

Baosteel GO Silicon Steel

Application Technology



Baosteel application technology concept

To be customer's sincere and reliable partner in providing silicon steels and their solutions to achieve win-win collaboration.

Baosteel application technology culture

Customer Thinking——From customer, Serve customer, Achieve customer

Synergy Thinking——Same target, Net-working, One word

Enterprising Thinking——Professional, Sincere dedication, Beyond expectation



Beaco

Baosteel application technology for GO silicon steel

Baosteel could offer a variety of specialized services and technical support from material selection in design of transformer cores to transformer manufacturing, including:

- Material selecting in core design for property/cost control.
- Optimization of structure in terms of cost and performance purposes.
- Technical support for core manufacturing to ensure the best performance.
- Recommendation of new products and technologies to enhance the competitiveness of transformer products.

Perfect product system of GO silicon steel

- Experience: Devoted in grain-oriented silicon steel 50 years ago, with a complete capability of R&D, manufacturing and application.
- Products: conventional, high permeability, domain refined, low magnetostriction and special coating heat-resistant domain refined grain-oriented silicon steel.
- Grade: The most advanced grade with iron loss $P_{1.7/50}$ lower than 0.55W/kg.
- Ability: The ever first steel company in China who developed low-temperature reheating technology with the ability of manufacturing 100% high grade grain-oriented silicon steel. The output of grain-oriented silicon steel ranks first in the world.



CORES

Conventional

B30G120	30Q120
B30G130	30Q130
B35G155	35Q155

High permeability

B18P075	B23P090	B30P095	18QG080	27QG090
B18P080	B23P095	B30P100	20QG080	27QG095
B20P075	B23P100	B30P105	20QG085	27QG100
B20P080	B27P085	B30P120	23QG085	30QG100
B20P085	B27P090	B35P115	23QG090	30QG105
B23P080	B27P095	B35P135	23QG095	30QG120
B23P085	B27P100		23QG100	35QG135

Domain Refined

B18R055	B20R075	B27R080	18RK065	23RK085
B18R060	B23R065	B27R085	18RK070	23RK090
B18R065	B23R070	B27R090	20RK070	27RK085
B18R070	B23R075	B27R095	20RK075	27RK090
B20R060	B23R080	B30R085	23RK075	27RK095
B20R065	B23R085	B30R090	23RK080	30RK100
B20R070	B23R090	B30R100		

BeCOREs



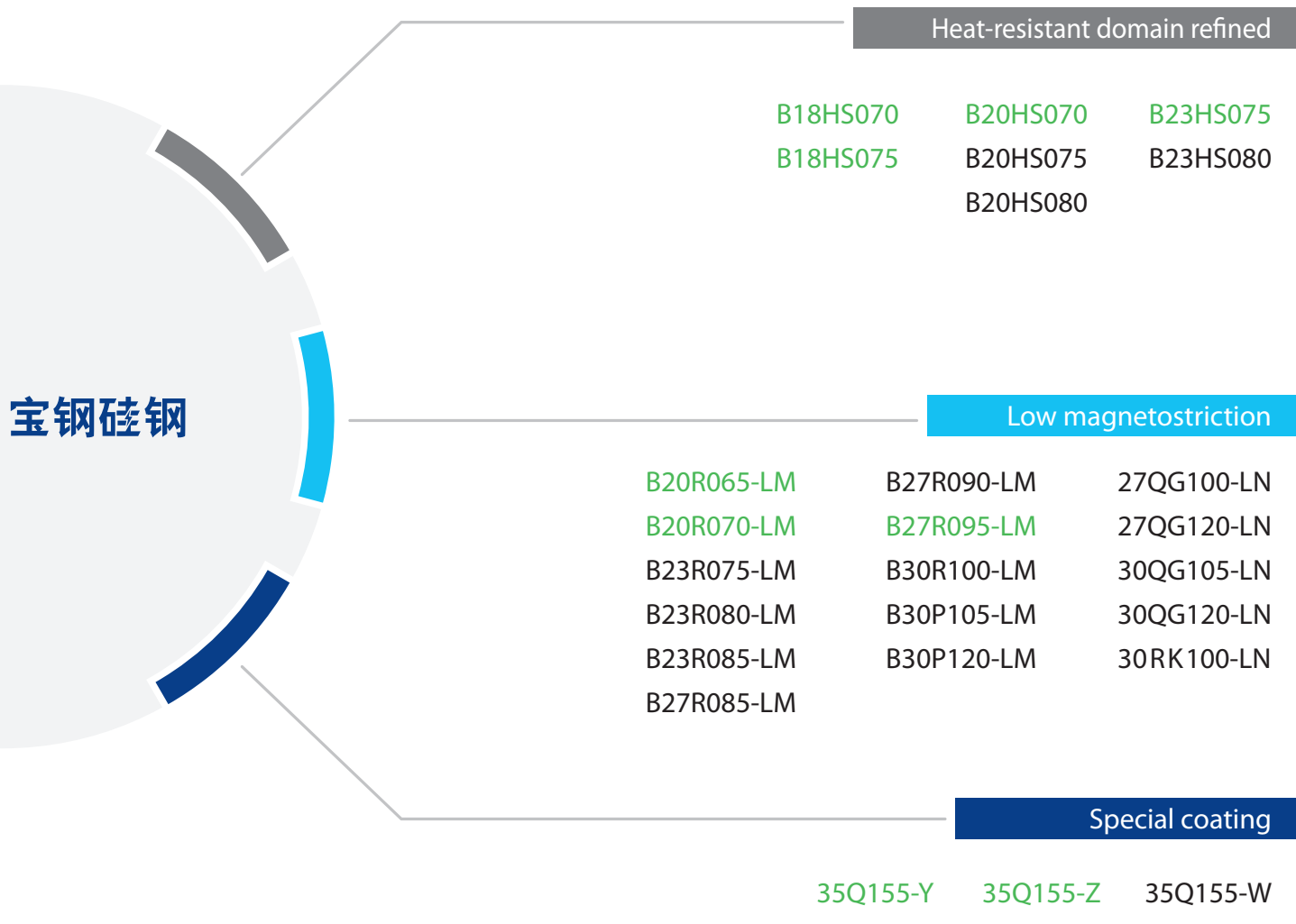
Energy efficiency grade I distribution transformer



Energy efficiency grade I distribution transformer with tridimensional wound



±800kV Converter transformer



Note: The products in green font are the world's premiere products.

"- W" stands for no - glass - film products;

"- Y" stands for C6 coating series products;

"- Z" stands for self-adhesive coating series products.



1000kV AC transformer



±1100kV Converter transformer

COMPREHENSIVE TECHNICAL SOLUTIONS FOR GO SILICON STEEL

Complete material database support for transformer 04

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COMPLETE MATERIAL DATABASE SUPPORT FOR TRANSFORMER

Baosteel continuously updates and improves properties database of products for transformer use, supporting customers with a range of full set of data from mechanical properties and basic magnetic properties to the properties under special working conditions. According to the diversified requirements, Baosteel can provide customers with performance data, the original curves, and other forms of data.

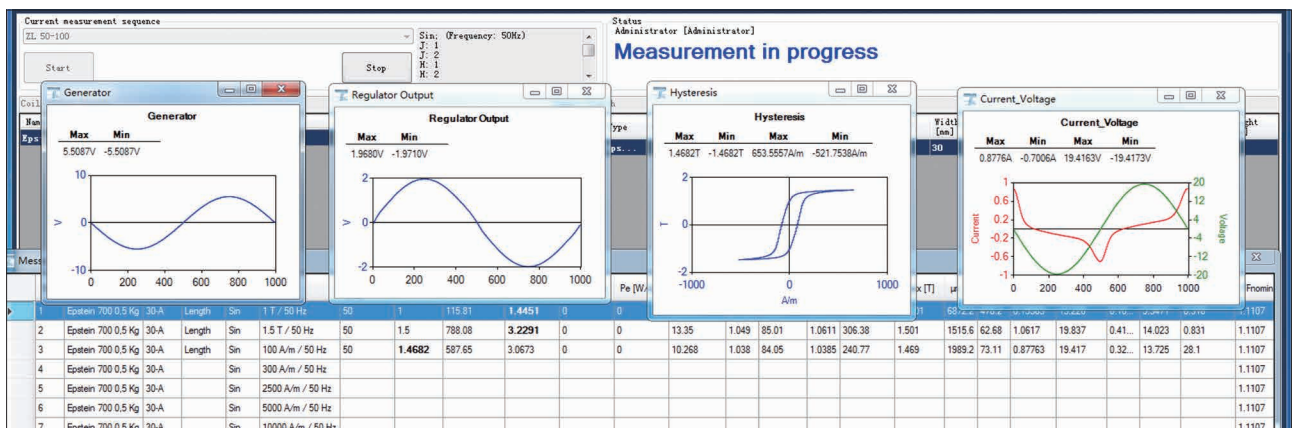
Transformer material database

Basic magnetic properties	Mechanical properties
Core loss curves	Tensile strength
A.C. Exciting power curves	Number of bends
D.C.Magnetization curves/D.C. Permeability curves	Yield strength
Core loss at high frequency	Elongation
Thermal conductivity	Hardness

COMPREHENSIVE PERFORMANCE TEST SUPPORT

Magnetic Properties Test Platform

With complete material property test platform, Baosteel could provide customers with magnetic property data at any frequency and magnetic flux density of all size of the material, and the measurement of B-P, B-H and H- μ and other forms of magnetic property curves, to fully make use of the material properties at the greatest extent.



Typical Magnetic Properties

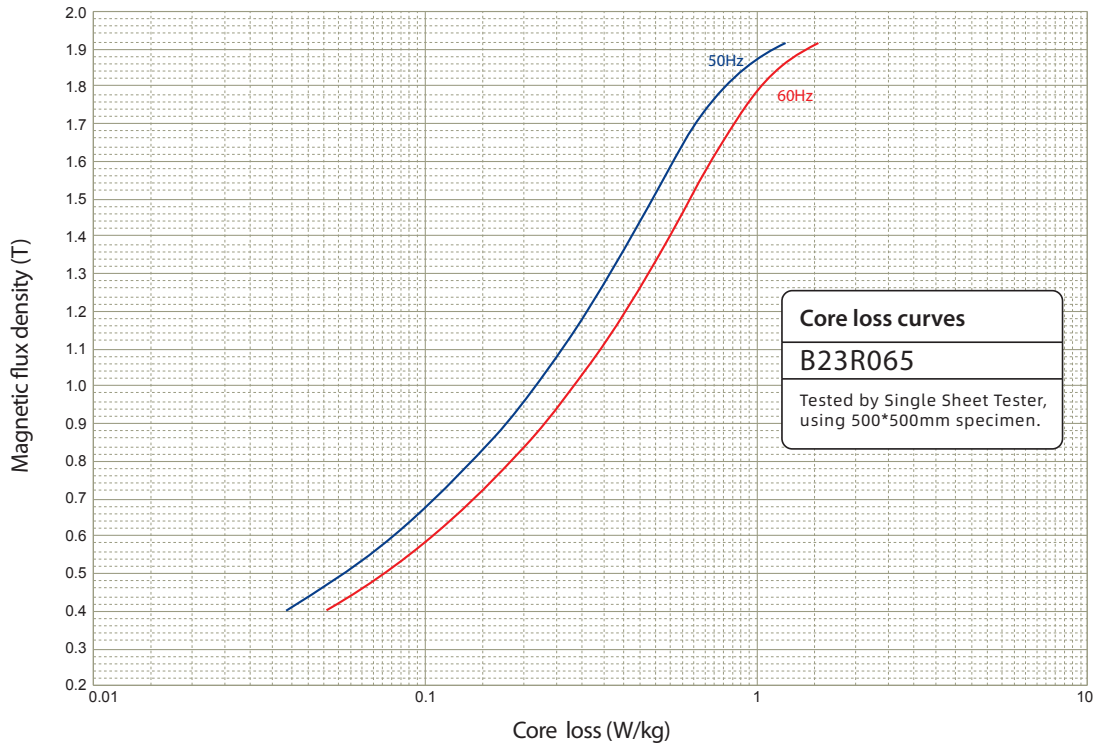
Typical magnetic properties of major grain-oriented silicon steel grades

Type	Grade	Specific total loss (W/kg)	Magnetic polarization (T)
		$P_{1.7/50}$	B8
High permeability type	B18P075	0.74	1.89
	B18P080	0.79	1.89
	B20P075	0.74	1.91
	B20P080	0.79	1.89
	B23P085	0.83	1.92
	B27P095	0.92	1.91
	B27P100	0.94	1.91
	B30P105	0.99	1.91
Domain Refined High Permeability Grades	B18R055	0.54	1.91
	B18R060	0.59	1.92
	B18R065	0.64	1.91
	B20R060	0.59	1.92
	B20R065	0.63	1.92
	B20R070	0.68	1.91
	B23R065	0.65	1.90
	B23R070	0.69	1.90
	B23R075	0.74	1.92
	B23R080	0.77	1.91
	B23R085	0.80	1.91
	B27R080	0.78	1.92
	B27R085	0.82	1.91
	B27R090	0.86	1.90
	B30R085	0.84	1.90
B30R090	0.88	1.92	
B30R100	0.94	1.91	
Heat-resistant domain refined	B18HS070	0.68	1.90
	B18HS075	0.73	1.90
	B20HS070	0.68	1.90
	B20HS075	0.73	1.90
	B20HS080	0.78	1.90
	B23HS075	0.73	1.90
	B23HS080	0.78	1.90

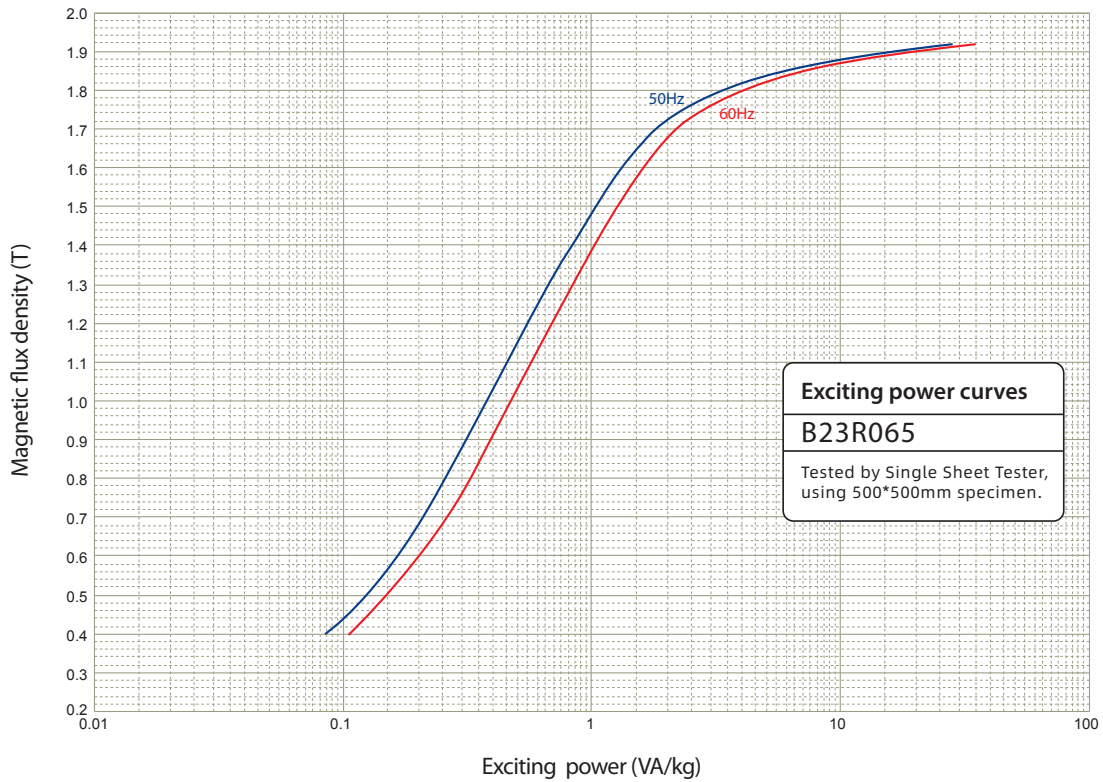
Typical Magnetic Curves

■ B23R065 : typical values $P_{17/50}=0.65\text{W/kg}$, $B_8=1.90\text{T}$

■ Iron Loss Curves



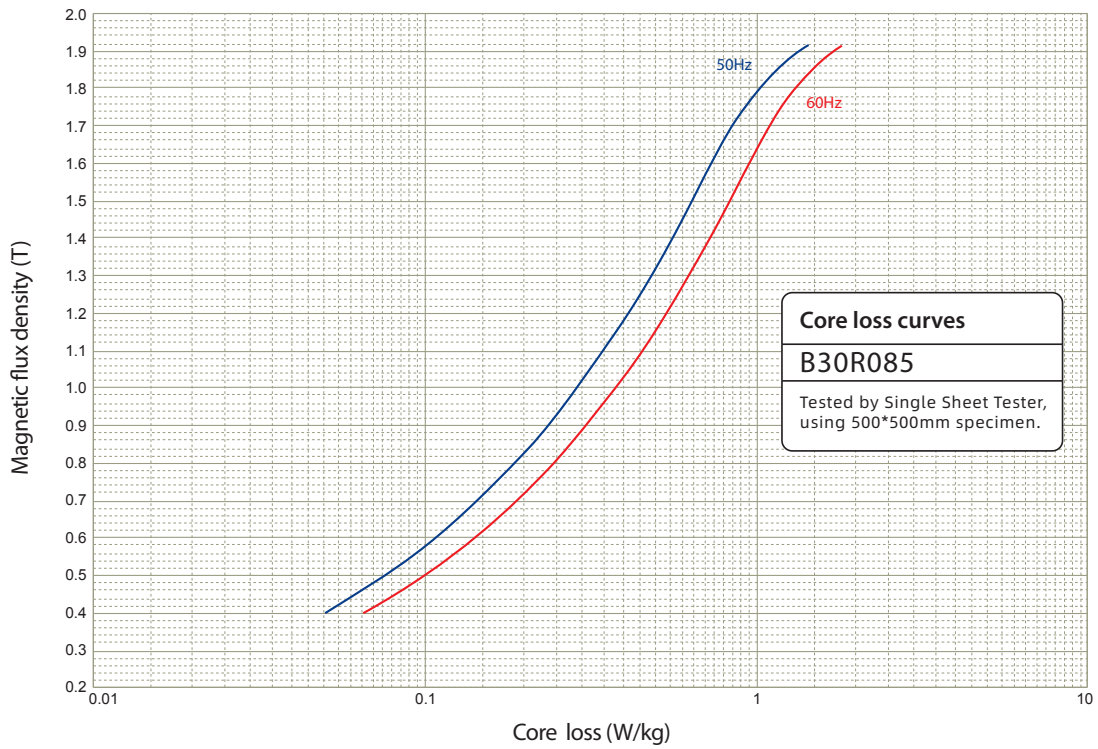
■ Exciting power curves



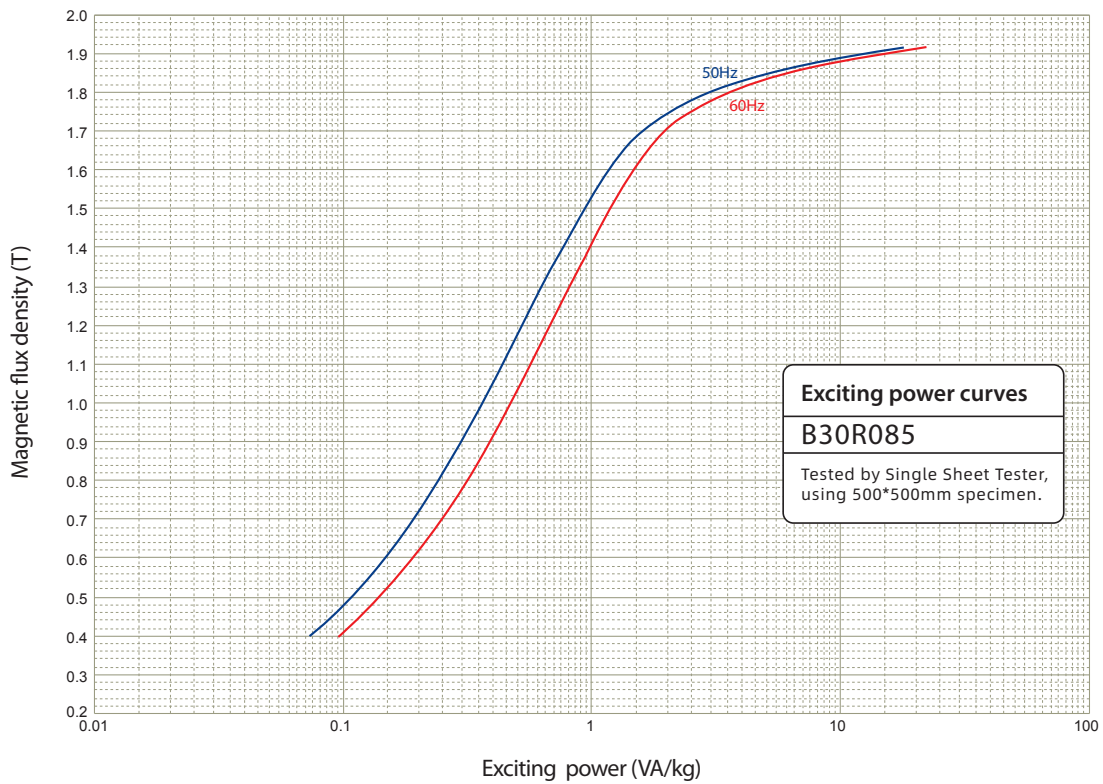
Typical Magnetic Curves

■ B30R085 : typical values $P_{17/50}=0.84\text{W/kg}$, $B_8=1.90\text{T}$

■ Iron Loss Curves



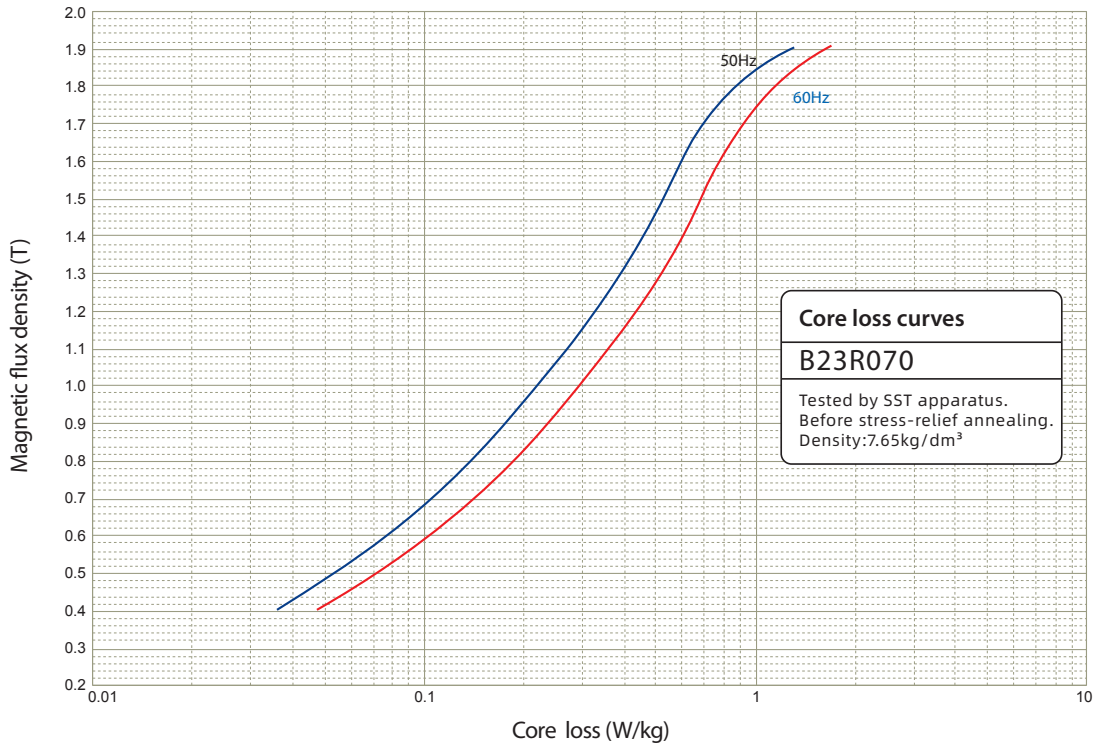
■ Exciting power curves



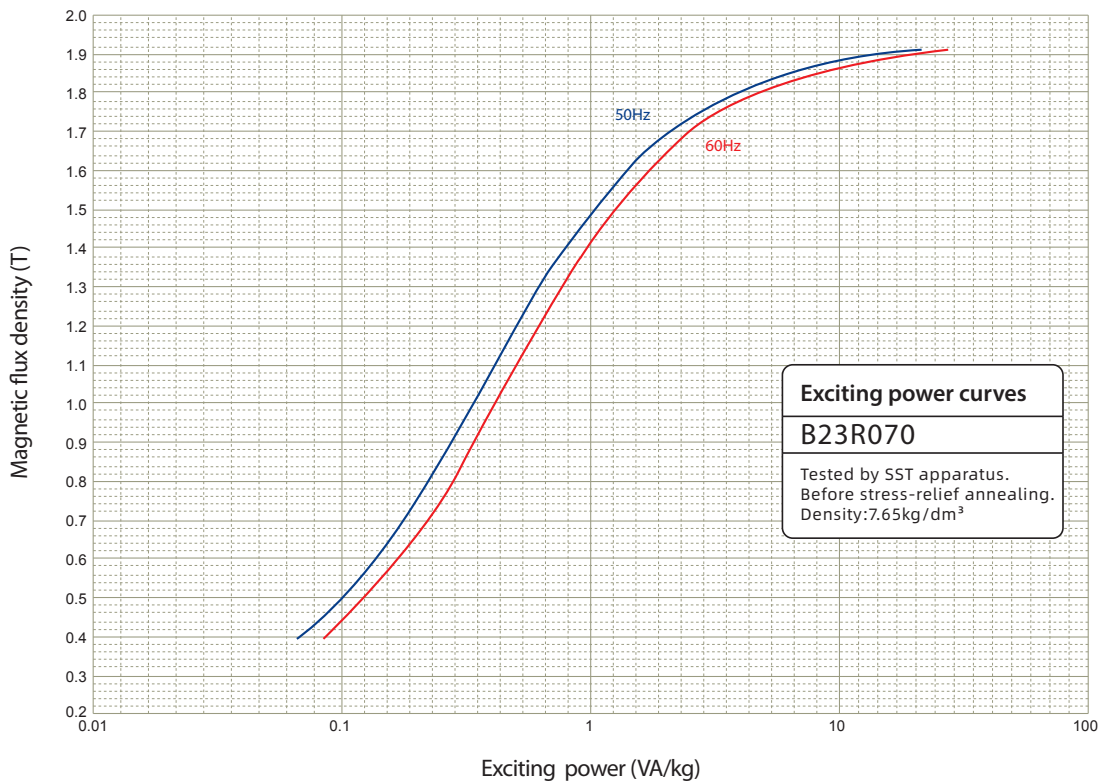
Typical Magnetic Curves

■ B23R070 : typical values $P_{17/50}=0.69\text{W/kg}$, $B_8=1.91\text{T}$

■ Iron Loss Curves

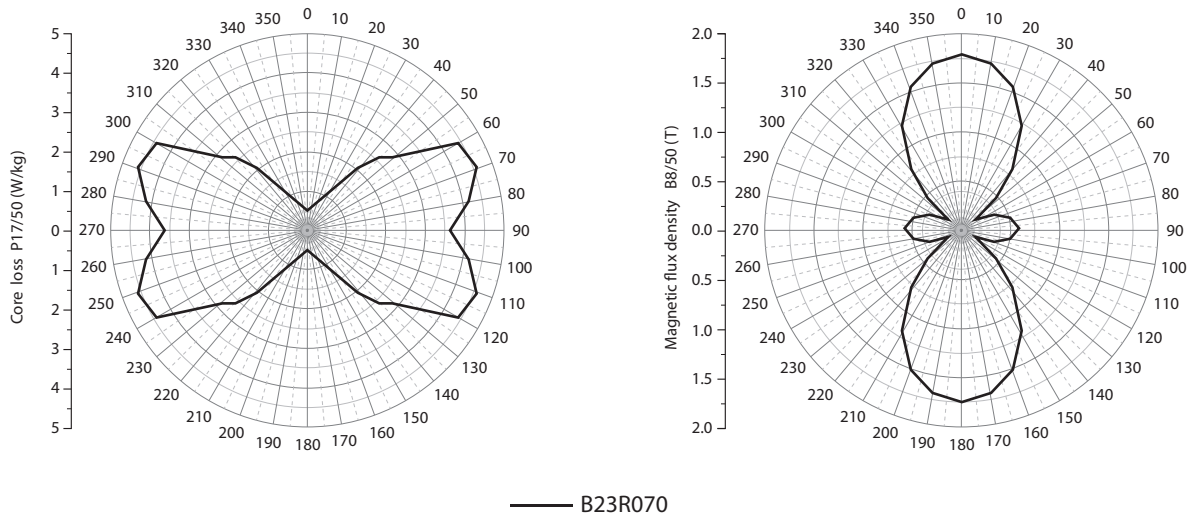


■ Exciting power curves

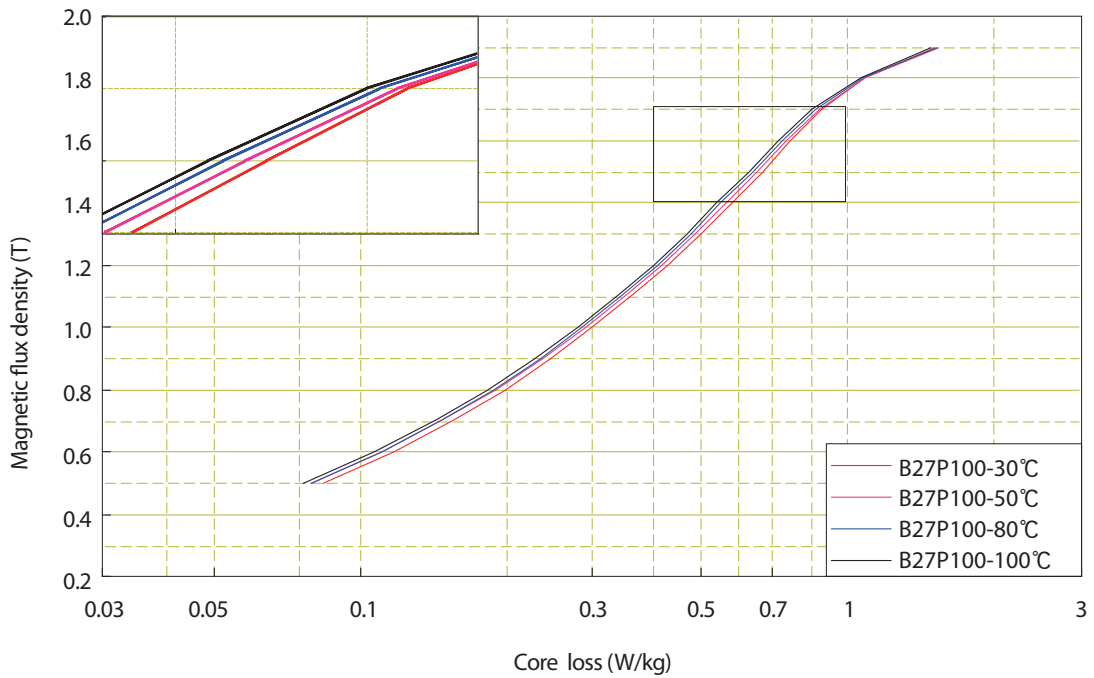


Magnetic Curves Under Special Conditions

Magnetic properties along various directions



Iron loss curves at various working temperatures



COMPREHENSIVE APPLICATION TECHNICAL SUPPORTS

Material Selection

Considering overall the factors such as material properties and prices, Baosteel could supply technical support for material selection for the design of transformer cores. By effective comparison between different materials through predicting core properties according to the design and process, the optimal cost can be achieved.

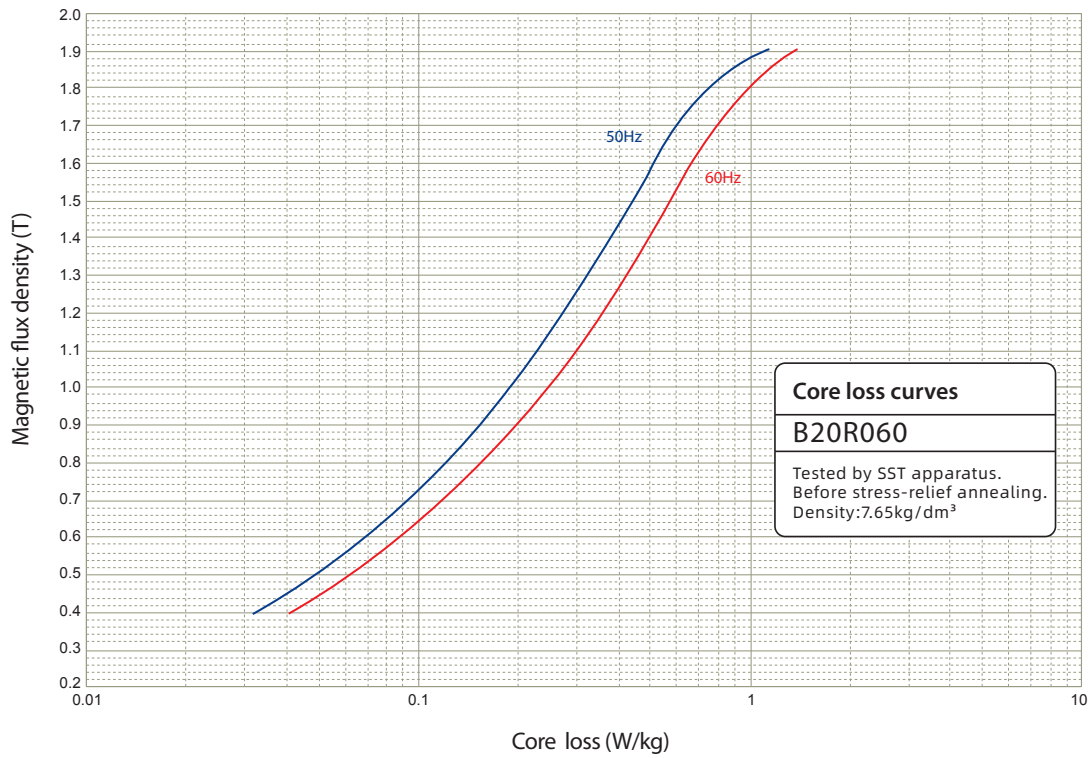
High efficiency distribution transformers

Grain-oriented silicon steel grades applied to high efficiency distribution transformers

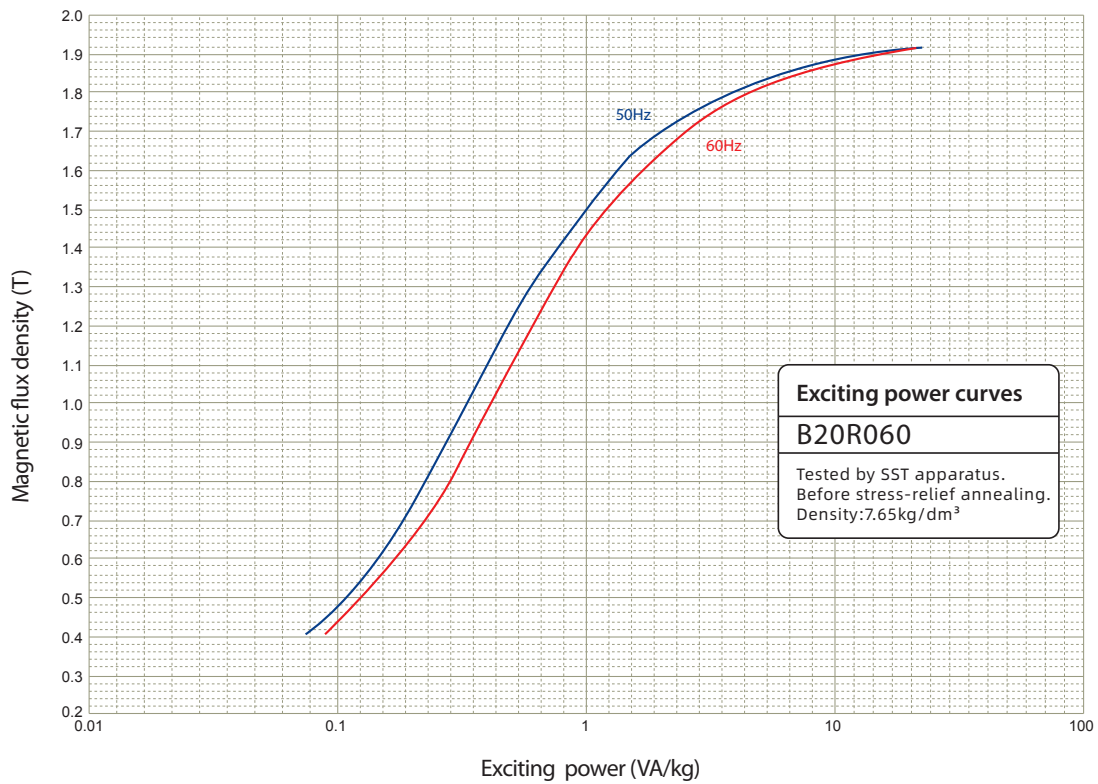
Energy efficiency grades for distribution transformers GB20052-2024	Energy efficiency grade 2		Energy efficiency grade 1	
	laminated core	wound core	laminated core	wound core
Oil-immersed distribution transformer	B20R070	B20P075	B18R055	B20HS070
	B23R070	B20P080	B20R060	B20P075
	B23R075	B23HS075	B20R065	B23HS075
Dry type distribution transformer	B20R075	B23HS080	B20R070	B18HS070
	B23R080	B23P085	B23R070	B20P075
	B23R085	B23P090	B23R075	B23HS075

■ B20R060 : typical values $P_{17/50}=0.59\text{W/kg}$, $B_8=1.91\text{T}$

■ Iron loss curves

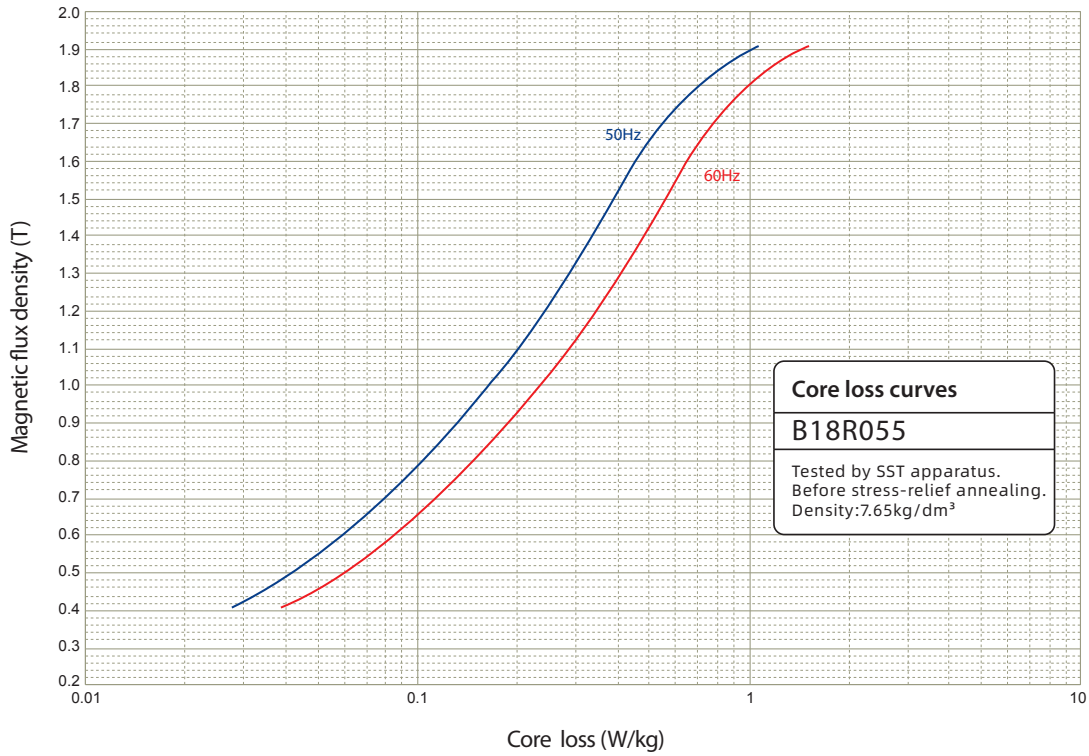


■ Exciting power curves

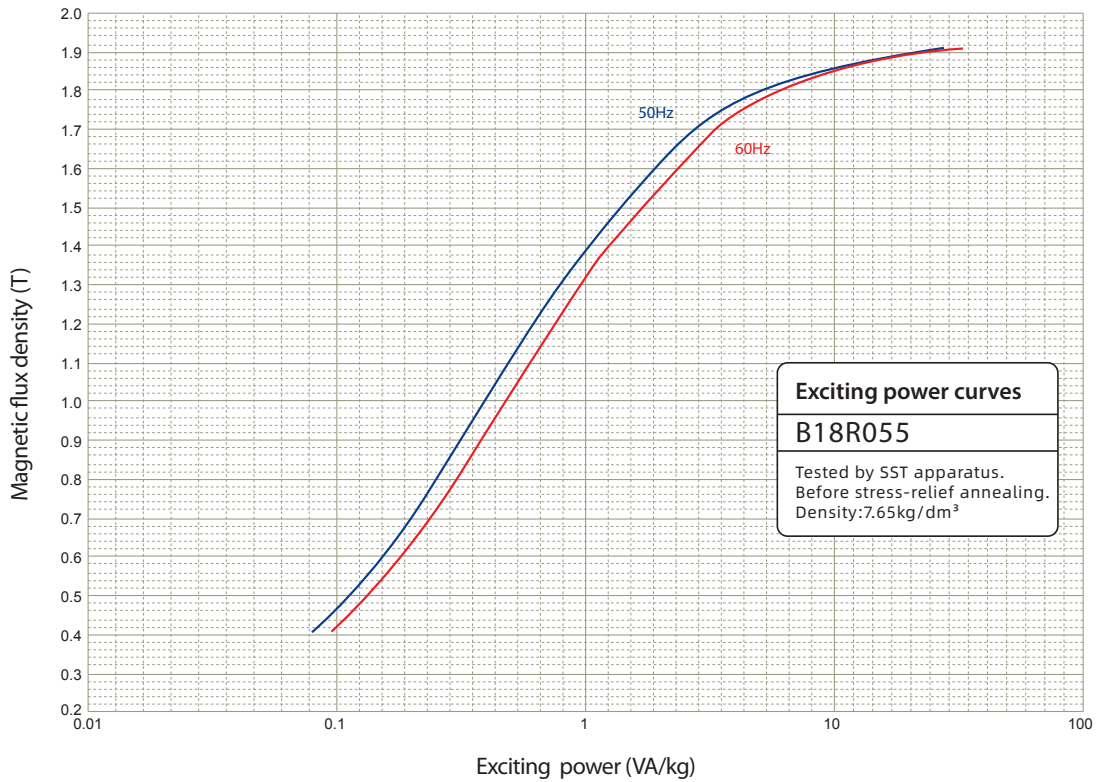


■ B18R055 : typical values $P_{17/50}=0.54\text{W/kg}$, $B_8=1.91\text{T}$

■ Iron loss curves

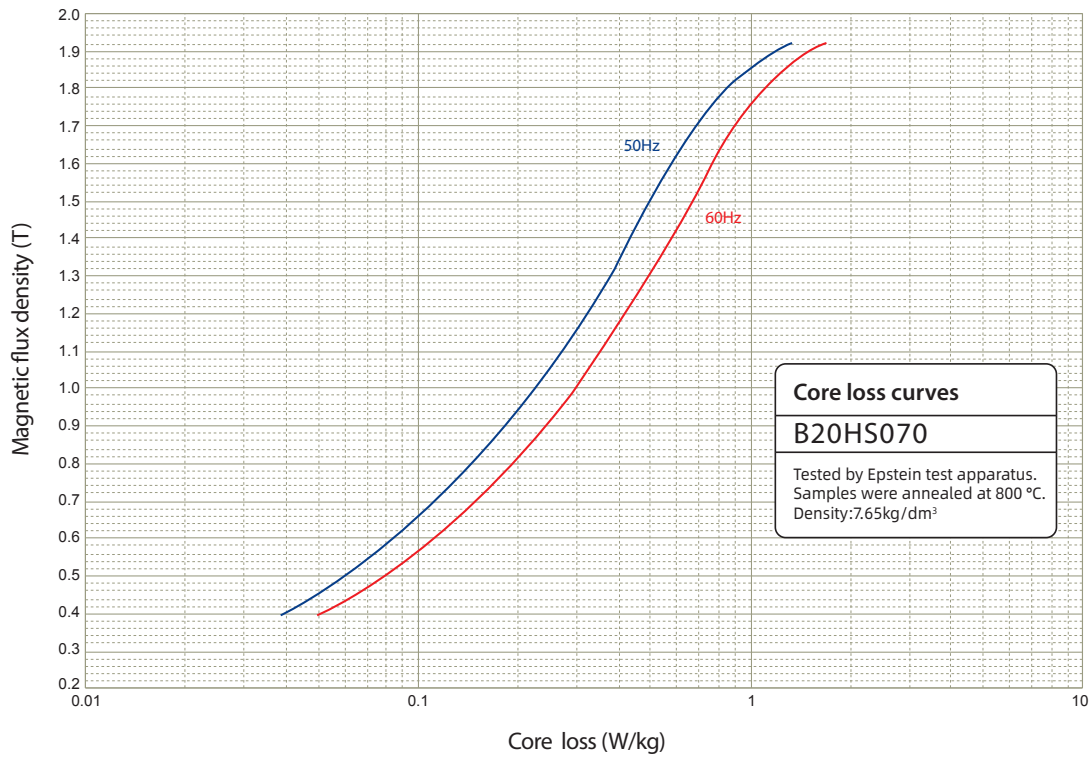


■ Exciting power curves

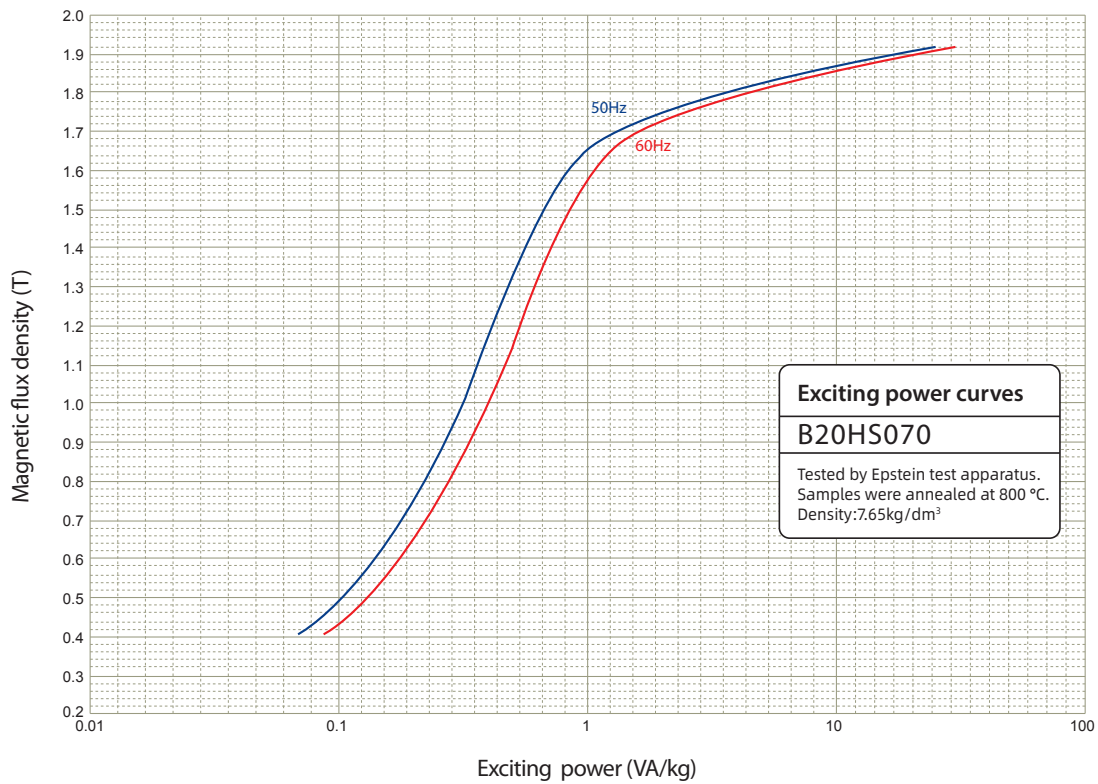


■ B20HS070 : typical values $P_{17/50}=0.68\text{W/kg}$, $B_8=1.90\text{T}$

■ Iron loss curves

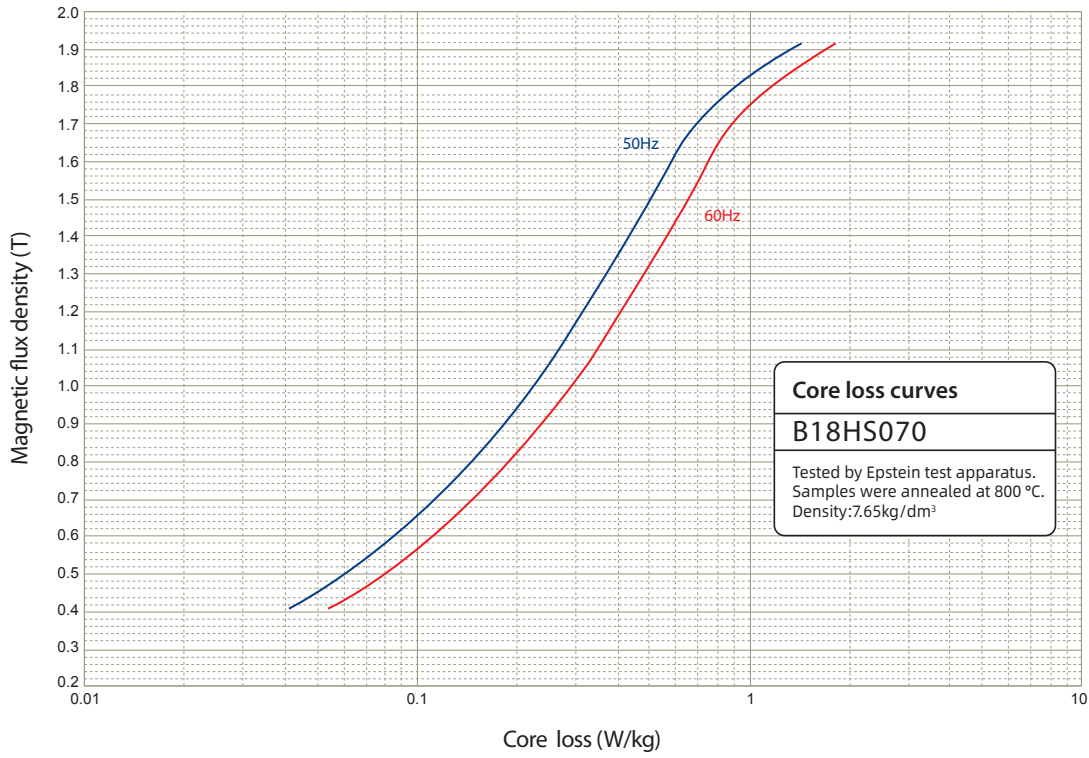


■ Exciting power curves

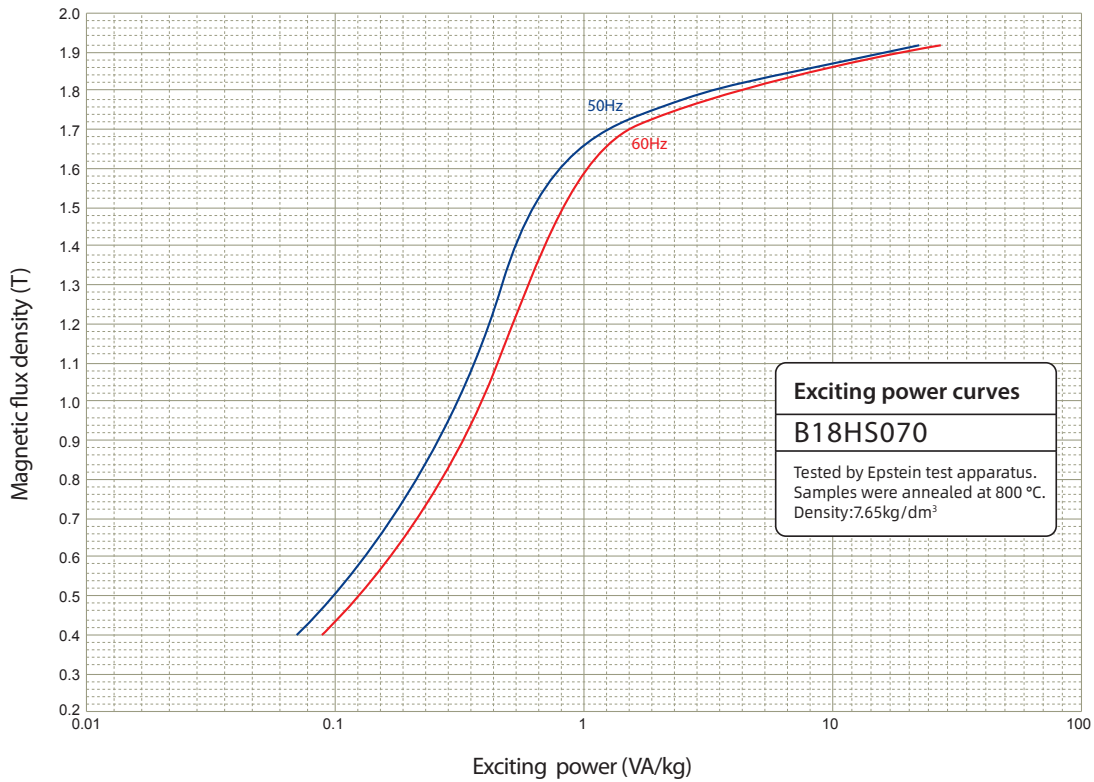


■ B18HS070 : typical values $P_{1.7/50}=0.68\text{W/kg}$, $B_8=1.90\text{T}$

■ Iron loss curves

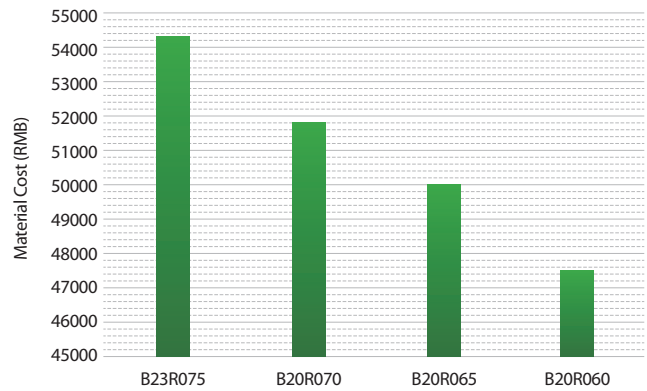
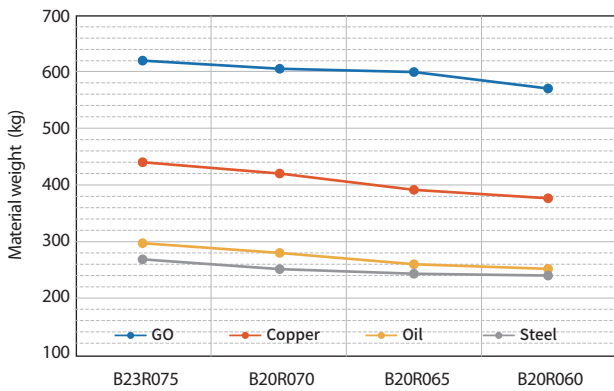


■ Exciting power curves

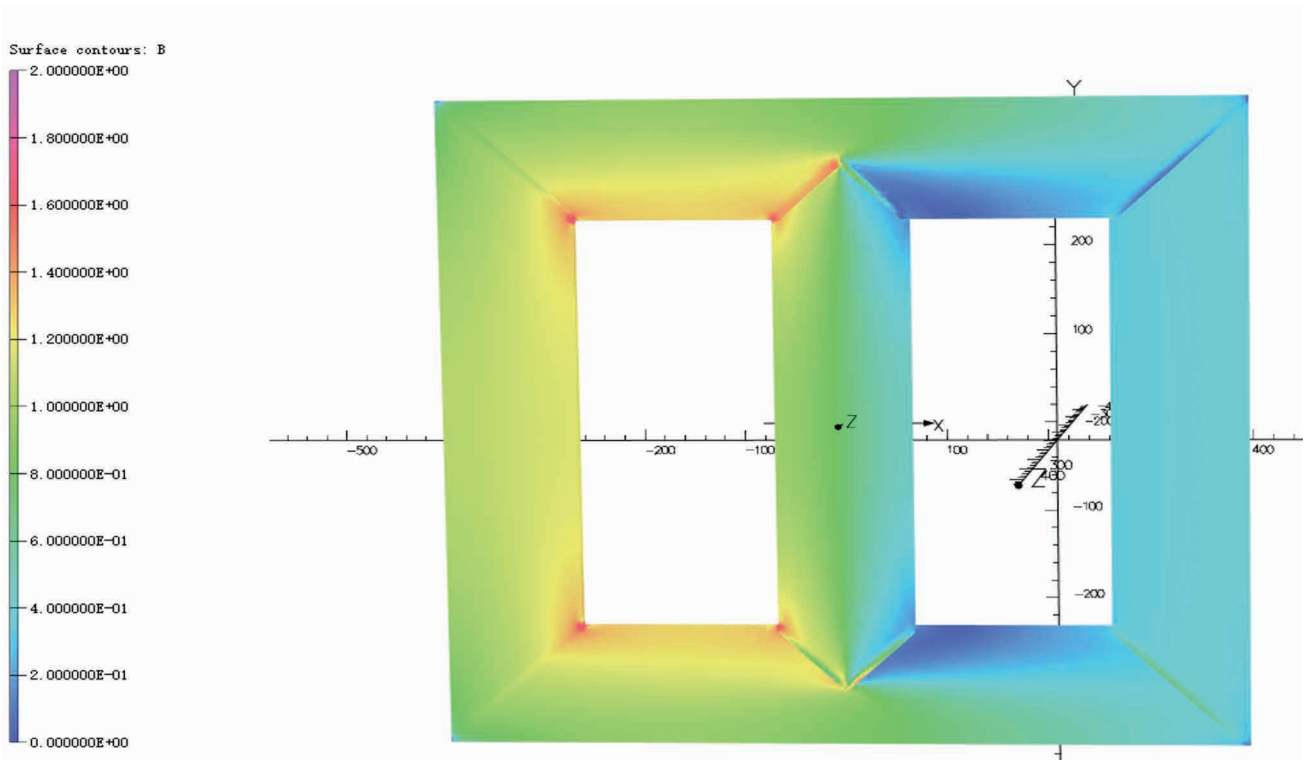


■ Case — Cost-performance ratio analysis for the distribution transformer

High cost-performance ratio is one motivation to use high-performance grain-oriented silicon steel. Taking the new energy efficiency grade 1 laminated core S22-M-400/10-NX1 oil immersed distribution transformer of GB20052 as an example, four kinds of silicon steel grades of Baosteel are used for transformer cost analysis.



GB20052 new energy efficiency grade 1 products S22-M-200/10, S22-M-400/10 transformers have been successfully manufactured with high grade GO silicon steel B18R055, B20R060, whose no-load loss and load loss all meet the requirements of the new grade 1 transformer.



The performance of energy efficiency 1 transformers made of B18R055、B20R060 and B18HS070、B20HS070

S22-M-200/10 Test items	Standard value	Measured value
No-load loss, W	190	174 (B18R055)
No-load loss, W	190	181 (B20R060)
S22-M-400/10 Test items	Standard value	Measured value
No-load loss, W	330	282 (B18R055)
No-load loss, W	330	306 (B20R060)
S22-MRL-400/10 Test items	Standard value	Measured value
No-load loss, W	330	266 (B20HS070)
No-load loss, W	330	315 (B20HS070)
No-load loss, W	330	304 (B18HS070)
S22-MRL-200/10 Test items	Standard value	Measured value
No-load loss, W	190	180 (B18HS070)
No-load loss, W	190	179 (B18HS070)
No-load loss, W	190	180 (B18HS070)

Energy saving power transformer

Grain-oriented silicon steel grades applied to energy saving power transformer

Grain-oriented silicon steel grades applied	$P_{1.7/50}$ (W/kg)	B8 (T)
B18R060	0.59	1.92
B20R065	0.63	1.91
B20R070	0.68	1.91
B23R070	0.69	1.92

■ Case — Application of energy saving power transformer Baosteel 2030 Cold Rolling main transformer.

Baosteel adopted two large-scale 110kV main transformer manufactured with B20R070 in the production line to upgrade and reform 2030 cold rolling mill. According to the 30 year life expectancy, 14.95 million kWh and 7.475 million RMB cost will be saved.

Baosteel 2030 Cold Rolling main transformer SFSZ-140000/110kV made with B20R070 performances

NO	Performance indicators	New main transformer	Old main transformer
1	No-load loss	37.46 kW	74.9 kW
2	No-load current	0.06%	0.31%
3	Load loss	483.2kW	522.6 kW
4	Energy saving in 30-year life	14.95 million kWh	—
5	Cost saving in 30-year life	7.475 million RMB	—

Large power transformers

Grain-oriented silicon steel grades applied to large power transformers

Grain-oriented silicon steel grades applied	$P_{1.7/50}$ (W/kg)	B8 (T)
B20RT065	0.63	1.91
B23RT075	0.72	1.91
B23RT080	0.77	1.91
B27RT085	0.82	1.91
B27RT090	0.86	1.91
B27RT095	0.89	1.91
B27PT100	0.94	1.91

■ Case — Dual million transformers used in the ultra high voltage AC transmission project

Baosteel high-grade grain-oriented silicon steel B27R090 was successful applied to manufacture the dual million transformer ODFPS-1000000/1000 for the ultra high voltage AC transmission project. All the transformer properties including no-load loss, no-load current and noise meet the design requirements.



Properties of the dual million transformer made with B27R090

Test items	Guaranteed value	Measured value
No-load loss, kW	185, +15%	177.9
No-load current, %	0.1	0.07
Noise, dB(A)	75	72

■ Case — Application in Changji - Guquan ±1100kV UHVDC transmission project from of State Grid.

Baosteel high grade grain oriented silicon steel B23R075 has been successfully applied to the production of converter transformer in Changji - Guquan ± 1100kV UHVDC transmission project of State Grid. The no-load loss, no-load current and noise of the transformer fully meet the technical requirements.



The performance of the ±1100kV UHV converter transformer made with B23R075

Model	Grades	No-load loss kW	No-load current %	Noise dB(A)
ZZDFPZ-587100/1000-275	B23R075	198.5	0.079	72
ZZDFPZ-587100/1000-550		199.8	0.089	73

■ Case — B20RT065 application in ±800kV UHVDC Project

For the first time, Baosteel's high grade silicon steel B20RT065 was used in the ultra-high voltage transformer, 9 step-lap of the core were used to reduce losses and noise. Compared to similar products, the no-load loss of the product has been reduced by 7.6%, and the noise has been reduced by 2-3 dB(A)



Special demand—low noise transformers

With the development of national economy, densification of population in cities, substation load is increasing. The noise requirements of transformers becomes stricter. Baosteel has also developed low-noise products of 0.20mm, 0.23mm, 0.27mm, and 0.30mm.

Grain-oriented silicon steel grades applied to low noise transformers

Grades	A _{wv1.7/50} , dB(A)		P _{1.7/50} , W/kg		B _{8,T}	
	Typical value	Guaranteed value	Typical value	Guaranteed value	Typical value	Guaranteed value
B20R070-LM	51.5	≤52	0.68	≤0.70	1.91	≥1.88
B23R080-LM	52.5	≤53	0.77	≤0.79	1.91	≥1.88
B23R085-LM	52.5	≤53	0.80	≤0.82	1.91	≥1.88
B27R095-LM	54	≤55	0.90	≤0.94	1.91	≥1.88
B30P105-LM	54	≤55	1.01	≤1.03	1.91	≥1.90
B30P120-LM	54	≤55	1.04	≤1.06	1.91	≥1.90

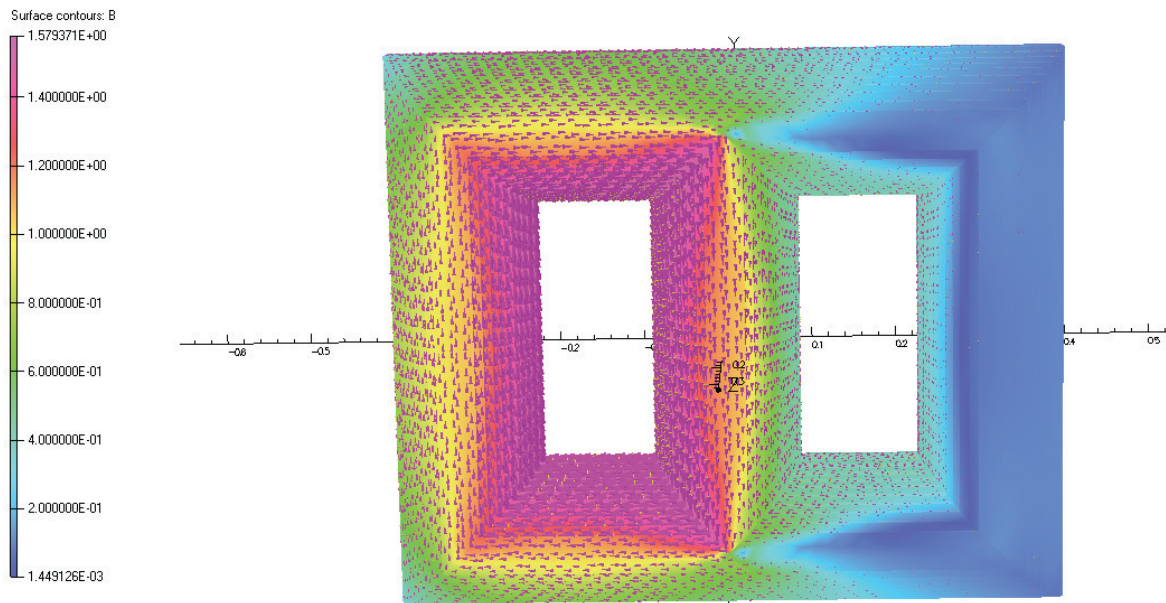
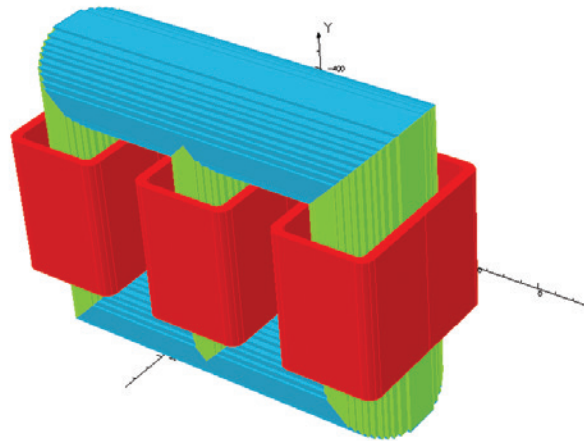
■ Cases

With transformer noise 2-3dB(A) lower than the requirement, Baosteel low magnetostriction GO silicon steel has been widely accepted by customers.

Power products	Noise requirements	Normal material	Low magnetostriction material
SSZ11-240000/220 transformer	63 dB(A)	—	60 dB(A)
SB11-M-500/10 transformer	47 dB(A)	44.3 dB(A)	42 dB(A)
SFSZ-180000/220 transformer	63 dB(A)	60 dB(A)	58 dB(A)
SZ-50000/110 transformer	60 dB(A)	58 dB(A)	56 dB(A)
SCB11-1000/10 transformer	50 dB(A)	47.5 dB(A)	44 dB(A)
DF11-120000/750 transformer	65 dB(A)	62 dB(A)	60 dB(A)
S14-M-400/10 transformer	48 dB(A)	45 dB(A)	42 dB(A)
BKS-90000/230 reactor	75 dB(A)	70 dB(A)	69 dB(A)
BKS-75000/230 reactor	75 dB(A)	74 dB(A)	72 dB(A)
SCB14-2000KVA Transformer	—	46 dB(A)	44 dB(A)

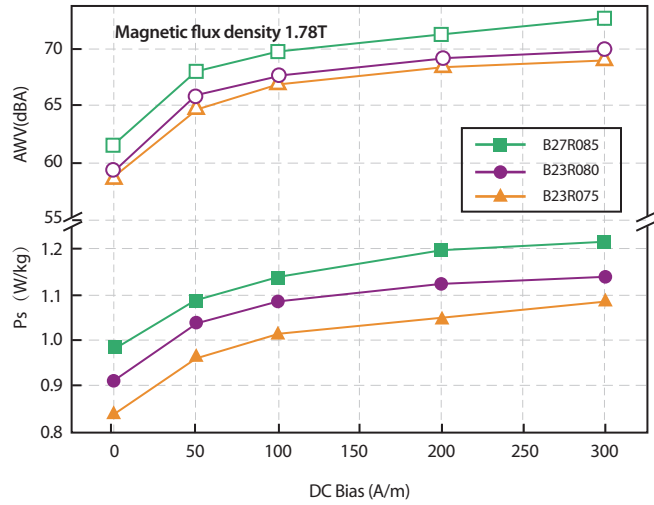
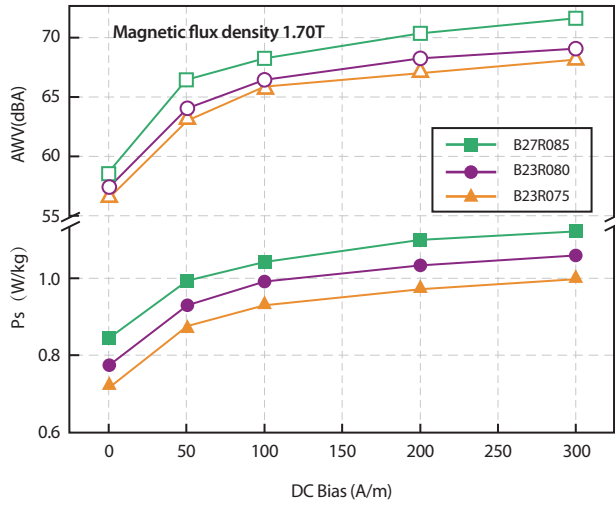
Simulation Analysis

- Ability to provide no-load characteristic analysis
- Ability to simulate magnetic field distribution
- Ability to simulate DC magnetic bias characteristics
- Ability to simulate harmonic characteristics

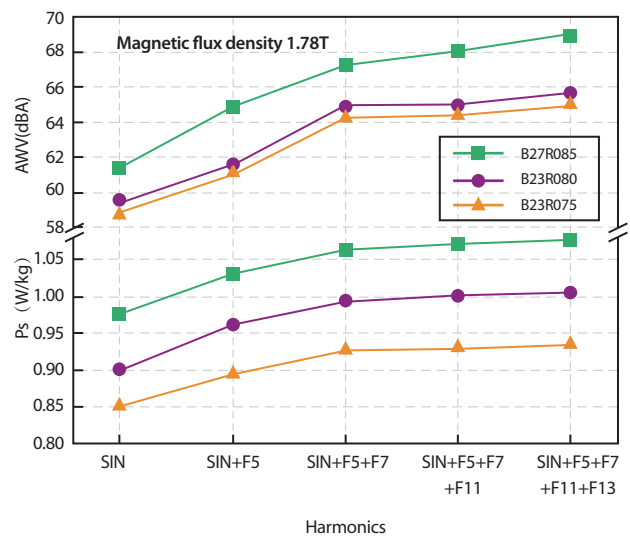
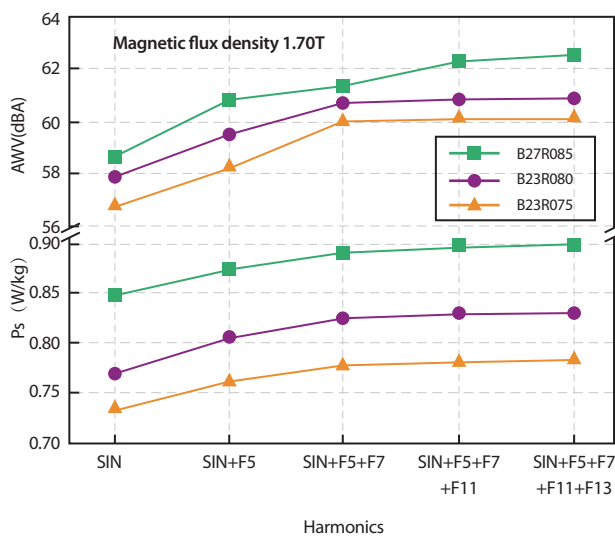


Technical Support in Special Operating Condition

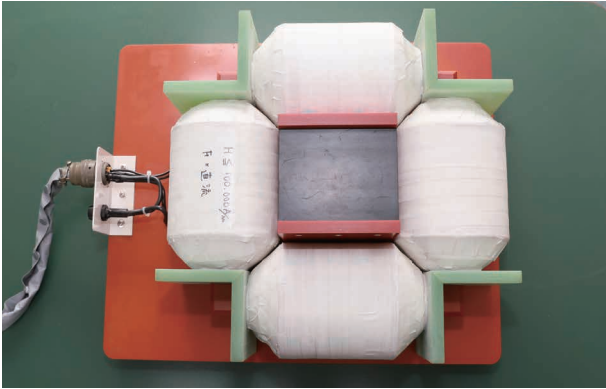
DC Magnetic Bias



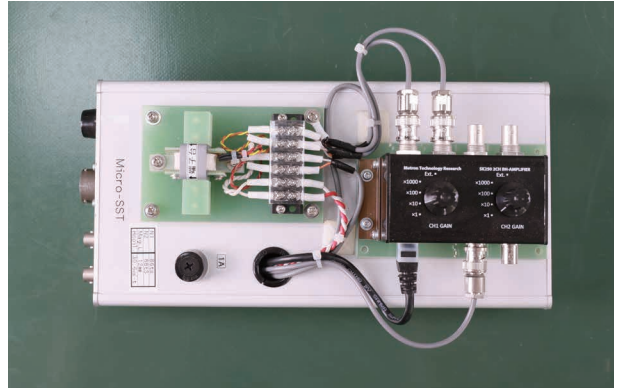
High Order Harmonic



Experimental Research Ability



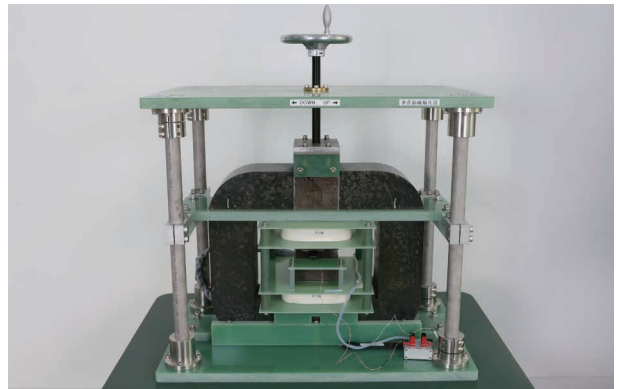
High magnetic field 100kA/m measurement frame



Micro silicon steel measurement frame



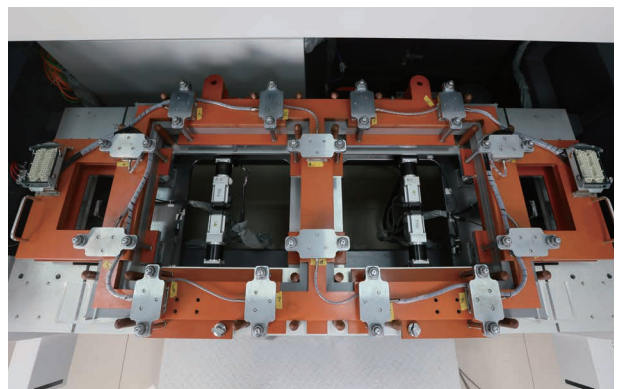
3D laser testing and measurement device



Measurement device for normal performance of silicon steel



Properties test under normal compress stress



Intelligent testing platform for transformer core

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