AI-TEK Active Sensors

Principles of Operation

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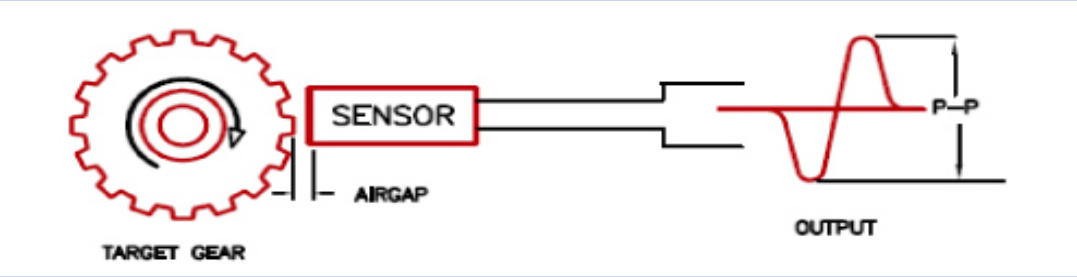
AI-TEK Sensor Training

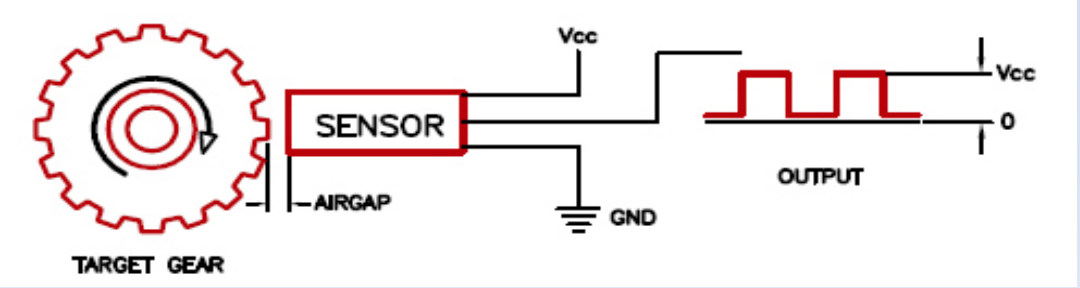
- Speed sensors bridge the gap between the mechanical and electrical world. They produce a frequency proportional to the speed of the target.

- AI-Tek offers ***two*** basic sensor technologies that can be used in a large variety of applications.

  - Variable Reluctance (Passive)



  - Hall Effect (Active)

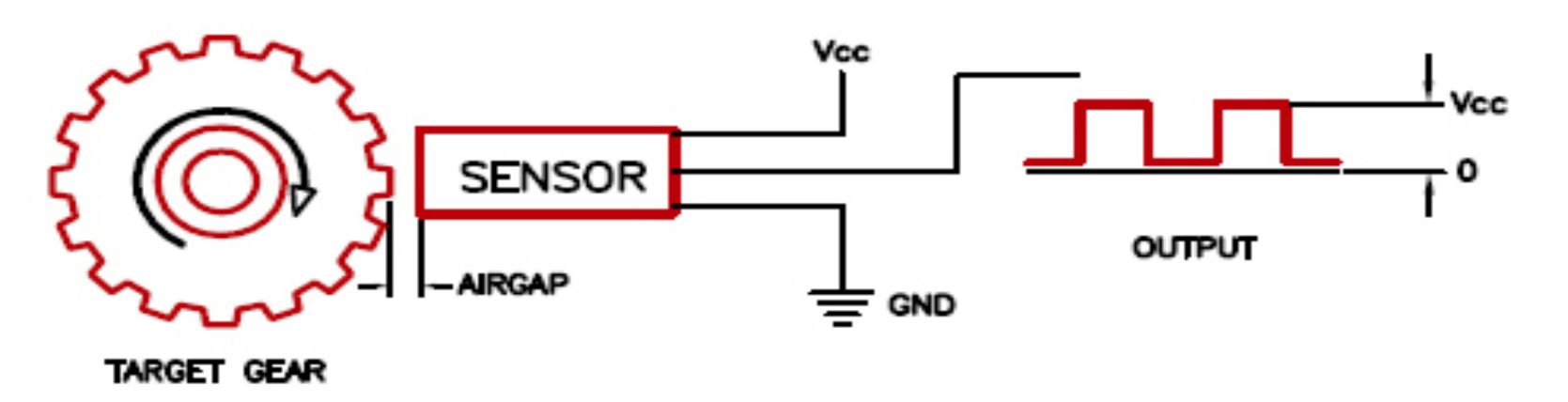


AI-TEK Sensor Training

Hall Effect – AKA Zero Speed and Active Sensors

Hall Effect Sensors

- Is an active, powered device that produces an output signal regardless of target speed from zero to 15kHz+
- It includes a silicon chip that has high level of circuit integration leading to high reliability
- Typical output from a Hall Effect Sensor is Digital, square-wave output; amplitude is independent of speed
- 3 wire connection (single channel), 5 wire connection (dual channel with direction)
- Very stable over wide temperature range -40°C to + 125°C



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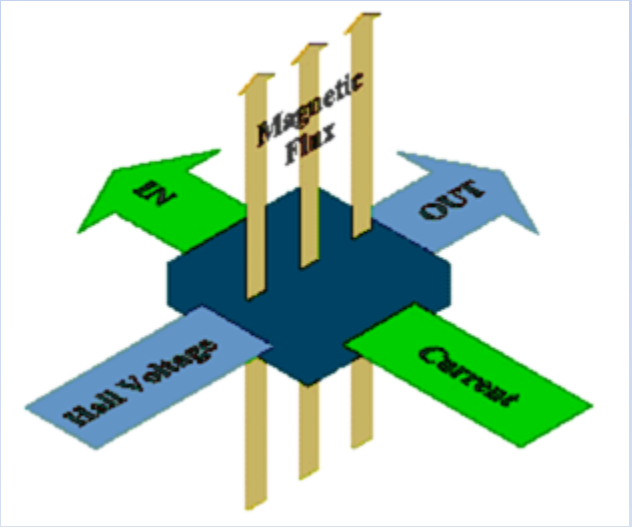
Hall Effect – AKA Zero Speed and Active Sensors

Principle of Operation.

- Basic building block of a hall effect sensor is the hall generator

- An output voltage is produced when the hall generator is exposed to magnetic flux and a bias current.



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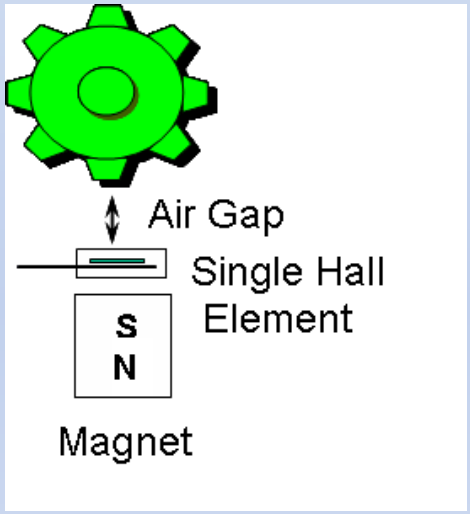
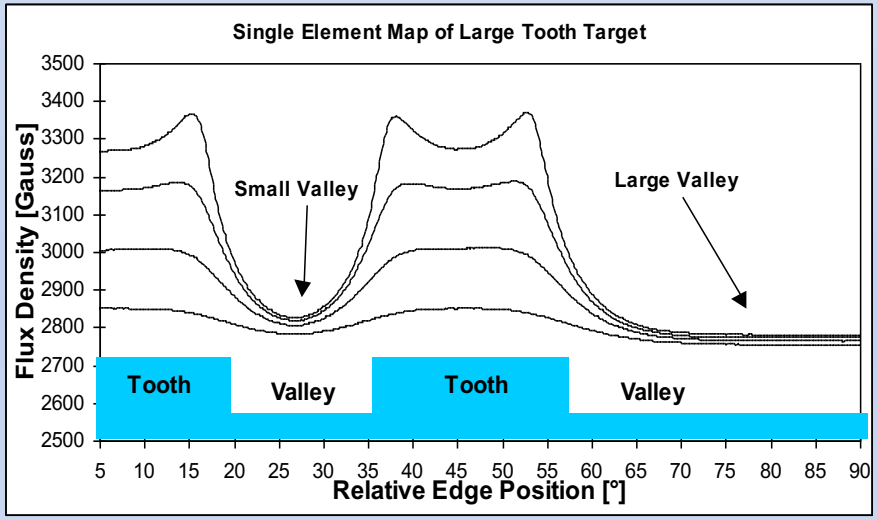
Hall Effect – AKA Zero Speed and Active Sensors

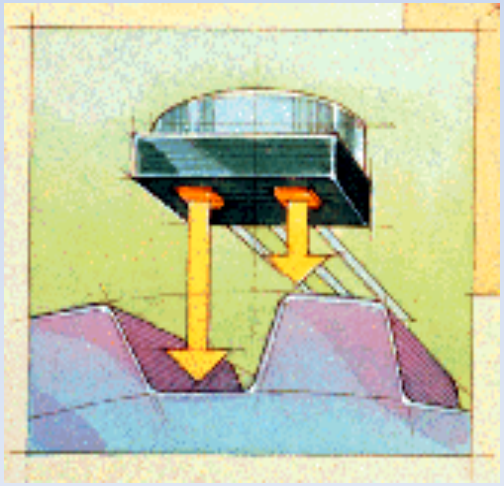
Principle of Operation – Single Element vs .Differential

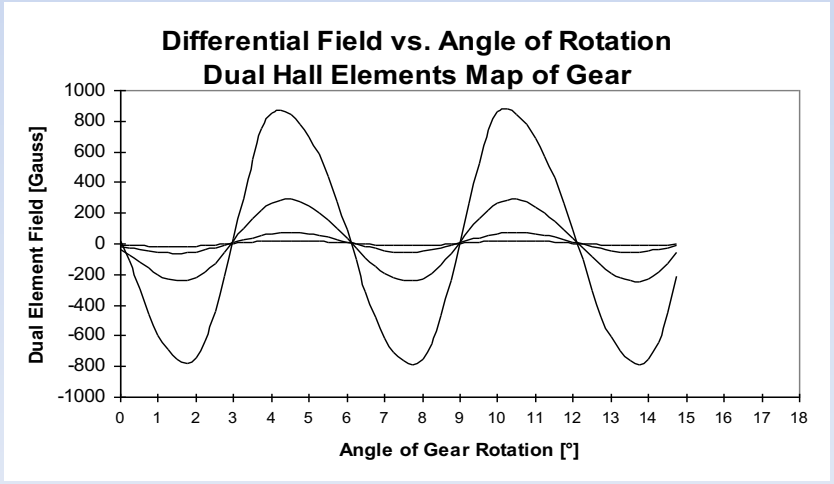
Single Element

RH Series – no need for alignment









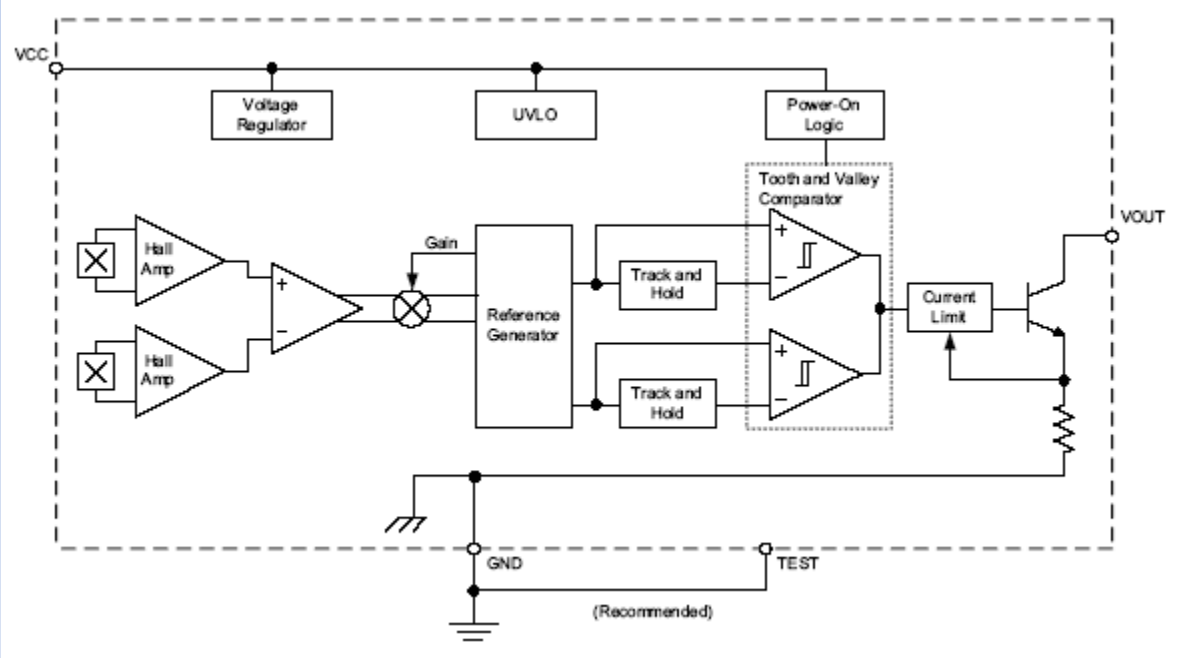
Differential

BH, DH Series – requires alignment

Sensor Technologies - Hall Effect

Principle of Operation; Differential.

Typical block diagram of differential amplifier circuit for BH and DH sensors



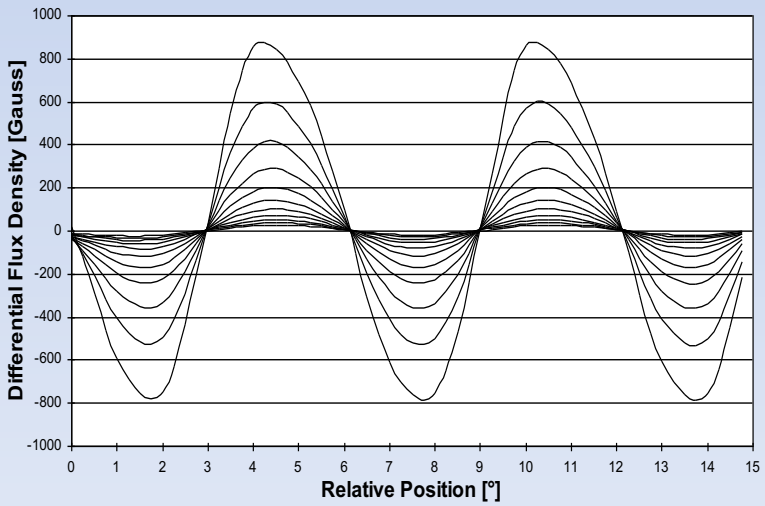
Sensor Technologies - Hall Effect

Advances in Switching Technology
BH and DH Sensors

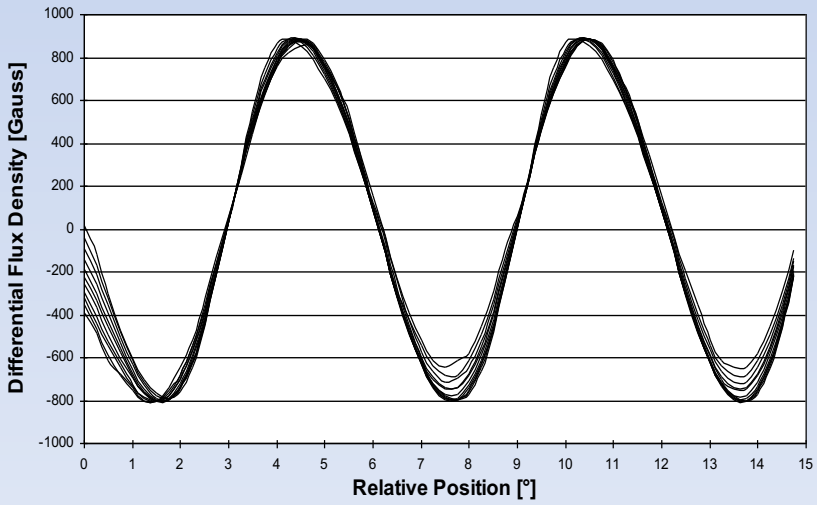
Self calibration, which normalizes signal amplitude, is accomplished through Automatic Gain Control (AGC) .

AGC is enabled at power-up to allow learning of the gear and then is disabled to prevent transient events from affecting device operation.

Differential Map of Typical Ignition Target



Gain Adjusted Differential Map of Typical Ignition Target



Tachometer Application

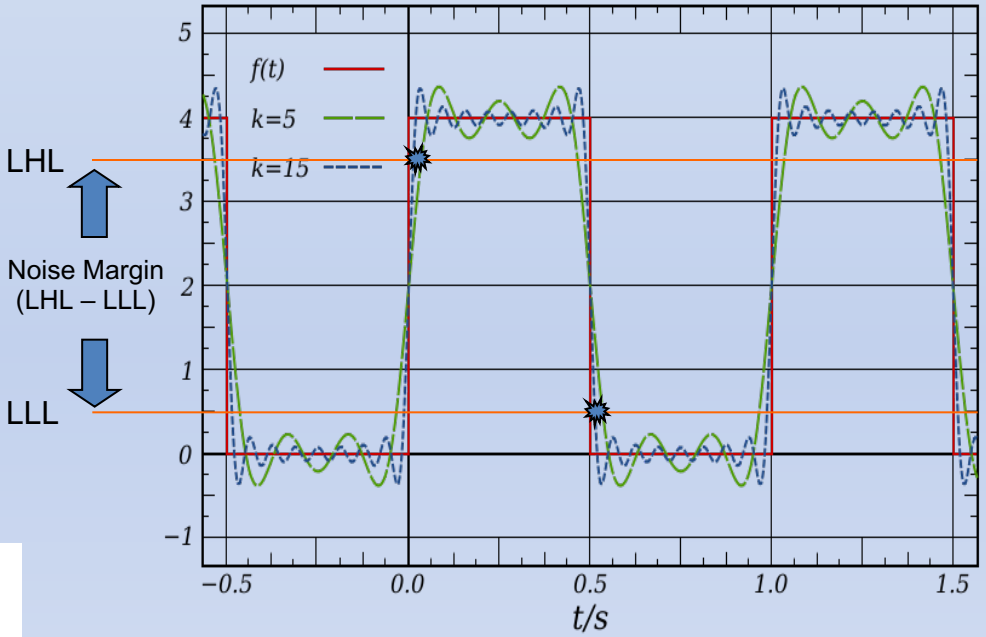
Logic Thresholds – Active (Hall Effect) Sensor Output - Square Wave

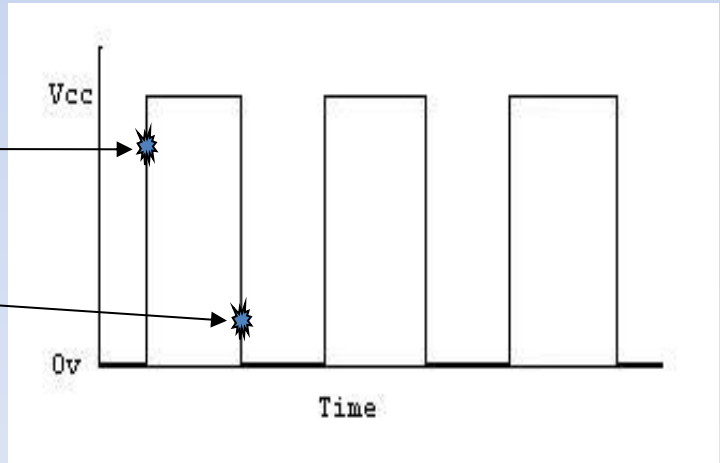
Logic thresholds:

Define a viable sensor pulse

Use to create filter to reject noise

LHL – LLL = Noise Margin

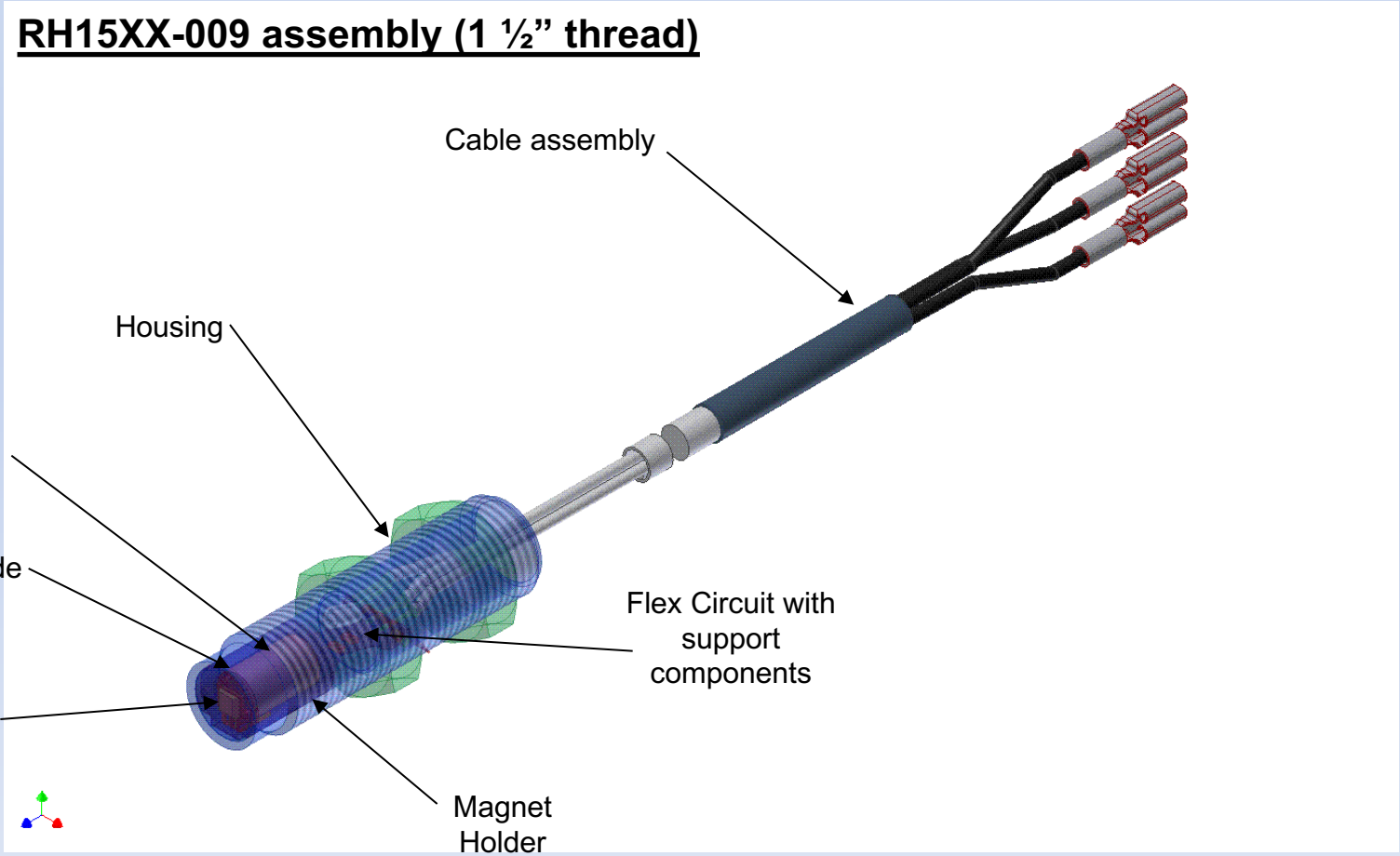




Sensor Technologies - Hall Effect

Typical RH Series Construction

Single Channel, Single element

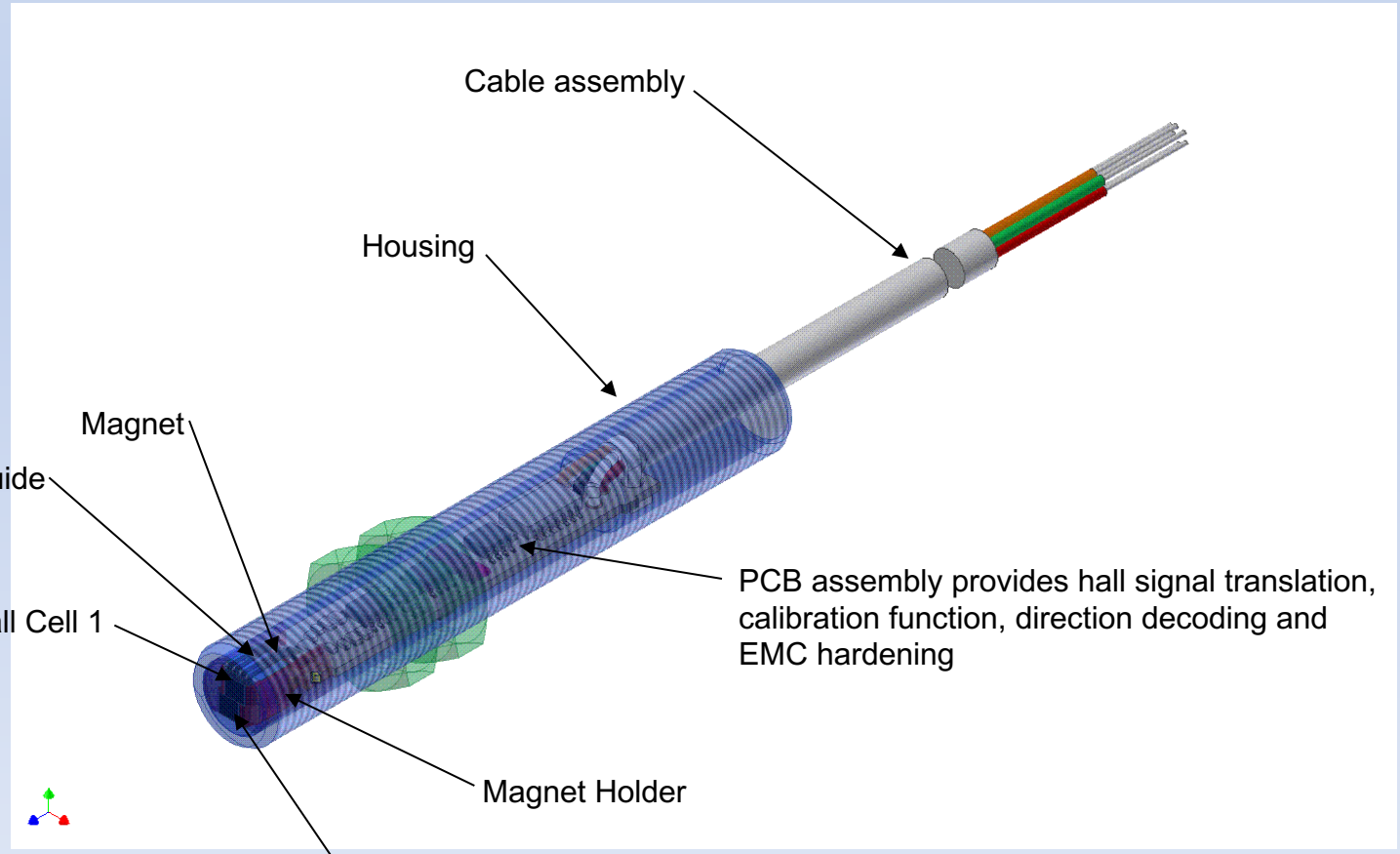


Sensor Technologies - Hall Effect

Typical BH Series Construction

Dual Channel, Bi-directional, Dual Differential

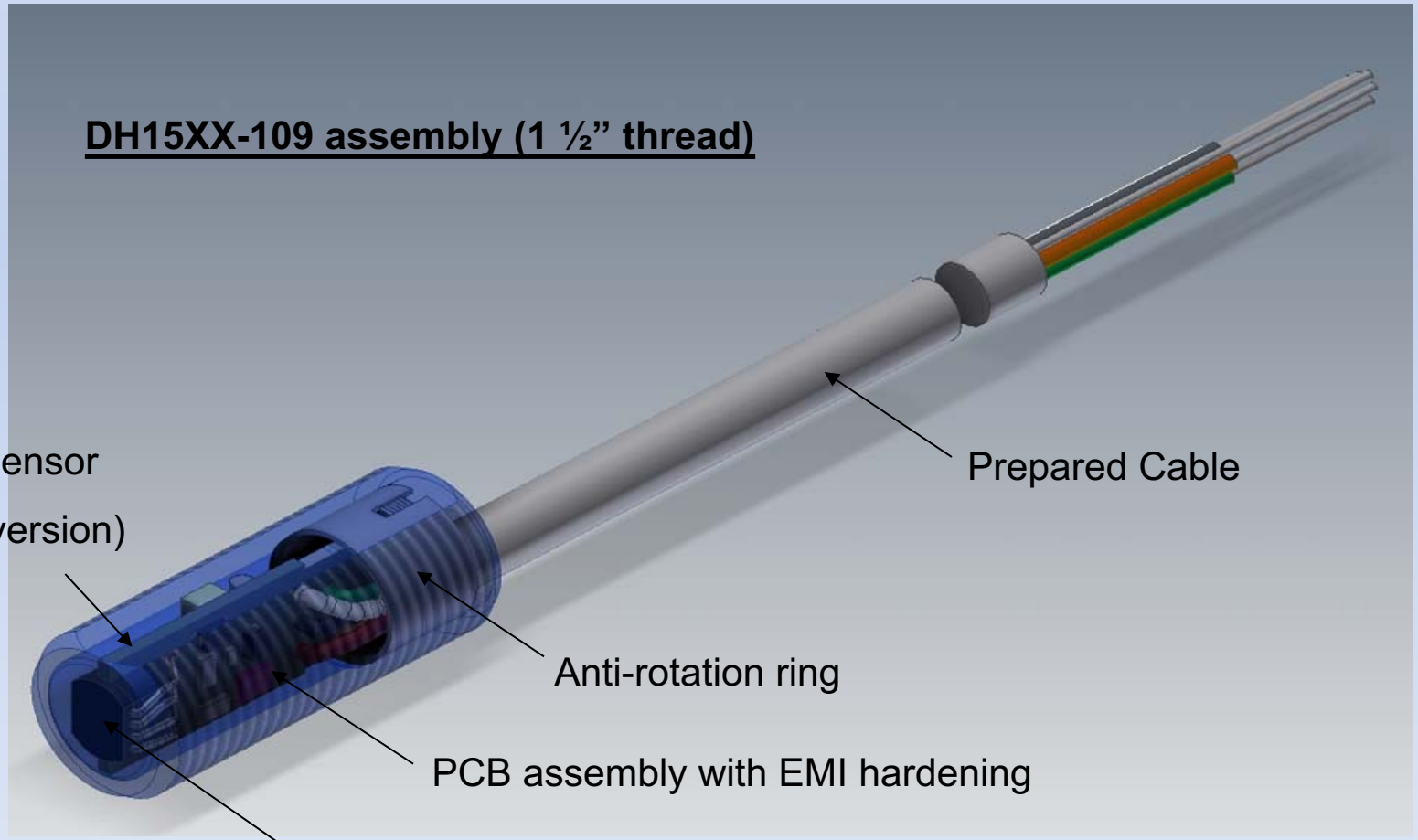
BH15XX-010 assembly (4" thread)



Sensor Technologies - Hall Effect

Typical DH Series Construction

Single channel, Differential



AI-TEK Sensor Training

Hall Effect – AKA Zero Speed and Active Sensors

Features

- High temperature range of -40 C to +125 C
- Wide range of supply voltage; 4.5-24Vdc (single channel) and 10-28 Vdc (dual channel)
- Two output options of Supply Tracking or TTL Compatible
- Increased air gap capability over VR Sensors; no loss of signal amplitude
- Output signal will react to the lowest increment of speed without loss of amplitude
- High level of intrinsic noise immunity
- Vibration Immunity

Benefits

- Easy installation
- No alignment for RH series sensors
- High reliability
- Direction Indication
- Reverse voltage protection, up to -30 Vdc, to prevent damage if mis-wired

Limitation

- Temperature – Max temp is 125C
- Not good with axial trajectory targets

AI-TEK Sensor Training

Application Considerations – Hall Effect

Which active sensor is right for your application?

PERFORMANCE	RH SERIES	DH SERIES	BH SERIES
Zero speed to 15kHz operation	X	X	X
Standard gear tooth sensing	X	X	X
Fine, 32 DP Capability		X	X
Single tooth/valley target		X	X
No installation alignment	X		
Extended airgap (0.100”+ for 12DP and coarser targets)		X	X
General noise immunity	X	X	X
EMI Hardened		X	X
High tolerance to target run-out		X	X
Self-calibrating		X	X
Direction Sensing			X
Lowest cost	X		
Temperature Sensing		X	

AI-TEK Sensor Training

Application Considerations – Hall Effect

TTL Compatible Sensor

- For use with TTL input circuits. Less sensitive to load capacitance than Supply Tracking.
- The disadvantage of a "TTL Compatible" sensor is more noise susceptible

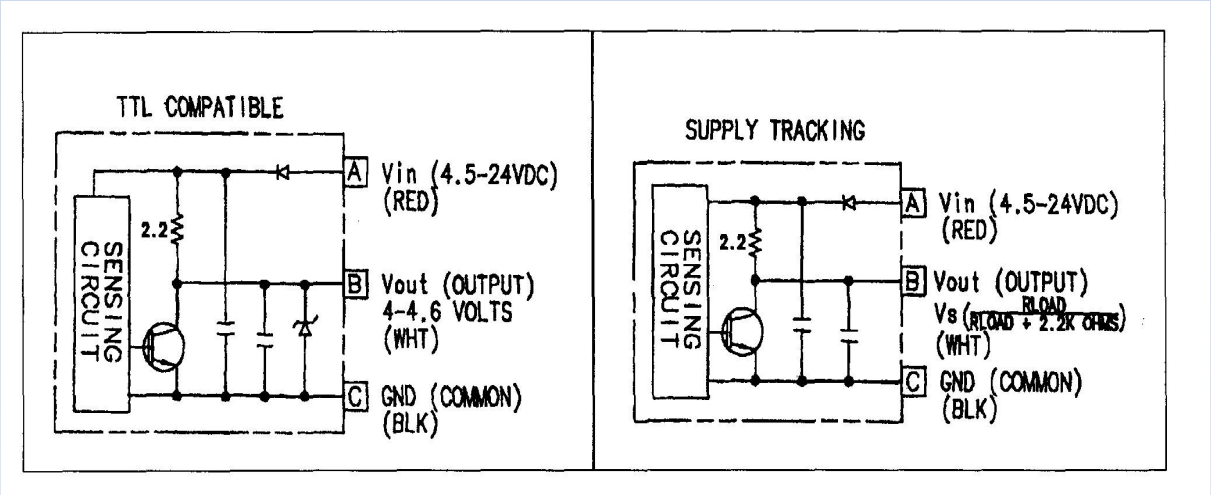
Supply Tracking Sensor

- means that the output voltage tracks the supply voltage

Advantage/Disadvantage

• Advantage: Supply Tracking is more noise immune compared to the "TTL Compatible" sensor whose zener diode clamps the Logic 1 voltage to approximately 4-4.6Vdc.

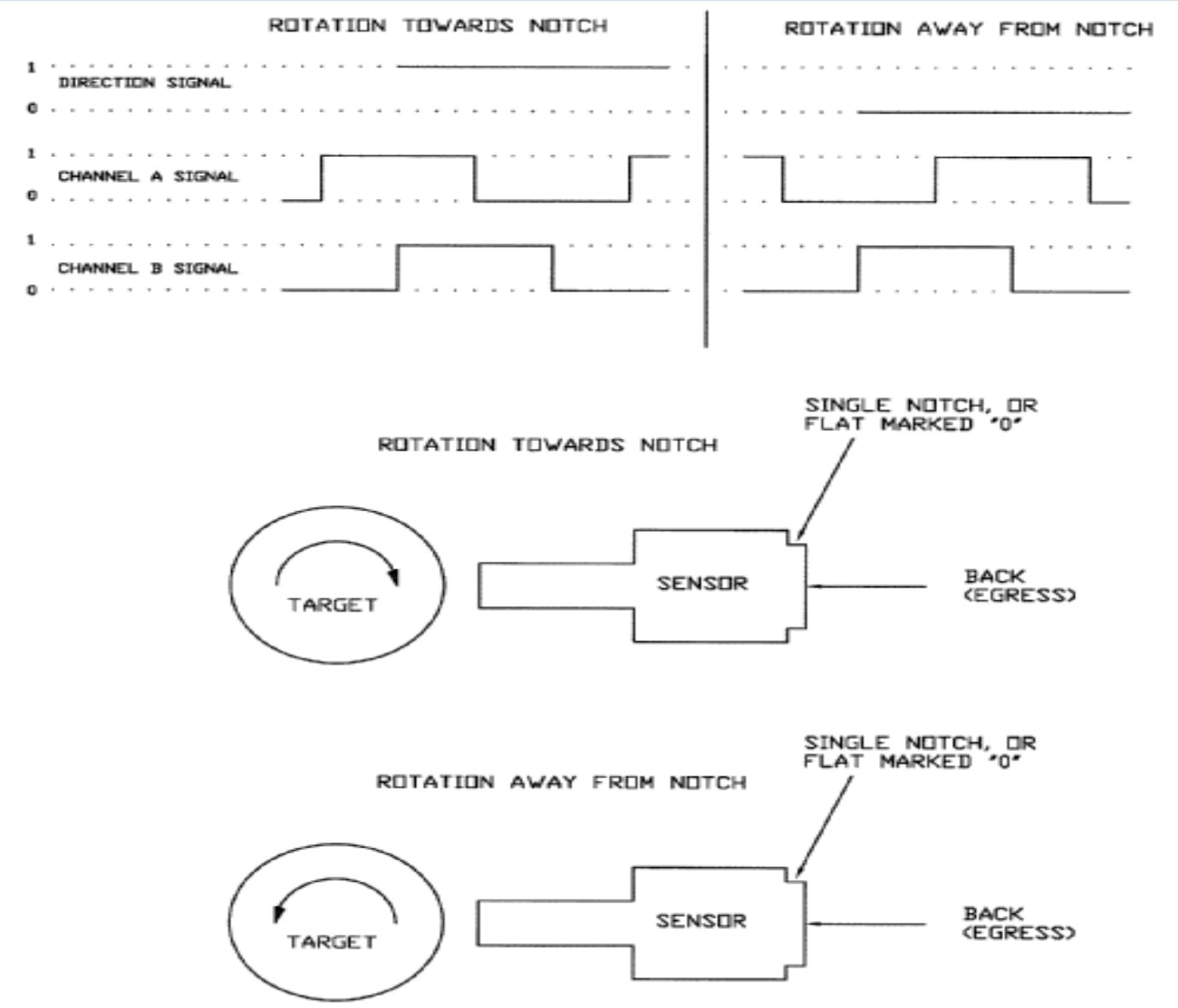
• Disadvantage: Supply tracking is more sensitive to high capacitance. High Capacitance is typically found in applications with very long distances between sensor and instrument location and can cause the sensor to fail to switch.



AI-TEK Sensor Training

Application Considerations – Hall Effect

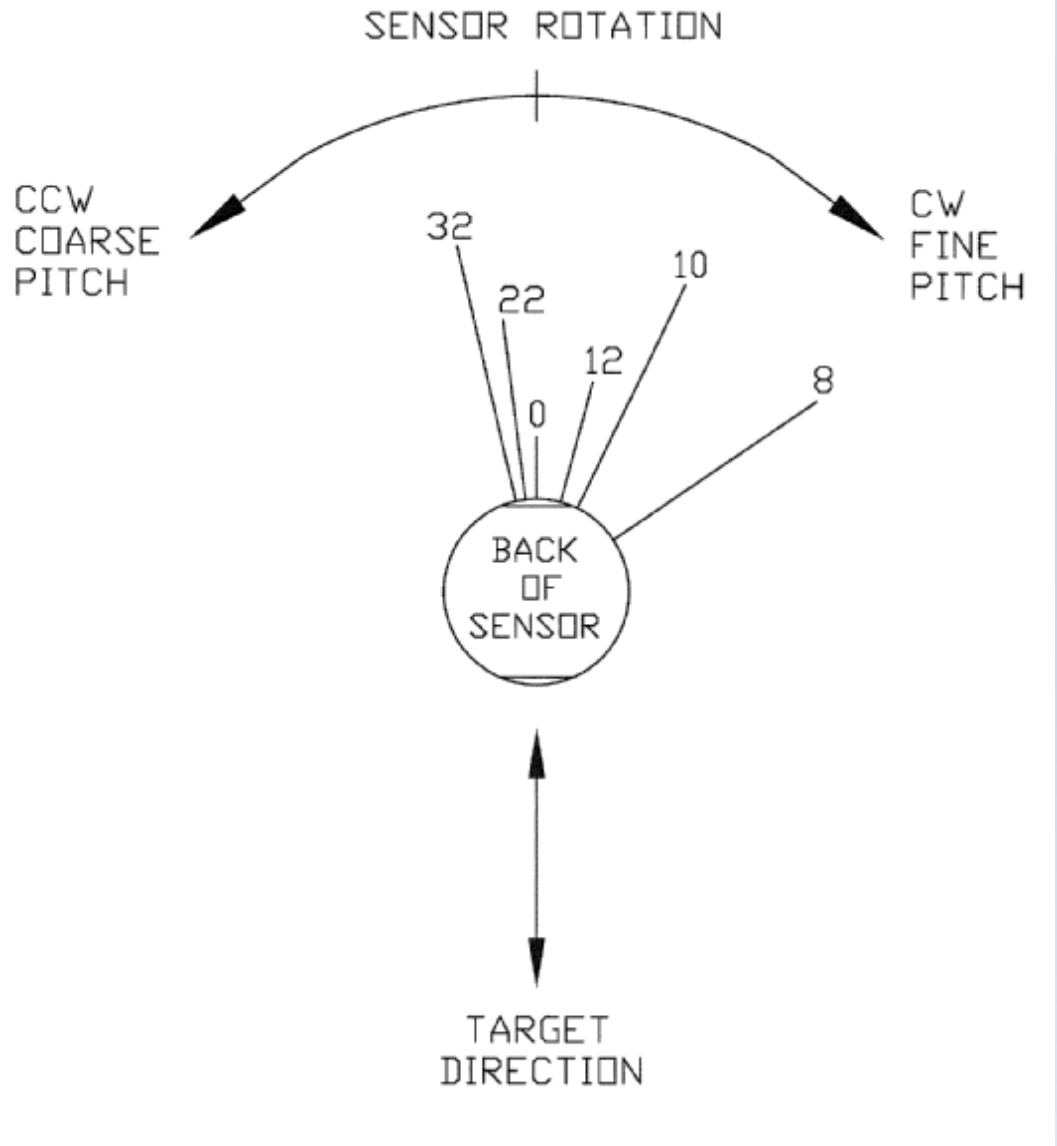
BH Series, Bi-Directional **A-B Output Channel Phasing / Direction Indication**



AI-TEK Sensor Training

Application Considerations – Hall Effect

BH Series, Bi-Directional **Diametral Pitch Phase Adjustment**



AI-TEK Sensor Training

Application Considerations – Hall Effect

Why do I need a Digital Signal Distance Amplifier (DSDA) ?

- For use with any AI-TEK active sensor or other brands that support TTL or Supply tracking sourcing output styles.
- When a sensor works fine locally (short cable) but fails at distance or high frequency.
- You may need a DSDA if an application has a combination of these factors:
  - Active Sensor wiring run exceeds 500 ft
  - Mutual capacitance between any 2 conductors exceeds 12,000pf (>>25pf/ft)
  - Load capacitance at the input device (PLC, etc) exceeds 1000pf - 3,000pf
  - Signal frequency exceeds 1000Hz

AI-TEK Sensor Training

Application Considerations – Hall Effect

Digital Signal Distance Amplifier (DSDA)

Hints to avoid needing one

- Follow best industry practices for wiring to help reduce the need for a DSDA.
- If possible run signal wires separate from power and ground
- Mutual capacitance multiplies with each wire pair. For example 1 pair = 1X, triad = 2X, quad = 3x mutual value.
- Larger wire sizes increase mutual capacitance
- Use 20 – 22 AWG wire with minimum capacitance and resistance
- Ensure large amounts of capacitance (above 1000 – 3000 pf) are not installed between the signal and ground or power.
- Balance signal load for bi-directional (BH series) sensors

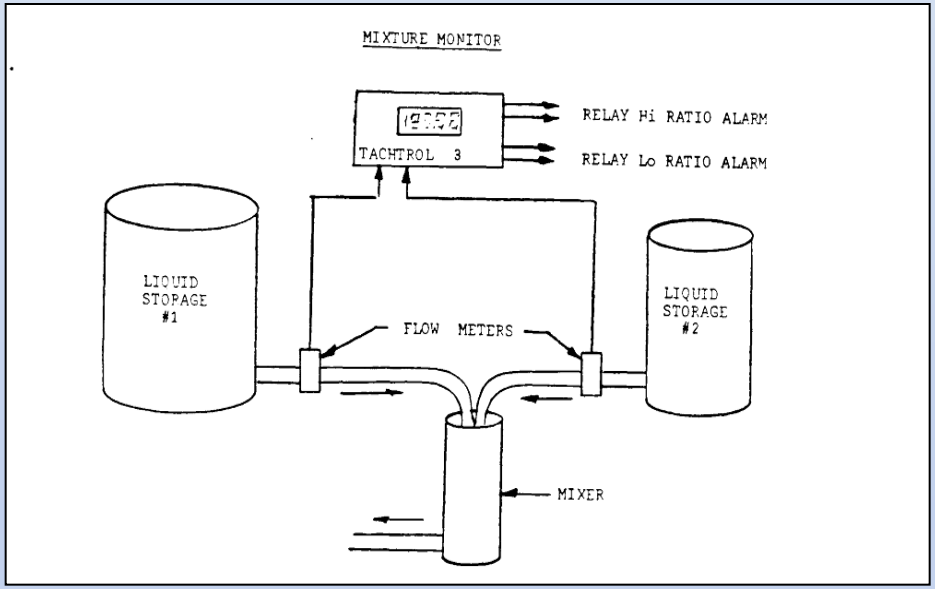
AI-TEK Sensor Product Overview

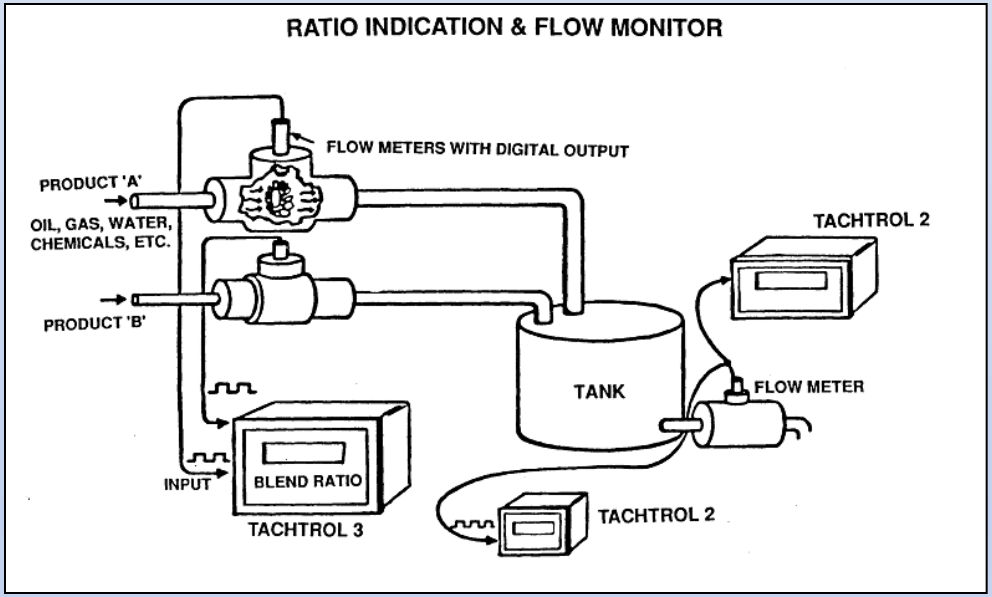
New Digital Signal Distance Amplifier (DSDA)

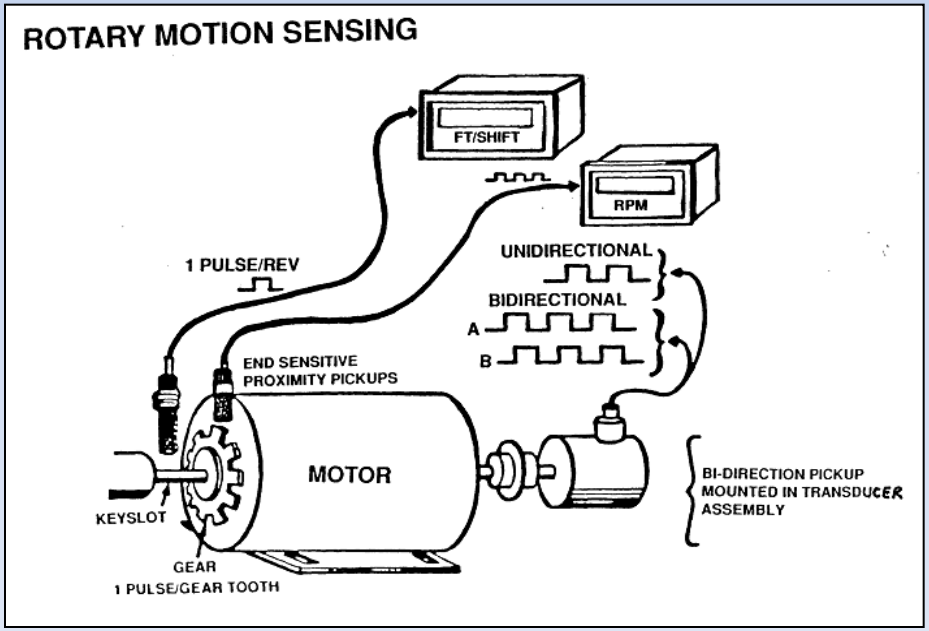
Features

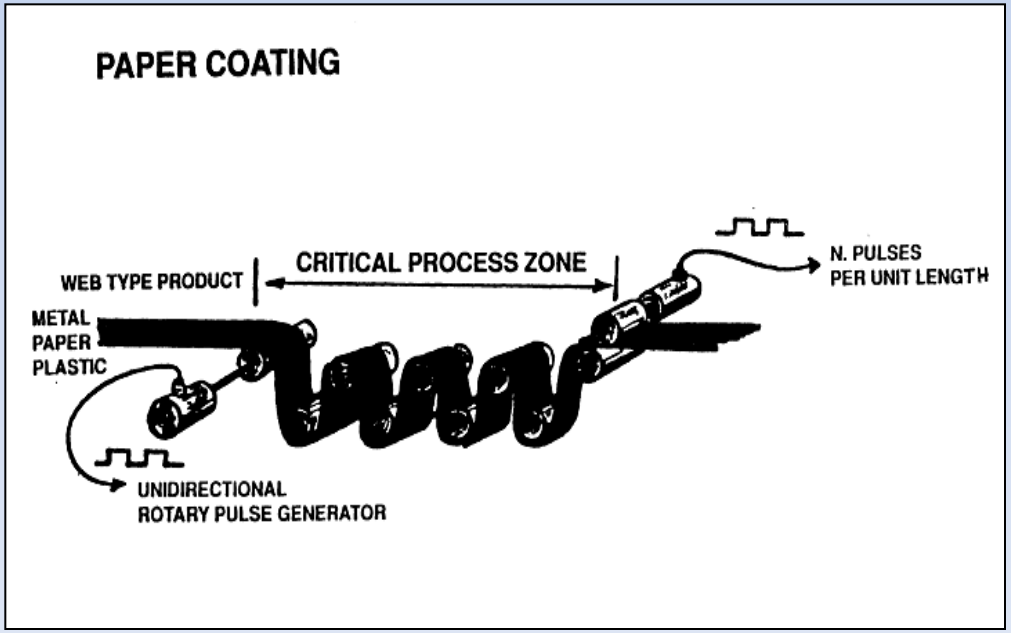
- The new AI-TEK DSDA's are designed for use with active sensors and serve to reduce line impedance, allowing cable runs of up to 3000ft.
- In some cases this represents a 10X improvement over installations not currently using a DSDA.
- Available in TTL and Supply Tracking outputs

Tachometer/Sensor Applications

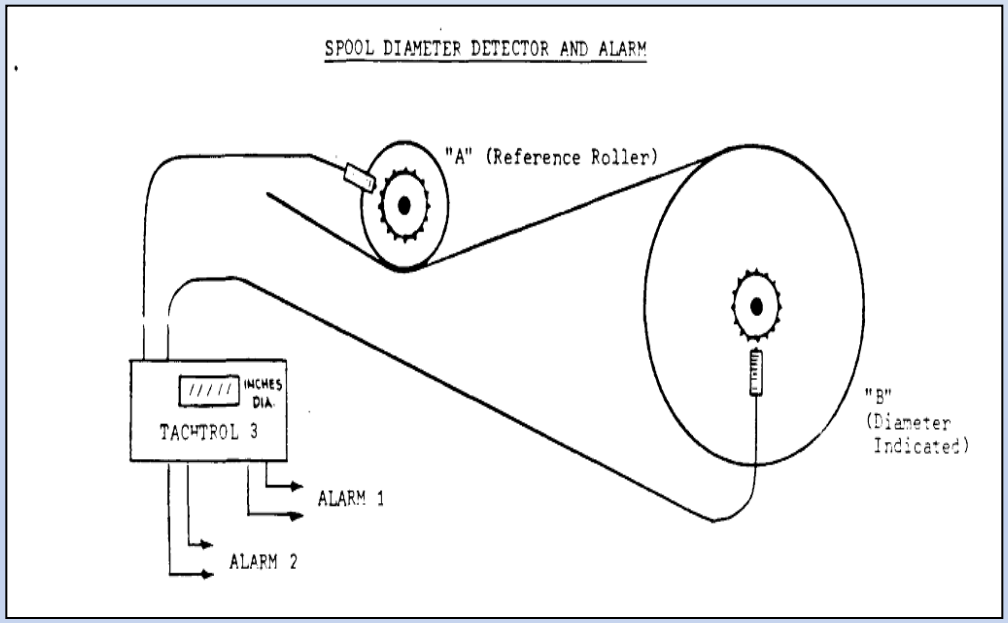


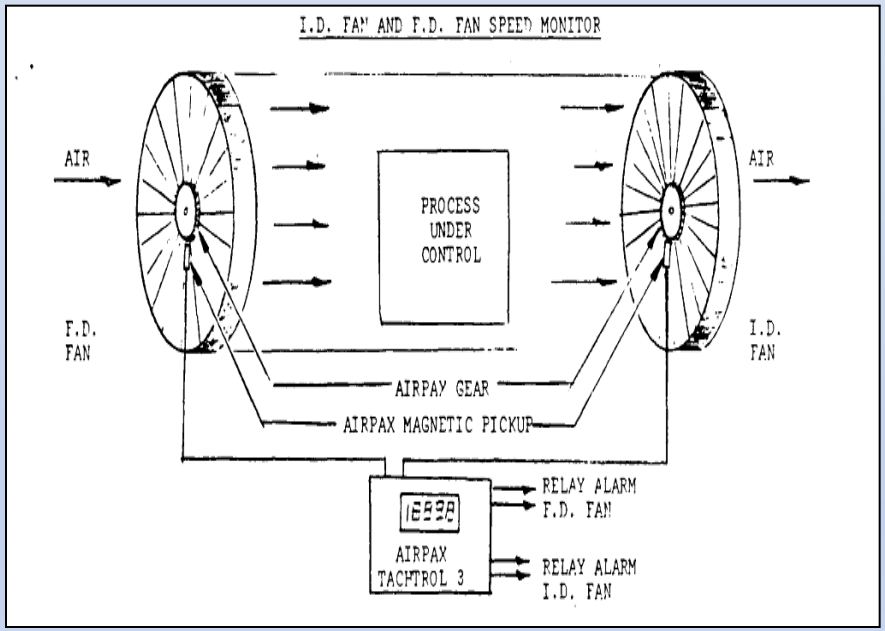


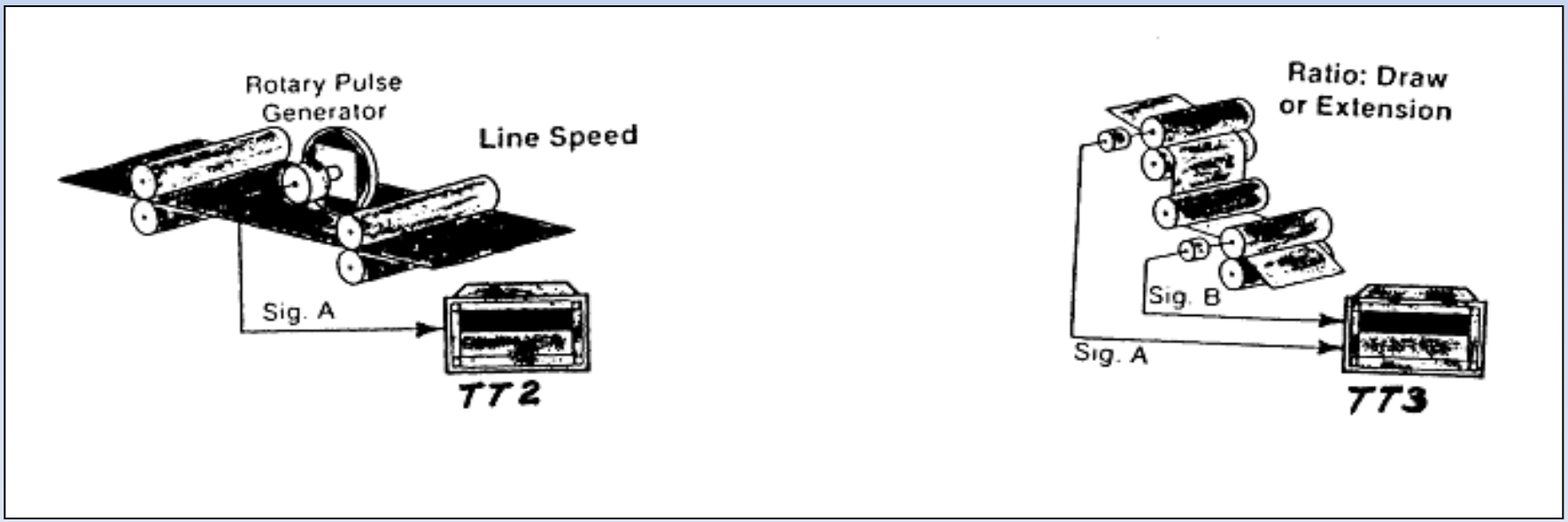




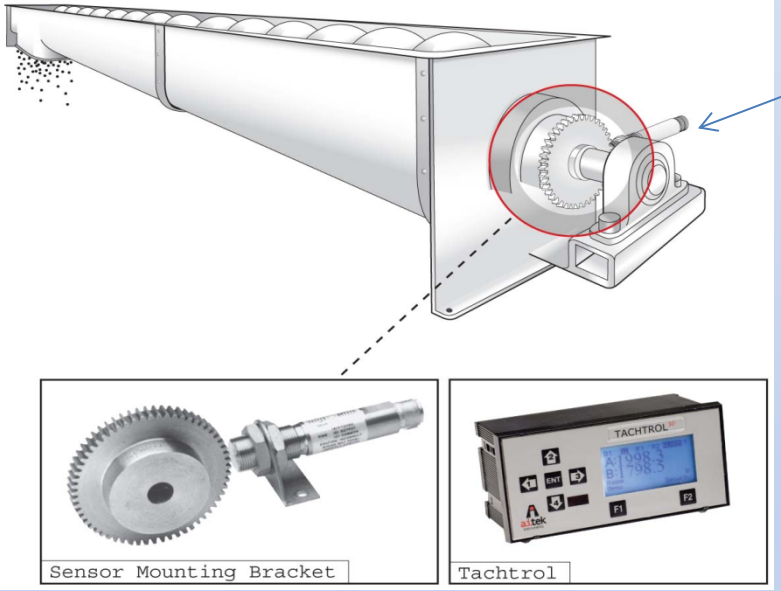
Tachometer/Sensor Applications





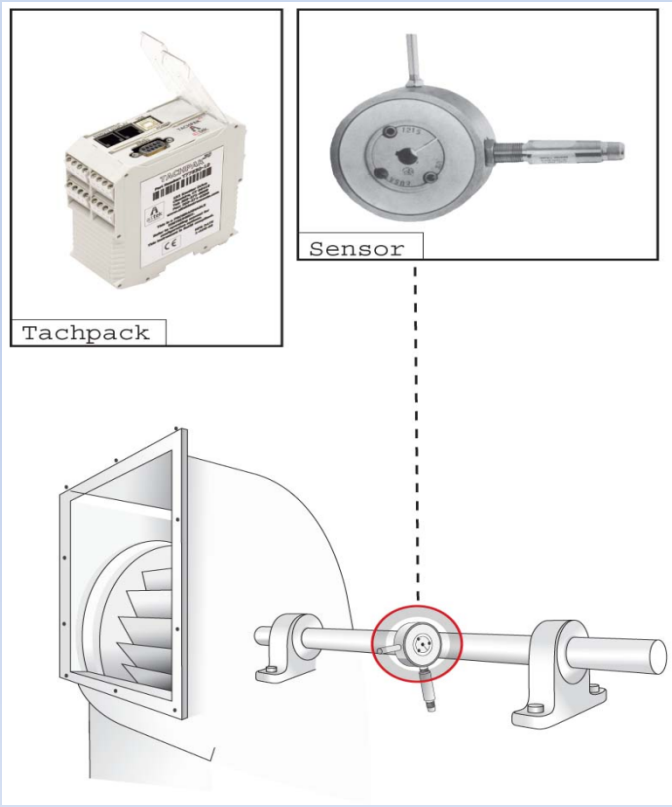


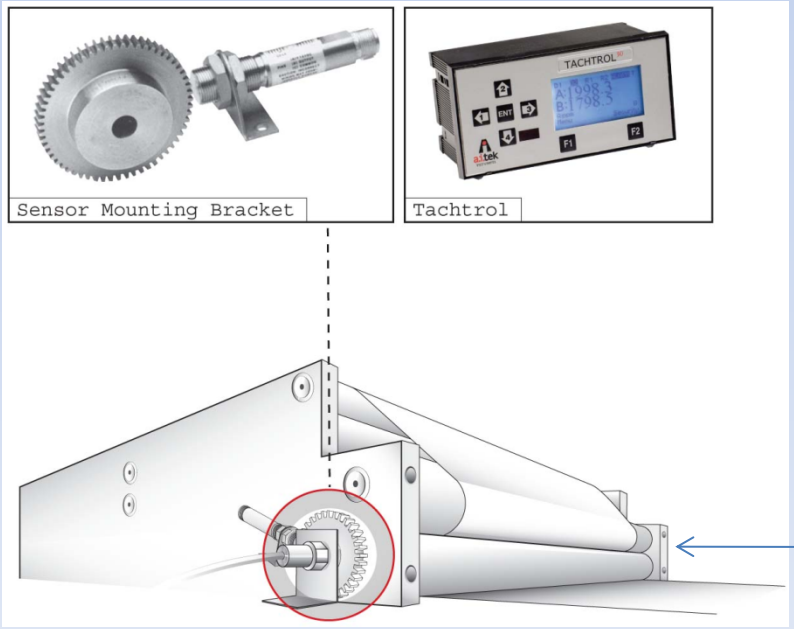
Tachometer/Sensor Applications



Detecting speed on screw conveyors

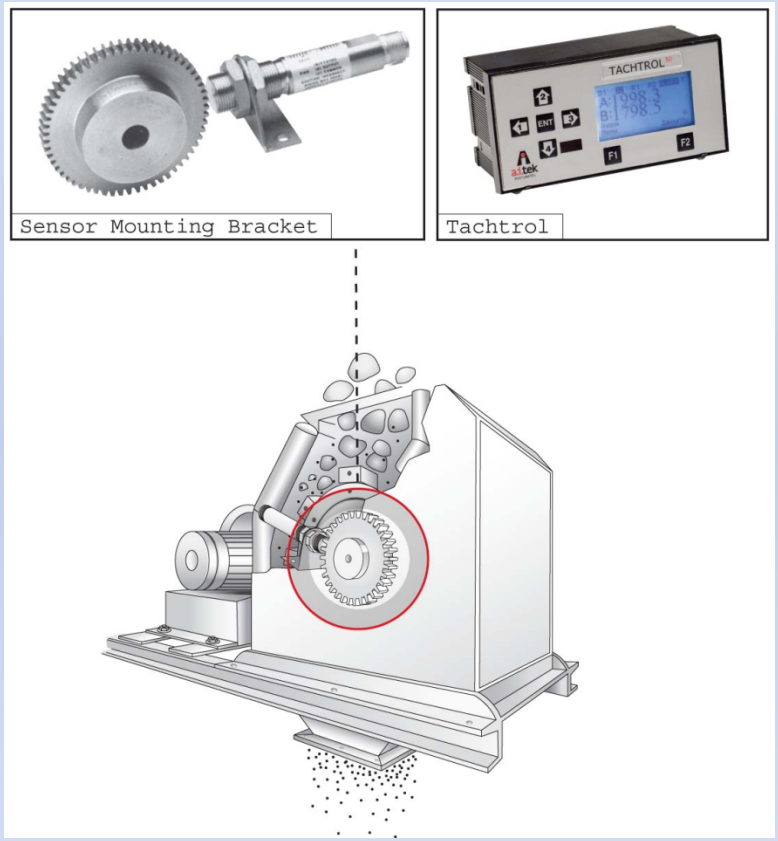
Detecting over-speed, under-speed or stoppage of fans and blowers



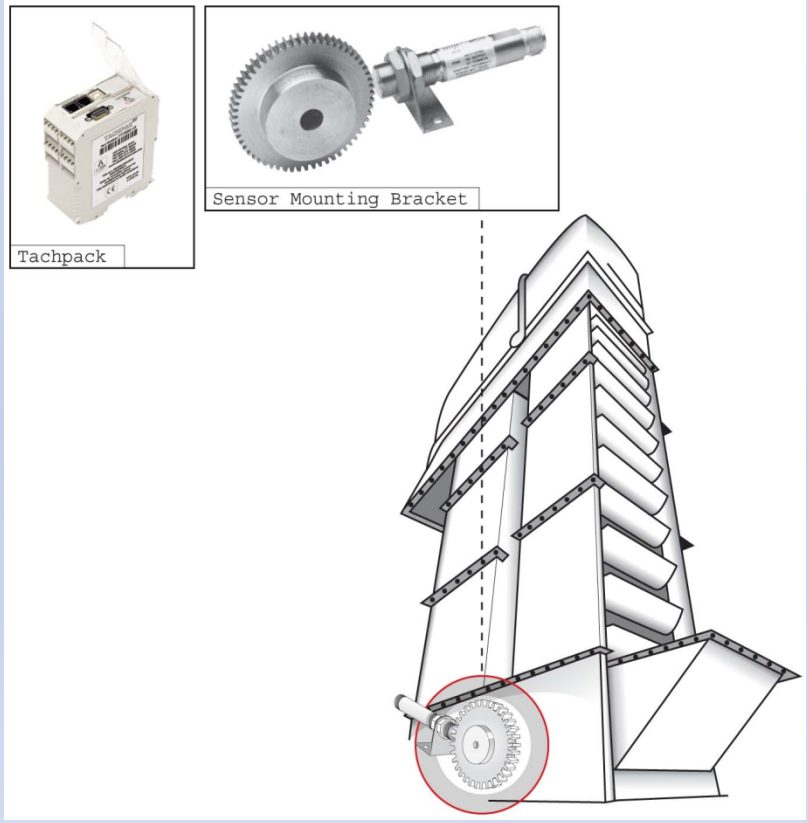


Monitoring web press

Tachometer/Sensor Applications

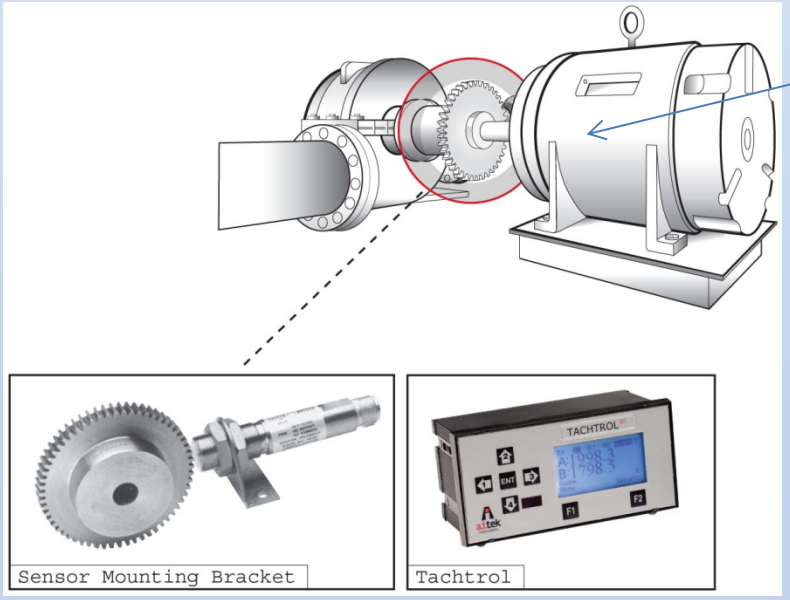


Monitoring hammer mill speed



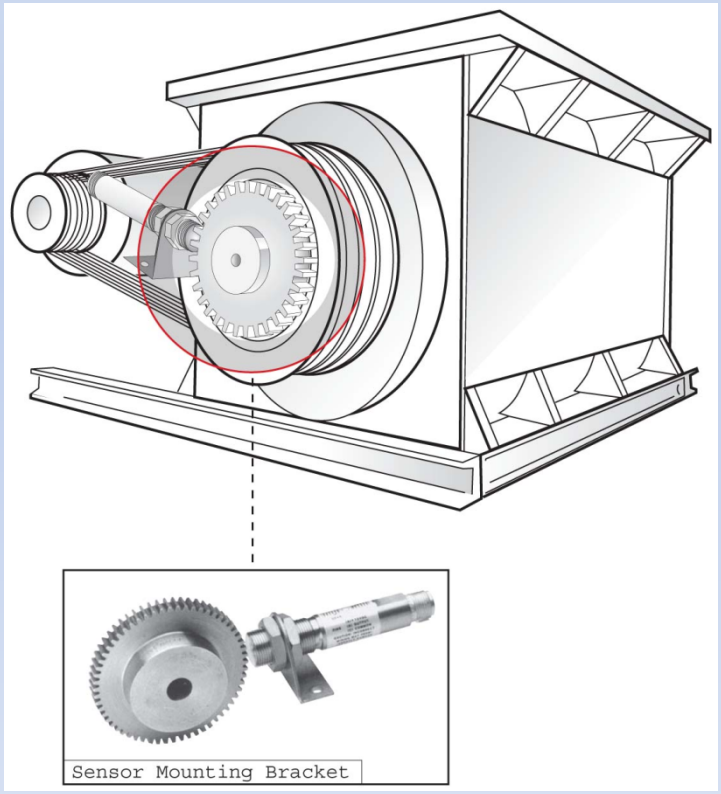
Monitoring shaft speed slowdown or belt slippage of a bucket conveyor

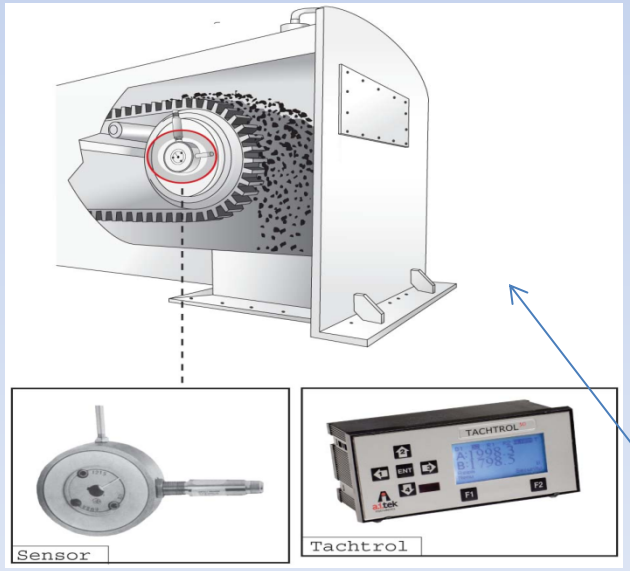
Tachometer/Sensor Applications



Pump application monitoring for reverse rotation or jam

Monitoring speed of a rotary air lock

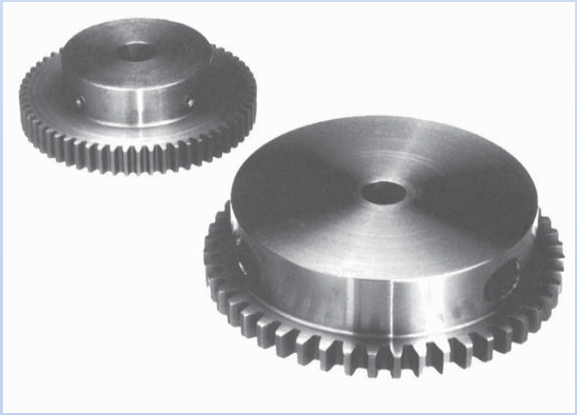




Monitoring shaft speed and coal feed on volumetric coal feeder

Accessory Products

Gears



Split Gears

Split gears provide a convenient and simple means of installation where shaft disassembly is not feasible. The two halves of the gear are fastened with clamping screws. All split gears are 12 diametral pitch, 14.5° pressure angle.

Solid Gear

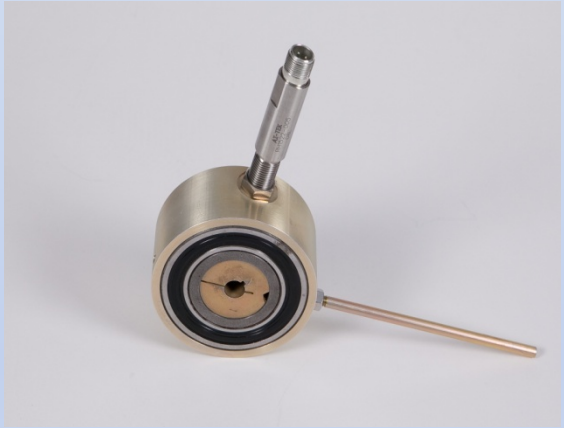
AI-Tek also offers a 20 diametral pitch, 14.5° pressure angle, solid steel gear. This gear can be rebored to fit shaft diameters up to 1.375". It is secured to the shaft with 2 set screws.

Cable Assemblies

Connectors and Cable Assemblies

- AI-Tek stocks a selection of connectors and cable assemblies for your convenience.
- Complete cable assemblies include the connector and 10' of recommended wiring for use with AI-Tek equipment.
- All wiring is insulated, and wrapped with braided or copper shield and jacketed in long-lasting PVC, Teflon or polyolefin insulation.
- Alternate cable length is 50', is available

Tachometer Transducer



Complete Sensing Solution

- Includes Sensor – VR or Hall
- Mounts on shafts up to 2 in dia.
- (2) types of mounting – Taper-Lock or Sleeve Type.
- Great for mounting long shafts and cannot allow close air gaps

AI-TEK Sensor Product Overview

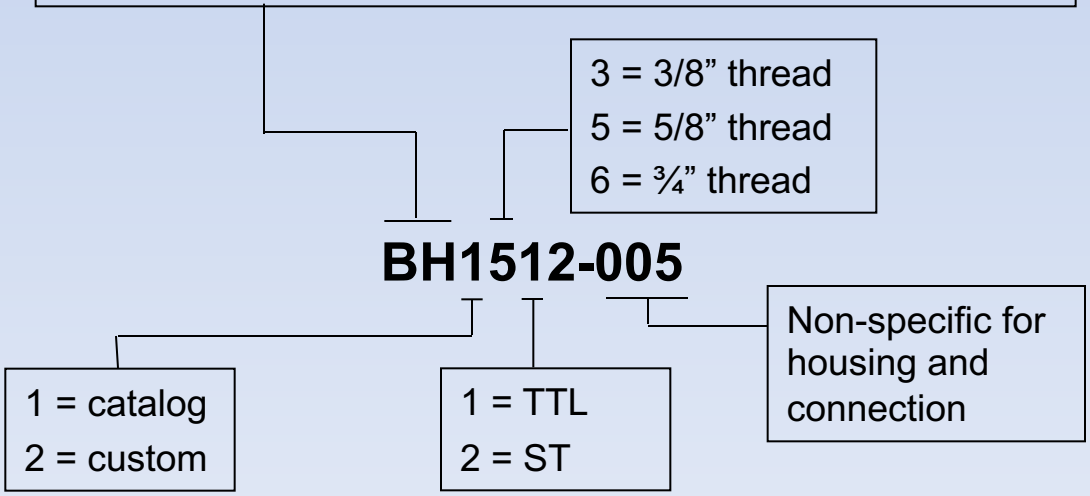
Active / Hall Effect Part Numbers

- **H Series** – single channel, differential, no calibration, early 1990's to mid 2005

- **RH Series** - single channel, single element, low-level calibration, mid 2005 to present

- **BH Series** – dual channel – bi-directional, EMC, differential, high-level calibration, mid 2004 to present

- **DH Series** - single channel, EMC, differential, high-level calibration, late 2011 to present



Passive / VR Part Numbers

- 70082-xxxx-xxx
  Automotive / Side Look

- 70083-xxxx-xxx
  Automotive / Custom - ¾"

- 70084-xxxx-xxx
  Automotive / Military / Custom – 5/8"

- 70085-1010-xxx
- 70085-8080-xxx
  Std Airpax / AI-TEK P/N's

- 70085-3030-xxx
  AI-TEK / IEC EX

- 086-xxx-xxxx
  MIL-AERO / Custom

AI-Tek Sensor Training
Key Sensor Selection Criteria

Target Info

Outside Dia. _____ # of Teeth (or holes) ____ Diametral Pitch (#T+2/OD in.)or module _____
Material _____

Mounting and Data needed

Max speed measured _____ Min. speed measured ____ Surface spd(OD* Π * RPM/60)
Max. ___ Min. ___

Air gap Max. _____ Min, _____ Min Output Voltage(Vp-p) _____Active Signal Type NPN PNP
Load on Sensor(ohms) _____ Thread size _____ length ____

Environment

Temperature _____ Atmosphere (air, oil, steam, pressure etc…) _____
Certification UL ____ FM ____ ATEX____ Termination (connector, cable, wire leads) _____
Other _____

Sales Detail

Volume/year _____ Target price_____ Due Date _____ Competition _____

Common Conversions

Formulas

f = RPM x PPR/60=ss x PPR/ Π x D

f = UPM x PPU/60 = UPH x PPU/3600

RPM = 60 x f/PPR = 60 x ss / Π x D

PPR = (D x DP)-2 = 60 x f/RPM

PPR = f x Π x D/ss

ss =RPM x Π x D/60=f x Π x D/PPR

D = (PPR +2)/DP = ss x PPR/f x Π

DP = (PPR +2)/D = 25.4/M

M = 25.4/DP = 25.4 x D/(PPR+2)

Definitions

f = frequency in Hz or cycles per second (cps)

RPM = rotary speed in revolution per minute

PPR = pulses per revolution or # of gear teeth

PPU = pulses per unit measure

Π = pi, 3.14

UPM = unit measure per minute

UPH = unit measure per hour

ss = surface speed in inches per second (ips)

D = outside diameter of target in inches

DP = diametral pitch, # teeth in 1 inch of pitch diameter

M = metric module, pitch diameter in mm divided by # of gear teeth

The End

Thank you