FLUXDRIVE®

ENERGY EFFICIENCY MADE EASY

Flux Drive FAQs

Frequently Asked Questions

VERSION 2.0

FLUX DRIVE MADE IN USA OF U.S. AND IMPORTED PARTS

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GENERAL PRODUCT QUESTIONS

What is the Flux Drive SmartCOUPLING (FSC)?

The Flux Drive SmartCOUPLING is the first 100% mechanical coupling that combines maintenance benefits and energy savings. The coupling uses rare earth permanent magnets to transfer torque by means of magnetic induction across a 'soft-torque' air gap. This completely isolates the motor from the driven load, virtually eliminating misalignment and vibration problems. In addition to cushioned start, which reduces start-up amps/kW on electric motor driven loads, the SmartCOUPLING also incorporates SmartPOWER™ air gap spacers for long term energy savings (kWh). The spacers allow operators to reduce the fixed operating speed of pumps, fans and blowers by up to 50% — matching output with actual demand to maximize energy efficiency. The FSC is available in both "Inline" (shaft end to shaft end) and "Belt-Pulley" models with operating torque up to 750 lb ft (250hp @ 1800rpm).

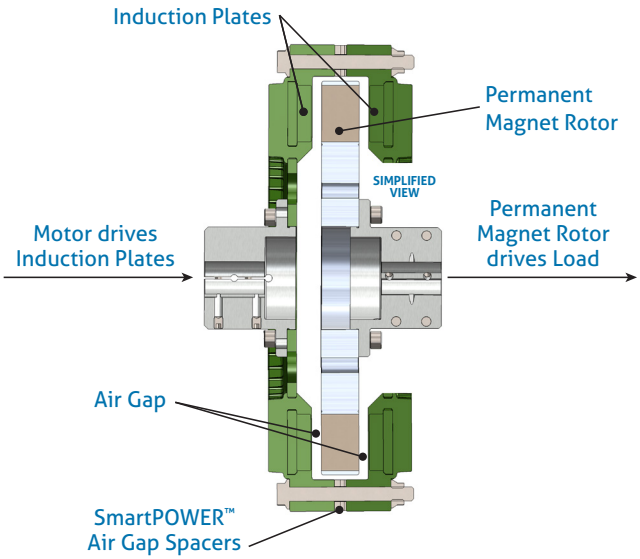
What is the Flux Drive Adjustable Speed Drive (ASD)?

The Flux Drive ASD is a fully dynamic 100% mechanical adjustable speed device that provides process control and energy savings on applications that require frequent or automated speed changes. It can be thought of as a frictionless transmission or clutch between a motor and pump, fan, blower, or other rotating machinery. Like the SmartCOUPLING, the motor and load sides of the ASD are separated by an air gap — providing vibration isolation and load seizure benefits in addition to maximum energy savings. The ASD is available in both Inline and Belt-Pulley models with operating torque up to 900 lb ft (300hp @ 1800rpm).

Do the SmartCOUPLING and ASD product lines share the same core technology?

Yes, both products incorporate Flux Drive's patented induction rotor design. This proprietary design results in an extremely powerful coupling effect in a relatively small size — especially when compared to eddy current magnetic couplings or fluid coupling & drive technologies.

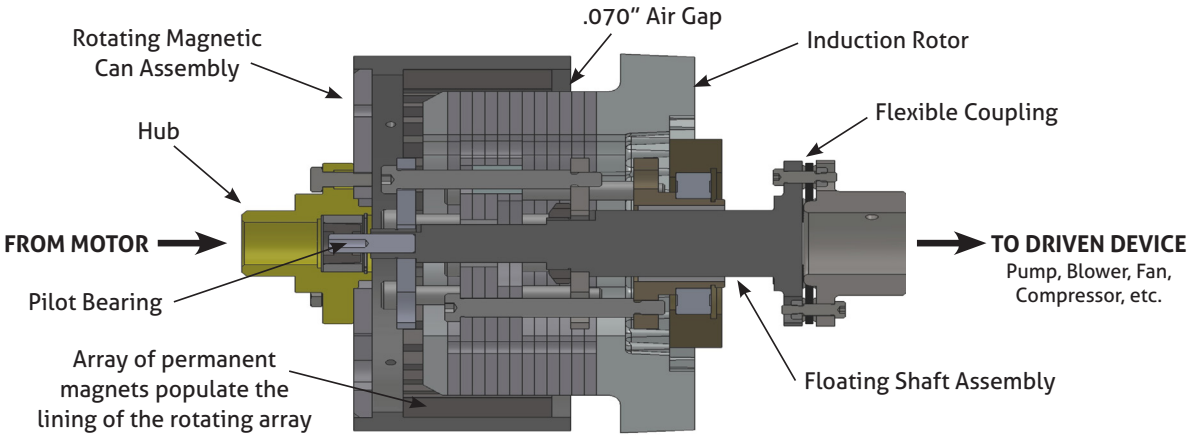
The FSC product has a radial design, with induction rotor plates positioned on both sides of a central magnet rotor. The magnet rotor is separated from the induction rotors by a variable air gap. Both the permanent magnets in the magnet rotor and the rotor bars in the induction rotor plates extend radially from the center of the coupling, allowing for a thin yet very powerful design that easily fits into typical shaft-to-shaft openings (DBSEs). With the FSC, the *width* of the air gap can be adjusted to reduce the magnetic coupling effect, allowing oversized loads to operate at more efficient slower speeds.



The induction rotor portion of the FSC, representing about 70% of the product's total weight, is typically mounted to the motor shaft. The two induction rotor plates are held together by thru-bolts. The separate aluminum rotor with embedded magnets is positioned between the two induction plates.

Alternative models are available with an internal pilot bearing and shaft for special applications. A belt-pulley model with integral sheave and radial support bearings is also available. In all FSC models, SmartPOWER air gap spacers can be installed between the induction plates to increase the total air gap — slowing down the load speed for maximum energy savings .

The ASD has a rotor-in-cylinder design, whereby the induction rotor (very similar to those found in induction motors) is positioned inside a cylinder populated with magnets around the inside diameter. Typically the magnet cylinder is attached to the motor and the induction rotor to the load, with a pilot bearing providing for relatively motion and stability between the two pieces. During operation, the induction rotor can be dynamically pulled out of the magnet can by the external linear actuator, reducing the number of magnets acting upon the rotor and weakening the coupling effect. In this product, it is the amount of overlap between the rotor and magnets that adjusts torque transmission and speed — rather than the size of the air gap. In the ASDs, the air gap remains a constant 0.070 – 0.100" depending upon model.



But how do these products transmit torque across an air gap?

In both products, it is the relative motion between the motor and load sides that begins the process. When the motor starts, it is initially decoupled from the load via the air gap — thus providing the cushioned start. As the permanent magnets pass over the induction rotor bars (or the bars are passed over the magnets) the rotor bars induce magnetic flux and rapidly begin to develop a magnetic field of their own. The resulting magnetic circuit turns the rotor into a very strong temporary magnet. The design of the rotor to maximize magnetism is one of Flux Drives core proprietary technologies.

Once fully magnetized, the induction rotor will attempt to follow the rotating permanent magnets — much like passing one magnet past another on a table will pull the second magnet along. Due to the extreme density of the magnetism and efficiency of the magnetic circuit, Flux Drive products are

capable or driving the load at up to 98.5% of motor speed. There must always be a small speed differential (known as slip) in order for the induction process to occur, but 98.5% efficiency at full speed is the highest efficiency level available from any adjustable speed device currently on the market).

What are the primary differences between the Flux Drive SmartCOUPLING (FSC) and the Flux Drive Adjustable Speed Drive (ASD)?

The SmartCOUPLING provides cushioned start and fixed speed control on a wide range of applications, including pumps, blowers, conveyors, and compressors. Speed reduction of up to 50% is possible on variable torque centrifugal loads (most pumps and fans) and up to 10% speed trimming on constant torque applications (positive displacement pumps & blowers, conveyors, compressors).

The FSC incorporates air gap spacer shims into a radial design to provide multiple levels of speed control. The shims are installed (or removed) when the coupling is not rotating, with more shims resulting in a larger air gap and slower load speed. The FSC is therefore not a solution for applications that require dynamically adjustable speed control (i.e. while the application is running). However, unlike any other flexible coupling, the FSC provides cushioned start, speed control and 100% vibration isolation in addition to misalignment correction and other flexible coupling benefits.

The Flux Drive Adjustable Speed Drive (ASD) provides soft start with the added ability to automatically adjust the overlap of the rotating magnet cylinder and induction rotor assembly. The ASD is fitted with an external linear actuator to provide real-time dynamic adjustable speed control — primarily on variable torque applications such as centrifugal pumps, blowers and fans. During normal operation the linear actuator responds to an incoming control signal for closed loop control based on process variables such as pressure, flow, or temperature. In addition, at motor start-up, the induction rotor and magnet cylinder can be slowly engaged, providing a true "soft-start" to reduce locked rotor current and duration.

Do Flux Drive products provide a 'cushioned' or 'soft' start?

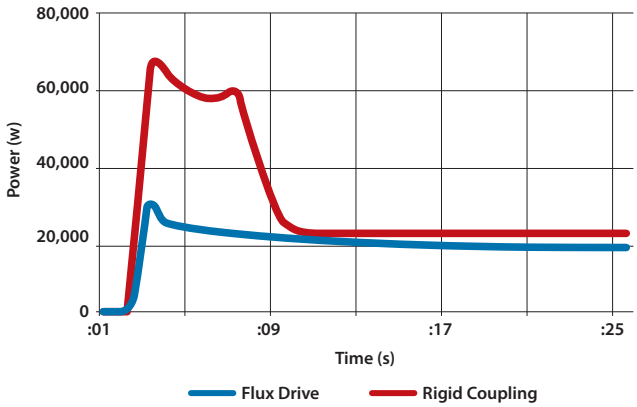
Yes, both the FSC and ASD provide inherent cushioned start, which can dramatically reduce motor amperage (both level and duration) during motor start-up events — particularly on high-inertia loads. When the motor is first energized, it is completely disconnected from the load via the air gap. Only after the motor side of the Flux Drive begins to rotate does magnetic induction build within the Flux Drive coupling/ASD itself. Within the FSC, this delay provides a cushioned start that can be adjusted using air gap spacer shims. When using the ASD, the soft start period can be programmed for any duration.

What's the benefit of Flux Drive's 'Soft-Start' feature?

Flux Drive's FSC and ASD provide an almost one-to-one transfer of power from the motor to the load. ASDs are sized to transfer 100% of the motor's torque at less than 2% slip (therefore 98+% efficient), while SmartCOUPLINGs are sized for 2–5% slip depending upon application.

As noted above, the 'soft-start' capability is inherent in both products and ultimately limits the full

torque/power at start-up to 140 percent of the coupling's full rated operating torque/power. No longer is a motor subject to high locked-rotor currents. Nor does the electrical system have to provide high peak power during a motor starting event. The coupling also provides over-torque protection during a load shaft seizure event. Instead of transmitting the motor's overload torque (often more than 200-300% of operating torque) into the load during a seizure, the Flux Drive will limit torque to approximately 140% — protecting shafts and other connected equipment from catastrophic damage.



What are the overall benefits of the Flux Drive ASDs and FSCs?

Benefits include the following:

- **Energy Savings:** In centrifugal applications, system power requirements vary with the cube of the pump speed or flow. Small decreases in speed or flow can significantly reduce energy use. For example, reducing the pump speed flow by only 20% will reduce input power requirements by as much as 30%. Both products provide energy savings benefits for oversized loads or those that can benefit from dynamic speed control.
- **Soft/Cushioned Start:** All loads, including constant torque devices such as conveyors, compressors, and positive displacement blowers, can benefit from Flux Drive's soft start feature. Soft or cushioned start-up of motors reduces torsional shock on connected components and lowers start-up amps, potentially reducing utility demand changes.
- **Easy Installation:** Flux Drive's are 100% mechanical, so there is typically no need for electricians or special programming/control systems staff.
- **Lower Vibration & Noise:** the air gap isolates motor from load in both devices. A central pilot bearing is the only touch point between the two sides of the Inline ASD, while the Inline FSC is 100% disconnected from side to side.
- **Retrofitting to Existing Motors:** unlike with VFDs, inverter duty motors are not required. The Flux Drive can be used on any type of motor.
- **Cost Effective for Medium Voltage Applications:** electronic soft starters or VFDs are

extremely expensive for application running at greater than 600 volts. Because it is mechanical, the Flux Drive is unaffected by motor voltage, providing a much more cost effective solution for energy and cost savings.

- **Reduction in Life Cycle Costs:** The bearings in the ASDs and belt-drive FSCs are serviceable and easily replaceable, allowing those products to last decades with minimal maintenance. The Inline FSC has no touching or wearable parts and will literally NEVER WEAR OUT!
- **Harsh Environment Operation:** All Flux Drives are designed for wet, hot, dirty, and corrosive operation.
- **Elimination of Locked Rotor Conditions:** the inherent cushioned start and over-torque protection reduce locked rotor peak and duration.
- **No Harmonic Interference:** unlike VFDs, Flux Drive's create no harmonics and will not cause the Electrically Induced Bearing Damage (IEBD) that leads to premature bearing failure in many VFD driven applications.

Are rare-earth permanent magnets really rare?

"Rare-earth" Neodymium, Iron, Boron (NdFeB) permanent magnets are used in both the ASD and FSC product lines. These magnet materials are not actually rare, but are found in the rare-earth section of the Periodic table; specifically the fifteen lanthanoids plus scandium and yttrium.

These magnet materials are actually very common and mined at various locations around the world as follows (including estimated % of deposits): 1) China (36%), 2) Russia (20%), 3) USA (15%), 4) Australia (5%), 5) India (3%), others (21%).

As noted by their name, permanent magnets are magnetized for life, and will operate the Flux Drive ASD and Coupling for hundreds of years if operated within the Flux Drive standard specifications. These magnets became commercially available in the early 1980's and have become the standard for permanent magnet motors and generators world-wide. Flux Drive selects a grade of magnets that will retain their performance at the highest possible temperatures under normal operation.

The Flux Drive magnet cylinder/rotor contains an array of permanent magnets arranged to provide high strength magnetic flux for torque transmission to the Induction Rotor. Patented magnetic circuits in both the ASD and FSC create extremely high efficiency and a stronger magnetic coupling effect than any other magnetic technology. In both devices, the magnetic circuit is completely contained inside the product, with no magnetism leaking outside the magnet cylinder on the ASD, and very little magnetic flux measurable around the perimeter of the FSC product.

All standard field maintenance can be performed without having to separate the induction rotors and magnets. In fact, separation of the magnetic portion of either product from the induction rotor component will void the Flux Drive warranty.

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COMPLIANCE AND DESIGN

Is the Flux Drive manufactured to some type of design standard?

Yes. Both the Flux Drive ASD and FSC products are designed and built to standards based on rules and requirements of the Certificate of Design Assessment program (PDA — Product Design Assessment) — Issued by ABS (American Bureau of Shipping) USA. The ASD products have been granted a Certificate of Design Assessment and ABS has just recently witnessed testing of the FSC product line and will be issuing the SmartCOUPLING CDA shortly.

How do Flux Drives withstand harsh environments?

Flux Drive products are purely mechanical devices that have coatings designed for harsh environments. All steel components have a standard electroless nickel coating (ASTM B733 SC2 Type II) to provide both corrosion protection and durability. Aluminum parts are either hard coat anodized (Mil-A-8625; Type II, Class 2) or powder coated with 3M ScotchKote™ Ultra Corrosion Resistant powder coating. Magnets are electroless nickel plated and all fasteners are either zinc (ASTM B633;SC2; Type II) or CAD coated or made of 304SS depending upon function.

The ASDs and Belt-Pulley FSCs contain internal bearings that are easily replaced if required per the recommended multi-year maintenance cycle. All bearings are sealed and all Flux Drive products are wash-down duty and outdoor duty capable. Ambient operating temperatures from -40C to 55C are acceptable.

Are Flux Drives easy to install?

Flux Drives are simple and economical to install and maintain:

- The SmartCOUPLING is designed to drop into common shaft-to-shaft openings for easy replacement of existing couplings.
- Only common hand tools are required — no special laser alignment equipment is necessary.
- Expensive electrical personnel are not required to maintain or service Flux Drive products — no in-depth VFD manuals or menu systems to master!
- All Flux Drive products operate in harsh environments without the need for special sealed enclosures or a clean/cooled machinery room
- Backup hand-wheel operation is provided with the 4-20mA automatic actuator for ASDs
- ASDs can be operated with just a manual actuator (no power required) if full automated control is not needed.

Will a Flux Drive ASD or SmartCOUPLING operate on a medium voltage (600+ volt) motor application?

Yes, since both products are purely mechanical devices, motor voltage has no impact whatsoever. Flux Drives will also operate without problem on non-inverter duty rated motors that cannot accept electronic VFDs.

How can a Flux Drive be retrofit to an existing system?

The Inline FSC is designed to fit into common shaft openings to replace existing couplings. The Belt-Pulley FSC simply slides onto the motor shaft in place of the existing sheave, so it is also extremely easy to retrofit to an existing system. The Inline ASD is installed between the motor and the load shaft and is longer than the FSC product line. This may necessitate moving the motor backwards several inches to accommodate the ASD, which may require slight modifications to the foundation or the installation of one of Flux Drive's base extension kits. The Belt-Pulley ASD is mounted on the motor shaft after a plate is installed under the motor to support the linear actuator. This simple installation requires no base modifications and allows the motor, Flux Drive and actuator to move together when belt tensioning is required. Belt-Pulley ASD installations are typically completed in a few hours.

Do Flux Drive products require Laser Alignment?

No. The Inline FSC product's air gap is designed to accommodate significant levels of misalignment. During installation, the jacking bolts are used to center the magnet rotor. As long as the air gap on each side of the magnet rotor is roughly equal to the naked eye, the product is aligned - and no additional laser alignment is required.

The Inline ASD incorporates a floating internal shaft and pilot bearing to center the Induction Rotor inside the Magnet Cylinder, also eliminating the need for laser alignment. Four jacking bolts (located at the 4 clock positions) keep the rotor centered within the magnet cylinder. The flex pack hub on the drive's output shaft is then rough-aligned to the flex pack hub on the load shaft by positioning the motor up/down and side to side using standard motor shims. When the bolts connecting the two flex pack hubs slide in easily from both sides, the system is adequately aligned (within 0.010" – 0.015"). At this point, the motor can be tightened in place. The magnet cylinder jacking bolts can then be loosened and the induction rotor will remain aligned within the acceptable off-set limit of 0.020". (Note: the design air gap in the ASD is = 0.070". The air gap in the Inline FSC starts at 0100" but can be further increased using the air gap spacer shims.)

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ENERGY SAVINGS AND ROI

How do Flux Drive products save power when the motor is running at a constant speed and not slowing down?

Consider the simplified motor power equation: *Power (kW) = Voltage (V) x Current (I).* Current (or amperage) is directly related to the amount of torque required to drive the load. On centrifugal loads, the Laws of Affinity dictate that torque requirements drop in a squared relationship with speed. As an example, only 49% of full speed torque is required when the load is operating at 70% of full speed (.7 x .7 = .49) When Flux Drive products are used to slow the speed of centrifugal loads (most pumps, fans, & blowers) much less torque is required at the slower speeds and the motor no longer draws as much current (amps). Per the equation above, reducing amps while keeping voltage constant will result in lower overall power (kW) consumption. When measured over time, the lower kW results in a smaller number of kilowatt hours (kWh), the unit of measure utilities use when billing customers. Utilities also incorporate "Demand" charges into utility bills, which reflect the highest amount of kW the utility must deliver to the customer over a specific amount of time. Because hard starts increase kW demand, Flux Drive's cushioned start feature can help reduce those charges as well!

Another good analogy is to look at riding a bike on a flat level grade. When keeping the pedal speed constant (no shifting) and starting to go up a hill, it takes much more energy (power) than going downhill, even if the rate of pedaling (rpm) remains the same. The person in this case is acting like a constant speed motor and consuming more or less power while operating at constant speed.

How do Flux Drive products influence power factor?

Operation of all AC induction motors at reduced power will decrease the power factor of the local system. This is a result of operation at reduced speed/power and not directly caused by the Flux Drive ASD. In rare occasions, utilities may charge a penalty if the facility's overall power factor is below an acceptable pre-determined level in that region. Experience to date has shown that power factor correction has not been an issue with the installation and operation of Flux Drive ASDs. In the rare case that power factor correction may be required, inexpensive power factor correction capacitors can be easily installed at each motor, and sized as required.

What is the reliability and longevity of Flux Drive products?

Flux Drives are mechanical devices incorporating simple designs, with long-life bearings (if applicable) that can be replaced over time if required. The other core components of the drive are permanent in nature and will easily outlast the connected motor and load. Again, the Flux Drive ASDs and Belt-Pulley FSC are 100% re-buildable with common replacement bearings — unlike VFDs which are often discontinued (with no replacement parts available) after just 3–5 years on the market. Over a 20 year period it may be necessary to replace the VFD up to three times. Because the Inline FSC product has no bearings and no other wearable parts it provides the ultimate in reliability and durability. It will literally never wear out!

How can a Flux Drive reduce life cycle costs?

Flux Drives are designed for long life (>20 years) with standard off the shelf parts that are serviceable for life. By drastically reducing (Inline ASD), or completely eliminating (Inline FSC) vibration transfer between motor and load, Flux Drive products isolate equipment vibrations that may otherwise cause damage to the entire system. New equipment also lasts longer between maintenance cycles or downtime as a result of soft start and slower operating speeds. In short, coupling failures due to misalignment or high torque loading/pulsations are now eliminated.

What is a typical ROI for the Flux Drive?

The typical ROI period for the ASD product line is 12–30 months (not including utility energy efficiency rebates) depending upon the level of speed reduction achieved. Due to lower initial cost, the ROI period for the SmartCOUPLING product line is typically 6–18 months. Many electric utilities also provide incentive funding to offset the upfront cost of energy efficiency upgrades. Extending as high as 70% of the total installation costs for product like the ASD and FSC, these programs can obviously dramatically increase overall ROI.

What are the drivers of the Total Cost of Ownership of Flux Drive products?

Smaller sized Inline ASDs (up to 150hp) may have higher initial costs than many electronic VFDs, but a complete Total Cost of Ownership analysis shows a higher long term value from the Flux Drive technology. While the VFD's "off the shelf" price may look appealing, the hidden cost to install, maintain and replace is far more expensive than the Flux Drive magnetic technology.

Factors leading to a lower Total Cost of Ownership for Flux Drive's ASDs include:

- 20 year serviceable life (compared to 5–7 year for VFD)
- Mechanical device, no high tech workforce required
- No A/C required nor does it need to be maintained
- No grounding brushes and of expensive electronic filters to eliminate Electrically Induced Bearing Damage (EIBD).
- No line reactors or harmonic filtering required
- No upgrades to inverter duty motors
- No motor overheating due to harmonics
- Motor runs at full design speed, remaining highly efficient and cool
- No upgrade to NEMA-4 enclosures for tough environment
- Operates with medium voltage (2300, 3300, 4160 volt) motors

It should also be noted that the installed cost of Flux Drive ASDs above 100hp is very similar to that of new VFD installations.

The SmartCOUPLING product line is truly in a class of its own in terms of ROI and TCO. Inline FSCs have no ongoing costs related to coupling maintenance whatsoever, so the initial purchase price is the only expense to factor into a TCO analysis. Savings are immediately realized in the form of reduced energy consumption (even if no shims are installed a small amount of energy savings is achieved) and reduced maintenance on connected equipment. If a fixed reduction in load speed is all that is required to "right size" an existing pump or fan, then complicated and short-lived VFDs are simply overkill. The FSC provides the same solution in a simple and robust mechanical package that will outlast all other application components.

APPLICATION AND ENGINEERING

Does the Flux Drive ASD or SmartCOUPLING create heat when running?

During full power/torque operation of the ASD and SmartCOUPLING, both are designed to operate with less than 2% slip at rated horsepower (98% efficiency). At this operating point, no noticeable heat will be produced within the Induction Rotor. This highly efficient power transfer is the inverse of electronic VFDs, where losses and heat generation are a maximum at full power operations. This condition requires the VFD to provide maximum cooling at the highest power levels and results in substantial energy losses that are documented to be between 4–6%. In many VFD installations, climate controlled rooms are required at a cost of additional space and power.

During reduced speed operations on centrifugal systems (i.e., pumps, blowers, and fans) the Flux Drive ASD and SmartCOUPLING will magnetically slip to adjust the output shaft speed to meet the required system flow rate. In this condition, heat is generated within the induction rotor and is dissipated by the cooling fins. The ASD contains a single cooling fin that draws and dissipates heat from the induction rotor. The heat fins are an integral part of the induction plates on the FSC products, providing an extremely efficient heat dissipation mechanism.

When running the ASD product, a heat fin surface temperature of 350 degrees F can be normal for steady state conditions at the speed at which maximum heat is generated (66% of motor speed). Note that operating the load below 66% of motor speed will actually decrease the total amount of heat from the ASD/coupling due to the dramatically dropping total hp required at those low speeds (per the Laws of Affinity). These surface temperatures are normal and are within design specifications. SmartCOUPLING rotors will run at lower temperature at all speed levels due to the integrated induction rotor/heat fin design.

Also, due to the constant movement of air past the ASD or coupling, the exhaust air temperature from the cooling fin is typically about 150 degrees F. The air gap that separates the induction rotor from the magnets in all Flux Drive products acts as a thermal barrier, keeping the temperature of the magnets well below their rated working temperature.

How do the Flux Drive ASD and SmartCOUPLING perform with constant torque loads?

In constant torque applications, speed reduction is limited with all mechanical adjustable speed drives - including Flux Drive products. Unlike centrifugal loads, power requirements do not decrease on a cubic scale on constant torque loads. As the name would suggest, the torque remains constant.

Flux Drive products are limited to a ten (10) percent reduction in speed (turn down) on this type of load unless the product is oversized for the application with Flux Drive pre-approval. This is due to direct heating issues that occur since the load torque (and corresponding power consumed) is constant throughout the entire speed/operating range.

It should also be noted that constant torque applications in general have limited energy savings potential compared to variable torque applications — regardless of the device used to slow speed. However, all constant torque applications can benefit from the *cushioned-start* benefits of the SmartCOUPLING. There are no limitations on the use of Flux Drive products for cushion-starting constant torque loads as long as the load is operated at 90% or more of full motor speed.

How do Flux Drive products eliminate locked rotor conditions and coupling failures during a load shaft seizure or restriction?

During a load seizure or restriction, AC induction motors have the ability to instantaneously draw more current, leading to higher and higher amperage and torque output (in excess of 200–300% of operating torque) until one of the connected components fails or the motor overheats. Because many load seizures occur instantaneously, the shock of the seizure is enough to break the load shaft or coupling before the motor's thermal protection can sense an overloaded condition and turn the motor off.

As described earlier, Flux Drive products are designed to provide a peak torque output that is approximately 140% of the required operating torque based on load horsepower and speed. During a load seizure, the Flux Drive will therefore magnetically slip before the shock of the seizure damages the connected components (shafts, bearings, downstream coupling). This magnetic "shear pin" effect is one of the most valuable benefits of the Flux Drive in applications where load seizures or restrictions are common (chippers, hogs, grinders, etc.).

At the same time, 140% of normal torque is still sufficient to place the motor into an overloaded condition. If the motor continues to draw more than normal operating current/amps, the system's thermal protection will eventually trip — saving all connected components from damage and allowing operators time to clear the problem. If the customer's existing motor control circuitry cannot be configured to trip the system within the recommended amount of time and at the recommended amperage level (typically 125% of normal operating amps for more than 30 seconds) Flux Drive can provide an optional auxiliary Current Sensing Relay (CSR) to perform that function.

How does the Flux Drive ASD provide automatic (closed loop) control and hold a setpoint?

The Flux Drive ASD is Flux Drive's solution for dynamic speed control on systems where load speed is dictated by a process variable such as flow rate, pressure, or temperature. To provide automated control, the ASD uses an electronic linear actuator to automatically adjust the level of overlap between the magnet cylinder and induction rotor — thus altering the amount torque transmitted into the load and therefore the load speed. The linear actuator is designed with multiple inputs to accept the control/speed signal (4-20 mA or 0-10 volts) from the facility's existing control system. The actuator provides smooth, highly accurate positioning with a user-configurable fail-safe position upon loss of control signal. Flux Drive offers two brands of actuators, Rotork and Exlar, to provide feature flexibility as well as IP65 and Explosion Proof ratings for use in the most adverse environmental conditions. Other brands of linear actuators may be used with the Flux Drive, but may require an adaptor and/or small engineering fee.

Does it matter which end of the ASD or SmartCOUPLING is attached to the motor?

Technically, the SmartCOUPLING or ASD can be mounted with either the induction rotor or magnet side mounted to either the motor or load shaft. It is the relative motion between the two sides that creates the coupling effect, so it does not matter whether the magnets or induction plates are being rotated by the motor.

However, for the SmartCOUPLING, we recommend connecting the rotor plates to the motor shaft for the best possible heat dissipation during a load seizure/restriction. This will ensure maximum cooling for the coupling.

For the ASD, we recommend installing the drive with the magnet cylinder connected to the motor. This allows for easier access to the pump, blower or fan for maintenance purposes. In the case of a gearbox, the Magnet Can should be mounted on the gearbox to allow the induction rotor fan to run at maximum speed all the time. Again, this provides maximum cooling, which may be required for constant, high torque devices.

Finally, belt-pulley versions of both products are designed with an internal shaft that automatically connects the induction rotor to the motor shaft, with the magnet side of the coupling connected to an integral pulley that drives the load.

Why is the Flux Drive ASD or SmartCOUPLING the best solution for remote pumping applications in industrial environments?

If dynamic speed control is required in dirty, wet, or corrosive environments, VFD's will not survive without the protection of special enclosures, clean room spaces or motor control centers (MCC). Air conditioners, heaters, and air filtration may also be required. Wire length from a VFD to a motor is also a limiting factor since long wire lengths can cause voltage reflections that damage the motor or trip the VFD. The cost to build these clean, air conditioned environments in close proximity to remote motors becomes prohibitive — and the pay back from energy savings is often not sufficient to compensate. In fact, in many cases there is simply no space to build a dry, clean, and corrosion free room — leaving the end user no choice but to continue using a control valve or damper control.

The Flux Drive ASD, on the other hand, mounts locally on the motor and load platform and does not require clean room spaces, air conditioners, or air filtration to protect it from environmental hazards. It requires no additional 480v+ wiring and in many cases an existing 4-20ma or 1-5 volt process signal (used for existing control valves or dampers) can be repurposed to control the Flux Drive.

In some cases VFDs are also used to achieve a fixed lower flow rate on oversized pumps. While the energy savings may provide an acceptable ROI, a VFD is simply overkill if a fixed lower speed is all that's required. The SmartCOUPLING is a much better energy savings solution for fixed speed control and provides other maintenance benefits (misalignment correction, vibration isolation, load seizure protection) that VFDs simply can't provide. The simplicity of the SmartCOUPLING design (coated aluminum and steel construction with no wearable or replaceable parts) also makes it the perfect fit for the absolute worst rotating equipment environments.

Do Flux Drive's Belt-Pulley products add weight to the motor/load bearings?

On the contrary, adding a Flux Drive Belt-Pulley ASD or Belt-Pulley SmartCOUPLING will typically unload the motor and fan/load bearings. The inherent "soft-start" feature of all Flux Drives means the number of belts can be selected based on running horsepower instead of starting horsepower. Using fewer belts will reduce overall belt tension and offset the weight of the Flux Drive.

Example: A 50 hp motor running an air supply fan may require five B-series belts and 500 lbs of belt tension to keep the belts from slipping during the start up event (100 lbs per belt). At full speed after start-up, torque will drop and only three belts and 300 lbs of belt tension will be required. Eliminating two belts and 200 lbs of belt tension and replacing it with a Flux Drive weighing 120lbs would reduce the radial load on the motor bearing by 80 lbs.

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FLUX DRIVE VS. COMPETING TECHNOLOGIES

Who are Flux Drive's competitors in the adjustable flow/speed control market?

The most common type of flow control in the market is throttling control valves and dampers. These devices waste large amounts of energy in centrifugal applications where system power requirements vary with the cube of the pump speed/flow. Flux Drive products are ultimately about saving energy by varying the drive speed. They offer an elegant mechanical solution with the highest efficiencies possible without introducing damaging harmonics to motor / electrical systems.

Beyond control valves, three other types of speed / flow control devices may be considered competitors:

1. Electronic variable frequency drives (VFDs)
2. Fluid drives
3. Eddy current drives

Each is described in the following questions.

Why use a Flux Drive Adjustable Speed Drive instead of a Variable Frequency Drive (VFD)?

Variable Frequency Drives adjust the output speed of a motor by varying the frequency and voltage of power supplied to the motor. This method of speed control has a number of drawbacks: it wastes energy by creating harmonics, it must be shielded for harmonic interference, it requires costly installation procedures, it doesn't work well in harsh or humid environments, and it is inherently an unreliable system due to its complex nature. The Flux Drive Adjustable Speed Drive, by contrast, is a simple mechanical device that provides similar energy savings, is easy to install, and is very reliable.

What are the principal advantages of a Flux Drive over a Variable Frequency Drive?

While Variable Frequency Drives provide similar energy savings to the Flux Drive, their installation and operation is not always practical or cost effective. Complex electronic components and a need for extensive infrastructure (shielded conduit, line reactors, harmonic filters) can increase installation costs and also require the skills of highly trained personnel for programming and service calls.

The simple and reliable Flux Drive ASD is ideally suited for pump, fan and blower applications providing significant energy savings without the complexities associated with VFDs. In addition, because all Flux Drives are mechanical air-gap based couplings, they eliminate vibration issues and no harmonic distortion is created. Being 100% mechanical, the Flux Drive is also not impacted by system voltage or frequency, making it a viable solution anywhere in the world, and a particularly cost effective solution on medium voltage applications (above 600v) when compared to extremely expensive MV VFDs.

Is the Flux Drive quieter than a VFD and does it create less vibration?

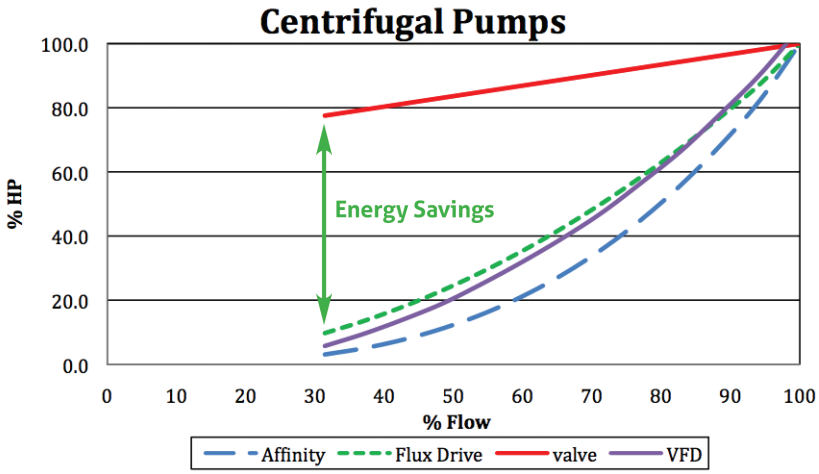
The typical ROI period for the ASD product line is 12–30 months (not including utility energy efficiency rebates) depending upon the level of speed reduction achieved. Due to lower initial cost, the ROI period for the SmartCOUPLING product line is typically 6–18 months. Many electric utilities also

provide incentive funding to offset the upfront cost of energy efficiency upgrades. Extending as high as 70% of the total installation costs for product like the ASD and FSC, these programs can obviously dramatically increase overall ROI.

How does the efficiency of the Flux Drive compare to a VFD?

An example showing the Flux Drive ASD performance vs. a throttling valve and a VFD (at varying flow rates and horsepower) is shown below. Note that both the Flux Drive ASD and the VFD provide substantial energy savings over the Throttling Valve. However, both consume slightly more power than the Laws of Affinity would seem to dictate. This is due to the real world losses/inefficiencies that can be found in all variable speed devices — including VFDs. The efficiency of other related components (motor, pump/blower, etc.) as well as the head pressure and other application-specific variables will also impact overall power consumption.

Note that closer to full power/torque operation (right side of curve), the Flux Drive ASD and SmartCOUPLING are also designed to operate at 98% efficiency. Once again, this shows that overall efficiency is superior to VFDs when operating speeds of 90% or greater are common.



If fixed speed control is needed for energy savings, does the Flux Drive have advantages over VFDs?

Yes — the SmartCOUPLING is the best Flux Drive solution for fixed speed control and is generally much less expensive initially than a VFD — with similar ongoing energy savings. SmartCOUPLINGs are also incredibly reliable and will literally never wear out. If dynamic speed control is not needed but an oversized flow rate can be reduced for energy savings, then there is no more cost effective choice than the SmartCOUPLING.

Once again, briefly, what are the major advantages of Flux Drive ASDs over Variable Frequency Drives?

Unlike VFDs, Flux Drive devices:

- Operate with any voltage motor without high cost upgrades
- Require no special filters and reactors
- Require no inverter duty motor
- Do not cause motor overheating at reduced pump or blower speeds
- Operate with zero harmonic interference and no power quality issues
- Create no motor noise (harmonic "whine")
- Do not introduce stray shaft currents that cause bearing damage
- Do not require expensive bypass starters
- Are not affected by electrical disturbances or lightening
- Do not create system electrical problems (harmonics, heating, etc.)
- Eliminate nuisance dropouts that occur with VFD control/power circuits

Are Flux Drive SmartCOUPLINGs similar to older Hydrodynamic/Fluid Couplings?

YES and NO. Like fluid couplings, SmartCOUPLINGs provide cushioned start to ensure maximum life of the system components and also provide protection against load seizures. However, unlike fluid couplings, there is no need to worry about leaking fluids, overheating oil, or regular fluid changes and maintenance. Because the Inline SmartCOUPLING has no touching or wearable parts, there is literally NO MAINTENANCE — and the coupling will also never wear out!

The SmartCOUPLING is also the first and only magnetic coupling with a torque curve/capacity that matches that of fluid couplings, meaning it can be used to start high-inertial loads such as conveyors and compressors without the need for over sizing. Finally, the SmartCOUPLING is typically less expensive than fluid couplings of the same capacity.

Is the Flux Drive an Eddy Current type device?

NO. All Flux Drives are induction devices that follow AC motor theory and design. As a result, they are ½ the size of older "eddy current" magnetic drives (for same HP) and operates at higher efficiencies (98% at full power/torque). In addition, and most importantly, the torque curve of the Flux Drive produces up to 140% torque at 100% slip (during starting). This allows the Flux Drive to start high inertia loads with plenty of torque available.

To the contrary, Eddy Current drives have a distinctive torque profile that rolls off at 100% slip and can create a 'stall' or slip condition. Not only will eddy current couplings fail to start high inertia loads at their rated horsepower (requiring over sizing) but they will overheat if left in a stall condition — destroying the coupling and potentially some of the connected equipment. (see slip curve noted below)

Exactly how are Flux Drive products different from older Eddy Current Drives?

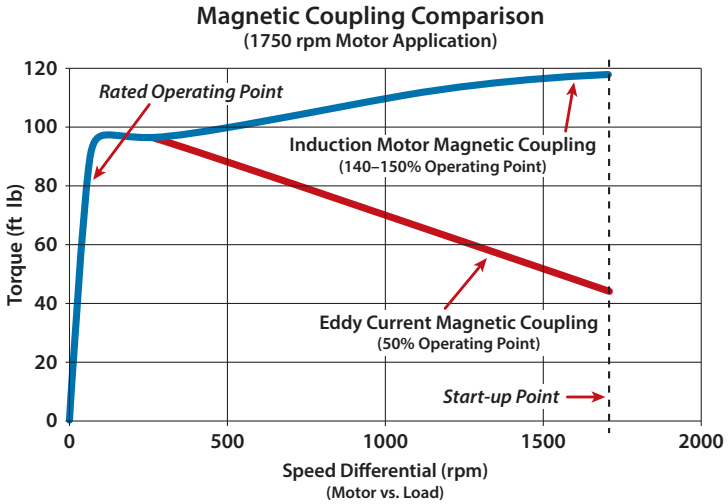
Eddy Current Drive technology has been around for more than 50 years. It began with the use of electromagnets that continuously drew current (amps) to create the magnetic field for torque

transmission. However, this process consumed energy in an effort to save energy, and was therefore not as efficient as using permanent magnets.

In the late 1990s eddy current drives based on rare-earth permanent magnets were introduced. While not requiring an external power source, making them more efficient than their electromagnetic cousins, these new products had several shortcomings of their own.

First, eddy current devices all have a declining torque profile/curve over their operating range. This means eddy current couplings or ASDs can only produce about 50% of their full power/torque at a 100% slip condition. Since 100% slip always occurs at the instant an application is started up, EC drives are limited to applications that required very low starting torque (such as centrifugal pumps and fans). Or, they must be dramatically oversized for applications with high starting torque (such as conveyors, compressors and centrifuges).

In comparison, all Flux Drive products transmit up to 140% of rated operating torque at start-up, thereby allowing worry free start-up of high inertia loads. As described earlier, this condition also allows the motor to "trip" off line in the event of an overload condition or load shaft seizure event. In those conditions, eddy current devices have the potential to overheat and fail and must often be accompanied by the installation of separate thermal or rpm sensors. The graph below demonstrates these radically different torque profiles:



Who are the Flux Drive SmartCOUPLING's competitors in the soft-start/flexible coupling market?

Flux Drive's SmartCOUPLING is much more than an energy savings device. While it allows for load speed reduction and the resulting reduction in kW consumption, it also provides significant maintenance benefits. Because the Inline SmartCOUPLING completely disconnects the motor from the load across an air gap, it provides far more "flexibility" in terms of misalignment correction and vibration reduction than other forms of flexible couplings — such as elastomeric, grid, gear and disc pack couplings. Unlike those products, it also provides inherent soft start. No other flexible coupling has the ability to slip during start-up to provide such a benefit.