GH103 飞轮储能实验系统

产品规格书

边缘磁极驱动技术，飞轮储能教学科研平台

□ 产品概述

GH103 飞轮储能实验系统采用 W→A（Wheel-to-Arm）边缘驱动架构，区别于传统轴心驱动模式，电磁力作用于飞轮外缘，力臂较轴心驱动提升 4-8 倍（视飞轮直径而定），可用于模拟大型储能飞轮的外转子电机驱动特性。适用于高校教学演示、科研实验及原型验证。

□ 核心技术

● 驱动方式对比

对比项	传统轴心驱动	GH103 边缘对称驱动
力学模型	T = F × r	$T = F_t \times 2R$
力臂	r（轴半径，小）	2R（飞轮直径，大）
力臂长度	~10-20 mm	200 mm
力矩提升	基准（1×）	4-8 倍

● 技术特点

- 独创边缘驱动：电磁力作用于飞轮外缘，力臂提升 4-8 倍
- 对称力偶布置：8 极均匀分布，形成 4 组对称力偶
- 真实模拟：完美复现大型储能飞轮外转子电机特性

□ 理论公式体系

● 基础动力学方程

公式	表达式	物理意义
转动定律	$\tau = J\alpha$	力矩等于转动惯量乘以角加速度
力矩定义	T = F × R	力矩等于力乘以力臂
GH103 边缘力矩	$T = F_t \times 2R$	切向力乘以直径（力偶臂），力矩提升 4-8 倍

- **电磁驱动方程**

公式	表达式	物理意义
总切向电磁力	$F_t = \eta \times f \times n \times \alpha$	综合气隙、吸力、极数和做功系数的切向驱动力
气隙磁导系数	$\eta = 1/k$	气隙距离倒数，决定磁场耦合强度
输出力矩	$T = F_t \times 2R$	GH103 核心驱动公式

- **运动学方程**

公式	表达式	物理意义
转速-频率关系	$n = 60f / N_{poles} = 60f / 8$	脉冲频率转换为飞轮转速（RPM）
角速度	$\omega = 2\pi n / 60 = \pi f / 4$	转速转换为角速度（rad/s）
储能动能	$E_k = ½J\omega^2 = ½J(2\pi n/60)^2$	飞轮旋转储存的动能（J）

- **能量转换方程**

公式	表达式	物理意义
输入电能	$E_{ele}c = \int_0^T V(t)I(t)dt$	驱动系统消耗的总电能
转换效率	$\eta = E_{kineti}c / E_{ele}c \times 100\%$	电能→动能转换效率
功率关系	$P = dE_k/dt = \tau \cdot \omega$	瞬时功率等于力矩乘以角速度

□ 系统参数

- **电磁驱动系统**

参数	数值	说明
工作电压	DC 12-100V	额定工作电压
单电磁铁吸力	0.5 kgf（4.9 N）	@DC12V，25mm×20mm
每极电磁铁数	2 个	对称布置
磁极总数	8 极	均匀分布于圆周，每极间隔 45°
电磁气隙	0.8 mm	电磁铁与飞轮外缘间隙
气隙磁导系数	1.25 mm^{-1}	$\eta = 1/k$

- **机械结构参数**

参数	数值	说明
飞轮半径 R	100 mm	力臂基准
力偶臂 2R	200 mm	直径，力矩作用臂
电磁铁尺寸	25mm×20mm	单电磁铁外形尺寸

□ 电磁力计算

- **总切向电磁力**

$F_t = \eta \times f \times n \times \alpha$

- **参数定义**

符号	数值	物理意义	单位
η	1.25	气隙磁导系数，η = 1/k	mm^{-1}
k	0.8	电磁气隙距离	mm
f	9.8	每极电磁吸力（等效 1 kgf，2×0.5 kgf）	N
n	8	磁极总数	个
nm	2	每极电磁铁数	个
α	0.5	有效做功系数（p/2，仅半数磁极切向做功）	—

- **计算实例（@DC12V）**

总切向电磁力计算：

$$
\begin{aligned}
F_t &= \eta \times f \times n \times \alpha \\
&= 1.25 \times 9.8 \times 8 \times 0.5 \\
&= 1.25 \times 9.8 \times 4 \\
&= 49\ N
\end{aligned}
$$

输出力矩计算：

$$
\begin{aligned}
T &= F_t \times 2R \\
&= 49\ N \times 0.2\ m \\
&= 9.8\ N\cdot m
\end{aligned}
$$

注： 8 极均匀分布（每极 45°），每极 2 个电磁铁对称布置，共 16 个电磁铁形成 4 组对称力偶。

实验公式速查卡

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┌──────────────────────────────────────┐
│        GH103 实验公式速查卡            │
├──────────────────────────────────────┤
│ 力矩计算    T = Fₜ × 2R = 9.8 N·m      │
│ 惯量计算    J = ½mR² (圆盘模型)         │
│ 动能计算    Eₖ = ½Jω² [J]             │
│ 转速换算    ω = 2πn/60 = 0.1047n [rad/s] │
│ 效率计算    η = Eₖ/∫VIdt × 100%        │
│ PWM 占空比   D = t⁺/(t⁺+t⁻)           │
│ 步进转速    n = 60f/8 [RPM]            │
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八极顺序脉冲驱动

- 8 极磁极周向均匀分布，步进式加速旋转磁场
- 每转 8 步，步进角 45°，运转平稳低振动
- 频率 10-400Hz 无级调节，转速精准可控

技术参数

机械系统

参数	规格	说明
飞轮直径	φ200 mm	高强度铝合金，动平衡 G2.5 级
砝码配重系统	5kg + 3kg + 2kg	模块化组合，惯量 0.025-0.25 kg·m²可调
磁极配置	单级 8 极	调压式电磁线圈，φ25mm
杠杆作用角	45°（π/4）	优化力矩传递效率
气隙调节	0.2-2 mm	适应不同实验需求
整机尺寸	600×600×400 mm	实验室桌面型设计
整机重量	约 380 kg	稳固防振底座

- **电气驱动**

参数	规格	说明
驱动电压	DC 12-100 V	宽范围可调，适配多种电源
脉冲频率	10-400 Hz	对应转速 75-3000 RPM（n = 60f/8）
正脉宽	1-20 ms	能量注入时间可调
负脉宽	1 ms	固定续流/制动
峰值功率	1.5 kW	满足加速与稳态需求
输入电源	AC 100-240V	宽电压全球通用

- **运动性能**

参数	规格	说明
转速范围	10-3000 RPM	覆盖低速调试到高速储能
额定转速	600 RPM	标准教学工况（f = 80Hz）
最大线速度	31.4 m/s	3000 RPM 时边缘线速度（v = ωR）
角速度	1.05-314 rad/s	宽范围动态响应
角加速度	0.02-2 rad/s^2	精密加速控制（α = τ/J）
启动时间	<5 s（0-600 RPM）	快速建立实验条件

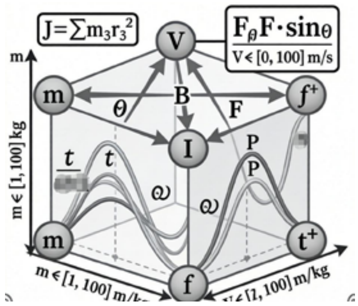
- **测控系统**

参数	规格	说明
转速检测	霍尔传感器+磁锥	8 脉冲/转，非接触测量
波形分析	Tektronix TDS7404B	100MHz，四通道实时观测
电气测量	HAMEG HM1507-3	电压/电流/频率/占空比
转速显示	4 位 LED 数码管	直观 RPM 读数
安全防护	GH19C 智能系统	过速/过流/过热/振动/位移五重保护

◻ 十维实验变量

序号	变量名称	符号	调节范围	实验意义	关联公式
1	配重质量	m	2–10 kg	转动惯量 J 调节	$J = \sum m_i r_i^2$
2	电磁力	F	0–500 N	驱动力矩 T = F·R	T = F·R
3	驱动电压	V	12–100 V	控制励磁电流	V = IR + L(dI/dt)
4	驱动电流	I	0–15 A	电磁力激励源	F ∝ B ∝ I
5	脉冲频率	f	10–400 Hz	转速设定	n = 60f/8
6	正脉宽	t^+	1–20 ms	能量注入时长	$E_{pulse} = VIt^+$
7	角加速度	α	实测值	动态响应输出	α = τ/J
8	磁场位移偏角	θ	±7–13.5°	最优作用角度	$F_t = F \cdot \sin\theta$
9	磁感应强度	B	0–1.2 T	与电流成正比	$B = \mu_0 \mu_r NI/l_g$
10	飞轮相位	(x,y)	$[0,2\pi]^2$	状态空间变量	$\dot{x} = Ax + Bu$

◻ 核心实验功能



● 基础物理实验

- 转动定律验证：τ = Jα，力矩-角加速度线性关系
- 惯量测定实验：$J = \sum m_i r_i^2$，对比理论计算与实测值
- 能量守恒演示：$E_{ele}C$ → E_k → $E_{ele}C$ 转换效率分析

● 电机驱动实验

- 开关磁阻电机原理：8 极顺序同相机制，n = 60f/8
- 机械特性曲线：转速-转矩-效率三维关系
- PWM 控制技术：$D = t^+/(t^+ + t^-)$，脉宽调制与占空比优化

● 储能系统实验

- 充放电循环：$\eta = E_k / \int VI dt$，能量存储与释放效率分析
- 动态响应测试：阶跃/斜坡/扰动响应，α = dω/dt
- 制动能量回收：能耗制动与反接制动对比

- **高级研究实验**

- 多变量耦合分析：十维参数正交实验设计
- 边缘驱动优化：气隙/角度/频率协同优化
- 模型辨识与验证：理论数学建模与实验对比

□ 适用对象

用户类型	应用场景	价值体现
高等院校	物理/电气/能源专业实验教学	填补飞轮储能实验设备空白，理论结合实践
职业院校	新能源技术实训	掌握储能系统装调与维护技能
科研院所	飞轮储能机理与控制研究	提供可重复的精密实验平台
企业研发	电机驱动与能量管理预研	低成本验证创新方案可行性

□ 产品优势

对比项	传统实验装置	GH103
驱动方式	轴心电机驱动	边缘磁极驱动，$T = F_t \times 2R$，力矩大 4-8 倍
参数调节	固定参数，实验单一	十维可调，实验设计灵活
测量手段	机械式/简易电子	霍尔传感+数字示波器，精密采集
安全防护	基础保护	GH19C 五重智能保护，安全可靠
扩展能力	封闭结构	模块化设计，支持多级扩展与真空升级
理论支撑	无系统公式体系	完整公式体系，教学科研一体化

□ 标准配置

- ✓ GH103 主机（飞轮转子、8 极驱动、控制系统、防护罩）
- ✓ 配重块组（飞轮砣：5kg×1、3kg×1、2kg×1，带快速锁紧机构）
- ✓ 泰克 TDS7404B 数字示波器（100MHz，四通道）
- ✓ HAMEG HM1507-3 多功能测量仪
- ✓ 霍尔传感器套件（8 组，含磁锥）
- ✓ 电气连接线束（电源线、信号线、BNC 线）
- ✓ 操作手册（含实验指导与理论推导）
- ✓ 出厂检验证书与质保卡

□ 可选扩展

选项	功能描述	应用场景
真空腔体套件	不锈钢真空罩+真空泵，真空度≤100Pa	高速低风阻实验，风损机理研究
二级扩展模块	增加 8 极磁极，16 极配置	高分辨率步进驱动，微振动分析
数据采集系统	16 位 USB-DAQ，4 通道同步，配套软件	自动化实验记录，大数据量采集
温度监测模块	8 路 PT100 温度传感器，磁极热管理	长时间运行热特性研究，效率优化
陶瓷轴承升级	高速轴承，支持 5000 RPM 扩展	超高速储能实验，极限性能测试

□ 服务承诺

服务项目	内容
质保期	整机 1 年，控制器及驱动器 3 年
安装调试	免费上门安装、调试、操作培训
技术支持	7×24 小时电话支持，远程诊断，现场服务
软件升级	控制算法持续优化，终身免费升级
定制开发	根据特殊需求定制参数、开发专属实验方案

□ 技术规格速查表

关键指标	数值
飞轮直径	200 mm
转速范围	10-3000 RPM
驱动电压	12-100 V
峰值功率	1.5 kW
转动惯量	0.025-0.25 kg·m^2
角加速度	0.02-2 rad/s^2
整机重量	~380 kg
防护等级	IP20

□ 联系我们

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GH103 飞轮储能实验系统——让抽象的储能理论，化为直观的实验数据。边缘磁极驱动，助力储能教学实践。

GH103 Flywheel Energy Storage Experimental System Product Specification

Edge Magnetic Pole Drive Technology | Flywheel Energy Storage Teaching & Research Platform

□ Product Overview

The GH103 flywheel energy storage experimental system adopts a W→A (Wheel-to-Arm) edge drive architecture, which differs from the traditional shaft-center drive mode. Electromagnetic force acts on the outer edge of the flywheel, and the moment arm is increased by 4-8 times compared to shaft-center drive (depending on flywheel diameter). It can be used to simulate the outer-rotor motor drive characteristics of large-scale energy storage flywheels. Suitable for university teaching demonstrations, scientific research experiments, and prototype validation..

□ Core Technology

● Drive Mode Comparison

Comparison Item	Traditional Shaft-Center Drive	GH103 Edge Symmetric Drive
Mechanical Model	$T = F \times r$	$T = F_t \times 2R$
Lever Arm	r (shaft radius, small)	2R (flywheel diameter, large)
Lever Arm Length	~10-20 mm	200 mm
Torque Enhancement	Baseline (1×)	4-8×

● Technical Features

● Proprietary Edge Drive: Electromagnetic force acts on flywheel outer rim, lever arm increased 4-8×
● Symmetric Couple Arrangement: 8 poles uniformly distributed, forming 4 symmetric couples
● Authentic Simulation: Perfectly reproduces outer-rotor motor characteristics of large-scale energy storage flywheels

□Theoretical Formula System

● Basic Dynamic Equations

Formula Name	Expression	Physical Meaning
Law of Rotation	$\tau = J\alpha$	Torque equals moment of inertia times angular acceleration
Torque Definition	$T = F \times R$	Torque equals force times lever arm
GH103 Edge Torque	$T = F_t \times 2R$	Tangential force times diameter (couple arm), torque enhanced 4-8×

● Electromagnetic Drive Equations

Formula Name	Expression	Physical Meaning
TotalTangential Electromagnetic Force	$F_t = \eta \times f \times n \times \alpha$	Combined air gap, suction force, pole count and work coefficient for tangential drive force
Air Gap Permeance Coefficient	$\eta = 1/k$	Reciprocal of air gap distance, determines magnetic coupling strength
Output Torque	$T = F_t \times 2R$	GH103 core drive formula

● Kinematic Equations

Formula Name	Expression	Physical Meaning
Speed-Frequency Relation	$n = 60f / N_{poles} = 60f / 8$	Converts pulse frequency to flywheel speed (RPM)
Angular Velocity	$\omega = 2\pi n / 60 = \pi f / 4$	Converts speed to angular velocity (rad/s)
Stored Kinetic Energy	$E_k = ½J\omega^2 = ½J(2\pi n/60)^2$	Kinetic energy stored in flywheel rotation (J)

● Energy Conversion Equations

Formula Name	Expression	Physical Meaning
Input Electrical Energy	$E_{ele}c = \int_0^T V(t)I(t)dt$	Total electrical energy consumed by drive system
Conversion Efficiency	$\eta = E_{kineti}c / E_{ele}c \times 100\%$	Electrical-to-kinetic energy conversion efficiency
Power Relation	$P = dE_k/dt = \tau \cdot \omega$	Instantaneous power equals torque times angular velocity

□ System Parameters

● ectromagnetic Drive System

ameter	Value	Description
Operating Voltage	DC 12-100V	Rated operating voltage
Single Electromagnet Suction Force	0.5 kgf（4.9 N）	@DC12V， 25mm×20mm
Electromagnets per Pole	2 pcs	Symmetric arrangement
Total Pole Count	8 poles	Uniformly distributed, 45° interval
Electromagnetic Air Gap	0.8 mm	Gap between electromagnet and flywheel outer rim
Air Gap Permeance Coefficient	1.25 mm^{-1}	$\eta = 1/k$

● Mechanical Structure Parameters

Parameter	Value	Description
Flywheel Radius R	100 mm	Lever arm reference
Couple Arm 2R	200 mm	Diameter, torque action arm
Electromagnet Dimensions	25mm×20mm	Single electromagnet outline dimensions

□ Electromagnetic Force Calculation

● Total Tangential Electromagnetic Force

$$F_t = \eta \times f \times n \times \alpha$$

● Parameter Definitions

Symbol	Value	Physical Meaning	Unit
η	1.25	Air gap permeance coefficient, η = 1/k	mm^{-1}
k	0.8	Electromagnetic air gap distance	mm
f	9.8	Electromagnetic suction force per pole (equivalent to 1 kgf, 2×0.5 kgf)	N
n	8	Total number of magnetic poles	pcs
nm	2	Number of electromagnets per pole	pcs
α	0.5	Effective work coefficient (p/2, only half poles work tangentially)	—

● (@DC12V) / Calculation Example (@DC12V)

Total Tangential Electromagnetic Force Calculation:

$$\begin{aligned} F_t &= \eta \times f \times n \times \alpha \\ &= 1.25 \times 9.8 \times 8 \times 0.5 \\ &= 1.25 \times 9.8 \times 4 \\ &= 49\ \text{N} \end{aligned}$$

Output Torque Calculation:：

$$\begin{aligned} T &= F_t \times 2R \\ &= 49\ \text{N} \times 0.2\ \text{m} \\ &= 9.8\ \text{N·m} \end{aligned}$$

Note: 8 poles uniformly distributed (45° per pole), 2 electromagnets per pole in symmetric arrangement, 16 electromagnets total forming 4 symmetric couples.

□ Experimental Formula Quick Reference Card

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┌─────────────────────────────────────────────┐
│  GH103 Experimental Formula  Quick Reference Card  │
├─────────────────────────────────────────────┤
│ Torque Calculation     T = Fₜ × 2R = 9.8 N·m     │
│ Inertia Calculation     J = ½mR² (Disk Model)      │
│ Kinetic Energy Calculation     Eₖ = ½Jω² [J]      │
│ Speed Conversion     ω = 2πn/60 = 0.1047n [rad/s] │
│ Efficiency Calculation     η = Eₖ/∫VIdt × 100%     │
│ PWM Duty Cycle     D = t⁺/(t⁺+t⁻)     │
│ Step Speed     n = 60f/8 [RPM]     │
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□ Eight-Pole Sequential Pulse Drive

- 8 magnetic poles uniformly distributed circumferentially, stepwise accelerating rotating magnetic field
- 8 steps per revolution, step angle 45°, smooth operation with low vibration
- Frequency 10-400Hz stepless adjustment, precise speed control

□ Technical Parameters

● Mechanical System

Parameter	Specification	Description
Flywheel Diameter	φ200 mm	High-strength aluminum alloy, dynamic balance G2.5
Weight Code System	5kg + 3kg + 2kg	Modular combination, inertia 0.025-0.25 kg·m² adjustable
Pole Configuration	Single stage 8 poles	Voltage-adjustable electromagnetic coil, φ25mm
Lever Action Angle	45° (π/4)	Optimized torque transfer efficiency
Air Gap Adjustment	0.2-2 mm	Adaptable to different experimental requirements
Overall Dimensions	600 × 600 × 400 mm	Laboratory desktop design
Overall Weight	~380 kg	Stable anti-vibration base

● Electrical Drive

Parameter	Specification	Description
Drive Voltage	DC 12-100 V	Wide range adjustable, adaptable to multiple power sources
Drive Voltage	10-400 Hz	Corresponding speed 75-3000 RPM (n = 60f/8)
Positive Pulse Width	1-20 ms	Energy injection time adjustable
Negative Pulse Width	1 ms	Fixed freewheeling/braking
Peak Power	1.5 kW	Meets acceleration and steady-state requirements
Input Power	AC 100-240V	Wide voltage, global universal

● Motion Performance

Parameter	Specification	Description
Speed Range	10-3000 RPM	Covers low-speed debugging to high-speed energy storage
Rated Speed	600 RPM	Standard teaching condition (f = 80Hz)
Maximum Linear Velocity	31.4 m/s	Edge linear velocity at 3000 RPM ($v = \omega R$)
Angular Velocity	1.05-314 rad/s	Wide range dynamic response
Angular Acceleration	0.02-2 rad/s^2	Precision acceleration control ($\alpha = \tau/J$)
Start-up Time	<8s（0-600 RPM）	Rapid experimental condition establishment

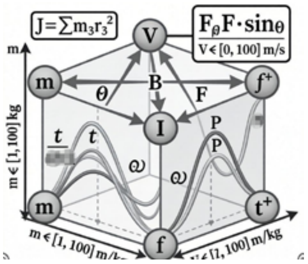
● Measurement & Control System

Parameter	Specification	Description
Speed Detection	Hall sensor + magnetic cone	8 pulses/revolution, non-contact measurement
Waveform Analysis	Tektronix TDS7404B	100MHz, 4-channel real-time observation
Electrical Measurement	HAMEG HM1507-3	Voltage/current/frequency/duty cycle
Speed Display	4-digit LED display	Intuitive RPM reading
Safety Protection	GH19C Intelligent System	Five-fold protection: overspeed/overcurrent/overheat/vibration/displacement

□ Ten-Dimensional Experimental Variables

No.	Variable Name	Symbol	Adjustment Range	Experimental Significance	Related Formula
1	Counterweight Mass	m	2–10 kg	Moment of inertia J adjustment	$J = \sum m_i r_i^2$
2	Electromagnetic Force	F	0–500 N	Drive torque T = F·R	$T = F \cdot R$
3	Drive Voltage	V	12–100 V	Control excitation current	$V = IR + L(dI/dt)$
4	Drive Current	I	0–15 A	Electromagnetic force excitation source	$F \propto B \propto I$
5	Pulse Frequency	f	10–400 Hz	Speed setting	$n = 60f/8$
6	Positive Pulse Width	t^+	1–20 ms	Energy injection duration	$E_{pulse} = VIt^+$
7	Angular Acceleration	α	Measured value	Dynamic response output	$\alpha = \tau/J$
8	Magnetic Field Displacement Angle	θ	±7–13.5°	Optimal action angle	$F_t = F \cdot \sin\theta$
9	Magnetic Induction Intensity	B	0–1.2 T	Proportional to current	$B = \mu_0 \mu_r NI/l_9$
10	Flywheel Phase	(x,y)	$[0,2\pi]^2$	State space variable	$\dot{x} = Ax + Bu$

□ Core Experimental Functions



- **Basic Physics Experiments**

- Law of Rotation Verification: $\tau = J\alpha$, linear torque-angular acceleration relationship
- Inertia Measurement Experiment: $J = \sum m_i r_i^2$, compare theoretical calculation with measured values
- Energy Conservation Demonstration: $E_{ele}c \rightarrow E_k \rightarrow E_{ele}c$ conversion efficiency analysis

- **Motor Drive Experiments**

- Switched Reluctance Motor Principle: 8-pole sequential in-phase mechanism, $n = 60f/8$
- Mechanical Characteristic Curves: Speed-torque-efficiency three-dimensional relationship
- PWM Control Technology: $D = t^+/(t^+ + t^-)$, pulse width modulation and duty cycle optimization

- **Energy Storage System Experiments**

- Charge-Discharge Cycles: $\eta = E_k/\int VIdt$, energy storage and release efficiency analysis
- Dynamic Response Testing: Step/ramp/disturbance response, $\alpha = d\omega/dt$
- Braking Energy Recovery: Comparison of dissipative braking and plug braking

● Advanced Research Experiments

- Multivariable Coupling Analysis: Ten-dimensional parameter orthogonal experimental design
- Edge Drive Optimization: Air gap/angle/frequency collaborative optimization
- Model Identification and Validation: Theoretical mathematical modeling vs. experimental comparison

□ Target Users

User Type	Application Scenario	Value Proposition
Universities	Physics/Electrical/Energy major experimental teaching	Fills the gap in flywheel energy storage experimental equipment, integrating theory with practice
Vocational Colleges	New energy technology practical training	Master energy storage system installation, commissioning and maintenance skills
Research Institutes	Flywheel energy storage mechanism and control research	Provides a repeatable precision experimental platform
Enterprise R&D	Motor drive and energy management pre-research	Low-cost validation of innovative solution feasibility

□ Product Advantages

Comparison Item	raditional Experimental Equipment	GH103
Drive Mode	Shaft-center motor drive	Edge magnetic pole drive, $T = F_t \times 2R$, torque enhanced 4-8×
Parameter Adjustment	Fixed parameters, single experiment	Ten-dimensional adjustable, flexible experimental design
Measurement Means	Mechanical/simple electronic	Hall sensor + digital oscilloscope, precision acquisition
Safety Protection	Basic protection	GH19C five-fold intelligent protection, safe and reliable
Expansion Capability	Closed structure	Modular design, supports multi-level expansion and vacuum upgrade
Theoretical Support	No systematic formula system	Complete formula system, integrated teaching and research

□ Standard Configuration

✓ GH103 Main Unit (flywheel rotor, 8-pole drive, control system, protective cover)
✓ Counterweight Set (flywheel weights: 5kg×1, 3kg×1, 2kg×1, with quick-lock mechanism)
✓ Tektronix TDS7404B Digital Oscilloscope (100MHz, 4-channel)
✓ HAMEG HM1507-3 Multifunction Measuring Instrument
✓ Hall Sensor Kit (8 sets, including magnetic cones)
✓ Electrical Connection Harness (power lines, signal lines, BNC cables)
✓ Operation Manual (including experimental guidance and theoretical derivation)
✓ Factory Inspection Certificate and Warranty Card

□ Optional Extensions

Option	Function Description	Application Scenario
Vacuum Chamber Kit	≤100Pa / Stainless steel vacuum cover + vacuum pump, vacuum ≤100Pa	High-speed low wind resistance experiments, wind loss mechanism research
Secondary Expansion Module	Add 8 magnetic poles, 16-pole configuration	High-resolution step drive, micro-vibration analysis
Data Acquisition System	16-bit USB-DAQ, 4-channel synchronization, supporting software	Automated experimental recording, large data volume acquisition
Temperature Monitoring Module	8-channel PT100 temperature sensors, magnetic pole thermal management	Long-term operation thermal characteristics research, efficiency optimization
Ceramic Bearing Upgrade	High-speed bearings, supports 5000 RPM expansion	Ultra-high-speed energy storage experiments, limit performance testing

□ Service Commitment

Service Item	Content
Warranty Period	1 year for complete machine, 3 years for controller and driver
Installation & Commissioning	Free on-site installation, commissioning, and operation training
Technical Support	7×24 hour telephone support, remote diagnosis, on-site service
Software Upgrade	Continuous optimization of control algorithms, lifetime free upgrades
Custom Development	Customize parameters according to special requirements, develop exclusive experimental solutions

□ Technical Specification Quick Reference

Key Indicator	Value
Flywheel Diameter	200 mm
Speed Range	10-3000 RPM
Drive Voltage	12-100 V
Peak Power	1.5 kW
Moment of Inertia	0.025-0.25 kg·m^2
Angular Acceleration	0.02-2 rad/s^2
Overall Weight	~380 kg
Protection Grade	IP20

□ Contact Us

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GH103 Flywheel Energy Storage Experimental System — Transforming abstract energy storage theory into intuitive experimental data. Edge magnetic pole drive, empowering energy storage teaching practice.