

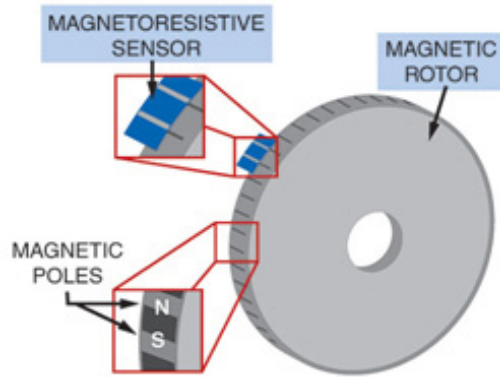


Eliminating Magnetic Encoder Interference from Brakes & Motors

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Introduction

Magnetic encoders use a sensor to detect the movement of one or more magnets. Their electronics produce output in proportion to speed and/or distance traveled.



So what happens when a magnetic encoder mounted on a motor is placed next to a conventional electric brake or an older motor with a magnetized motor shaft?

The answer isn't always good for the encoder. However, by selecting and applying components carefully, designers and users can eliminate magnetic interference problems from older motors and brakes.

Problem

Rotary magnetic encoders utilize sensors to detect the rotation of a magnetized ring attached to a rotor and shaft mechanism. Sensors detect the orientation (and movement) of the magnetic lines of flux from the ring. The sensor data are fed to digital signal processors to produce a quadrature signal (A Quad B plus marker Z). These signals provide speed and position feedback.

The problem is that magnetic fields generated by brakes (and other magnetic fields) can distort or swamp the lines of magnetic flux from the rotor. Magnetic fields from (older, often rebuilt) motor shafts can be 50-300 gauss, and brakes can easily produce external fields of 500-2000 gauss (0.2 Tesla)! This causes a magnetic encoder to partially or completely malfunction: It may produce no output at all, or it may produce the incorrect number of pulses for the real-world movement it is monitoring, or even output pulses while stationary!

Optical encoders seem like the obvious solution, but their durability in severe environments limits their use. With their reliance on seals to keep out dirt, dust and oil, optical encoders quickly fail in rough environments.

Even mounting the optical encoder inside the brake is not a perfect solution: The encoder is still exposed to heavy temperature cycling which will break down the seals over time. Once brake dust or moisture enters the optical encoder it will fail.

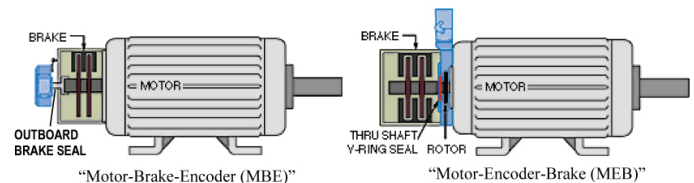
Proposed Solution

To eliminate magnetic interference, the installer and/or designer must combine:

- Knowledge of magnetic encoder construction
- Knowledge of brake types
- Flexible installation applications
- Experience with encoder brands

Background

Motors, encoders, and brakes typically intersect on crane and hoist applications. Other motion control applications require this combination as well.



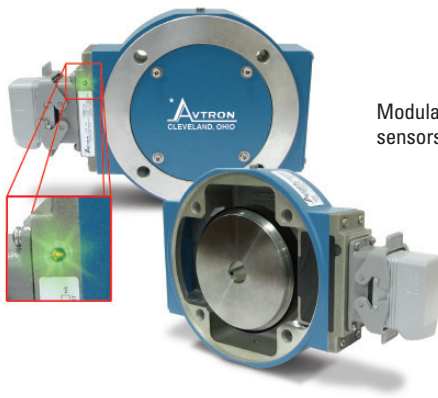
There are two common motor, encoder, and brake combinations used worldwide on heavy crane and similar installations:

Motor-Brake-Encoder (MBE) combinations offer quick replacement of the encoder, but are not without problems. The outboard brake seal is a significant source of maintenance. It is frequently damaged by the shaft movement caused by the brake itself. The encoder is exposed to damage from any moving objects nearby. Hollow shaft or coupled solid shaft encoders must be used, which have bearings, another potential source of failure.

Motor-Encoder-Brake (MEB) combinations protect the encoder from external damage and eliminate the encoder bearings through the use of a modular encoder. The outboard shaft seal on the brake is eliminated. The entire assembly is bolted together, end-to-end. This makes the MEB combination extremely low-maintenance and extremely impervious to damage. However if the encoder fails, dis- and re-assembly can take hours.

Modular Encoders

Modular encoders (also called pancake or C-face mount) are bearingless, two-piece designs. A rotor is mounted on the motor shaft. The stator contains the sensor and electronics. Inboard and outboard flanges provide alignment of the MEB sandwich, and bolts are passed through the brake frame, through the encoder stator bolt holes into tapped holes on the motor C-face or flange.



Modular Encoders with removable sensors Front & rear views

Encoder models with removable sensors solve the MEB disassembly problem. If the electronics are damaged, the user can simply replace the sensor without disassembling the MEB package. Only the rotor is inaccessible, and rotor failure is extremely rare.

Hollow Shaft Encoders

Hollow shaft encoders (also called tethered) grip the stub shaft extending from the brake (MBE configuration). A tether (antirotation arm) prevents the encoder housing from turning with the shaft. Replacement is quick and easy, but the encoder's exposed location behind the brake may result in damage and frequent replacement unless heavy or severe duty encoders are used.

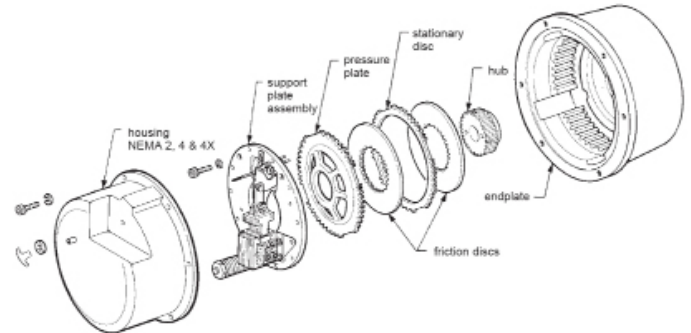


Severe Duty Hollow Shaft Encoder

Solenoid Actuated Brakes:

Solenoid actuated brakes use a lever arm and a solenoid to overcome spring action. This allows the friction disc to rotate freely until power is removed.

Self-Adjusting Disk Brakes - Main Components



(Source: Rexnord.com web site)

Case Examples

Example #1: Solenoid Actuated Brake Interference

A major crane and hoist controls manufacturer was experiencing intermittent problems with sandwiched modular encoders (MEB). These MEB packages used solenoid actuated brakes. After extensive testing they concluded that the magnetic brake was causing intermittent extra “counts” from the encoder. When the coil of the solenoid was activated the encoder would intermittently produce an output pulse as though the sensor had seen encoder movement. When this test was performed with the rotor and shaft clamped rigidly in place these “counts” were easily determined to be interference from the brake.

After extensively documenting the problem the controls manufacturer performed in-house testing on several brands of encoders under identical test conditions. It was determined that Nidec-Avtron THIN-LINE™ encoders were not affected by the solenoid actuated brakes.

This controls manufacturer changed to Nidec-Avtron THIN-LINE™ (now THIN-LINE II™) encoders, and the problem of intermittent counts was solved.

Example #2: Magnetic Process Interference

An aluminum processor had installed a series of new hoist cranes with modular encoders (MEB) and solenoid actuated brakes. The newly installed encoders would not work at all at startup, due to a combination of magnetic fields from the aluminum process and the solenoid actuated brakes.

The processor replaced the encoders with Nidec-Avtron M85 (now AV85) THIN-LINE™ encoders; the hoists worked perfectly without any other changes.

Example #3: Magnetized Motor Interference

A paper mill had problems where older (rebuilt) DC motors were heavily magnetized. Magnetic encoders used on these motors would provide fluctuating signals and cause drive tripping.

Nidec-Avtron's AV850 encoder includes advanced sensor technology, combined with magnetic shields to keep out external fields. The AV850 replaced the older models, without the signal fluctuations, and the customer's installation went from shaky to rock-solid-reliable.

Example #4: Armature Actuated Brake Interference

A major crane OEM was seeking to replace older encoder models for higher reliability in MBE installations. Typical magnetic encoders used behind the brake were nearly blinded by the magnetic fields created by the powerful armature actuated brake and speed control was impossible.

Heavy Duty HS45 Encoder with Optional Super Magnetic Shielding

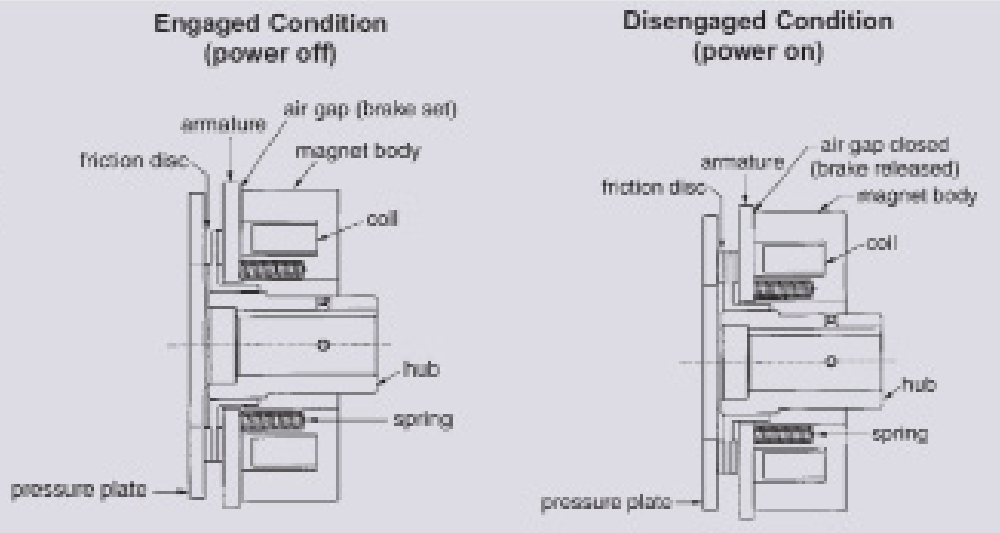


Nidec-Avtron's HS45 with super magnetic shielding option and advanced sensor technology was able to produce great control signals and greatly improved reliability over older encoder models.

Armature Actuated Brakes:

Operating Principle

When electrical power is applied, the armature is pulled by the electromagnetic force in the magnet body assembly, which overcomes spring action. This allows the friction disc to rotate freely. When electrical power is interrupted, the electromagnetic force is removed and the pressure spring mechanically forces the armature plate to clamp the friction disc between itself and the pressure plate. This develops torque to stop or hold the load.



(source: Rexnord.com web site)

Armature actuated brakes use far more powerful magnetic coils than solenoid actuated brakes. The magnetic fields are not contained by the shape of the brake coils in an armature actuated brake. This combination makes them a far more powerful source of magnetic interference than solenoid actuated brakes.

SUMMARY: APPLICATION GUIDANCE TO AVOID MAGNETIC BRAKE INTERFERENCE WITH ENCODERS

First Guideline: Be aware that not all magnetic brakes create equal interference effects:

- Armature actuated brakes create far larger, more powerful magnetic fields; use solenoid actuated brakes where practical.

Second, if interference is a problem, more space and non-magnetic materials may resolve the issue:

- Magnetic field density falls off proportional to the square of the distance from the source. Use wider encoders with smaller motor stub shafts, and larger rotor diameters: Nidec-Avtron AV125 (~8.5"/220mm rotor) vs. AV850 (5.5"/140mm) vs. AV85 (4"/100mm). This will keep the magnetic fields of the brake and a possibly magnetized motor or brake shaft farther from the sensor of the encoder.

- Non-magnetic flange adapters and spacers (typically aluminum or stainless steel) can be utilized to create more space between the magnetic interference source and the encoder sensor. Many brake manufacturers will offer non-magnetic stub shafts upon request.

Third, magnetic shield systems make a huge difference. Manufacturers may also offer additional shielding upon request:

- Nidec-Avtron AV45, AV125, AV485, AV685, AV850, HS45 and XP45 encoders include built-in shields to minimize interference.
- If the encoder comes with an external shield or plate, be sure to install it according to the manufacturer's instructions.
- Specially shielded sensors or versions are often available as an option for extremely powerful magnetic field applications. Nidec-Avtron offers super magnetic shielding on many models, including AV56, AV67, AV85, AV115, AV125, AV485, AV685, AV850, and HS45.

Last, select manufacturers and models carefully:

- Beware of the immediate reaction to change to optical encoders: Optical encoder models are less durable than their magnetic counterparts. Quite simply, optical encoders come from the factory sealed-up to prevent contamination. With temperature cycling and moisture, optical encoders always draw contamination into the encoder and malfunction no matter what their IP rating. For tough applications stay with a carefully selected magnetic encoder.
- Different manufacturer's magnetic encoder sensors have widely varying sensitivity: Nidec-Avtron models show a much greater ability to ignore magnetic interference than competitive models. A list of these magnetic encoders can be found in an attached appendix, including good/better/best comparative performance evaluations.

APPENDIX:

Nidec-Avtron Magnetic Encoders:

All Nidec-Avtron magnetic encoders feature advanced sensor technology designed to ignore magnetic interference from outside sources such as magnetic brakes and motor magnetic fields.

Nidec-Avtron Solid Shaft Encoders

With the large space created by shaft coupling to create Motor-Brake-Encoder (MBE) combinations, magnetic interference is rarely a problem for solid shaft encoders.

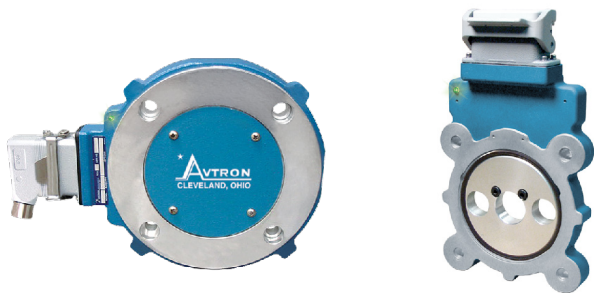
AV485: These heavy and severe duty magnetic solid shaft encoders have advanced sensor technology and shielding to eliminate the effects of magnetic interference. Their extremely heavy construction protects them from damage at the exposed location behind the brake. Super sensor magnetic shielding is available as an option, but rarely required.

Nidec-Avtron Modular Encoders:

Modular encoders are highly protected from external damage when mounted in Motor-Encoder-Brake (MEB) combinations. Their bearingless construction gives them extremely long life; they have no contacting moving parts. MTBF can exceed 4,500,000 hours. Models are listed below in order of increasing magnetic resistance:

Good:

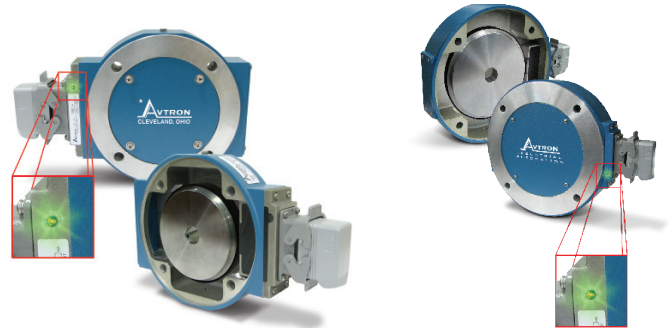
AV56, AV56S, AV67, AV85 & AV115: These THIN-LINE II™ heavy mill duty encoders have advanced sensor technology to ignore the effects of magnetic interference. Optional super magnetic shielding kits further improve performance in high magnetic fields.



Nidec-Avtron Modular Thin-Line II™ Encoders

Best:

AV125 & AV850: These SMARTach II™ heavy mill duty encoders have advanced sensor technology to ignore the effects of magnetic interference. Their standard integral shields and larger rotor diameters provide further magnetic isolation. Optional super magnetic shielding enables them to operate in the strongest magnetic environments.



Nidec-Avtron Modular Encoders

Nidec-Avtron Hollow Shaft Magnetic Encoders:

Hollow Shaft Encoders are mounted outboard of the brake in Motor-Brake-Encoder (MBE) combinations which are convenient for quick replacement, but are more vulnerable to damage. Select heavy and severe duty models for best results. Models are listed below in order of increasing magnetic resistance:

Good:

HS35M: This mill duty magnetic encoder features advanced sensor technology to resist magnetic interference.

XP45: This severe duty encoder includes advanced sensors, and integral magnetic shields.

Better:

M4-3/F: These heavy mill duty encoders offer advanced sensor technology, combined with larger, wider housings which provides additional magnetic isolation.

Best:

HS45: This heavy mill duty magnetic encoder features advanced sensor technology, built-in shielding and an optional super magnetic shielding kit to resist the largest magnetic fields.

AV685: This severe duty magnetic encoder features advanced sensor technology, and the largest, widest housing for the maximum protection from external magnetic fields. Magnetic shielding is standard, and special super-magnetic-shielded sensors are available.



Nidec-Avtron Hollow Shaft Encoders

For more information about this article or encoders & tachometers in general, contact:

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