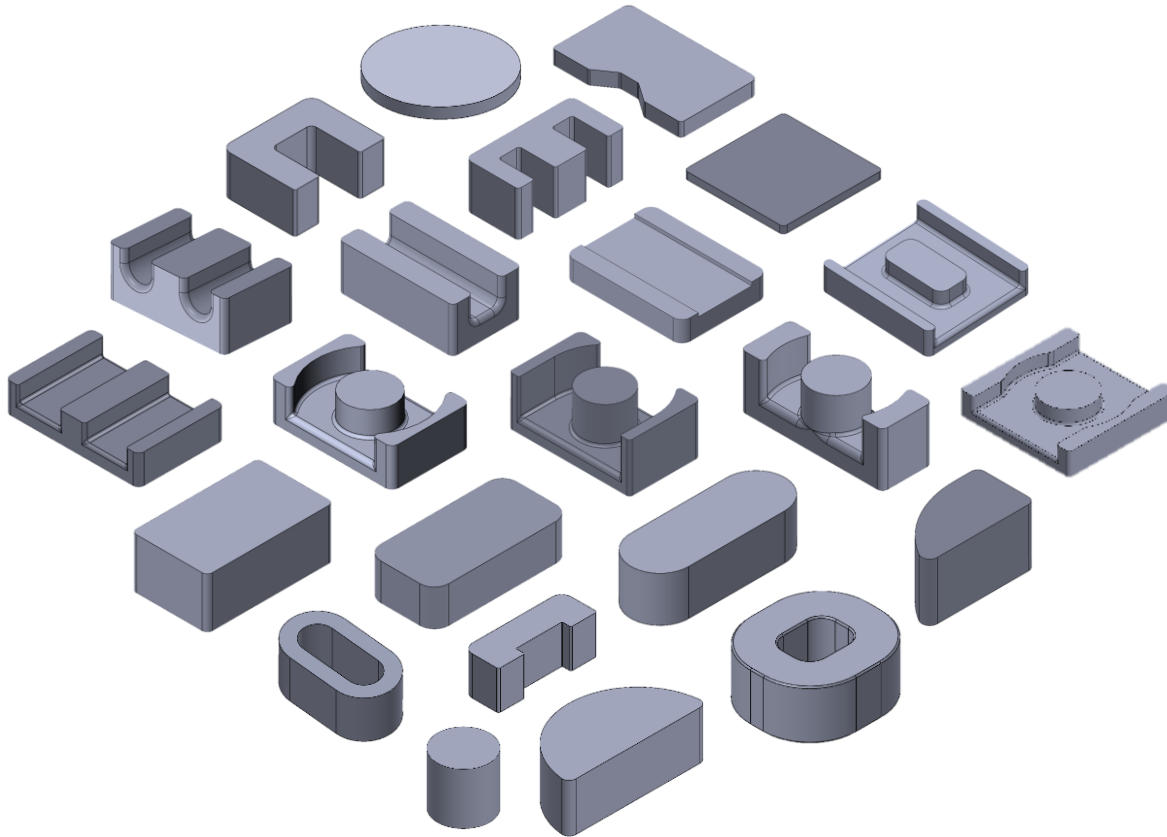


SECTION 2.

CSC Special Shape Core

SPECIAL SHAPE CORE

- FITTING WELL ANY APPLICATIONS



State-of-the-art Technology

- 5G Base Transceiver Station
- Hyperscale Data Center
- Self-Driving Automotive
- Wireless Charging Lane

Life

- Medical Instrument
- Consumer Electronic
- Desktop & Laptop
- Adaptor & Wall Charger

Energy Infrastructure

- Mega Solar Farm
- Windmill
- UPS
- DC Charger

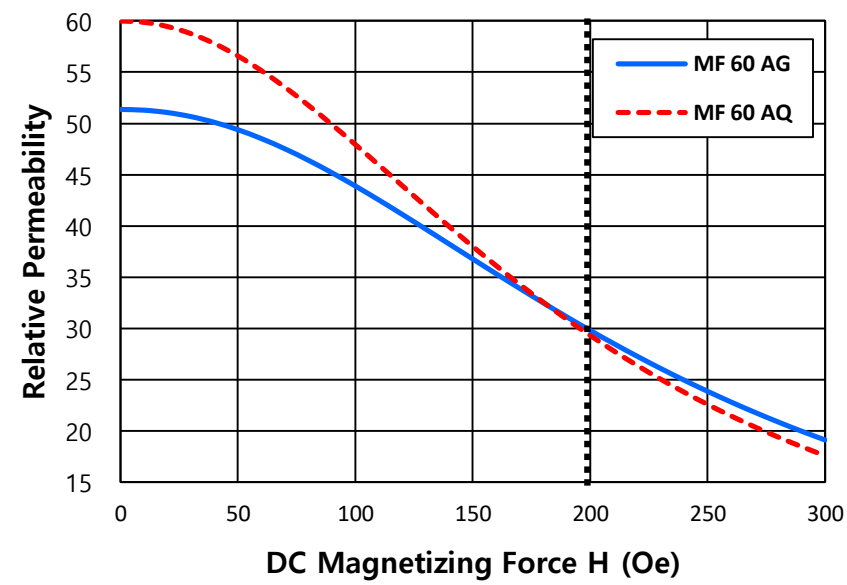
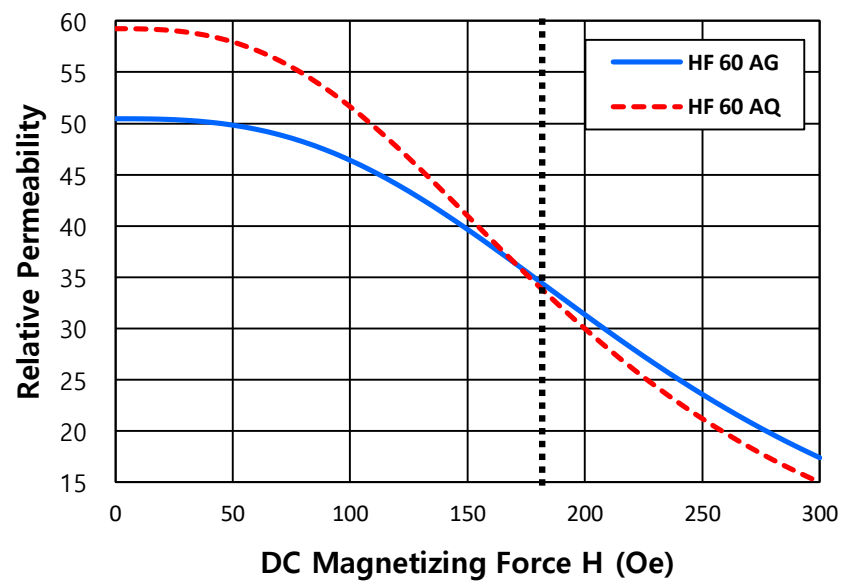
Industrial

- Automation
- Industrial Machinery
- Electric Tool
- High Capacity SMPS

AG & AQ PART

- HIGH RELIABILITY & ANTI RUST

- EQ & ER Shape
- High Flux & Mega Flux
- Permeability – 60μ



For Getting Higher AL to 300Oe

High Flux Design Point

- 0Oe ~ 180Oe – High Flux 60 AQ
- Over 180Oe - High Flux 60 AG

Mega Flux Design Point

- 0Oe ~ 200Oe – Mega Flux 60 AQ
- Over 200Oe - Mega Flux 60 AG

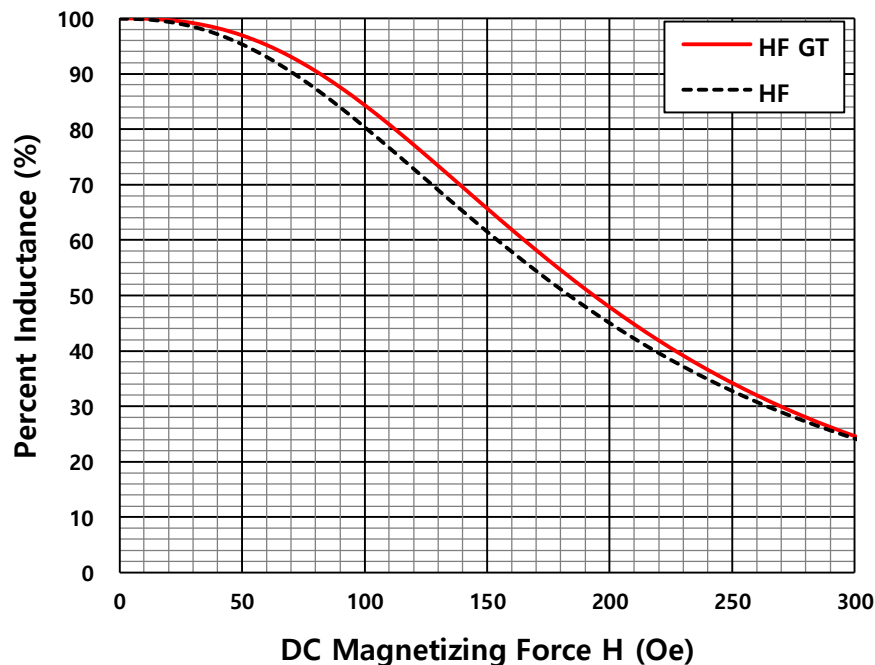
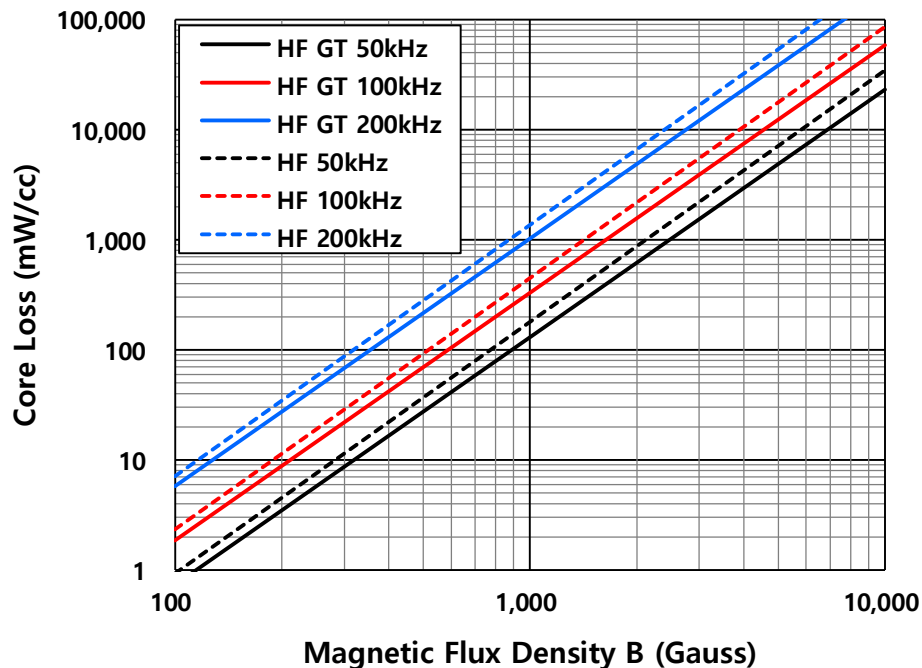
SECTION 3.

NEW Core Material

HIGH FLUX TITANIUM

- Toroidal
- Permeability – 60 μ

BEST SOLUTION FOR HYPERSCALE SERVER APPLICATION



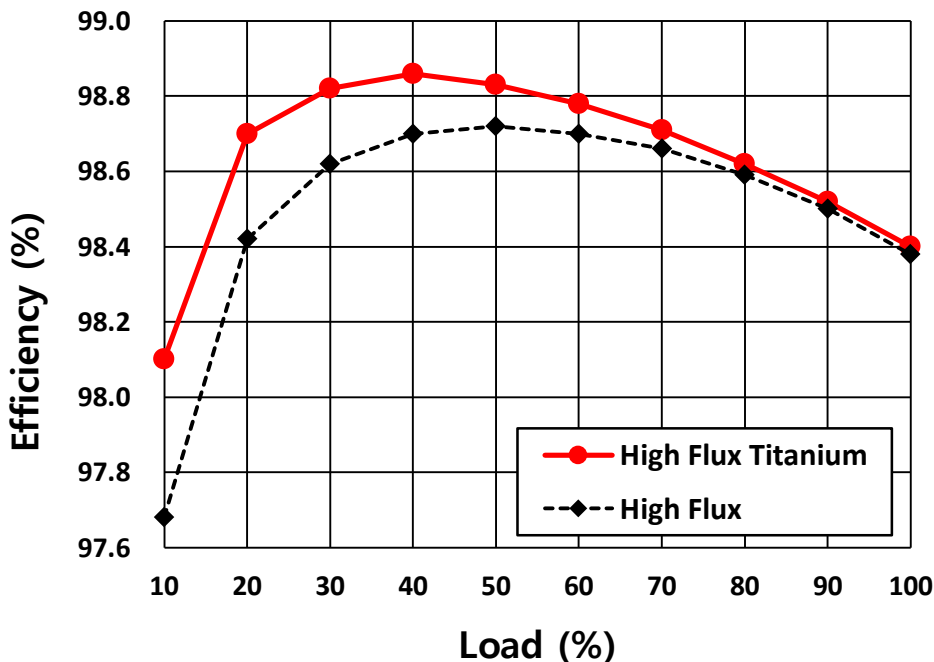
Material	50kHz, 1kG	200kHz, 1kG
High Flux 60 μ Titanium	130mW/cc	1030mW/cc
High Flux 60 μ	180mW/cc	1370mW/cc

Material	100Oe	200Oe	300Oe
High Flux 60 μ Titanium	84.4%	47.9%	24.6%
High Flux 60 μ	80.4%	45.1%	24.2%

HIGH FLUX TITANIUM

- Product – Server Power PFC
- Capacity – 3kW
- 80+ Certification – TITANIUM

• PFC Inductor – CH270060GT18 vs. CH270060E18



Material	Efficiency @50% Load
High Flux 60μ Titanium	98.83%
High Flux 60μ	98.72%

The Big Improvements Light to Mid Load
HF GT – Best solution for Server PFC Application



HIGH FLUX TITANIUM

- Product – Server Power PFC
- Capacity – 2.4kW
- 80+ Certification – TITANIUM

- PFC Inductor – CH270060GT14 vs. Competitor’s Counterpart

Load	CSC _{REF.}	A Company _{ΔEFF.}	B Company _{ΔEFF.}	C Company _{ΔEFF.}
10%	0	-0.11%	0.03%	-0.08%
20%	0	-0.09%	0.01%	-0.1%
30%	0	-0.07%	0%	-0.07%
40%	0	-0.07%	-0.01%	-0.07%
50%	0	-0.07%	-0.02%	-0.08%
60%	0	-0.08%	-0.03%	-0.1%
70%	0	-0.09%	-0.05%	-0.12%
80%	0	-0.12%	-0.07%	-0.13%
90%	0	-0.14%	-0.08%	-0.17%
100%	0	-0.16%	-0.09%	-0.2%

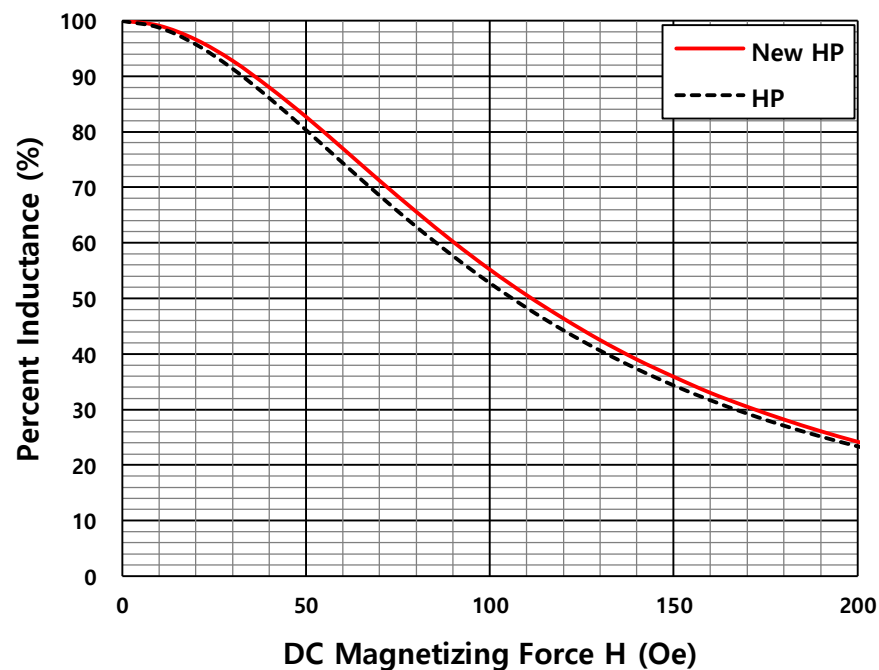
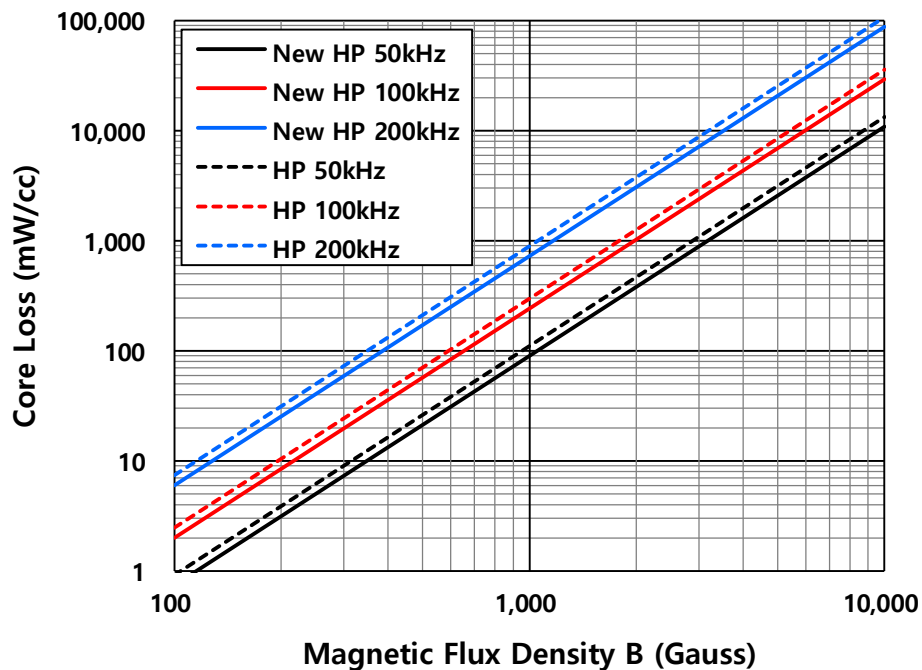
CH270060GT14 showing better performance
 HF GT – Best solution for Server PFC Application



HP

- Toroidal
- Permeability – 60 μ

• EXTREMELY LOW CORE LOSS APPLICATION



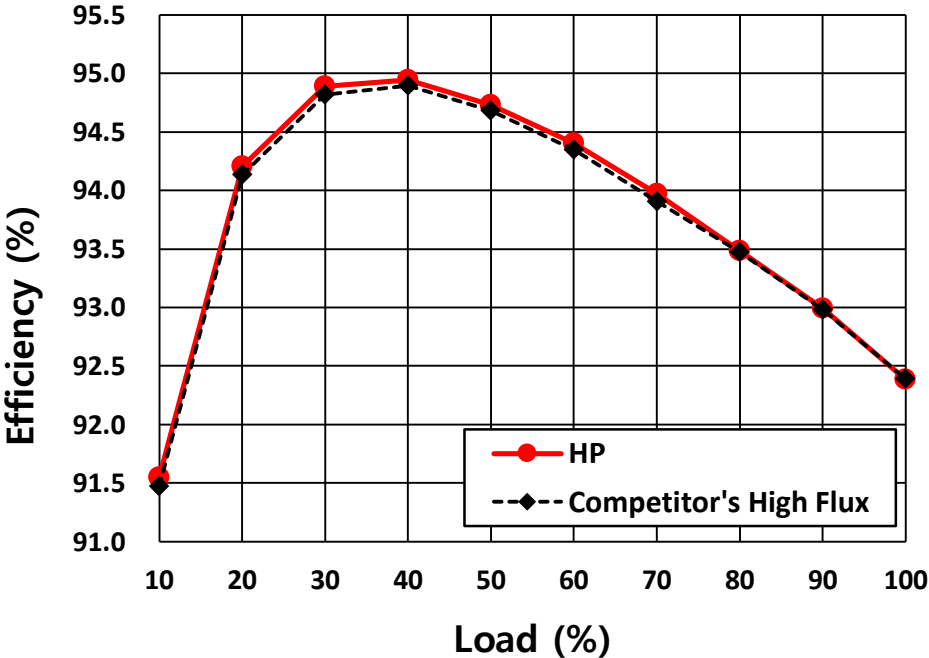
Material	50kHz, 1kG	200kHz, 1kG
New HP 60 μ	90mW/cc	780mW/cc
HP 60 μ	110mW/cc	900mW/cc

Material	100Oe	200Oe	300Oe
New HP 60 μ	55.2%	24.2%	12.7%
HP 60 μ	52.8%	23.4%	12.5%



- Product – Server Power PFC
- Capacity – 900W
- 80+ Certification – PLATINUM

• PFC Inductor – HP270060G vs. Competitor’s High Flux (Same Size)



Material	Efficiency @50% Load
HP 60μ	98.83%
Competitor's High Flux 60μ	98.72%

Slightly Higher Performance Compared to Competitor’s High Flux
 HP – Good alternative for Server PFC Application under 1kW





- Product – Server Power DC to DC
- Capacity – 2.2kW

• Resonant Inductor – HP270060G Efficiency Result

Load	P _{OUT}	P _{IN}	P _{LOSS}	EFF.	SPEC.
10%	224.414W	247.29W	22.876W	90.75%	90%
20%	446.933W	477W	30.067W	93.70%	92%
50%	1103.261W	1168W	64.739W	94.46%	94%
100%	2194.179W	2378W	183.821W	92.27%	92%

Showing Sufficient Efficiency Margin

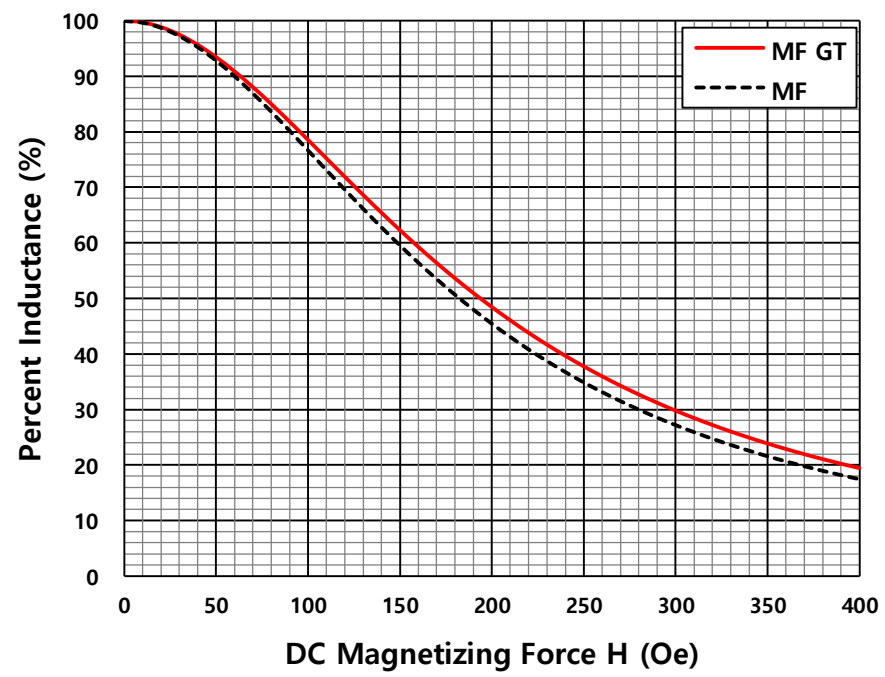
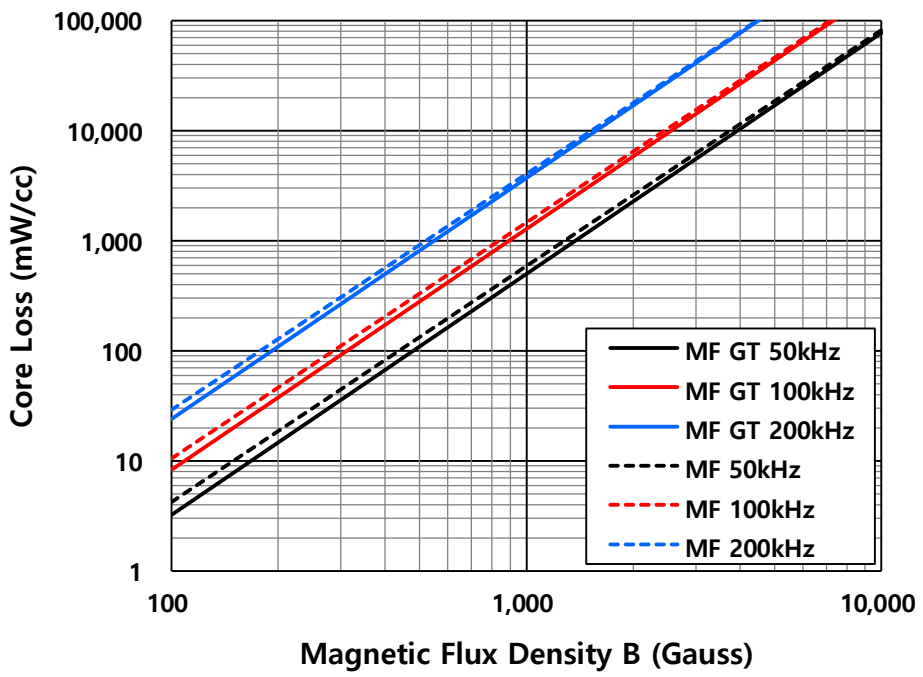
HP – Suitable for applications requiring extremely low core loss



MEGA FLUX TITANIUM

• HIGH CURRENT LOAD APPLICATION

- Toroidal
- Permeability – 60 μ



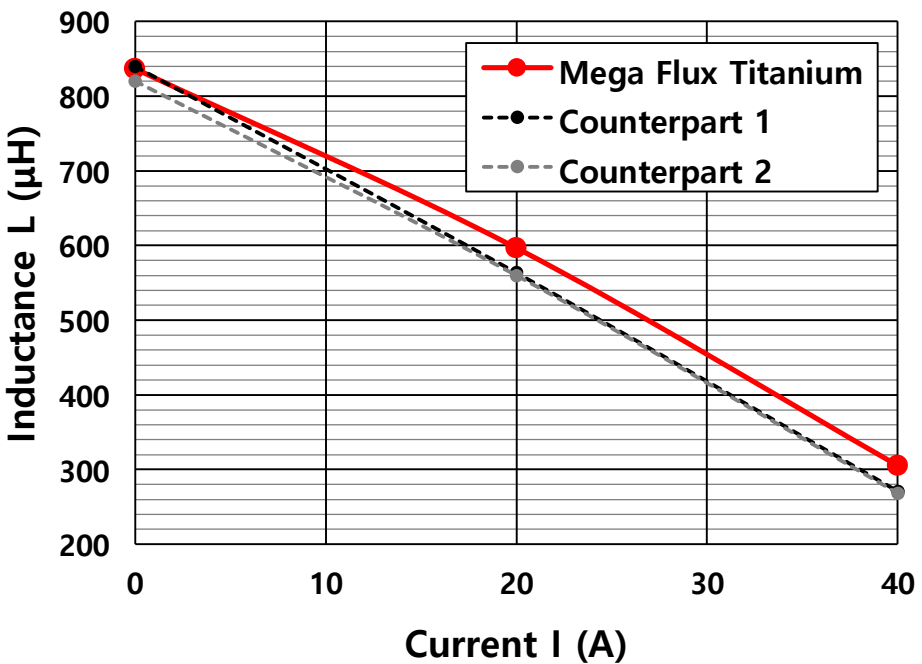
Material	50kHz, 1kG	200kHz, 1kG
Mega Flux 60μ Titanium	500mW/cc	3720mW/cc
Mega Flux 60 μ	590mW/cc	4050mW/cc

Material	100Oe	200Oe	300Oe
Mega Flux 60μ Titanium	78.5%	48.5%	29.8%
Mega Flux 60 μ	76.7%	45.5%	27.2%

MEGA FLUX TITANIUM

- Product – EV Charging Station PFC
- Capacity – 40kW

• PFC Inductor – CK508060GT vs. Competitor's Counterpart



Material	Core Loss @50kHz/500G
Mega Flux 60µ Titanium	104mW/cc
Competitor 1	121mW/cc
Competitor 2	126mW/cc

Material	L(0A)	L(20A)	L(40A)
Mega Flux 60µ Titanium	836.7µH	596.7µH	305.4µH
Competitor 1	840.3µH	563.7µH	271.0µH
Competitor 2	823.0µH	560.0µH	268.3µH

Better Core Loss & DCB Characteristics

MF GT – Good Solution for Cost Effectiveness & Large Current Application

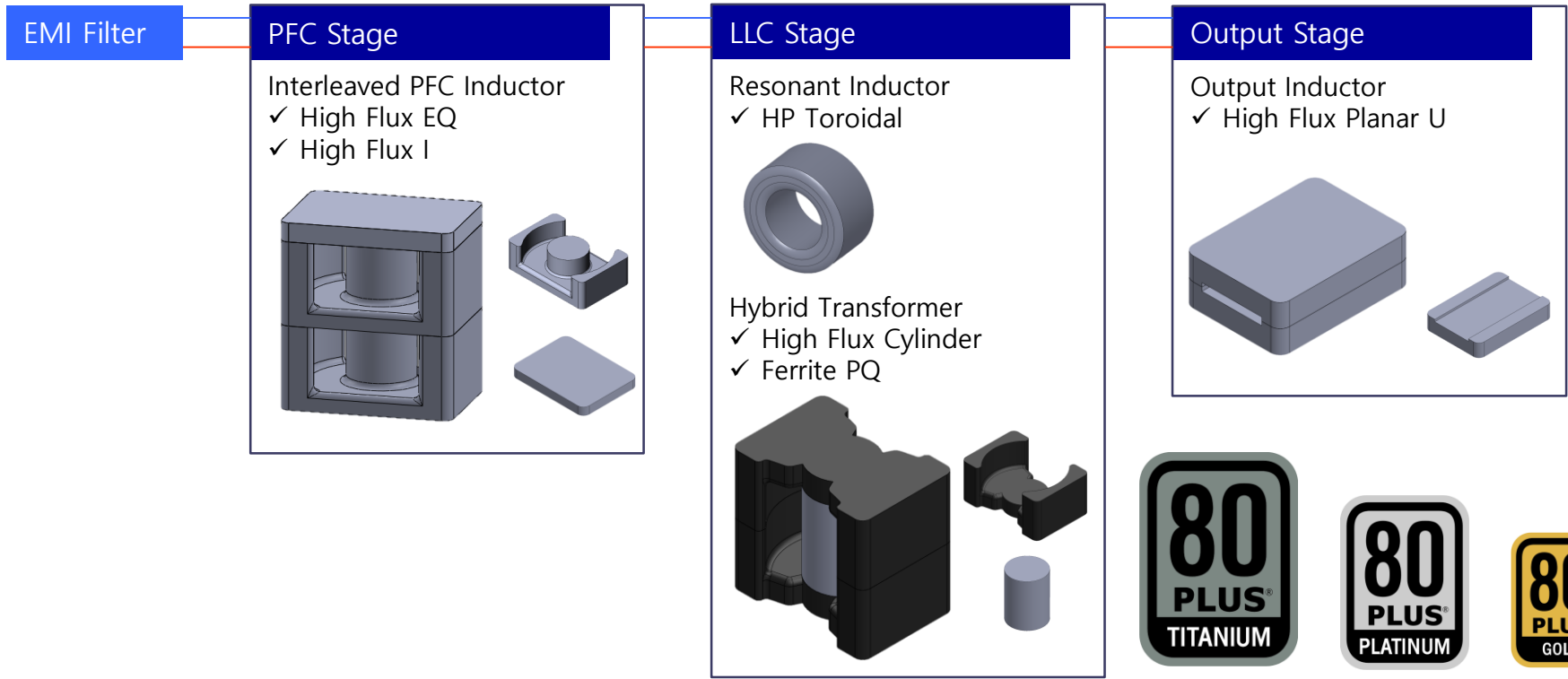
SECTION 4.

Application Introduction

SERVER PSU

- High Magnetic Flux Density
- High Relative Permeability
- Low Core Loss
- High Reliability

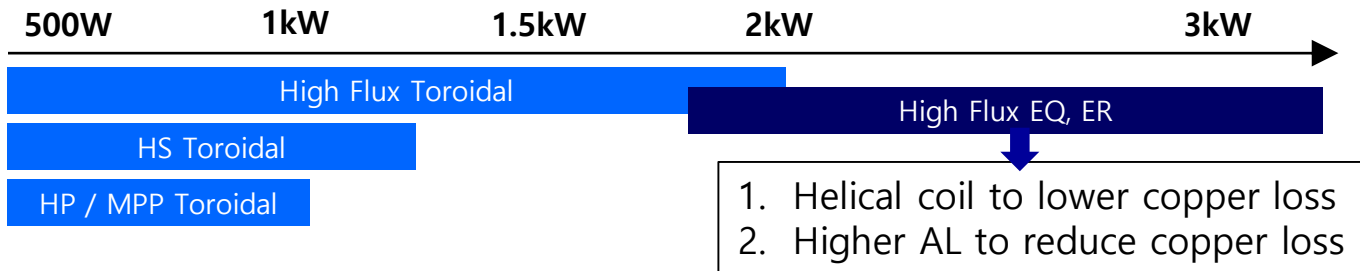
• APPLICATION EX) – BRIDGELESS PFC + LLC CONVERTER



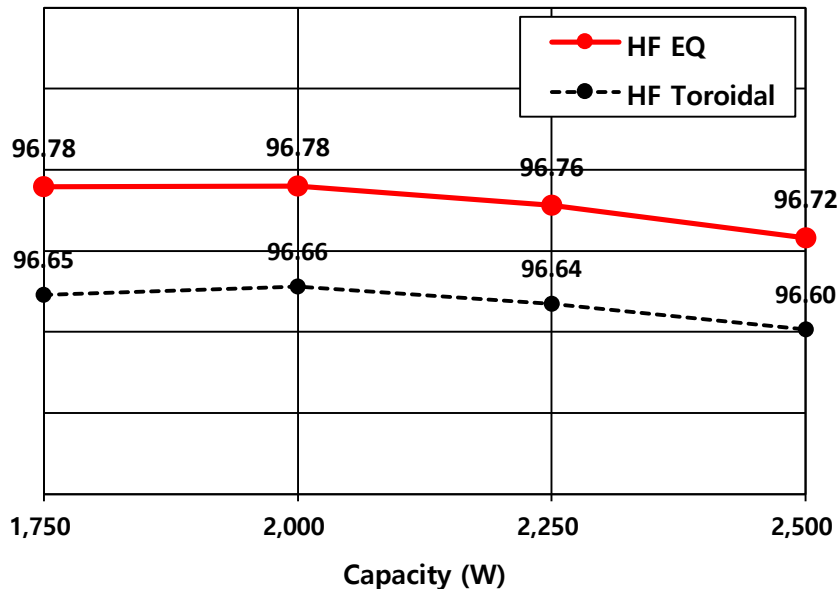
SERVER PSU EXAMPLE

- Product – Server Power PFC
- Capacity – 4.5kW
- 80+ Certification – TITANIUM

• PFC INDUCTOR FOR HIGH POWER CAPACITY



PFC Inductor Efficiency Comparison – EQ vs. Toroidal



Core Type	HF EQ 60μ	HF Toroidal 60μ
Size (Excluding Coil)	36 * 26 * 20.6	30.8 * 30.8 * 23.6
AL	205nH/N ²	136nH/N ²
Efficiency @2kW	98.78%	98.66%

* 1 Rail Result

* Based on CSC's Design Experience



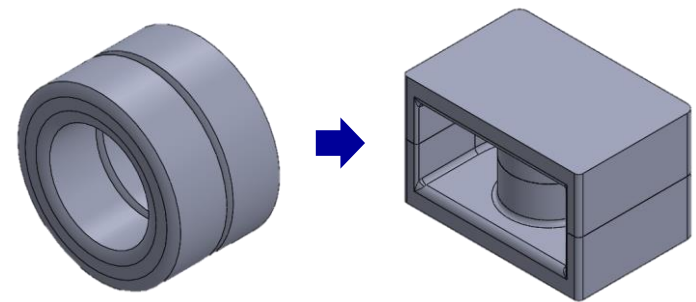
SERVER PSU EXAMPLE

- Product – Server Power DC to DC
- Capacity – 3kW
- 80+ Certification – TITANIUM

• OUTPUT INDUCTOR FOR HIGH POWER CAPACITY

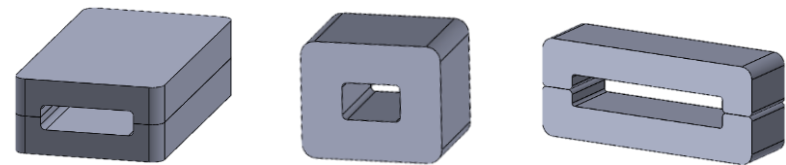
DC to DC Output Inductor Loss Comparison – ER vs. Toroidal

Core Type	HF ER 60μ	HF Toroidal 60μ
Size (Excluding Coil)	36 * 24 * 22.4	33.8 * 33.8 * 23.2
AL	197nH/N²	122nH/N ²
Core Loss	0.3W	0.2W
Copper Loss	2.6W	5.1W
Total Loss	2.9W	5.3W



Output Inductor Design Trend

- ✓ 1-Turn Inductor Preferred
 - **Reduce Copper Loss**
- ✓ Switching Frequency – 100 ~ 200 kHz
- ✓ **Higher Permeability – over 90μ**
 - Need to take off on technical constraints -> Getting Higher Permeability for special shapes
- ✓ **Larger Cross Section Area**
 - Way to Get High Inductance instead of Increasing Permeability



<1-Turn Output Core>

* Based on CSC's Design Experience



TELECOM

• APPLICATION EX) – INDUCTOR FOR TELECOM APPLICATION

1. Telecom Server PSU

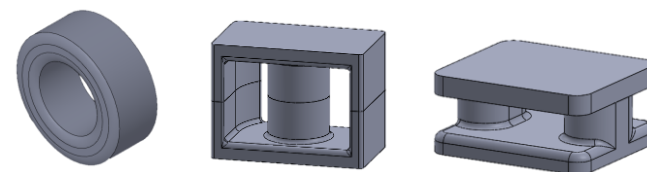
✓ **Nearly Same Requirements as Server PSU Application** – Lower Core Loss & Higher DCB

✓ PFC Inductor

- Switching Frequency – 65 ~ 120 kHz

✓ Output Inductor

- Switching Frequency – 100 ~ 200 kHz



<PFC Inductor Design>

2. Telecom Equipment

✓ PFC Inductor for Rectifier

- Toroidal Shape Preferred

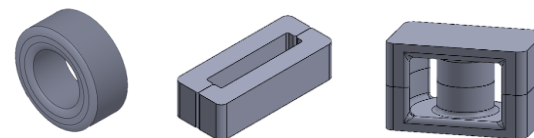
- Switching Frequency – 20 ~ 30 kHz

✓ Surge Inductor for PDU (Power Distribution Unit)

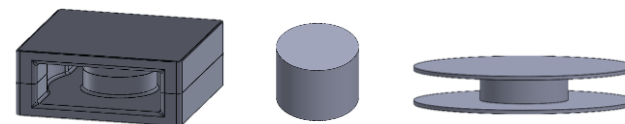
- Low Profile – **Planar Type Core**

- High Surge Current – High DCB Characteristics (**Mega Flux Material**)

- Flat Helical Wire Using – (Reduce Length for 1-Turn)



<Output Inductor Design>



<Surge Inductor>

* Based on CSC's Design Experience

AUTOMOTIVE

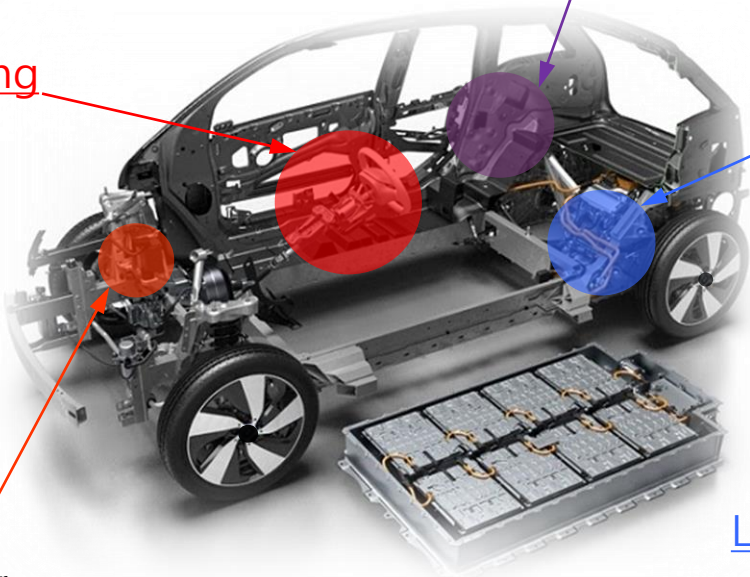
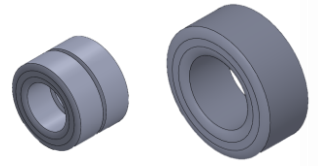
- High Magnetic Flux Density
- Low Core Loss
- Extremely High Reliability

Etc.

- IDSG (Idle Stop & Go)
- A/C Compressor
- Navigation
- Audio
- EMI Filter

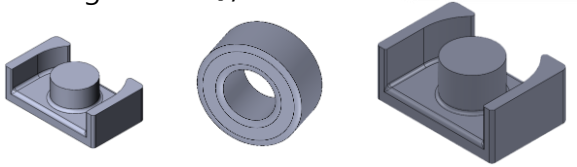
Electric Power Steering

Application: Boost Inductor
 ✓ High Flux Toroidal



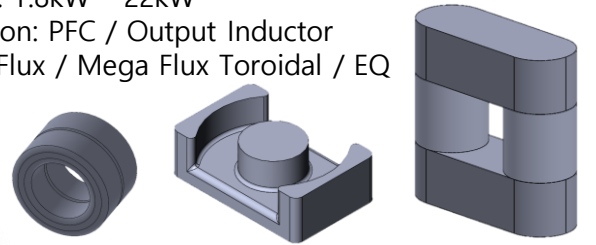
HV Coolant Heater

Capacity: 1.5kW – 6kW
 Application: Output Inductor
 ✓ Mega Flux EQ / ER



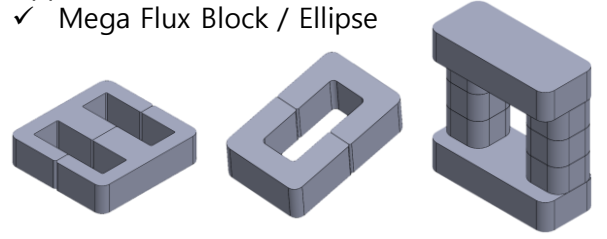
On Board Charger

Capacity: 1.8kW – 22kW
 Application: PFC / Output Inductor
 ✓ High Flux / Mega Flux Toroidal / EQ



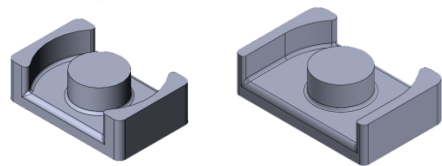
High Voltage DC to DC

Capacity: 30kW – 200kW
 Application: Buck/Boost Inductor
 ✓ Mega Flux Block / Ellipse



Low Voltage DC to DC

Capacity: 1.5kW – 4kW
 Application: Output Inductor
 ✓ Mega Flux EQ / ER

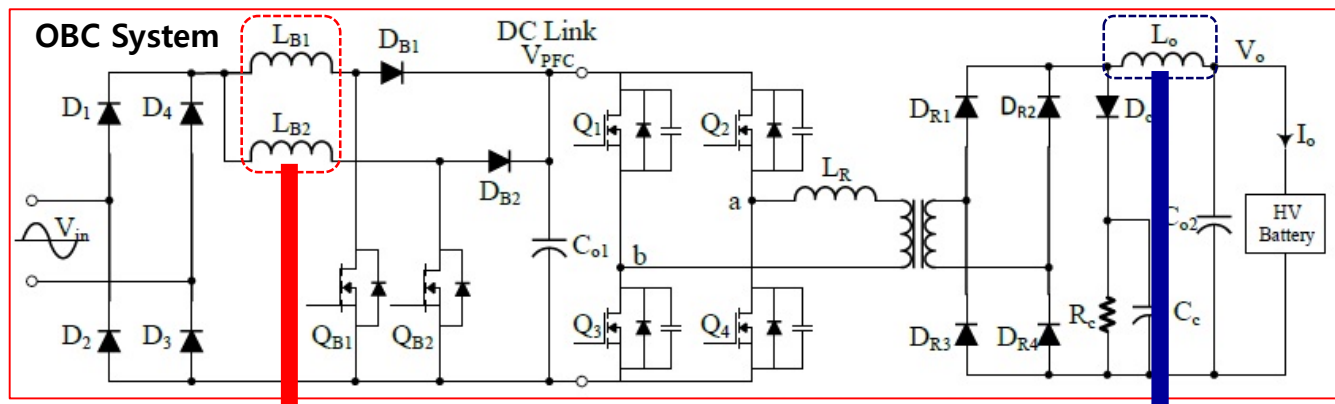
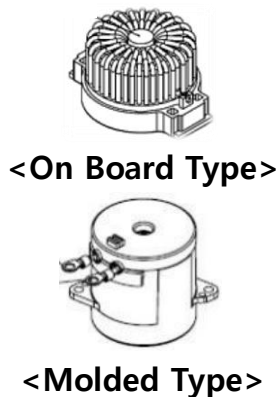


AUTOMOTIVE EXAMPLE

DESIGN EXAMPLE – OBC INDUCTOR

PFC Inductor Design Trend

- ✓ Toroidal Shape Preferred
- ✓ Switching Frequency – 50 ~ Over 80kHz
- ✓ **On Board Type** – **High Flux Material** with Thermal Conductive Plastic Case (**Very Low Core Loss**)
- ✓ **Molded Type** – **High Flux and Mega Flux Material** with Metal Case



1. PFC Inductor
 $f_s = \sim 50\text{kHz}$
 - High Flux, Mega Flux, HS Toroidal (400 ~ 468 Size)
 - High Flux, Mega Flux EQ (4128 ~ 5032 Size), ER (4225 ~ 4628 Size)
 $f_s = \sim 120\text{kHz}$
 - High Flux, HS Toroidal (270 ~ 358 Size)
 - High Flux, Mega Flux EQ (3222 ~ 4128 Size), ER (3222 ~ 4225 Size)

2. Output Inductor (DM Choke)
 - Toroidal (203 ~ 330 size)

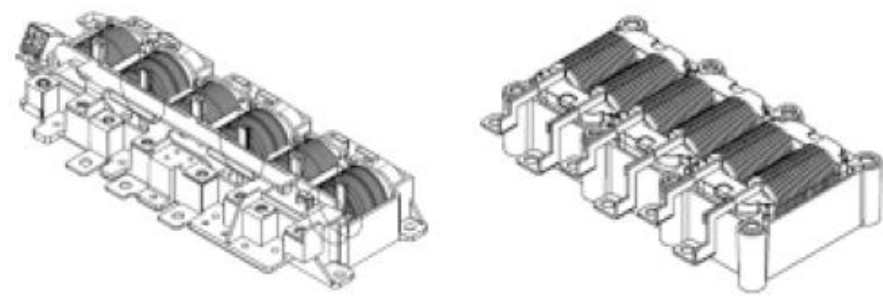
* Based on CSC's Design Experience

AUTOMOTIVE EXAMPLE

• DESIGN EXAMPLE – HDC INDUCTOR

Buck/Boost Inductor Design Trend

- ✓ Block + Cylinder, Ellipse, E Shape Preferred
 - Edgewise Coil
 - Large Window Area (**Lots of Winding Turns**)
 - Easy to Expand (**Higher AL Value**)
- ✓ Switching Frequency – around 20kHz
- ✓ DCB Characteristics Dominant
 - **Mega Flux Material**
 - **Low Permeability (26μ ~ 40μ)**

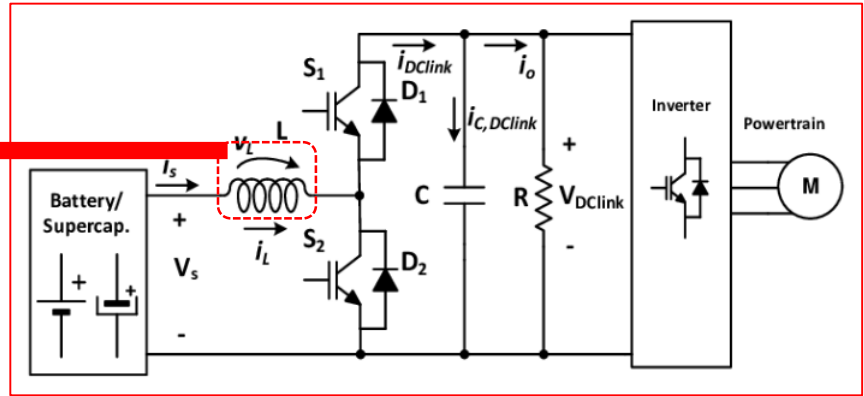


<3 Phase Boost Inductor>

High Voltage DC to DC Converter

Buck/Boost Inductor
 $f_s = \sim 20\text{kHz}$

- Mega Flux E (5528 ~ 8038 Size)
- Mega Flux Block + Cylinder (Customized Size)
 - * 55×34×60 ~ 80×32×90
- Mega Flux Ellipse (Customized Size)
 - * 50×30×60 ~ 74×30×80



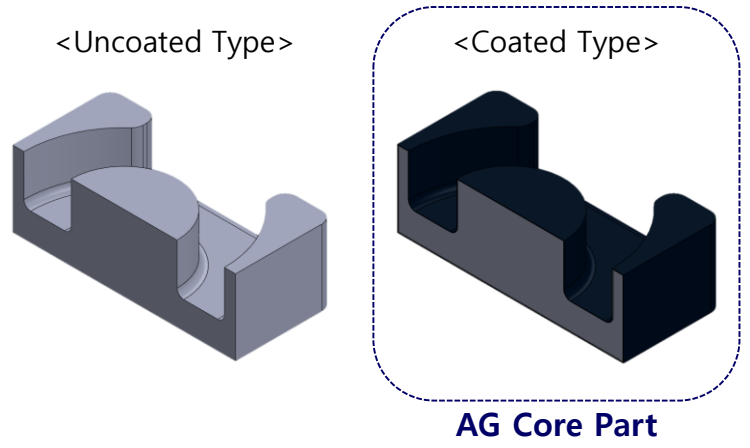
* Based on CSC's Design Experience

AUTOMOTIVE EXAMPLE

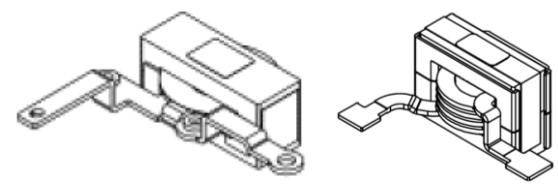
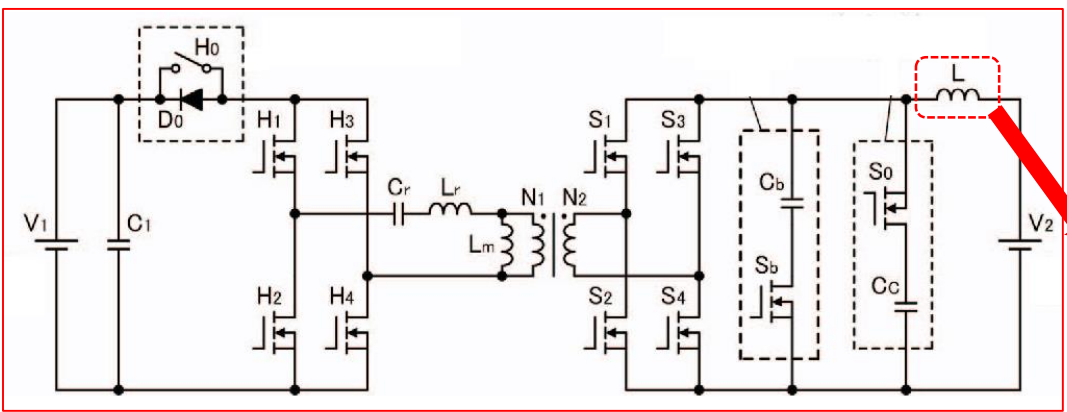
DESIGN EXAMPLE – LDC INDUCTOR

Output Filter Inductor Design Trend

- ✓ EQ, ER, EER Shape Preferred
 - Flat Helical Coil (**Low Copper Loss & Less Length for 1-Turn**)
 - Very Few Winding Turns
- ✓ Switching Frequency – 100 ~ 200kHz
- ✓ Large Current Load (Over 100A)
- ✓ DCB Characteristics Dominant – **Mega Flux Material**
- ✓ **CSC AG Core Part**
 - **High Reliability, Anti-Rust & Better Hi-Pot**
 - **Better DCB due to Gap Effect – All Coated including Mating Area**



Low Voltage DC to DC Converter



<LDC Inductor>

Output Inductor (Smoothing Coil)
 $f_s = 100 \sim 200 \text{kHz}$
 - EQ (4128 ~ 5032 Size)
 - ER (4225 ~ 4628 Size)

* Based on CSC's Design Experience

UPS

- High Magnetic Flux Density
- Very Large Current Load
- High Reliability

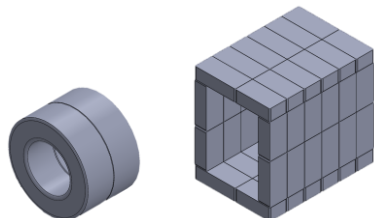
• APPLICATION EX) – BASIC UNINTERRUPTIBLE POWER SUPPLY

WHERE to USE

- Public Institution
- Server
- Telecom Base Station
- ESS
- Industrial
- Home

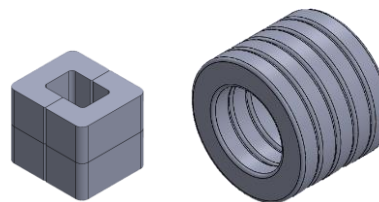
Rectifier (AC-DC)

Application: DC Inductor
 ✓ Mega Flux Toroidal / Block



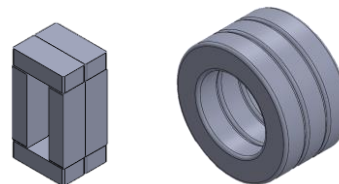
Inverter (DC-AC)

Application: AC Inductor
 ✓ Mega Flux Toroidal / Block



Battery Charger (DC-DC)

Application: Boost Inductor
 ✓ Mega Flux Toroidal / Block



UPS CAPACITY

- Residential – 400VA – 3kV
- Commercial – 1kVA – 160kVA
- Industrial – 10kVA – 1500kVA



UPS EXAMPLE

• DESIGN EXAMPLE – UPS INDUCTOR

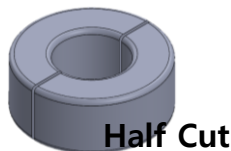
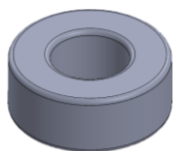
Inductor Design Trend

✓ Large Current Load (up to 5000e)

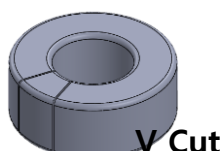
- Low Permeability Preferred – $19\mu \sim 40\mu$
- DCB Characteristics – Mega Flux Material
- Inductance under Large Current (for Mid to High Capacity) – Stacked Core Design

✓ Edgewise Flat Wire

- Low Copper Loss -> Round to Edgewise Flat
- Core Cutting & Wire Inserting -> Cannot Winding Flat Wire on Toroidal Shape



Half Cut



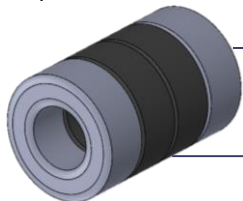
V Cut

✓ Switching Frequency – 6 ~ 20kHz

- Acoustic Noise Issue – Powder Core Preferred (Mega Flux, Sendust, HP Material) Compared to Amorphous Strip

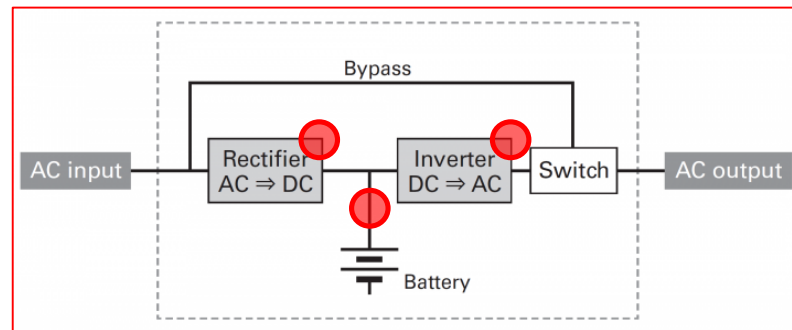
✓ Customized Characteristics & Cost Effectiveness Design – Different Material Assembly

- EX) HP Material + Mega Flux Material

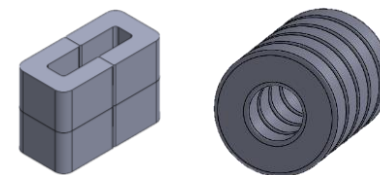


Mega Flux Material – For Better DCB

HP Material – For Better Core Loss



* Basic UPS Block



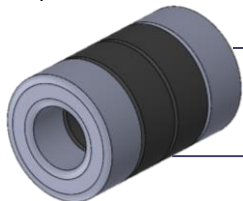
<Stacked Design>

✓ Switching Frequency – 6 ~ 20kHz

- Acoustic Noise Issue – Powder Core Preferred (Mega Flux, Sendust, HP Material) Compared to Amorphous Strip

✓ Customized Characteristics & Cost Effectiveness Design – Different Material Assembly

- EX) HP Material + Mega Flux Material



Mega Flux Material – For Better DCB

HP Material – For Better Core Loss

* Based on CSC's Design Experience

CHARGING STATION

- High Magnetic Flux Density
- Cost Effectiveness
- High Reliability

• APPLICATION EX) – SOLAR INVERTER + DC CHARGER = SOLAR EV CHARGER

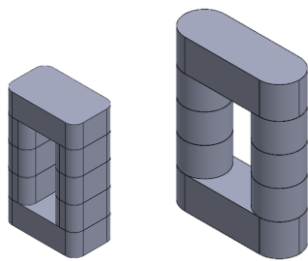
PV INVERTER CAPACITY

- Residential – 3kW – 6kW
- Commercial – 10kW – 50kW
- Industrial – 50kW – 100kW



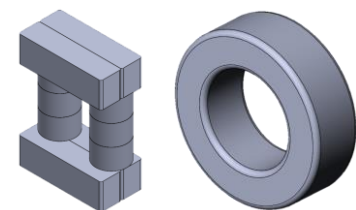
PV Converter (DC-DC)

Application: Boost Inductor
 ✓ Mega Flux Block / Cylinder



PV Inverter (DC-AC)

Application: AC Inductor
 ✓ Mega Flux Block / Cylinder



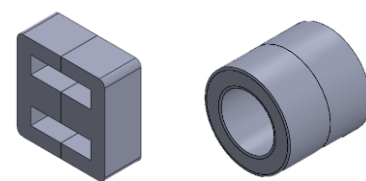
EV CHARGER CAPACITY by TESLA

- Level 1 (Home) – 1.4kW
- Level 2 (Charging Station) – 3.7kW – 17.2kW
- Level 3 (Super Charger) – up to 140kW



DC Charger (DC-DC)

Application: PFC Inductor
 ✓ Mega Flux Toroidal

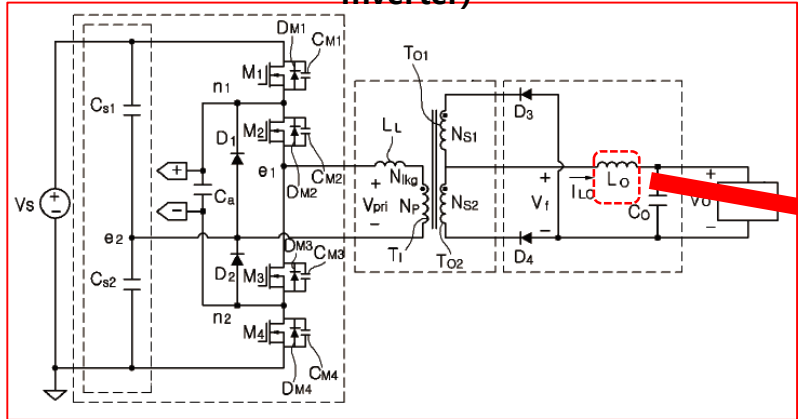


RAILWAY

- High Relative Permeability
- High Reliability
- Low Core Loss

• APPLICATION EX) – RAILWAY (TRAIN & SIGNAL) SYSTEM

Auxiliary Power Supply (Static Inverter)



1. Output Inductor for APS

- ✓ High Flux Material Preferred
- ✓ Large Current Load
- ✓ High Output Efficiency – Over 92%
- ✓ For Providing Power in Rolling Stock

Output Inductor

- Toroidal (610 ~ 740 Size)
- Block

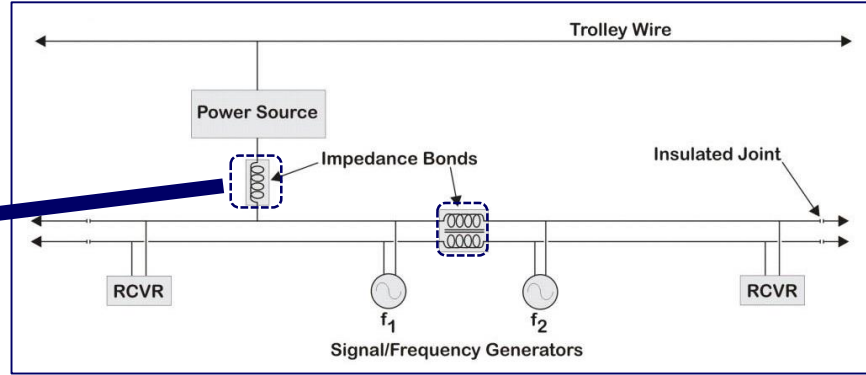
2. Inductor for Impedance Bond

- ✓ MPP Material Preferred
 - Over 110 μ
- ✓ Very High Reliability Required
- ✓ For Controlling Railway Signal

Inductor

- Big Toroidal (1013 ~ 1625 Size)
- Block & Cylinder

Impedance Bond on Railroad



* Based on CSC's Design Experience



THANK YOU