# EDDY DRIVEN VALVE

ULTRA-FAST, HIGH-PRESSURE, EDDY CURRENT DRIVEN GAS VALVE

**TECHNICAL SPECIFICATION**

## SYSTEM OVERVIEW

The **Eddy Driven Valve (EDV)** is a high-speed, high-pressure gas valve designed for rapid delivery of compressed gases in fusion research, high-field laboratory environments, and fast gas-puff diagnostics.
It uses an **eddy-current electromagnetic actuator** to achieve **millisecond-scale opening**, enabling controlled release of gas from a **150 bar**, **1000 cm³** reservoir.

The design emphasises:

- repeatability,
- durability under mechanical, magnetic and radiation load,
- and wide gas compatibility.

The EDV is not operational on its own; it requires an external high-voltage driver (recommended: **CEFusion EddyDriver©**).

## FUNCTIONAL DESCRIPTION

### ACTUATION PRINCIPLE

The actuator consists of:

- a **primary coil** driven by high-voltage capacitor discharge,
- a **conductive secondary ring** rigidly connected to the piston assembly,
- and a **spring-based return mechanism**.

Upon triggering, current in the primary coil induces eddy currents in the secondary ring.
The opposing magnetic fields generate **10–20 kN** of force, accelerating the piston and removing the plug from the orifice within **1–2 ms**.

The plug reseats via spring force, producing a **controlled mechanical impact** designed for long-term durability.

## MECHANICAL STRUCTURE

### PRESSURE VESSEL ASSEMBLY

- Stainless-steel cylindrical body
- Nominal **150 bar** internal operating pressure
- Internal gas volume: **1000 cm³**
- Front and rear flanges with **200 mm bolt circle**
- Gas outlet interface: **DN40** (custom options available)
- Body OD: **200 mm**, flange OD: **250 mm**, overall length ~ **250 mm**

### PISTON AND PLUG

- Stroke: **1–8 mm**

- Plug material and shape optimized for sealing and controlled impact durability
- Spring return mechanism ensuring repeatable closure

### MOVING MASS

- Configuration-dependent (Stainless steel/Titanium variants)
- Approximate total valve mass: **~30 kg**

## PERFORMANCE CHARACTERISTICS

### GAS DELIVERY

- Deliverable amount: **1–20 bar·L**
- Reproducibility: **~0.1 bar·L**
- Gas velocity: **up to Mach 5** (CFD-validated)
- Fine-resolution operation possible with reduced orifice diameter

### DYNAMIC BEHAVIOUR

- Opening time: **1–2 ms**
- Peak actuation force: **10–20 kN**
- Rising-edge sharpness tuneable via capacitor voltage
- Gas output scales with initial pressure, stroke profile, and driver energy

### ENVIRONMENTAL ROBUSTNESS

- Magnetic field: operational up to **≥275 mT**, minor sensitivity → **compensable via adjusted actuation voltage**
- Ionizing radiation: **1 MGy 14 MeV neutron hard**
- Vacuum compatibility: **UHV-capable**, low leak rate

## GAS COMPATIBILITY

Compatible with **$H_2$, $D_2$, He, $N_2$, Ar, Ne**, and mixed compositions.
All gas-contact materials are corrosion-resistant and suitable for cryogenic/room-temperature feeds.

ATEX-compatible configuration available upon request.

## RELIABILITY & CYCLE LIFE

- Cycle lifetime validated over **>1000 actuations**
- No mechanical degradation observed in plug, seat or piston guidance
- Closure impact is within material fatigue limits
- Stable reproducibility over long campaigns demonstrated in fusion research environments

## INTEGRATION & INTERFACES

### MECHANICAL INTERFACE

- DN40 gas outlet as standard; customized flanges available
- 200 mm bolt circle for system mounting
- Straightforward integration into vacuum chambers or external gas lines

## ACTUATION INTERFACE

- Requires high-voltage driver with controlled capacitor discharge
- Triggering via TTL or external control signal
- Recommended driver: **EddyDriver©**, supporting:
  - configurable charge voltage,
  - sequence timing,
  - safety interlocks.

## OPTIONS & CUSTOMIZATION

- Magnetic-field optimized configuration
- Radiation-hard configuration
- UHV-optimized sealing
- ATEX gas-path configuration
- Custom gas outlet/mounting interface

## SAFETY & COMPLIANCE

- Designed and tested according to high-pressure component practices
- Radiation and magnetic field performance validated experimentally
- Gas path materials compatible with hazardous gases (+ATEX option)

## APPLICATIONS

- Fast gas-puff experiments
- SPI/MGI fusion R&D
- Supersonic gas injection, wind tunnel drivers
- High-field laboratory environments
- Repetitive, stable gas delivery systems

## SUMMARY

The **Eddy Driven Valve** provides:

- reliable **1–2 ms** opening,
- **150 bar** operation,
- **1–20 bar·L** gas delivery with excellent repeatability,
- robustness against magnetic fields and radiation,
- and validated long-term performance.

A proven, fusion-grade fast gas valve for advanced scientific and industrial applications.

## REFRENCES

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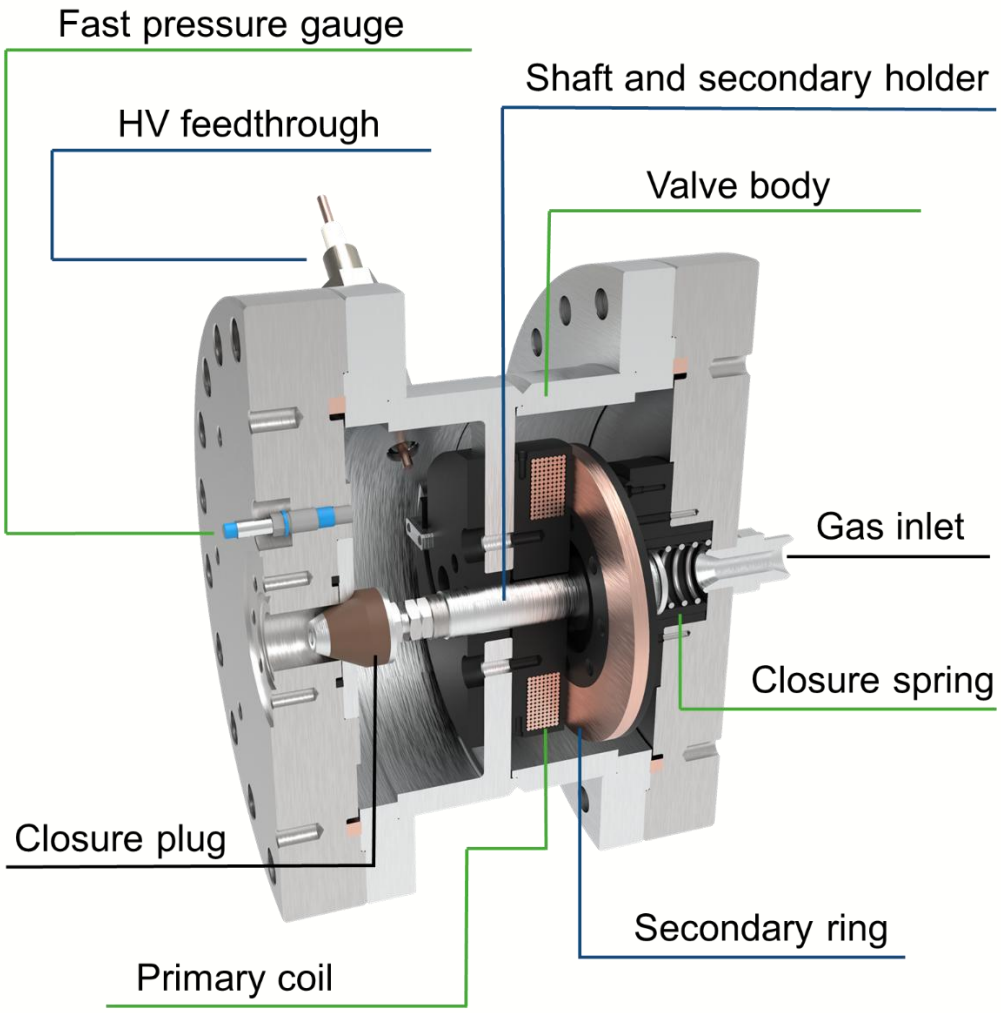
Fast pressure gauge
HV feedthrough
Shaft and secondary holder
Valve body
Gas inlet
Closure spring
Closure plug
Secondary ring
Primary coil