How Fiber Optic and Electromechanical Position Sensors play a critical role in industrial, medical and other harsh environment applications

Presented by **Dennis Horwitz**, Technical Sales Manager, Micronor LLC

MD Webinar March 23, 2021
Updated March 30, 2021

Webinar Outline

- ❑ What is a Position Sensor?
- ❑ Types of Position Sensors
- ❑ How Encoders, Resolvers and Switches Work
- ❑ Combinational Position Transducers
- ❑ Comparison of Position Sensor Technology
- ❑ Case Study #1: Industrial – Arc Furnace
- ❑ Case Study #2: Material Handling – Cranes and Hoists
- ❑ Case Study #3: Power and Energy – Wind Turbines
- ❑ Case Study #4: Medical – MRI Applications
- ❑ Case Study #5: Infrastructures – Dams and Overflow Gate Controls
- ❑ Case Study #6: Transportation – Electric Railway
- ❑ Case Study #7: Energy & Radiation Environment – ITER Fusion For Energy Project
- ❑ How To Design For Position Sensors
- ❑ Summary – What have we learned?
- ❑ Questions and Answers

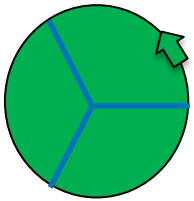
Poll Question

How many of you have a basic understanding of how encoders work and when they are used?
Yes/No

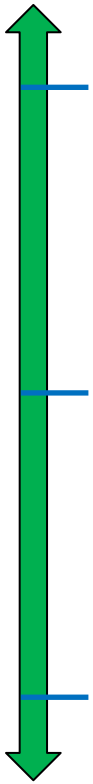
What is a Position Sensor?

A position sensor is any type of device which detects the movement of a chosen object in either a rotary or linear motion and converts the movement into output signals which are suitable for processing, transmission or control depending on the application.

- Position
- Speed or Velocity
- Acceleration



Single Turn (ST) or Multi-Turn (MT)



What type of position feedback is required?

Continuous: Provides precise position value over the entire range of motion – rotary or linear.

Discrete: Limit switches provide feedback at specific position points, typically for simple position or fail-safe status. Outputs can be either logic output or open/closed contact.

Major Types of Continuous and Discrete Position Sensors

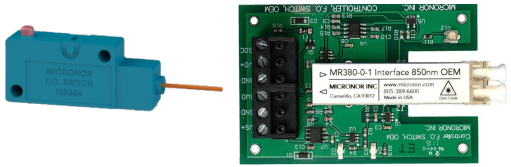
In this presentation, we will discuss the major types of **Continuous** and **Discrete** position sensors and why they are specifically used for some challenging medical, industrial and harsh environment applications:

Continuous Position:

- Fiber Optic Encoder
- Optical/Magnetic Encoder
- Resolver

Discrete Position:

- Fiber Optic Micro Switch
- Electromechanical Micro Switch
- Electromechanical Cam Switch



Encoders

Definition: Encoders convert position of a shaft or axle or encoder strip to a digital code.

Electromechanical:

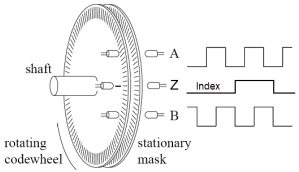
An optical encoder has a disc patterned with transparent and opaque areas. A light is shined through the disc, and a photo detector reads the optical pattern that results and processes it into a digital output.

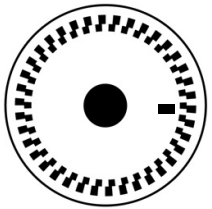
Fiber Optic:

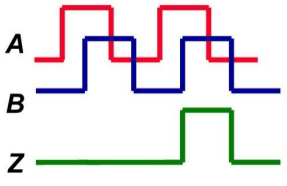
A fiber optic encoder is entirely optical and totally passive. A remote optoelectronics interface module allows all light transmission to occur over two fibers. Both incremental and absolute encoders use differential optical techniques – so each uses unique controller or interrogator unique to its family.

Incremental vs Absolute Position

Incremental Encoders are used when velocity is to the key value to be measured but can also infer position and acceleration. Their native outputs are the A & B quadrature pulses and (optional) Z index pulse.







Incremental Encoder

Absolute Encoder
Serial SSI or Digital Word
"1010110101001001"

Absolute Encoders are used when position is to the key value to be measured but can also infer velocity and acceleration. Single turn (ST) absolute encoders provide position of 0-360°. Multi-turn (MT) encoders provide ST position but also count the number of turns the encoder has registered. Standard interface options include Analog, Parallel, USB, Serial SSI, RS485, Modbus, Profibus, CANbus and Ethernet. All outputs are based on an internally digital value.

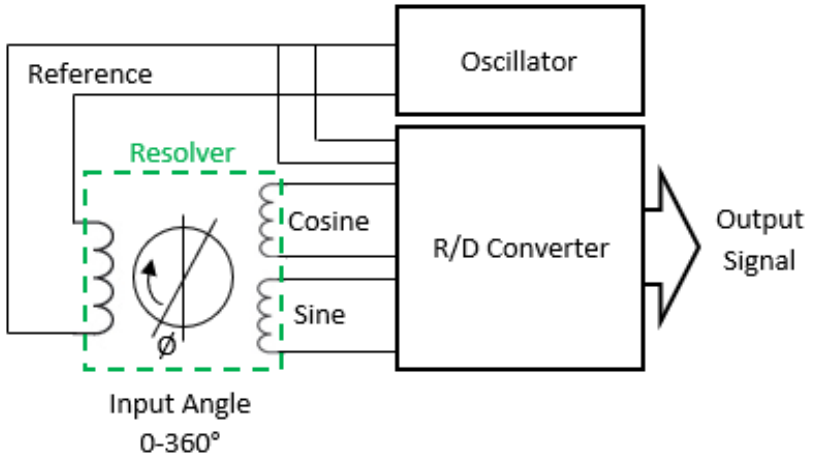
micronor
a division of PHOTON CONTROL

Resolvers

Resolvers are rotary transformers that use the magnitude of energy in its windings to determine **absolute** shaft position. Energy is supplied to a single reference winding attached to the rotor, while two secondary windings – SIN and COS – are displaced 90 degrees from each other. An external R/D (resolver-to-digital) interface is required.

Standard Resolver with Wired Rotor

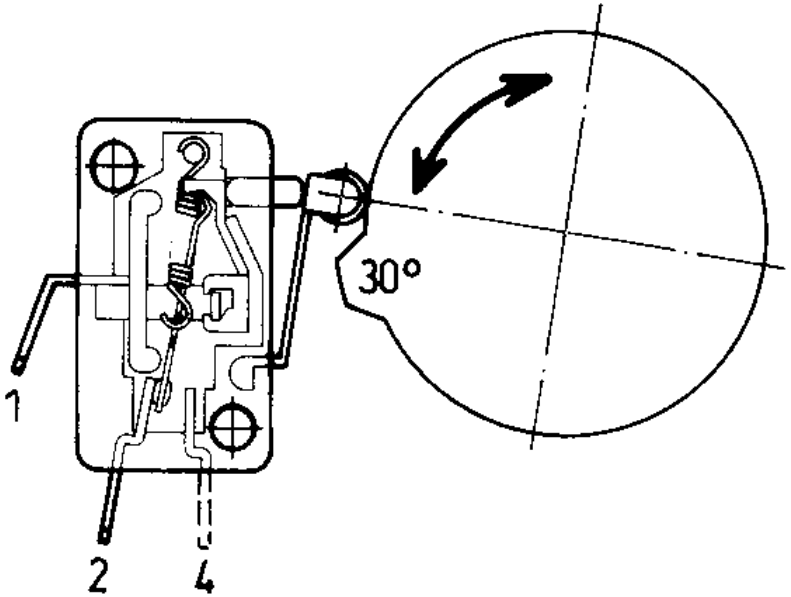
High Performance Resolver with Solid Rotor (Magnetically Shaped)



Limit Switches

A **limit switch** is physically actuated by the motion of a machine part. They are used for controlling machinery as part of a control system, as safety interlocks or to count objects passing a point.

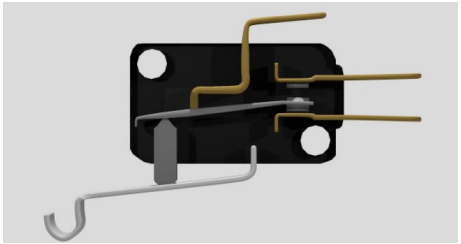
The plunger is actuated by the external machinery. Special purpose actuators such as leaf springs, arms and rollers are available to match the range of motion of the application.

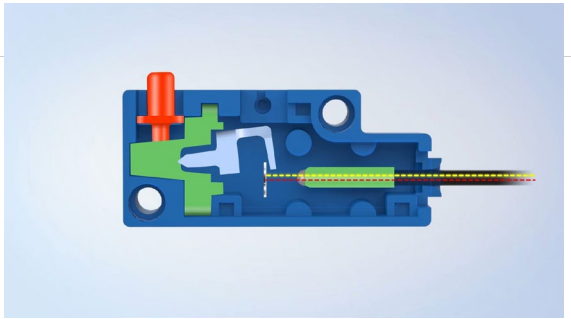


Electromechanical versus Fiber Optic Micro Switches

Electromechanical Micro Switches have an actuator that, when depressed, opens or closes the electrical contacts. These contacts control whatever electrical loads are connected – for example, control power directly to a device, control a relay or solenoid for switching a larger electrical load, or control a logical voltage signal to a PLC.

Fiber Optic Micro Switches are completely optical. Instead of contacts opening or closing, it uses a photo interrupt scheme whereby the internal actuator is positioned to either allow or block transmission of the optical signal. The optical signal triggers the remote controller which causes the relay contacts to flip accordingly.



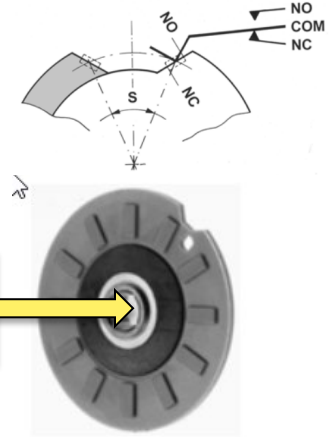


Rotary or Linear Cam Switches

Cam switches offer discrete position feedback or fail-safe backup control without the need for electronics or software. Cams are mechanically programmed to actuate microswitches based on the position of the input shaft.

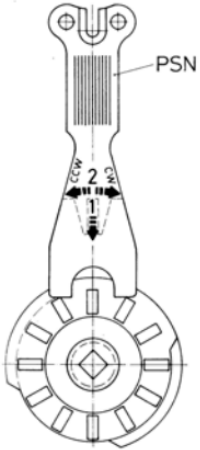
Input Shaft

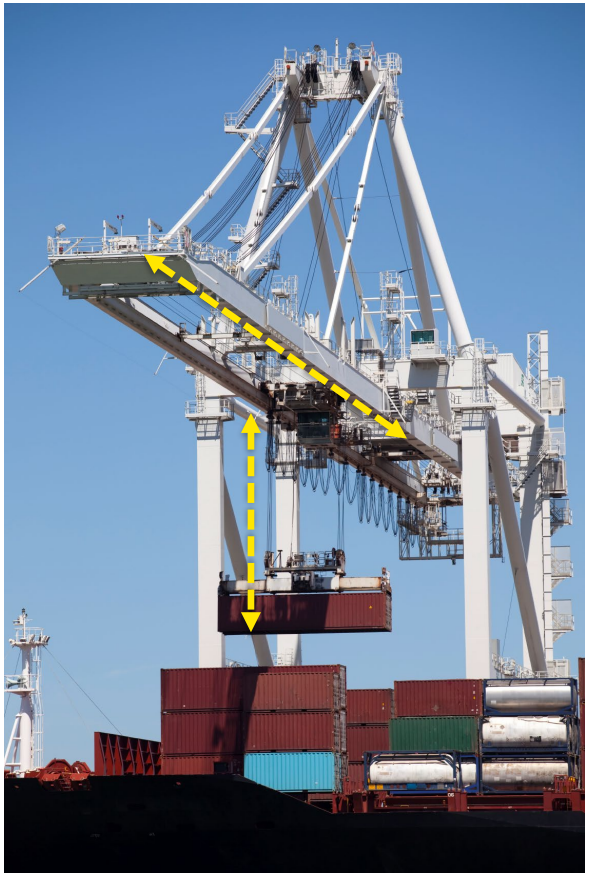
Increase 1:X or Reduce X:1



Single Cam
(Fixed 20° Notch)

Double Cam
(Two 180° Single Cams Joined Back-to-Back Provide Actuation Range of 4° to 356°)





micronor
a division of PHOTON CONTROL

Combinational Position Transducers

In some applications, dual requirements present the need for multifunctional position transducers – position sensors and limit switches in a single, integrated unit.

For example, the yaw position sensor in a wind turbine requires both monitoring both angular position and fail-safe cable twist set-points. Combining an encoder with dual-channel geared limit switches simplifies installation using a single package and maximizes reliability.

Comparison of Position Sensor Technology

Performance Comparison of “Continuous” Position Sensors

Typical Characteristics	Resolver	Optical or Magnetic Rotary Encoder	Fiber Optic Rotary Encoder
Classification	Electrical	Opto-electronic or Hall-effect Magnetic	Optical
Types Available	Absolute-Single Turn	Absolute or Incremental	Absolute or Incremental
External Interface Required	Resolver/Digital Converter	None (Self Contained)	Encoder-specific Interrogator
Form Factor	Solid Shaft or Frameless	Solid Shaft or Hollow Shaft	Solid Shaft or Hollow Shaft
Temperature Range	-60°C to +200°C	-40°C to +110°C	-60°C to +150°C
Max. Speed (RPM)	200,000	10,000	8,000
Resolution	12-bit	Inc: 36,000 ppr Abs: 17-bit	Inc: 1024 ppr Abs: 14-bit
Accuracy	± 0.05°	1 count	1 count
Max. Distance (m)	20	20	2000

Environmental Capabilities of Encoders & Resolvers

Environment	Resolver	Optical or Magnetic Rotary Encoder	Fiber Optic Rotary Encoder
Benign Environment	✓	✓	✓
High Temperature > +110°C	✓	✗	✓ (Up to 125°C)
Low Temperature < -45°C	✓	✗	✓
Long Distance > 50 m	✗	✗	✓
High Speed > 10,000 rpm	✓	✗	✗
EMI/RFI	✗	✗	✓
Magnetic Fields	✗	✗	✓
RF Fields	✗	✗	✓
High Voltage/Lightning	✗	✗	✓
Explosive Atmosphere	● (EX Proof required)	● (EX Proof required)	✓ (Inherently Safe)
Radiation (Nuclear)	● (Requires red-hard resolver)	✗	● (Requires rad-hard fiber)

✓ Recommended

● Provisional

✗ Not Recommended

Performance Comparison of “Discrete” Position Sensors

Typical Characteristics	Electromechanical Micro Switch	Fiber Optic Micro Switch
Classification	Electromechanical	Optical
External Interface Required	None	Fiber Optic Controller (Remote Relay)
Temperature Range	-15°C to +80°C (Standard V-series Switches) -53°C to +85°C (Mil Microswitch) -65°C to +400°C (High Temperature)	-40°C to +80°C
Switch Rating	UL: 5A – 25A (Standard V series Switches)	UL Rating, Controller Relay: 30VDC @ 2.0A 110VDC @ 0.3A 120VAC @ 0.5A 240VAC @ 0.25A
Max. Distance	20m	2000m

Environmental Capabilities of Microswitches

Environment	Electromechanical Micro Switch	Fiber Optic Micro Switch
Benign Environment	✓	✓
High Temperature > +110°C	✗	✗
Low Temperature < -45°C	✗	✗
Long Distance > 50m	✗	✓
EMI/RFI	✗	✓
Magnetic Fields	✗	✓
RF Fields	✗	✓
High Voltage/Lightning	✗	✓
Explosive Atmosphere	● (Ex Proof Required)	✓
Radiation (Nuclear)	● (Rad Hard Required)	✗

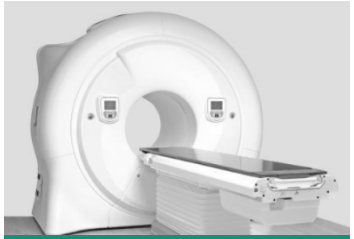
✓ Recommended

● Provisional

✗ Not Recommended

Harsh Environment Applications Where Position Sensors Are Used

Numerous Applications



Medical (MRI)

Defense & Communications

Power & Energy

CNC Machinery

Dams & Flood Control

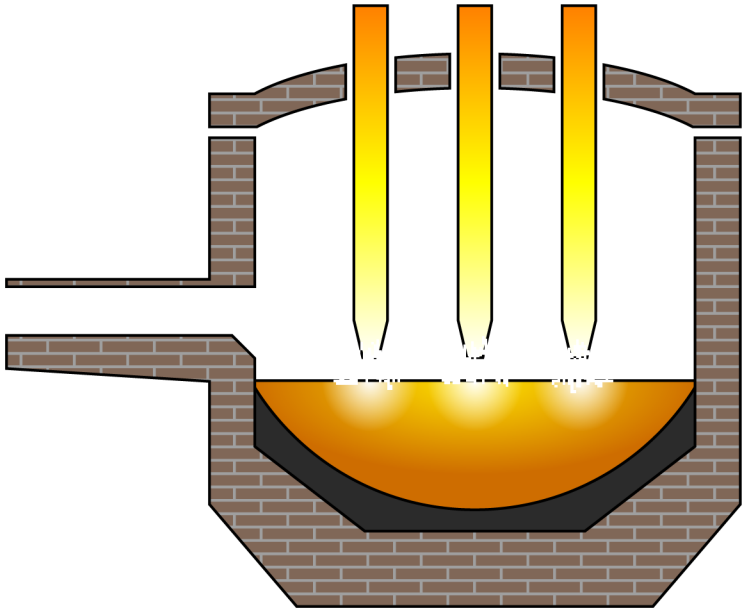
Material Handling

Metallurgy

Transportation

micronor
a division of PHOTON CONTROL

Case Study #1: Industrial – Electric Arc Furnace



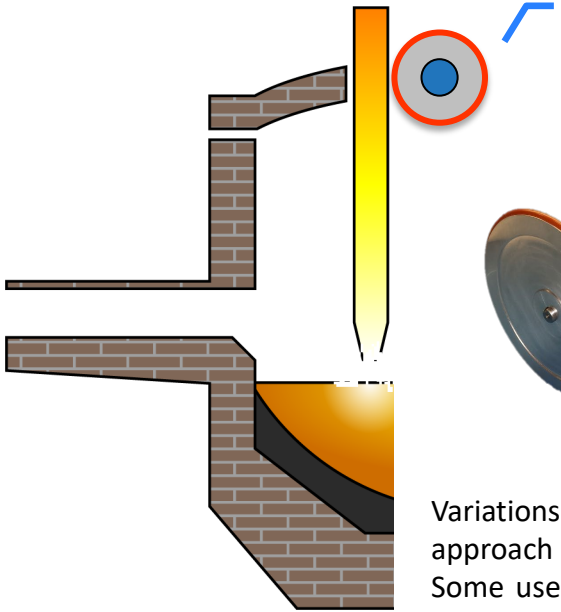
Typical AC-driven Electrical Arc Furnace (AC-EAF)
Servo motor or hydraulic cylinders control electrode position.
Position feedback and control critical to performance.

APPLICATION
An EAF heats charged material by means of an electric arc. It is a common method for processing raw and scrap steel, platinum, silica and other ores. Mid-size furnaces operate at 60,000,000 Volt-Amperes (60 MVA) with secondary voltage 400-900V at up to 44,000A.

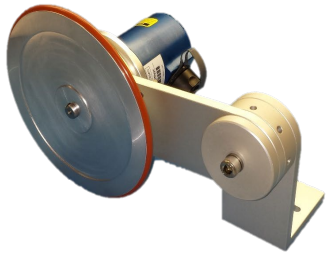
CHALLENGE
The carbon/graphite electrodes wear over time and electrode position must be monitored for optimal ore processing. The equipment operates at sustained elevated temperature and high electrical noise environment.

SOLUTION
The size and parameters of the specific furnace define the operating environment for the position sensor. The typical solution is an incremental encoder driven by a friction wheel contacting the electrode surface.

Measuring Wheel using FO or EM Encoder



Encoder Mounted On Axis of Wheel with High Temperature Silicone Rubber Tread



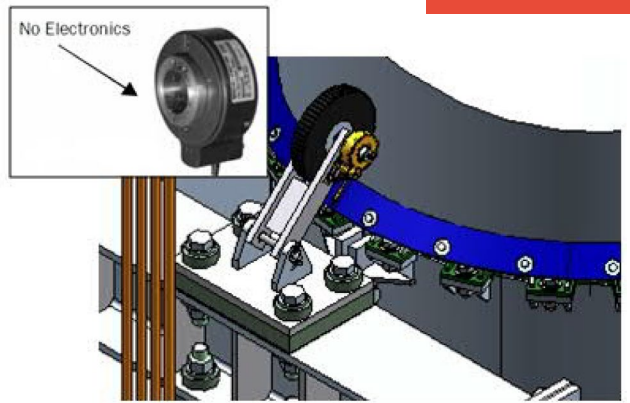
Variations of the Measuring Wheel approach are used by customers. Some used Fiber Optic Encoders and other uses EM Optical Encoder. Furnace size and application define the operating environment for the position sensor.

	Fiber Optic Encoder	Optical Encoder
Temperature	Max 125°C	Max 85°C
EMI and High Voltage Immunity	✓	● (Requires expensive, heavy duty, high temperature shielded cabling)
Encoder Power Requirements	N/A	Requires Power
Reliability Issues	None	Reliability affected by HV spikes & transients
Resolution	1024 ppr	Up to 36,000 ppr
Acquisition Cost	$$	$
Operating Cost	$	$$

Customer Installation using FO Encoder

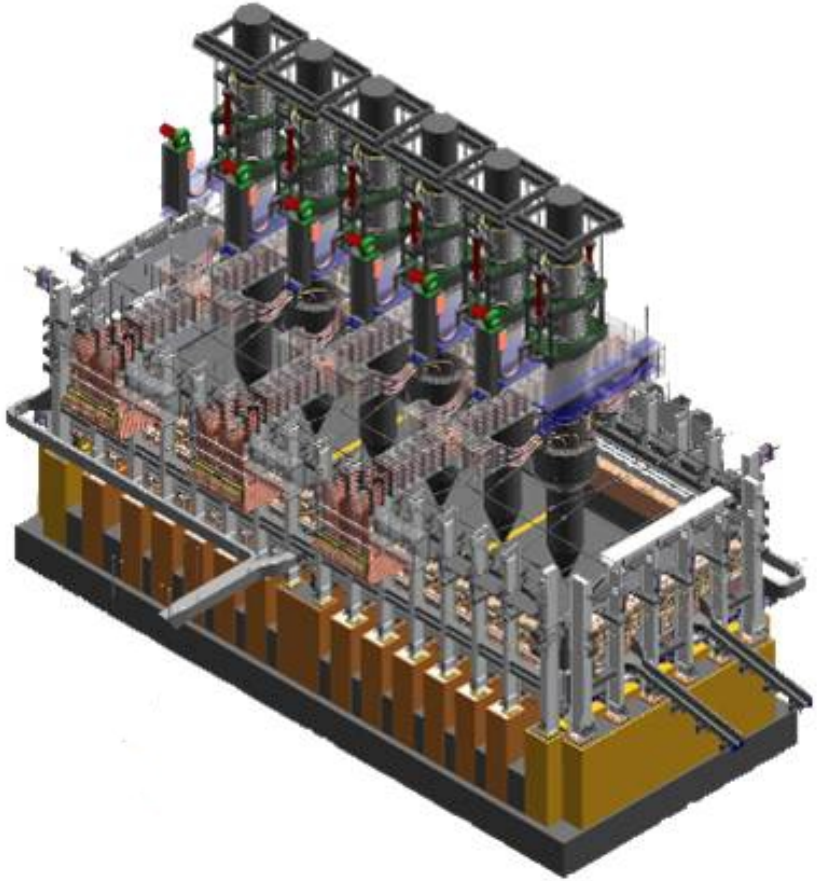
Photos and renderings courtesy of Hatch Ltd

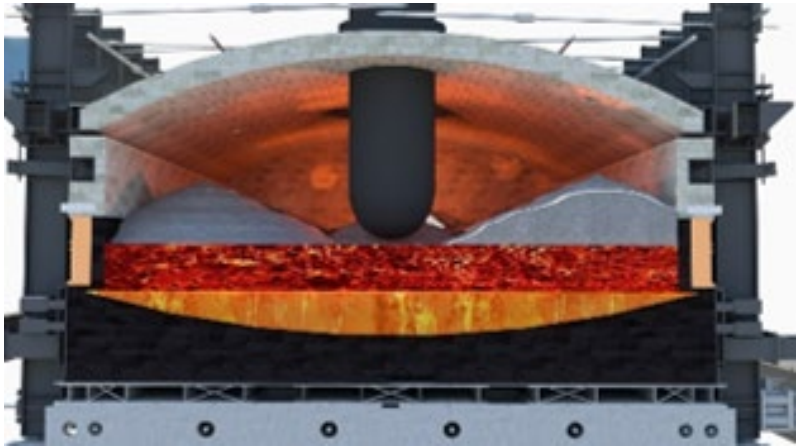
MR324/MR344
Hollow Shaft Encoder



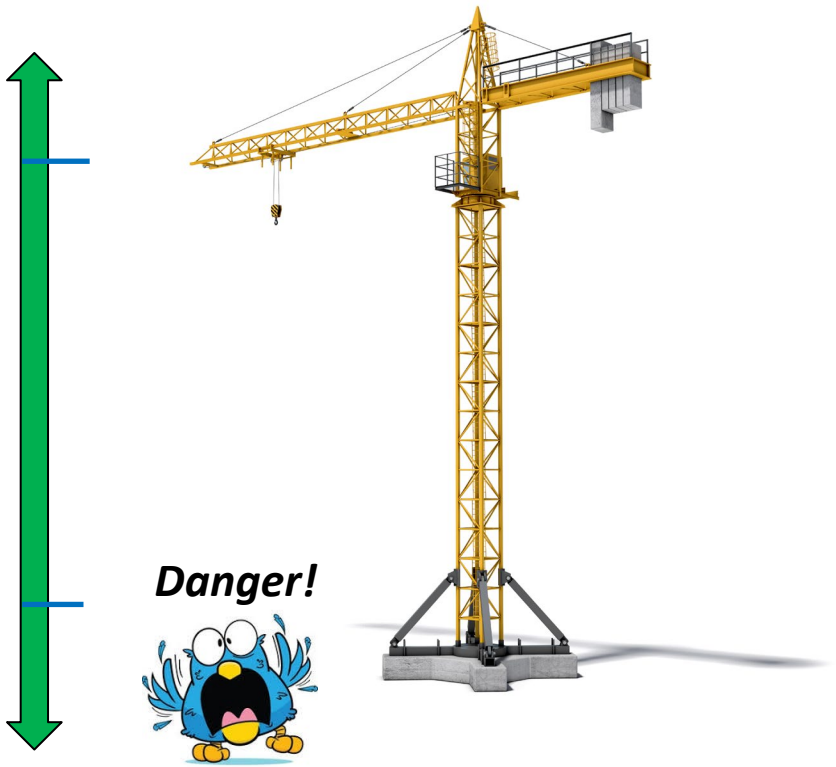
Hatch slipping systems measure slip distance and schedule slipping to maintain the desired electrode length

Customer Installation using FO Encoder





Case Study #2: Material Handling – Cranes & Hoists



APPLICATION

Typically cranes and hoists use a drum method to lift loads. The position of the object being lifted is controlled by letting out or pulling in the wire or rope wrapped around a drum.

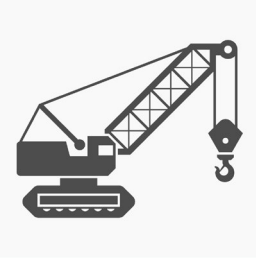
CHALLENGE

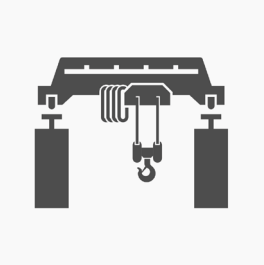
Based on the worksite and cabling available, cranes and hoists have a limited range of motion. Pulling the cable too high can damage the crane. Dropping the load too load could create a hazard for loading personnel as well as the loading platform (i.e., deck of a cargo ship). To prevent injury and damage, the position of the cabling drum must be constantly monitored.

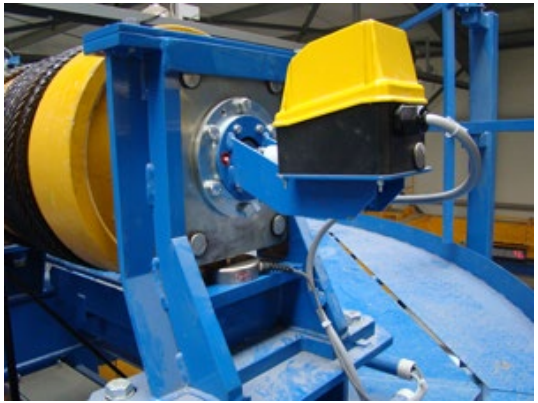
SOLUTION

Cranes and hoists typically use a combination of encoder/resolver for continuous position and independent limit switches for fail-safe operation.

Monitoring Crane or Drum Hoist Position







	Mainstream Application	Special Purpose Nuclear Application
Position Feedback	Optical Encoder or Resolver	Fiber Optic Encoder (Standard or Radiation Resistant)
Limit Feedback	Limit Switch (for fail-safe feedback)	Limit Switch (for fail-safe feedback)
Radiation Environment	✘	✓ Radiation Resistant Fiber Optics

Case Study #3: Power & Energy – Wind Turbines

Similar Control Application: Satellite Ground Antenna, Azimuth and Elevation

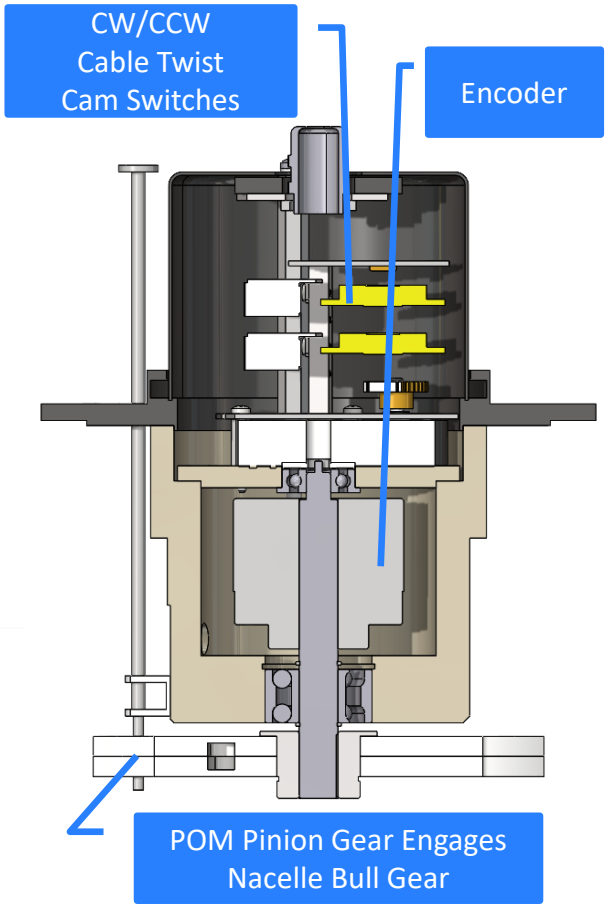
APPLICATION
For optimal wind turbine operation, the turbine must be pointed into the wind. A servo motor control uses position feedback to achieve power production optimization.

CHALLENGE
As the wind turbine changes angular position, control and power cables running down the tower can become twisted. The equipment must monitor the position of the turbine to maximize efficiency, while preventing cable failure due to over-rotation. The wind turbine must also be located where lightning cannot zap electronics.

SOLUTION
Using both an encoder and geared limit switches provides an efficient solution for controlling position while restricting over-rotation.

Satellite ground antennas have similar requirements – monitoring azimuth and elevation.

Monitoring Yaw Position using FO or EM Encoder



	Standard Version	Lightning Resistant	Special Purpose
Position Feedback	Optical Encoder	Optical Encoder with Lightning Protection Circuitry	Fiber Optic Encoder
Limit Feedback (For CW and CCW cable twist limits)	2x Limit Switches	2x Limit Switches	2x Limit Switches
EMI Environment	✘	✘	✓
Lightning Immunity	✘	✓	✓
Acquisition Cost	$ (No Protection)	$$	$$$
Cost of Ownership	$$$$ Lightning induced failures have high cost of lost power	$$ Reduced exposure to Lightning induced failures	$ Immune to Lightning

Case Study #4: Medical – MRI

APPLICATION

MRI scans allow doctors to create detailed pictures of areas within the body, usually for treating patients or for medical research. The MRI bore uses radio waves and powerful magnets to generate images. Typical MRI bores operate with a magnetic field strength up to 3 Tesla (T).

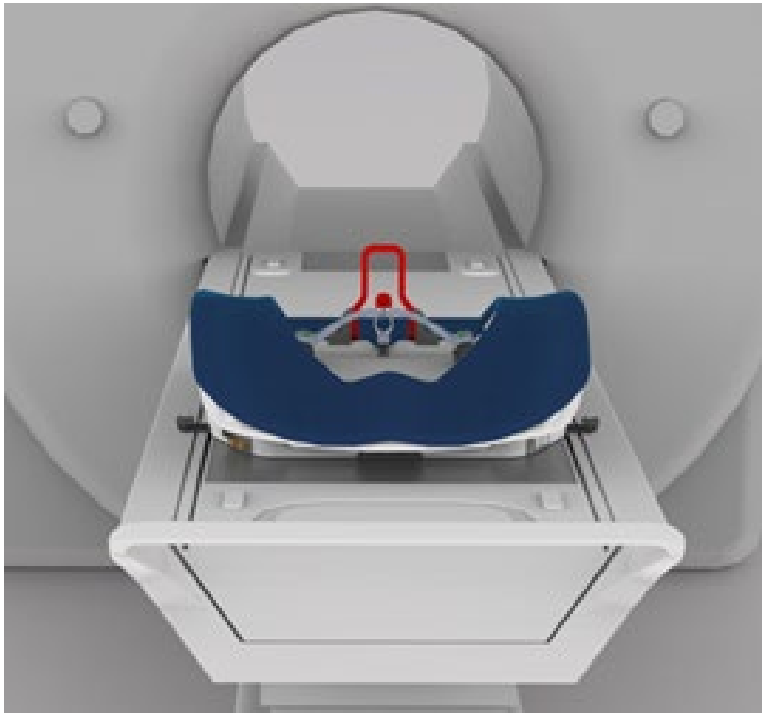
CHALLENGE

The position of a device within an MRI bore must be tracked while conducting research. Each sensor must dynamically measure movement while remaining immune and invisible to magnetic fields to prevent being registered by the MRI.

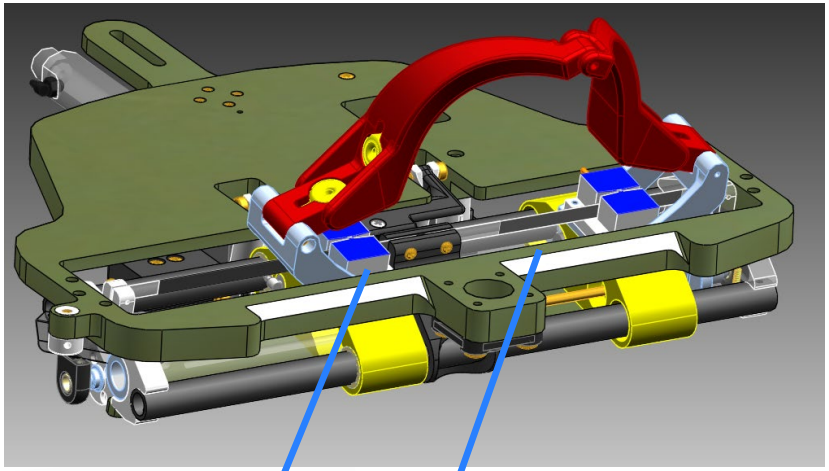
SOLUTION

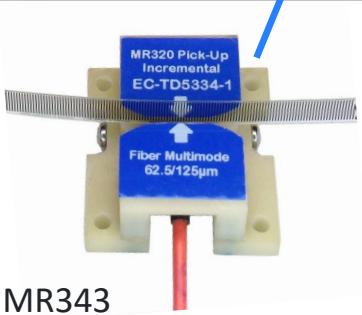
An MRI-safe fiber optic encoder has no metal parts and can be used to monitor position without affecting or appearing on MRI scans.

MRI Guided Biopsy Robot uses FO Linear Encoder



Photos and renderings courtesy of
Polymer Robotics / Umano Medical



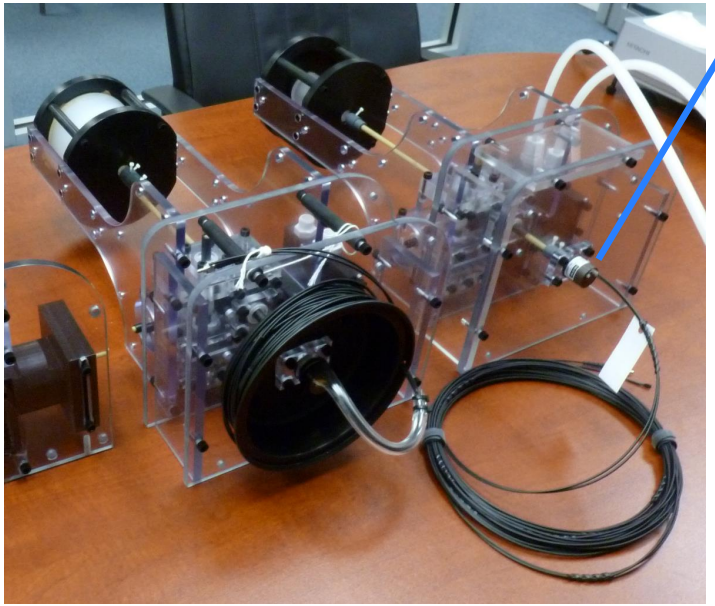


MR343
FO Linear Encoder
(2 Axes Shown)

Precision MR343
Incremental
Film Strip
(2 Axes Shown)

micronor
a division of PHOTON CONTROL

Dynamic Phantom – Fiber Optic Rotary Encoder



MR431 POF-based Absolute Encoder

The MRI Dynamic Brain Phantom is designed to address training and quality assurance protocols for MRI machines by providing rapid control feedback from within the MRI bore, while remaining invisible to MRI scans.

MRI Compatibility - Encoders

	Fiber Optic Encoder	Optical Encoder
Position Feedback	Fiber Optic Encoder	Optical Encoder
Limit Feedback	Limit Switch (for fail-safe feedback)	Limit Switch (for fail-safe feedback)
Materials	✓ MRI Compatible Non-metallic	✗ Metallic
EMI/RFI Resistant	✓	✗
Magnetic Field Resistant	✓	✗
Invisible to MRI Scan	✓	✗

micronor
a division of PHOTON CONTROL

Case Study #5: Infrastructure – Sluice & Flood Gates

Dams, Hydroelectric Generating Plants, Levees and Flood Control facilities use gates to release and control the flow of water.

APPLICATION

Position feedback of gates for either remote manual monitoring or automatic control of water flow:

- Sluice gates are adjustable gates used to channel and control the flow of water to a generating plant or mill.
- Flood gates are used to control water flow in flood barriers, reservoir, river, stream, or levee systems.

CHALLENGE

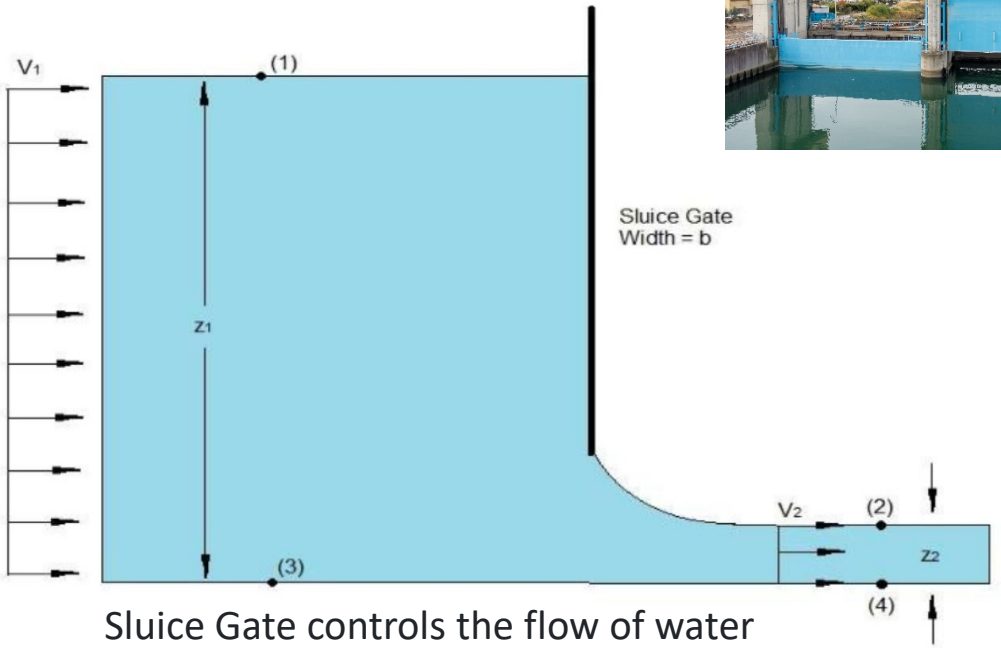
Full control of gate requires both continuous and discrete position feedback. Dams and flood control systems are transitioning from manual operation to PLC-based automated control – replacing obsolete technology 40+ years old.

SOLUTION

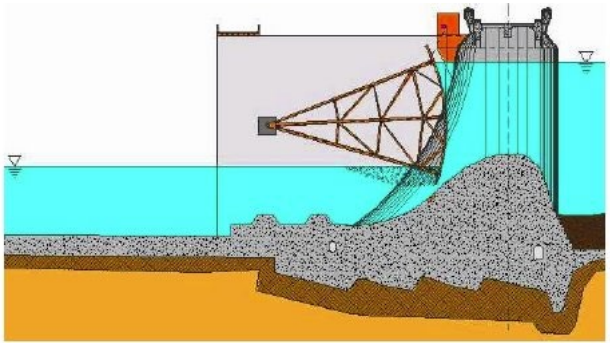
Typically, an absolute encoder provides continuous position feedback to the PLC while limit switches provide independent, fail-safe position feedback at specific operating points. The specific gate design determines how the absolute position and limit switches are integrated into the system.

Types of Sluice Gates

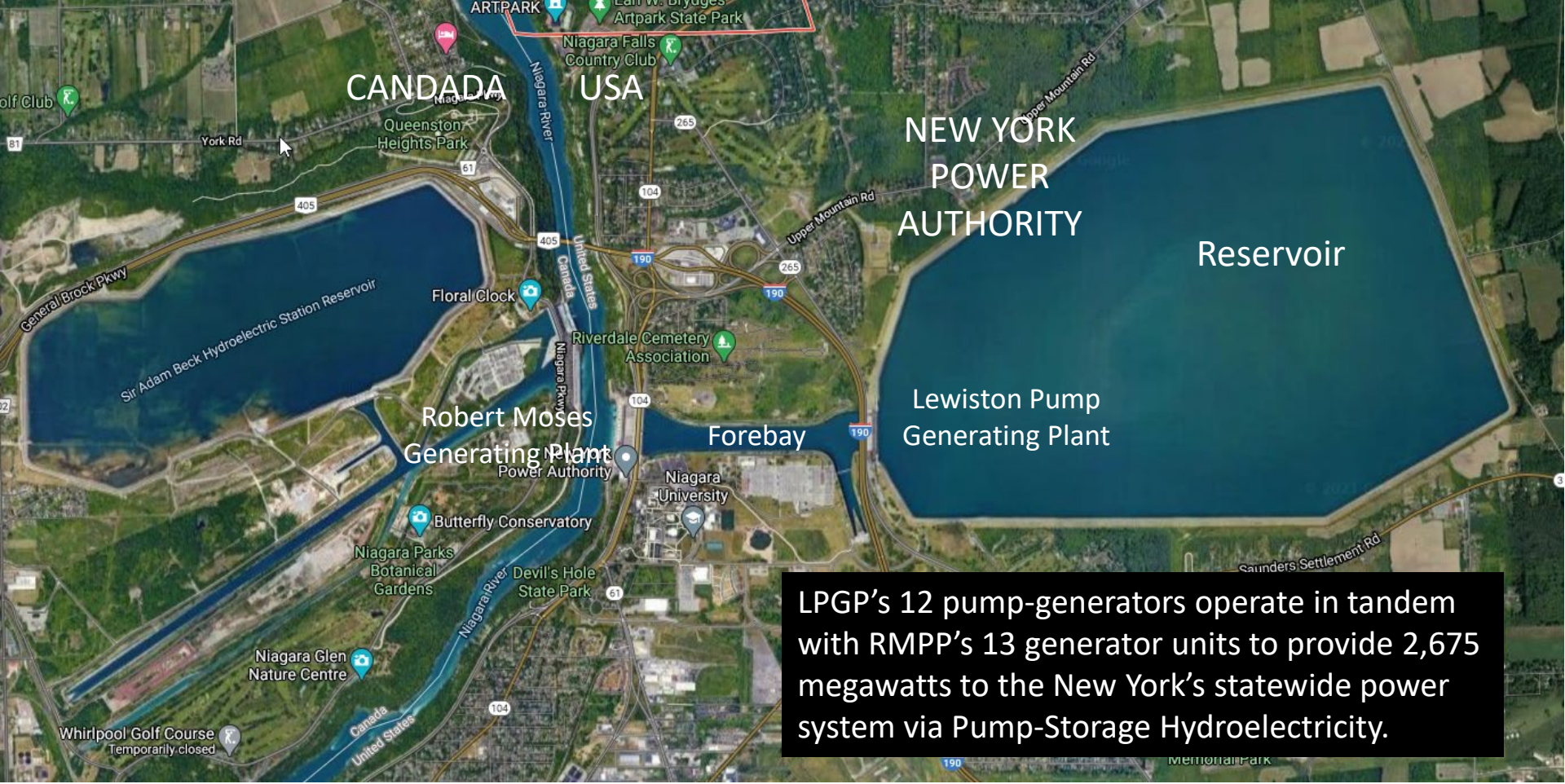
Bulkhead (Vertical Riser) Gates consist of a flat plate sliding in the vertical direction and are controlled by machinery, typically a drum hoist.



Sluice Gate controls the flow of water



Radial (Tainter) Gates are a cylindrical design which rotate up to allow water to pass underneath.



LPGP's 12 pump-generators operate in tandem with RMPP's 13 generator units to provide 2,675 megawatts to the New York's statewide power system via Pump-Storage Hydroelectricity.

New York Power Authority – Niagara-based Lewiston Pump Generating Plant (2014) and Robert Moses Generating Plant (2021) Upgrade Projects

Robert Moses Generating Plant
Niagara, New York

At night, two tunnels divert water (600,000 US gallons per second) in the Niagara River to the forebay. Electricity generated in the Moses plant powers the pumps to push water into the upper reservoir behind the Lewiston Dam. The water is pumped at night because the demand for electricity is much lower than during the day. In addition to the lower demand for electricity at night, less water can be diverted from the river during the day because of the desire to preserve the appearance of the falls.

During the following day, when electrical demand is high, water is released from the upper reservoir through the pump-generators in the Lewiston Dam. The water flows into the forebay, where it falls through the turbines of the Moses plant. This arrangement is a variant of **Pump-Storage Hydroelectricity**.

Micronor Position Feedback Solution for LPGP/RMGP

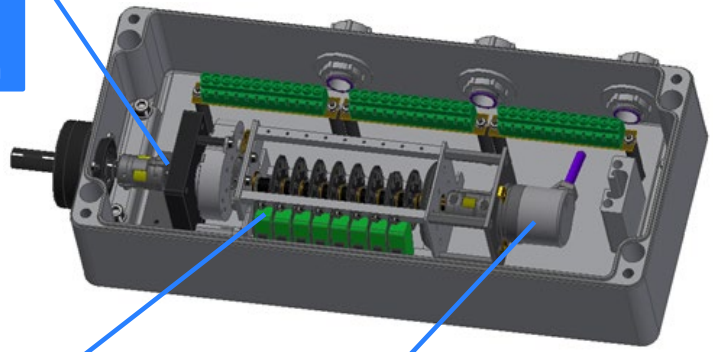
Fully Up (22.5 Turns)
Extreme Open

Above Water
Fully Open

Partially Closed
Closed

Original Unit, 1960s

25:1 Gear Reduction



8x Cam Switches

ST Absolute Encoder with 4-20mA Output

Micronor TD 9500.00.900, 2014-2021

NYPA HEADGATE CONTROLS
LIMIT SWITCH DEVELOPMENT TABLE

	Switch Point -4.4'	4mA Closed 0"	- CCW -> Full Opened 6"	35'	44'	50'	Full Travel 54'
LS-1							
LS-2							
LS-3							
LS-4							
LS-5							
LS-6							
LS-7							
LS-8							

NOTES
Relative to facing input shaft of Micronor feedback unit

LS-1	OPEN WHEN GATE IS ABOVE WATER
LS-2	CLOSED WHEN GATE IS CLOSED, OPENS WHEN GATE IS 6" FROM BOTTOM
LS-3	OPEN WHEN GATE IS FULLY OPEN
LS-4	OPEN WHEN GATE IS CLOSED
LS-5	CLOSED WHEN GATE IS FULLY OPEN
LS-6	OPEN WHEN GATE IS CLOSED
LS-7	OPEN WHEN GATE IS IN EXTREME OPEN POSITION
LS-8	CLOSED WHEN GATE IS 6" ROM BOTTOM, OPEN WHEN GATE IS CLOSED

Micronor Position Feedback Solution for LPGP and RMGP Sluice Gates

Standard MR221/MR222 Series
Geared Limit Switches

	Original Solution	Modern Solution
Continuous Position Sensor	Potentiometer	PLC-Compatible ST or MT Optical Absolute Encoder
Discrete Position Sensor	Fixed Limit or Cam Switches	Cam Switches
Acquisition Cost	$$$$ Replacement Cost of Original Solution	$$
Cost of Operation	$$$ Potentiometer or Potentiometer-based Position Transducers use obsolete parts which are no longer replaceable.	$

Case Study #6: Transportation – Electric Railway

APPLICATION
Electric trains use pantographs mounted on the roof to collect power from an overhead contact line (OCL). Pantographs with OCLs have become the dominant form of current collection because of their ability to use voltages up to 25,000 volts (V), compared to just 750 V in a third rail system.

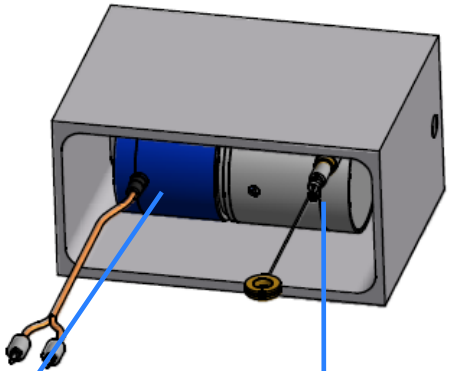
CHALLENGE
Vertical movement of the OCL is monitored to assess performance and ensure that power supply to the vehicle is stable. Railway sensors must be able to withstand high voltage spikes and remain immune to large amounts of electrical noise.

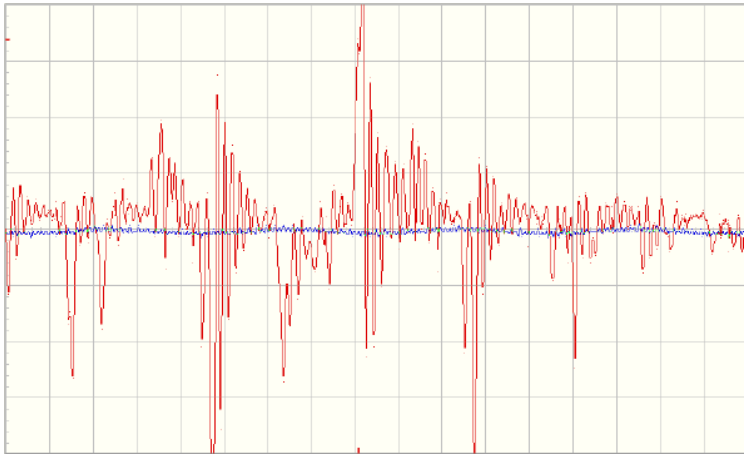
SOLUTION
A fiber optic drawstring encoder is 100% passive and resistant to high voltages. This allows direct measurement of the contact wire by mounting the sensor directly above it.

Fiber Optic Drawstring Encoder

Fiber Optic Drawstring Encoder mounted above Contact Wire

The fiber optic encoder allows direct measurement of the overhead contact line, whereas an optical encoder would fail in the presence of high voltage and produce irregularities due to high electrical noise in the system.





FO Incremental Encoder

Draw Wire Mechanism

micronor
a division of PHOTON CONTROL

Customer Installation using FO Drawstring Encoder

FO Drawstring Wire
FO Encoder Module

High Voltage Tension Line is “brushed” by passing Train’s Pantograph, causing line oscillations which reveal Pantograph condition

micronor
a division of PHOTON CONTROL

Case Study #7: Energy & Radiation Environment – Fusion for Energy

APPLICATION

The mission of Fusion for Energy (F4E) is to make fusion possible on Earth. ITER ("The Way") will be the first fusion device to generate more heat than is used to start the reaction. The process involves raising the temperature to 150 million °C to generate super-hot plasma, producing heat in the range of 500 MW for about 7 minutes.

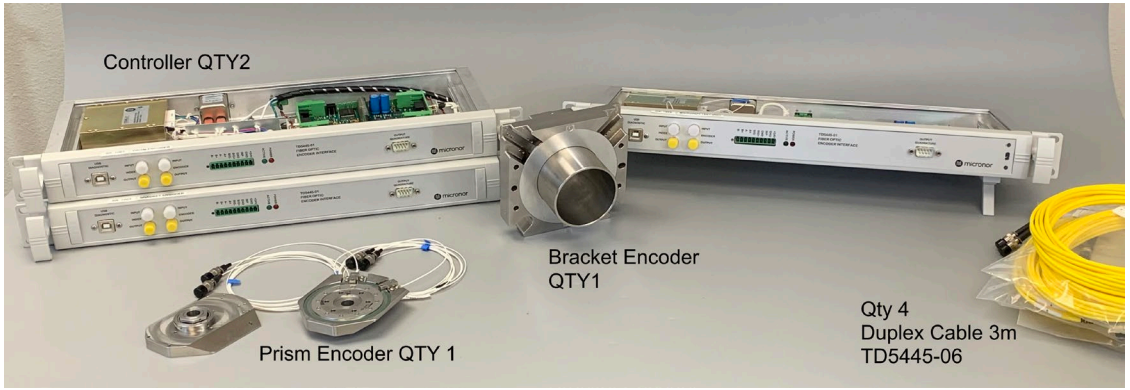
CHALLENGE

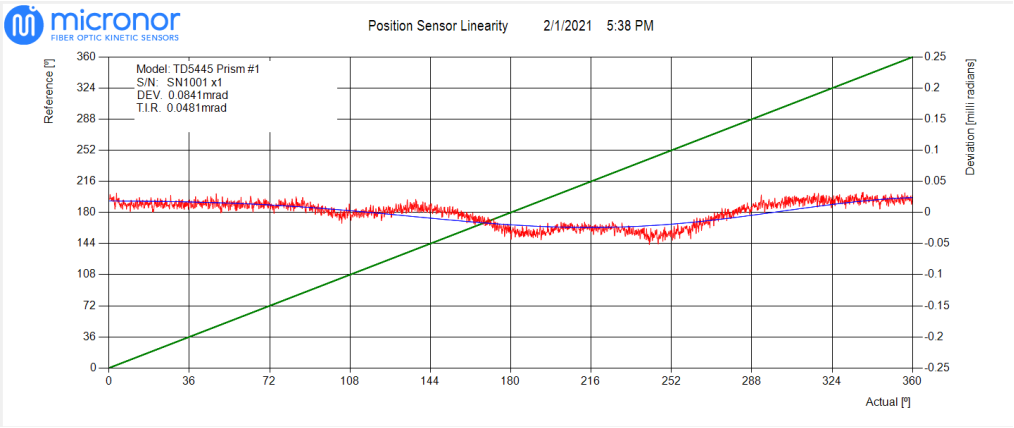
One of many challenges in this project is viewing the inside of the vacuum vessel to examine plasma-facing components when the fusion device is turned off. This requires an extremely precise inspection system, performed by the In-Vessel Viewing System (IVVS).

SOLUTION

Six probes are used at different points within the machine. Each uses a laser beam and rotating turret to scan the surface. Extremely high-resolution encoders measure this rotation, producing a 3D map of the machine.

High-Resolution Prism Encoder





	IVVS Prism/Bracket Encoders
Outputs	A/B/Z Quadrature Outputs
Resolution	157,050 ppr
Phase 1.2	Built proof-of-concept, functional units
Phase 2a	Incorporated Enhanced Resolution into Phase 1.2 Units (To Be Delivered)
Phase 3	Engineer and Build First Radiation Resistant Unit

How To Design For Position Sensors

A 6-Step Design Methodology

1. Choose appropriate Encoder, Resolver or Switch solution consistent with the application, installation requirements, operating environment, power and distance requirements.
2. Choose System-Compatible Interface.
3. Choose Appropriate Connector Types.
4. Choose Appropriate Fiber/Cable.
5. Follow Bend Radius and Clamping Rules (Do’s and Don’ts)
6. Choose Appropriate Interconnect and Feedthrough Solution.

1. Choose Position Sensor Technology that Best “Fits” the Application

1. What is the most important parameter to be monitored?
   - ❑ If position, then select Absolute Encoder.
   - ❑ If speed, then select Incremental Encoder.
   - ❑ For fail-safe limit feedback, select Limit Switches
   - ❑ Do you need a combinational, integrated feedback solution?
2. What is the range of motion – rotary or linear, total travel? Convert range of travel to # of turns when using rotary sensors. For multi-turn, position–driven applications, consider reduction gearing with ST absolute encoder/resolver or use a MT absolute encoder.
3. What is the minimum resolution requirement?
4. What is the maximum speed – either rotary rpm or linear m/s?
5. What is the shaft size? Determines size of sensor.
6. What is the preferred housing type? Solid shaft, hollow shaft or frameless?
7. Is this an Ex rated explosive atmosphere?
8. Is there operating criteria that require a FO Encoder?

Environmental Capabilities of Encoders & Resolvers

Environment	Resolver	Optical or Magnetic Rotary Encoder	Fiber Optic Rotary Encoder
Benign Environment	✓	✓	✓
High Temperature > +110°C	✓	✗	✓ (Up to 125°C)
Low Temperature < -45°C	✓	✗	✓
Long Distance > 50 m	✗	✗	✓
High Speed > 10,000 rpm	✓	✗	✗
EMI/RFI	✗	✗	✓
Magnetic Fields	✗	✗	✓
RF Fields	✗	✗	✓
High Voltage/Lightning	✗	✗	✓
Explosive Atmosphere	● (EX Proof required)	● (EX Proof required)	✓ (Inherently Safe)
Radiation (Nuclear)	● (Requires red-hard resolver)	✗	● (Requires rad-hard fiber)

✓ Recommended

● Provisional

✗ Not Recommended

Environmental Capabilities of Microswitches

Environment	Electromechanical Micro Switch	Fiber Optic Micro Switch
Benign Environment	✓	✓
High Temperature > +110°C	✗	✗
Low Temperature < -45°C	✗	✗
Long Distance > 50m	✗	✓
EMI/RFI	✗	✓
Magnetic Fields	✗	✓
RF Fields	✗	✓
High Voltage/Lightning	✗	✓
Explosive Atmosphere	● (Ex Proof Required)	✓
Radiation (Nuclear)	● (Rad Hard Required)	✗

✓ Recommended

● Provisional

✗ Not Recommended

All Different Shapes, Sizes, Form Factors

The encoder/resolver “landscape” is very fragmented:
Solid Shaft, Hollow Shaft, Measuring Wheel, Draw Wire, Ball Screw,
Linear Scale, Linear Guided, Piston, Panel Encoder, Manual Pulse Generator





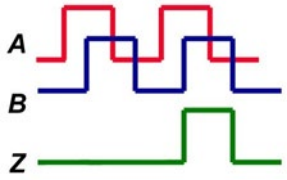






micronor
a division of PHOTON CONTROL

2. Choose System-Compatible Interface

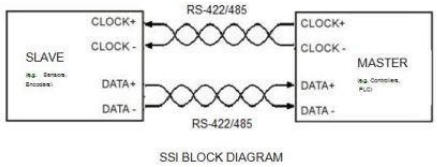


INCREMENTAL ENCODERS

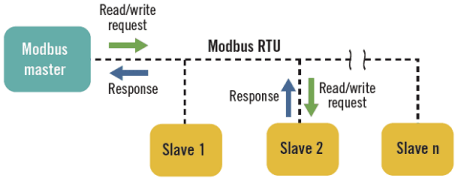
- A/B/Z Quadrature, RS422 or Push-Pull

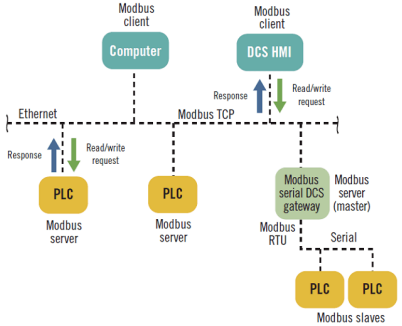
ABSOLUTE ENCODERS

- Standard Interface: SSI (Serial Synchronous Interface)
- Analog Interface: 4-20mA
- Standard Computer Interfaces: USB, RS232
- Fieldbus Interfaces: RS485/ModbusRTU, Profibus, CANopen
- Network Interfaces: Ethernet/ModbusTCP
- Additional Option: Incremental Encoder Track Output



SSI BLOCK DIAGRAM





3. Choose Appropriate Connector Types

Non-Environmental
Duplex LC FO Connector

Environmental and Non-Environmental
MIL MS-Series Multi-pin Connectors

Environmental-rated
Duplex IP-LC FO Connector

Environmental and Non-Environmental
DIN M23 Multi-pin Connectors

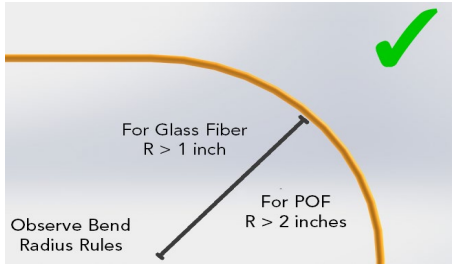
4. Choose Appropriate Cable

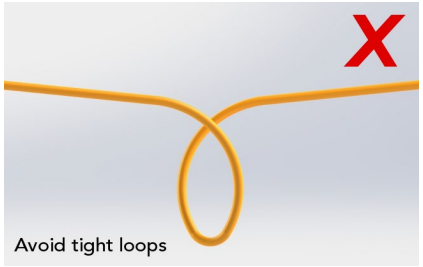
Heavy Duty, High Temperature EM Cables

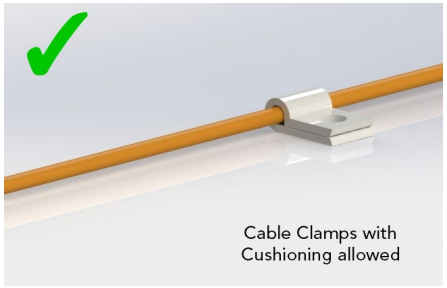
Heavy Duty FO Mil-Tac For Outdoor Environments

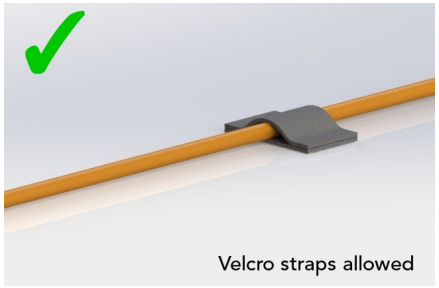
Choose appropriate cable type consistent with the application, industry standards and operating environment (tactical, festoon, mining, oil rigs, shipboard, aerospace, vacuum, etc.)

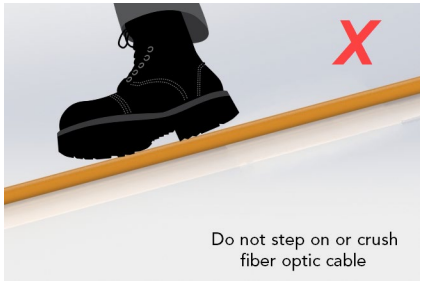
5. Observe Bend Radius and Clamping Rules when Routing and Securing either Electrical or FO cabling

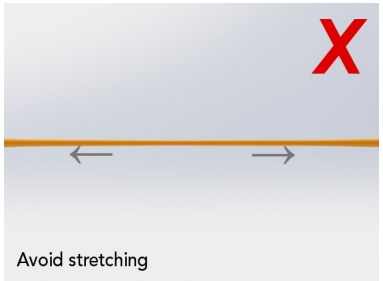












6. Choose Appropriate Interconnect & Feedthrough Solution

MIL and DIN series
Receptacles

FO Bulkhead Adapters
FC , ST and IP-LC shown

Cable Glands

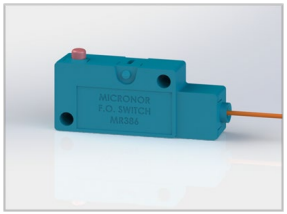
Hermetic/Vacuum Feedthrough
For FO, Electrical and Hybrid Application

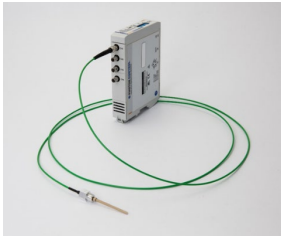
Summary

- Engineers need to start a project with a clear definition of their position sensor requirements.
- Electromechanical encoders and resolvers are the cost-effective solution for benign operating environments.
- Limit switches play a crucial role in functional safety where cost of machine failure/damage and operator injury can be eliminated via their use as fail-safe sensors.
- Fiber optic position sensors enhance applications where electro-mechanical encoders are unreliable, justifying the high acquisition cost and lower operating cost/cost of failure.
- Where multiple position sensor technologies are required, an easy-to-install, integrated solution can be provided.
- With our access to multiple technologies, reach out to Micronor with your next position sensor application.

Micronor LLC

Fiber Optic and Electromechanical Sensors





Fiber Optics

- ❑ Absolute and Incremental Encoders
- ❑ Emergency Stop
- ❑ Microswitch
- ❑ Accelerometer (Micronor AG)
- ❑ Temperature (Photon Control FluoTemp and Weidmann FOTEMP GaAs sensors)
- ❑ Temperature and Strain (FiSens FBGs)

Electromechanical

- ❑ Position Transducers/Feedback Units
- ❑ Rotary Limit Switches
- ❑ Optical/Magnetic Encoders
- ❑ Resolvers
- ❑ Cam Timers/Motorized Potentiometers
- ❑ HMI – Handheld Pendants and MPGs

micronor
a division of PHOTON CONTROL

WHY CHOOSE MICRONOR

'One stop shop' for critical measurement solutions such as optical temperature, strain, position sensors for harsh environments

EXPERTISE

- Develop customized solutions (OEM)
- Assist in reducing design constraints

SOLUTIONS

- Fiber Optic and Electromechanical
- Sensor solutions in harsh environments

PRODUCT

- Provide many different technologies (GaAs, Phosphor, FBG etc.) for critical measurement
- ISO 9001:2015

SUPPORT

- Technical engineers and sales staff to help you make the right decisions
- Drawings, datasheets, specs available on Micronor.com

Questions?

Dennis Horwitz
Technical Sales Manager,
Micronor LLC

Office +1-805-389-6600
Direct +1-805-242-4296
dennis@micronor.com

PHOTON CONTROL

+

micronor
FIBER OPTIC KINETIC SENSORS

=

MEASURE WHAT MATTERS