



Technical White Paper on Reluctance Motor Drive Systems

Next-Generation Industrial Drive Solutions: High Efficiency, Intelligence, and Reliability

1. Introduction

Driven by the global acceleration of the "dual carbon" (carbon peak and carbon neutrality) strategy and the ongoing industrial intelligent transformation, motor systems featuring high energy efficiency, low maintenance, and strong adaptability have become critical enablers of industrial upgrading.

Although traditional induction motors and permanent magnet synchronous motors (PMSMs) are widely used, they still face challenges in complex operating conditions — such as frequent start-stop cycles and low-speed operation — including reduced efficiency, high costs, and insufficient reliability.

Dongying Jingtao Energy Technology Co., Ltd. ("Jingtao Energy") has leveraged over a decade of core technology R&D to successfully develop and commercialize both Switched Reluctance Motor (SRM) and Synchronous Reluctance Motor (SynRM) drive systems. These systems overcome historical technical bottlenecks of reluctance motors — particularly in noise, vibration, and control precision — achieving IE5 ultra-premium efficiency, >15% average energy savings, and large-scale field validation across demanding sectors including oilfields, mining, and chemical processing.

This white paper systematically outlines the core technical principles, performance advantages, typical application scenarios,



and verified benefits of Jingtao Energy's reluctance motor drive systems, offering industrial users a reference for next-generation green and intelligent drive solutions.

2. Technical Principles and System Architecture

2.1 Switched Reluctance Motor (SRM) System

Working Principle:

Based on the physical principle that “magnetic flux follows the path of least reluctance,” the SRM generates torque by sequentially energizing stator windings to create magnetic attraction that pulls the rotor into alignment. The motor contains no permanent magnets, no rotor windings, and no mechanical commutator.

System Composition:

Comprises the motor body and a fully digital intelligent controller, using a DSP chip to implement four-dimensional closed-loop servo control over speed, position, current, and torque.

Core Innovations:

- Proprietary amorphous alloy stator core material that significantly reduces iron losses.
- Instantaneous torque control algorithm that suppresses torque ripple, markedly lowering noise and vibration.
- High fault tolerance: Capable of safe operation under single-phase failure or 120% overload conditions.

2.2 Synchronous Reluctance Motor (SynRM) System

Working Principle:

Utilizes the saliency (reluctance difference) of a specially designed rotor structure to generate reluctance torque, enabling



synchronous operation. The rotor contains no conductors or permanent magnets.

Advantages vs. Alternatives:

- Compared to induction motors: Eliminates rotor copper losses, improving efficiency by 3 – 8 percentage points and reducing temperature rise by $>15^{\circ}\text{C}$.
- Compared to PMSMs: No risk of demagnetization; $>30\%$ lower cost; suitable for high-temperature, high-humidity, and high-vibration environments.
- Wider high-efficiency operating range, delivering superior energy savings under light-load or variable-load conditions.

3. Key Performance Specifications

Parameter	Switched Reluctance (SRM)	Synchronous Reluctance (SynRM)
Efficiency Class	IE5 (Ultra-Premium)	IE4–IE5
Speed Range	50–3500 rpm (continuous)	Full-speed high efficiency
Starting Torque	$\geq 200\%$ rated torque	$\geq 150\%$ rated torque
Starting Current	$\leq 30\%$ rated current	$\leq 50\%$ rated current
Power Factor	≥ 0.95 (across all loads)	≥ 0.90
Protection Rating	IP54–IP55	IP55
Explosion Protection	Ex d IIC T4 / Ex tb IIIC T130°C Db (optional)	Optional
Control Precision	Speed error ± 1.5 rpm; steady-state accuracy 0.15%	Encoder-supported closed-loop servo



4. Typical Applications and Verified Benefits

4.1 Oilfield Production

Equipment: Beam pumping units, belt-driven pump jacks, progressive cavity pumps, water injection pumps

Technical Fit:

- Perfectly matches the “slow downstroke, fast upstroke” operational profile, enhancing pump efficiency.
- Maintains high efficiency at low speeds—solving the inefficiency issues of conventional VFD-driven motors.
- Eliminates need for reactive power compensation, simplifying power distribution.

Measured Energy Savings:

- PetroChina Changqing Oilfield: **23.68%**
- Sinopec Shengli Oilfield (semi-direct-drive): **28%**
- Huabei Oilfield water injection pumps: **14.08%**

Case Highlight:

When integrated with Jingtao Energy’ s Digital Smart Oil Production System, AI-based autonomous optimization delivered an additional 14.65% energy saving, reducing kWh per ton of fluid by 16%—even on top of already optimized production regimes.

4.2 Mining Operations

Equipment: Mine locomotives, endless rope haulage systems, flotation cells, conveyors

Key Advantages:



- High starting torque ($2.5 \times$ rated) enables easy heavy-load starts.
- Brushless, winding-free rotor ensures intrinsic safety in explosive atmospheres.
- Supports regenerative braking and grid feedback during downhill operation.

Field Results:

- Shandong Energy mine locomotive: 30% lower no-load current, zero failures after one year of operation.
- Luoyang Baohuashan flotation cell: 31.26% energy savings with simultaneous productivity gains.

4.3 Other Industrial Applications

- **Chemical Industry:** Agitators, centrifugal compressors — corrosion-resistant, maintenance-free.
- **Rubber Processing:** Mixing mills, calenders — rapid response for frequent forward/reverse cycling.
- **New Energy Vehicles:** Electric trucks, forklifts — extended range due to wide high-efficiency zone; no demagnetization risk.
- **Smart Appliances & Robotics:** Compact size, high responsiveness, low noise.

5. Digital Enablement: Smart Oil Production & Remote Operations

Jingtao Energy's Digital Smart Oil Production System integrates three key modules:

- **Intelligent Monitoring Module:** Real-time acquisition of load, displacement, oil pressure, temperature, and more.
- **Control Unit Module:** Edge computing + AI models for automatic condition diagnosis and stroke rate optimization.
- **Analytics Module:** Cloud-synchronized data generation of soft dynamometer cards, replacing traditional mechanical sensors.



Key Features:

- Remote parameter adjustment and start/stop control via mobile app.
- Vision AI for real-time detection of unsafe personnel behavior with active alerts.
- Cabinet self-diagnostics (temperature, humidity, water ingress, door status).
- Supports IPv6 and containerized deployment, meeting industrial cybersecurity standards.

6. Conclusion and Outlook

Jingtao Energy's reluctance motor drive systems—anchored in high efficiency, high reliability, low lifecycle cost, and intelligent integration—are redefining the landscape of industrial drives. Their proven stability in extreme conditions, economic advantages over the full asset lifecycle, and seamless compatibility with Industrial IoT make them an ideal choice for realizing “smart manufacturing” and “green factories.”

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