
FLUXWORX: THE ERA OF ACTIVE MAGNETIC CONTROL

From Static Iron to Dynamic Reluctance: The "Transistor Moment" for Energy

Executive Summary

For the last 70 years, the world of electronics has followed Moore's Law, becoming exponentially smaller, faster, and more efficient. The world of power magnetics has advanced more slowly, remaining heavily dependent on fixed geometry, material limits, and control-by-current approaches.. We still manage magnetic flux using the same "Brute Force" principles established in the 19th century: heavy iron cores, massive copper windings, and rare-earth materials.

FluxWorx introduces the **Magnetic Transistor**, a fundamental shift in how we interact with the electromagnetic force. By moving from **Passive Magnetics** (fixed geometry) to **Active Magnetics** (dynamic reluctance modulation), we enable a new class of motors, transformers, and power systems.

This architecture decouples performance from mass. It allows for the creation of rare-earth-free motors that close the performance gap with permanent-magnet machines, DC power systems with improved fault-management behaviour, and magnetic-state computing architectures with improved radiation resilience.. FluxWorx is not just an incremental improvement; it is the digitization of the magnetic field.

FluxWorx has completed Australian provisional filings and lodged its international PCT patent application covering Differential Flux Steering and related Magnetic Transistor architectures.

The Problem: The Stagnation of a Force

Modern energy systems are limited by the physical properties of "Hard" Magnetics.

- **The Saturation Ceiling:** Iron cores have a fixed capacity for flux. Once saturated, they behave like air, causing massive inrush currents and efficiency losses.
- **The Back-EMF Wall:** In motors, magnetic fields are "always on." At high speeds, these fields generate opposing voltage that fights the battery, killing range and generating heat.
- **The "Brute Force" Control Loop:** To change a magnetic field today, we apply an opposing current. This "fighting" approach creates heat, requires heavy shielding, and generates Electromagnetic Interference (EMI).

We have spent a century refining the materials (better steel, purer copper) but we have never changed the fundamental architecture. In many high-power systems, we are still relying on passive magnetic structures in an age that increasingly demands active, software-defined control

The Core Technology: The Magnetic Transistor

FluxWorx replaces control-by-opposition with active magnetic-state control.

At the heart of our IP is the ability to modulate the **Reluctance** (magnetic resistance) of a flux path in real-time. Just as a silicon transistor uses a small control current to steer a large flow of electrons, the FluxWorx architecture uses a comparatively small control input to influence a much larger magnetic operating condition.

The Mechanism: Active Reluctance Modulation

By actively biasing selected regions of a coupled magnetic structure, DFS changes the effective reluctance/permeance distribution and reshapes how flux density is distributed. This allows us to:

1. **Steer Flux:** Guide magnetic operating conditions toward the desired working region on demand.
2. **Shape Waves:** Shape magnetic transitions to reduce abrupt waveform behaviour, torque ripple, acoustic noise, and EMI-sensitive edges.
3. **Clamp Surges:** Rapidly shift magnetic operating conditions to limit energy transfer during the early stages of a fault.

This is a "High Gain" system. A few watts of control power can steer a much larger main-field operating condition, with the exact control ratio depending on geometry, material selection, and application.

Vertical 1: Mobility & Motion (The EV Revolution)

The electric vehicle market is currently trapped by a reliance on Neodymium (Rare Earth) magnets and the trade-off between torque and highway efficiency.

3.1. The Smart Switched-Reluctance Motor (SRM)

Standard SRMs are cheap and robust (no magnets) but suffer from violent torque ripple and noise. FluxWorx uses active flux shaping to "round off" the magnetic edges. DFS targets smoother, quieter SRM operation while retaining the steel-and-copper advantages of reluctance machines.

- **Impact:** Eliminates geopolitical supply chain risk; can reduce Bill of Materials (BOM) cost by up to 30%.

3.2. Geometric Field Weakening

To drive at highway speeds, standard EVs burn energy injecting negative current to fight their own magnets. FluxWorx motor architectures aim to dynamically reshape magnetic loading at high speeds, reducing reliance on wasteful counter-current field weakening.

- **Impact:** Increases highway range without increasing battery size; reduces thermal load on the inverter.

3.3. Wireless Power Transfer

DFS may support future wireless power-transfer research by improving control over coupling conditions and reducing leakage-field behaviour. By increasing the coupling coefficient via reluctance steering, we minimize leakage flux.

- **Impact:** Potentially supports safer, better-contained high-power wireless charging architectures, subject to standards compliance and application-specific testing.

Vertical 2: Infrastructure & The Grid

As the world electrifies (AI Data Centers, DC Microgrids), the stability of power delivery is threatened by inrush currents and fault arcs.

4.1. Ultra-Fast DC Fault Protection

DC grids are prone to uncontrollable plasma arcs. FluxWorx modules act as a "magnetic-layer fault-control mechanism." In a fault condition, the device instantly biases the reluctance to reducing peak energy transfer during fault onset and improving coordination with electronic protection systems.

- **Impact:** Enables safe residential and industrial DC grids; should replace massive mechanical breakers.

4.2. Soft-Start Transformers

Energizing a large transformer causes a "Magnetic Hammer" effect (Inrush Current) that stresses the grid. FluxWorx allows for a "Soft Magnetic Start," ramping up the internal flux density linearly.

- **Impact:** Extends asset life; eliminates voltage sags/brownouts in data centers.

4.3. The AI Power Crunch

Power conversion for AI chips generates massive heat due to high-frequency switching losses. FluxWorx enables "Soft Switching" by steering flux away from the core during the transition, bypassing the hysteresis penalty.

- **Impact:** Reduces cooling costs; improves PUE (Power Usage Effectiveness) in hyperscale data centers.
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Vertical 3: The Edge (Space & Defense)

In environments where silicon fails, magnetics survive.

5.1. Radiation-Hardened Logic

Standard silicon chips store data as Charge, which is easily corrupted by cosmic radiation (Single Event Upsets). FluxWorx logic gates explore magnetic-state representation rather than conventional charge-storage dependence.

- **Impact:** Computing systems for Space, Nuclear, and Defense applications that should offer improved resilience in radiation, EMP, and high-EMI environments, depending on implementation and system design.

5.2. Linear Actuators for Robotics

We linearize the force curve of solenoids. Instead of the force dropping off exponentially with distance, we modulate the reluctance to maintain constant force throughout the stroke.

- **Impact:** Should enable smoother force control and reduced sensing burden in selected actuator designs.
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The Economic Thesis: Dematerialization

FluxWorx aims to extract more useful performance from magnetic systems through control, rather than simply adding more material.

1. **Material Substitution:** We replace expensive, price-volatile materials (Neodymium, heavy copper shielding) with cheap, abundant materials (Steel, Aluminum) + Control IP.
 2. **Asset Utilization:** By reducing unwanted flux behaviour, thermal stress, and dynamic losses, we allow smaller transformers and motors to do the work of larger ones.
 3. **Lifecycle Cost:** By eliminating mechanical stress (torque ripple, inrush shock), we can improve equipment lifetime and reliability margins, (subject to application-specific testing).
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Conclusion

We are standing at the threshold of the **Magnetic Age**. Just as the semiconductor transistor allowed us to manipulate information with unprecedented precision, the Magnetic Transistor allows us to manipulate energy with unprecedented control.

FluxWorx is not a component manufacturer. We are developing a new magnetic control primitive. From the traction motor in an EV to the logic gate in a satellite, we are proving that the best way to handle power is not to fight it, but to steer it.

www.fluxworx.org