AMT203 Absolute Encoder

Contents

Purpose

The purpose of this training module is to familiarize you with rotary absolute encoders and show the benefits of the AMT203.

Objectives

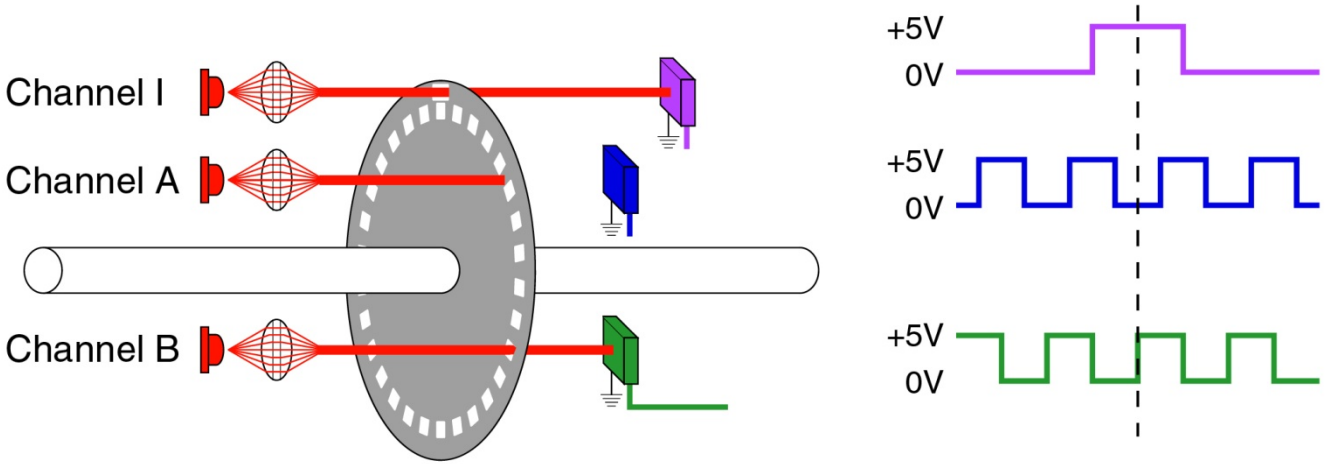
- Describe the functional theory of encoders; specifically absolute encoders
- Understand what makes the AMT203 revolutionary
- Explain the different components that make up the AMT203
- Describe the installation and assembly of the AMT203
- Illustrate the flexible options available with the AMT203

Content: *23 pages*
Learning time: *15 minutes*

What Is An Encoder?

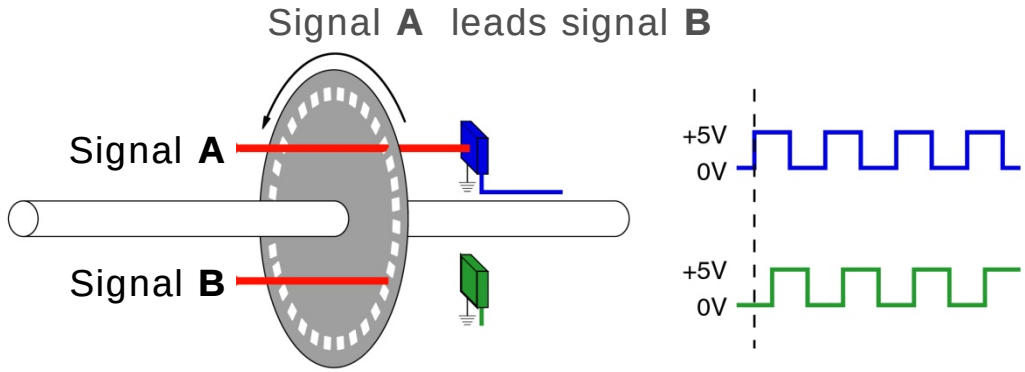
An encoder is a device that senses mechanical motion. It translates motion such as speed, direction, and shaft angle into electrical signals.

How An Encoder Functions

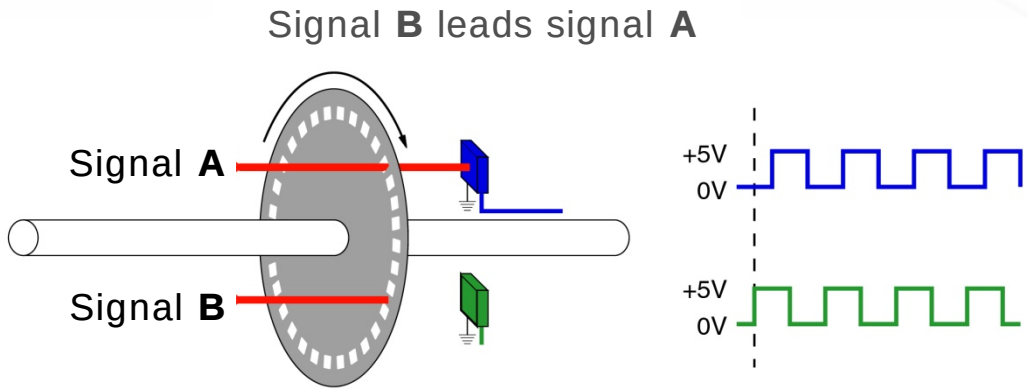


Encoders Provide Directional Information

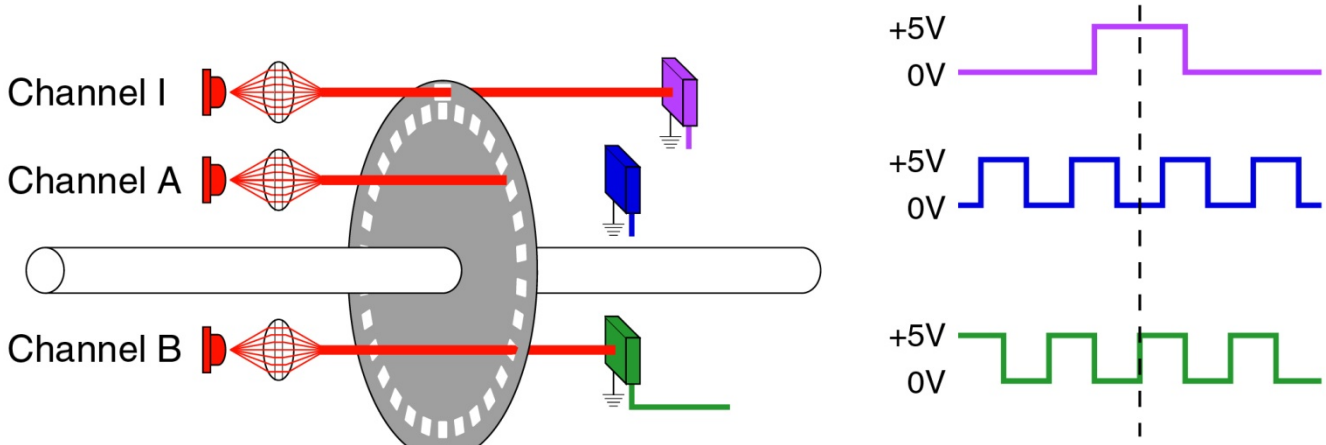
In this example, Signal A leads B, i.e., Signal A outputs a rising edge before Signal B. This indicates the shaft is rotating counter-clockwise.



In this example, Signal B leads A. This indicates the shaft is rotating clockwise.



Encoders Provide Position Information



Encoders Provide Speed Information

Encoders can detect speed when the number of output pulses is counted in a specified time span. The time element is typically provided by an internal oscillator or clock. The number of pulses in one revolution must also be known.

The equation for calculating speed is: $$S = \frac{C}{PPR} \div \frac{t}{60}$$

Where "S" is speed in rpm, "C" is the number of pulses counted in a "t" time interval. If 60 pulses were counted in 10 seconds from a 360PPR encoder, the speed can be calculated:

$$S = \frac{60}{360} \div \frac{10}{60} = 0.1666 \div 0.1666 = 1 \text{ rpm}$$

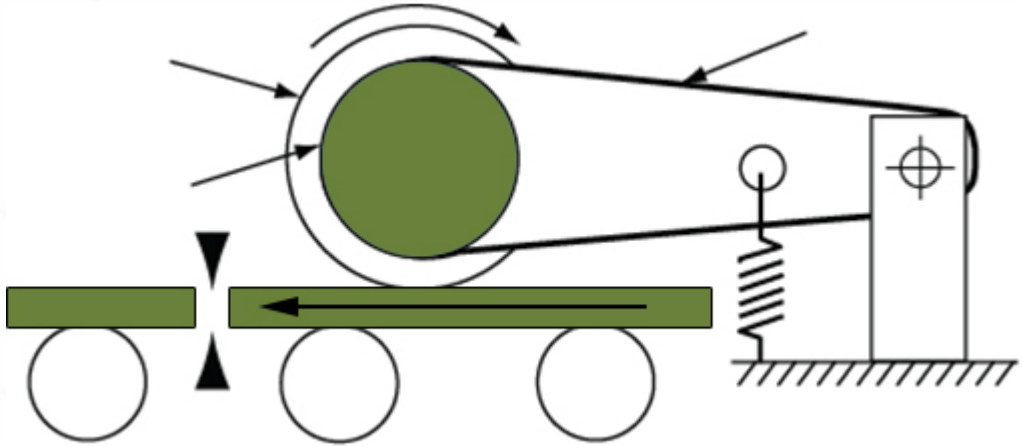
All of the counting, timing and calculations can be done electronically in real time and used to monitor or control speed.

Encoders Provide Distance Information

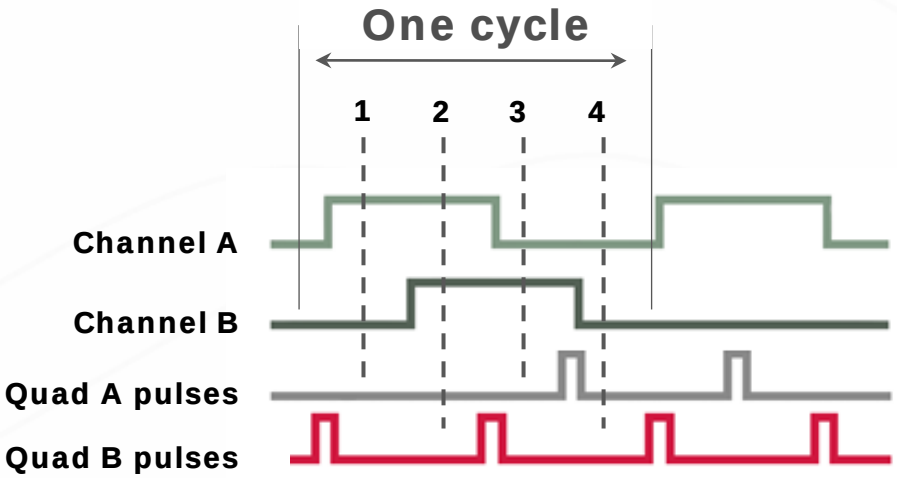
Pulse count to achieve desired linear travel can be calculated in a similar fashion for devices that use ball screws, gears or pulleys to convert rotary motion to linear travel.

$$C = L \div (\pi * D) * PPR$$

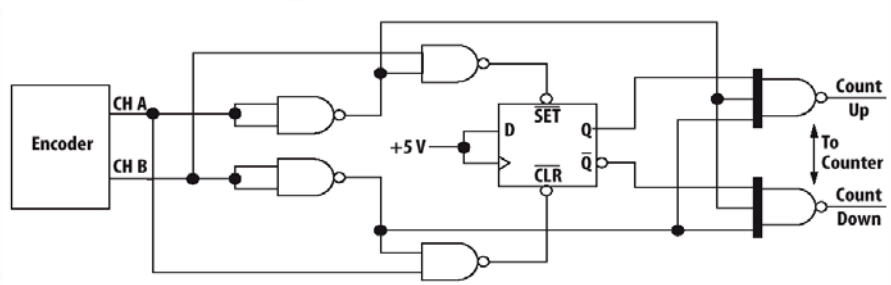
$$C = 12 \div (3.142 * 8) * 2000 = 955$$



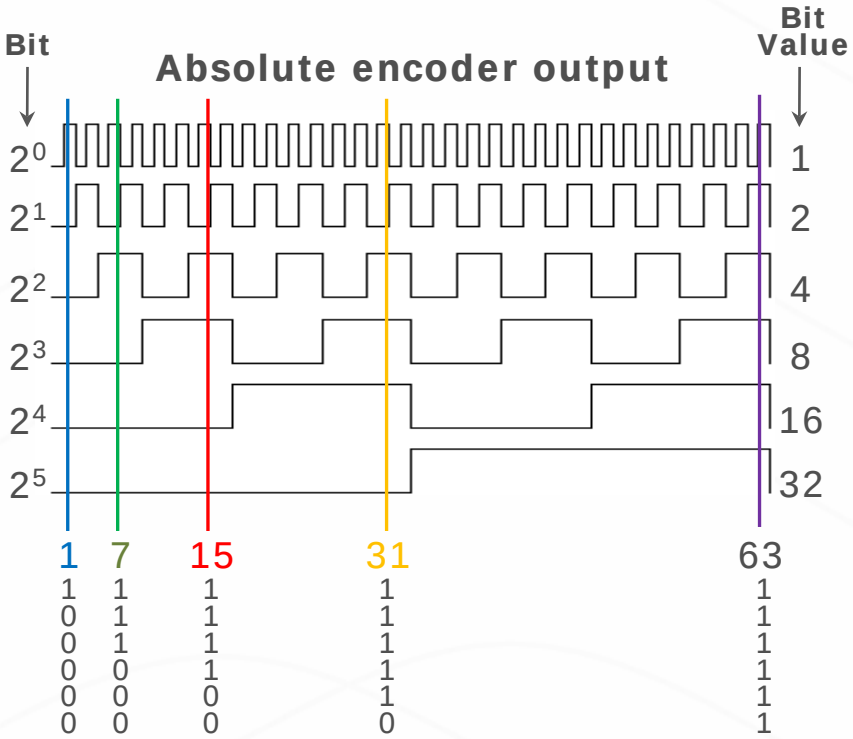
Quadrature Decoding

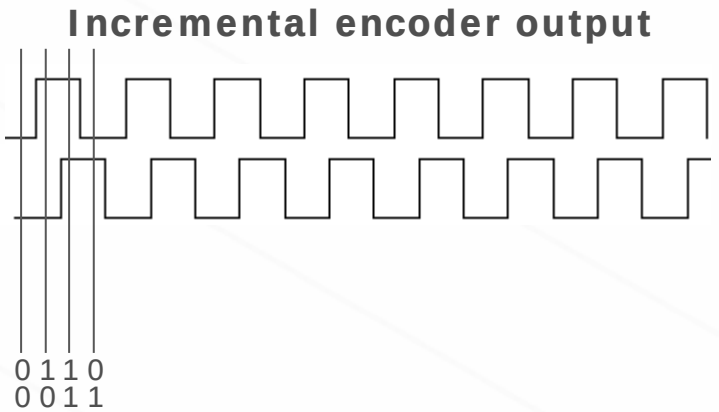


Quadrature decoder circuit

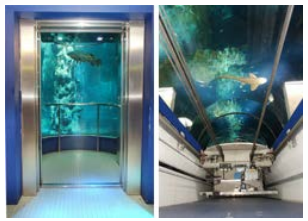
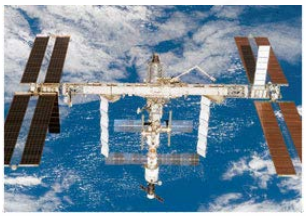


What is an Absolute Encoder?





Where Are Encoders Used?

elevators 	factory 	aircraft 	automobiles 
satellites 	medical devices 	machine tools 	process automation 
mobile equipment 	pick and place 	packaging automation 	industrial robots 

Types of Rotary Encoders

Mechanical

2^4 (16) – 2^8 (256)

Optical

2^8 (256) – 2^{19} (524,287)

Magnetic

2^8 (256) – 2^{17} (131,071)

Fiber Optic

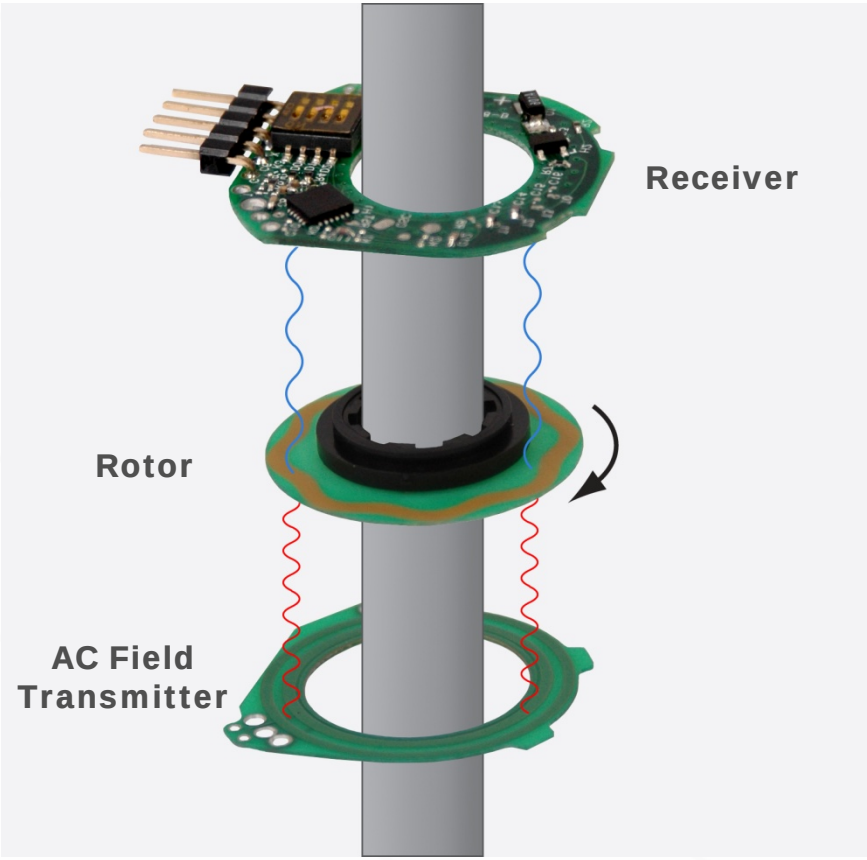
2^8 (256) – 2^{13} (8,192)

Capacitive

2^{12} (4,096)

How a Capacitive Encoder Works

- AC field transmitter sends a signal to the metal rotor as it turns
- The metal pattern on the rotor creates a signal that is repetitive and predictable
- CUI's proprietary ASIC converts the modulated signal to output pulses



Benefits of Capacitive vs Optical Technology

Capacitive

- Greatly reduced assembly time & cost
- Rugged code disc
- Not susceptible to airborne contaminants
- Much higher gap tolerance

Optical

- Higher operating temperature range
- Lower mass, almost zero backlash
- No LEDs to fail

AMT203 Specification and Feature Highlights

- **High resolution-** 12-bit (4,096 PPR)
- **Broad temperature range-** -25 – +85° C
- **Incremental option-** A/B quadrature option for >8,000 RPM
- **Low profile-** 11 mm depth
- **Light-weight mechanical design-** 15g net weight (0.53 oz.)
- **Low current consumption than optical-** <10 mA
- **Programmable zero position-** saves time and money
- **Robust design-** capacitive technology not susceptible to dust and particulates
- **Adapts to 9 common shaft diameters-** allows for a high level of flexibility

Ideal For Direct Motor Mounting

The AMT Series can be used on any rotating shaft, however, it is ideal for mounting directly to motors:

- Zero position set by SPI interface – no mechanical adjustment!
- Mounting patterns for popular AC & DC motors
- 9 shaft diameter options
- Extremely low mass reduces potential backlash
- Small size fits in tight spaces
- Quick and easy mounting process

Easy Assembly And Installation

Assembly of the AMT203 requires minimal time and effort.

With just a few durable pieces, it snaps together in seconds without risk of damaging a glass optical disk or other fragile components.

AMT203 Assembly

click on the illustration below to view a short assembly video

Versatile Shaft And Mounting Options

Shaft adapter & sleeves

Using the shaft adapter and the 9 color-coded sleeves, both the AMT203 can be adapted to 9 different motor shaft sizes.

This is done by snapping one of the sleeves into the shaft adapter.

mounting patterns

hole pattern mm/in	# of holes	hole size
Ø16/0.63	2	M1.6
Ø19.05/0.75	2	#4
Ø21.45/0.844	3	M1.6 or M2
Ø25.4/1.0	4	M1.6 or M2

shaft sleeves

- Ø2 mm
- Ø3 mm
- Ø1/8 in
- Ø3/16 in
- Ø4mm
- Ø5 mm
- Ø6 mm
- Ø1/4 in
- Ø8 mm

Sleeves

Shaft Adapter

AMT203 Demo Board

With the AMT203 Demo Board you can:

- Set zero position
- Monitor shaft position
- Set CW or CCW for count increase/decrease
- Select HEX or DECIMAL position display
- Select incremental (A/B) or counter (STB/UDN) output
- Access/read/write 128 bytes of user EEPROM
- Experiment with all encoder functions

Serial Peripheral Interface

Features of SPI:

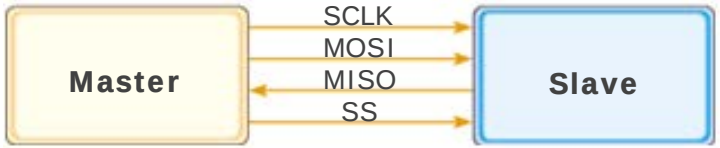
SPI is a Master-Slave protocol
- The Master device controls the clock (SCK)
- No data is transferred unless a clock signal is present
- All slaves are controlled by the master clock
- The slave devices may not manipulate the clock

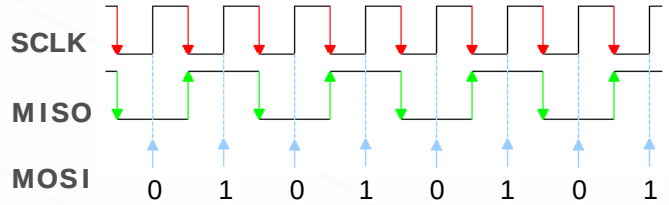
SPI is a Synchronous protocol
- The data is clocked along with a clock signal (SCK)
- The clock signal controls data I/O and read
- Since SPI is synchronous, the clock rate can
- Vary, unlike RS-232 style communications

SPI is a Data Exchange protocol
- As data is being clocked out, new data is clocked in
- Data is ***exchanged -*** *no device can transmit only or receive only*
- The master controls the exchange through the clock line (SCK)

Advantages of SPI:

- Very fast >10 MHz
- Simple protocol (easy to program)
- Simple interface (no bidirectional pins)
- Supports full duplex data streaming





Example of SPI Mode 1,1
Note that the data only changes on the falling edge of SCK and is only read on the rising edge of SCK.

AMT203 Purchasing

AMT203-V kit includes:

- AMT203 encoder
- Shaft adaptor and 9 sleeves
- Centering tool
- Spacing tool

View AMT203-V

AMT203-DMK includes:

- AMT203 demo board
- AMT203-V encoder kit
- USB cable
- Board to encoder interface cable
- Power supply
- Flash drive with drivers

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