PRACTICAL DESIGN TECHNIQUES FOR SENSOR SIGNAL CONDITIONING

1 Introduction

2 Bridge Circuits

3 Amplifiers for Signal Conditioning

4 Strain, Force, Pressure, and Flow Measurements

5 High Impedance Sensors

■ 6 Position and Motion Sensors

7 Temperature Sensors

8 ADCs for Signal Conditioning

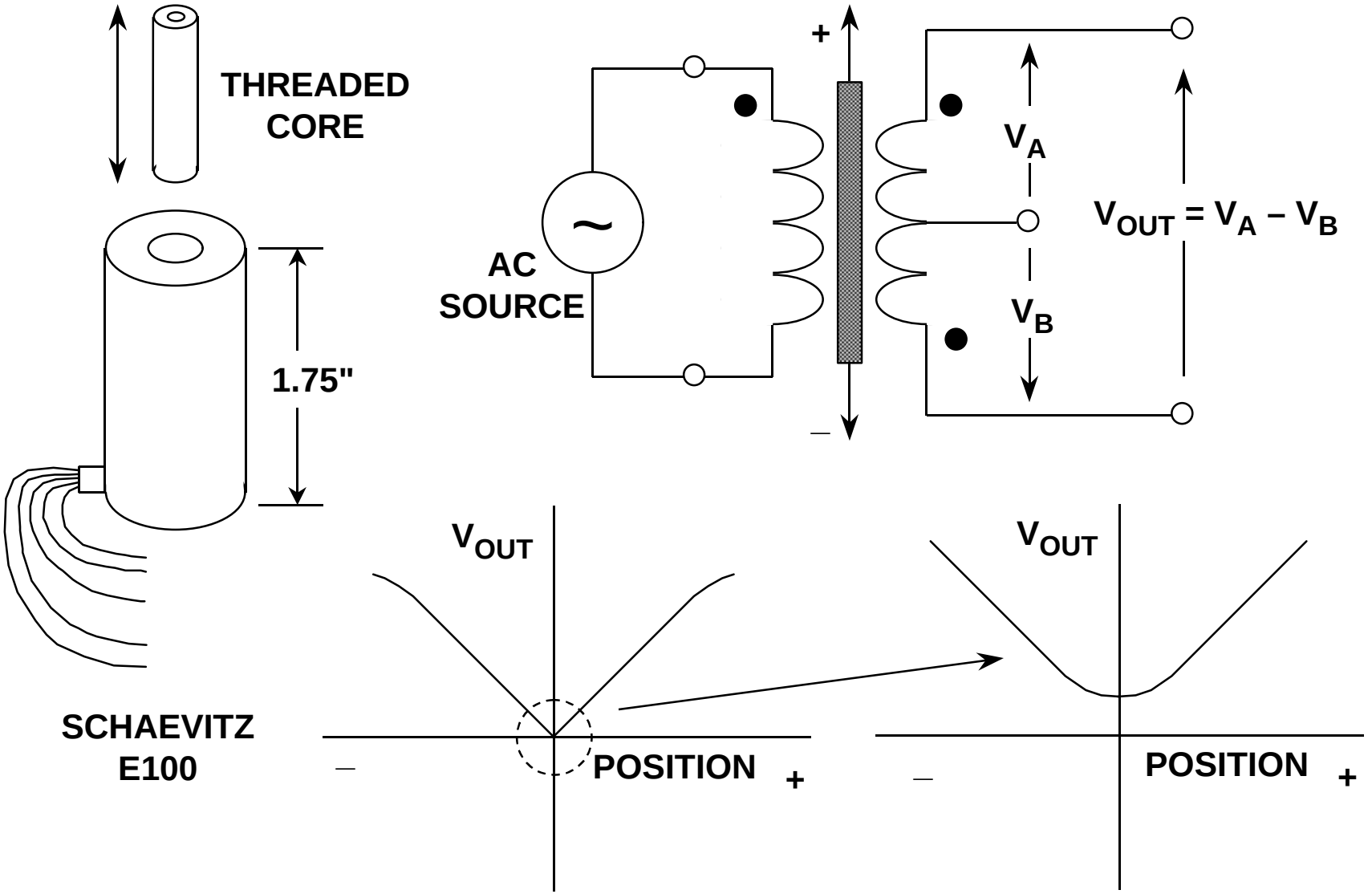
9 Smart Sensors

10 Hardware Design Techniques

POSITION AND MOTION SENSORS

- **Linear Position: Linear Variable Differential Transformers (LVDT)**
- **Hall Effect Sensors**
  - **Proximity Detectors**
  - **Linear Output (Magnetic Field Strength)**
- **Rotational Position:**
  - **Rotary Variable Differential Transformers (RVDT)**
  - **Optical Rotational Encoders**
  - **Synchros and Resolvers**
  - **Inductosyns (Linear and Rotational Position)**
  - **Motor Control Applications**
- **Acceleration and Tilt: Accelerometers**

LINEAR VARIABLE DIFFERENTIAL TRANSFORMER (LVDT)



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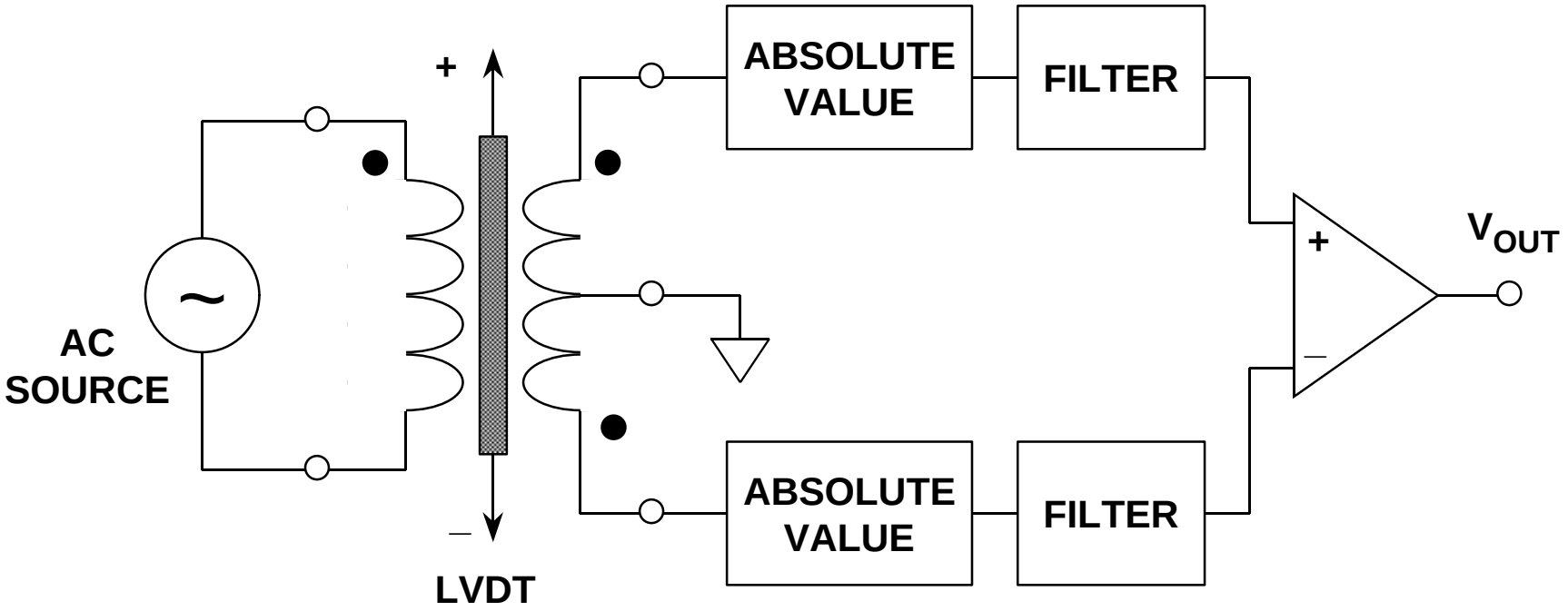
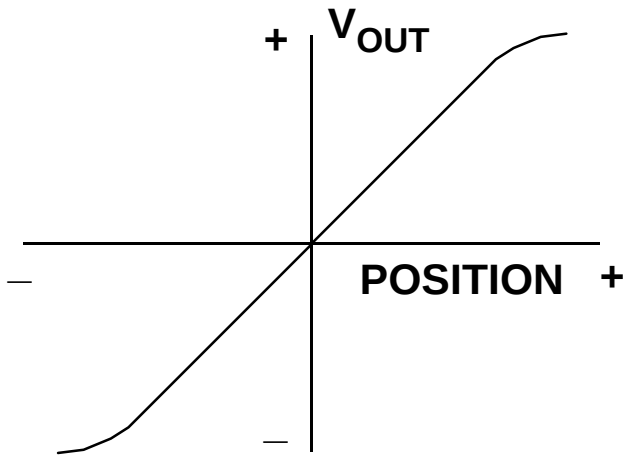
SCHAEVITZ E100 LVDT SPECIFICATIONS

- **Nominal Linear Range: ±0.1 inches (± 2.54mm)**
- **Input Voltage: 3V RMS**
- **Operating Frequency: 50Hz to 10kHz (2.5kHz nominal)**
- **Linearity: 0.5% Fullscale**
- **Sensitivity: 2.4mV Output / 0.001in / Volt Excitation**
- **Primary Impedance: 660Ω**
- **Secondary Impedance: 960Ω**

IMPROVED LVDT OUTPUT SIGNAL PROCESSING





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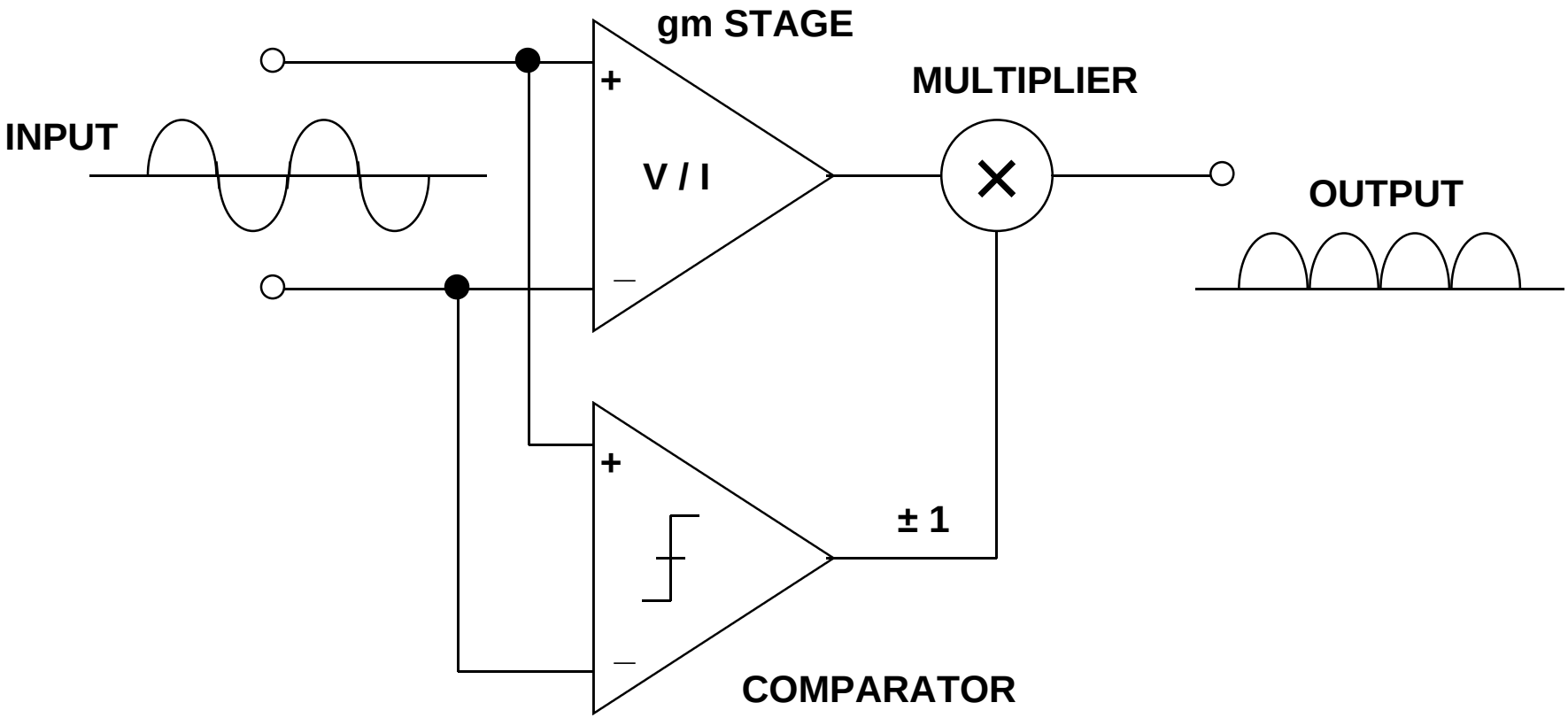
PRECISION ABSOLUTE VALUE CIRCUIT
(FULL-WAVE RECTIFIER)



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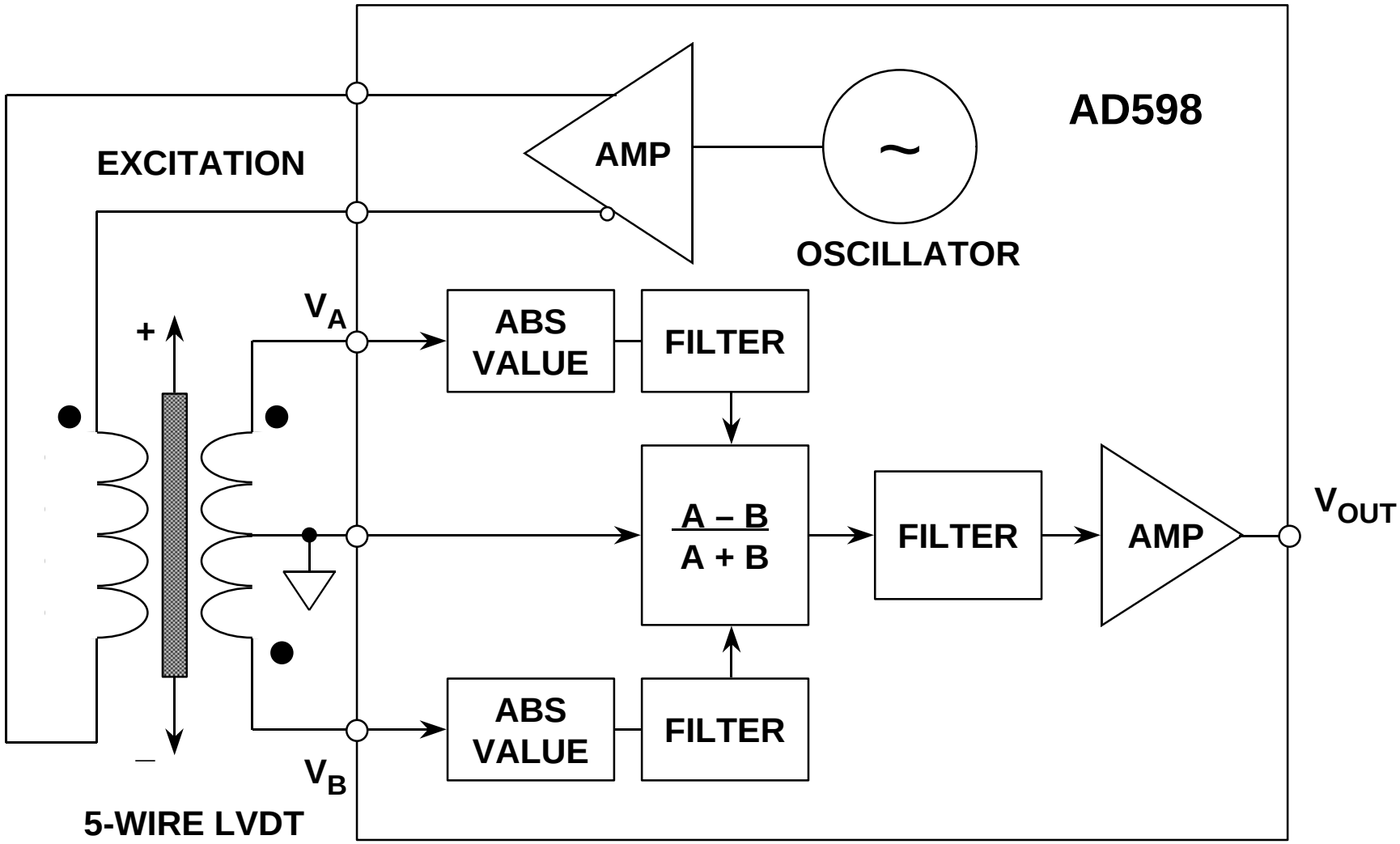
AD598 LVDT SIGNAL CONDITIONER (SIMPLIFIED)



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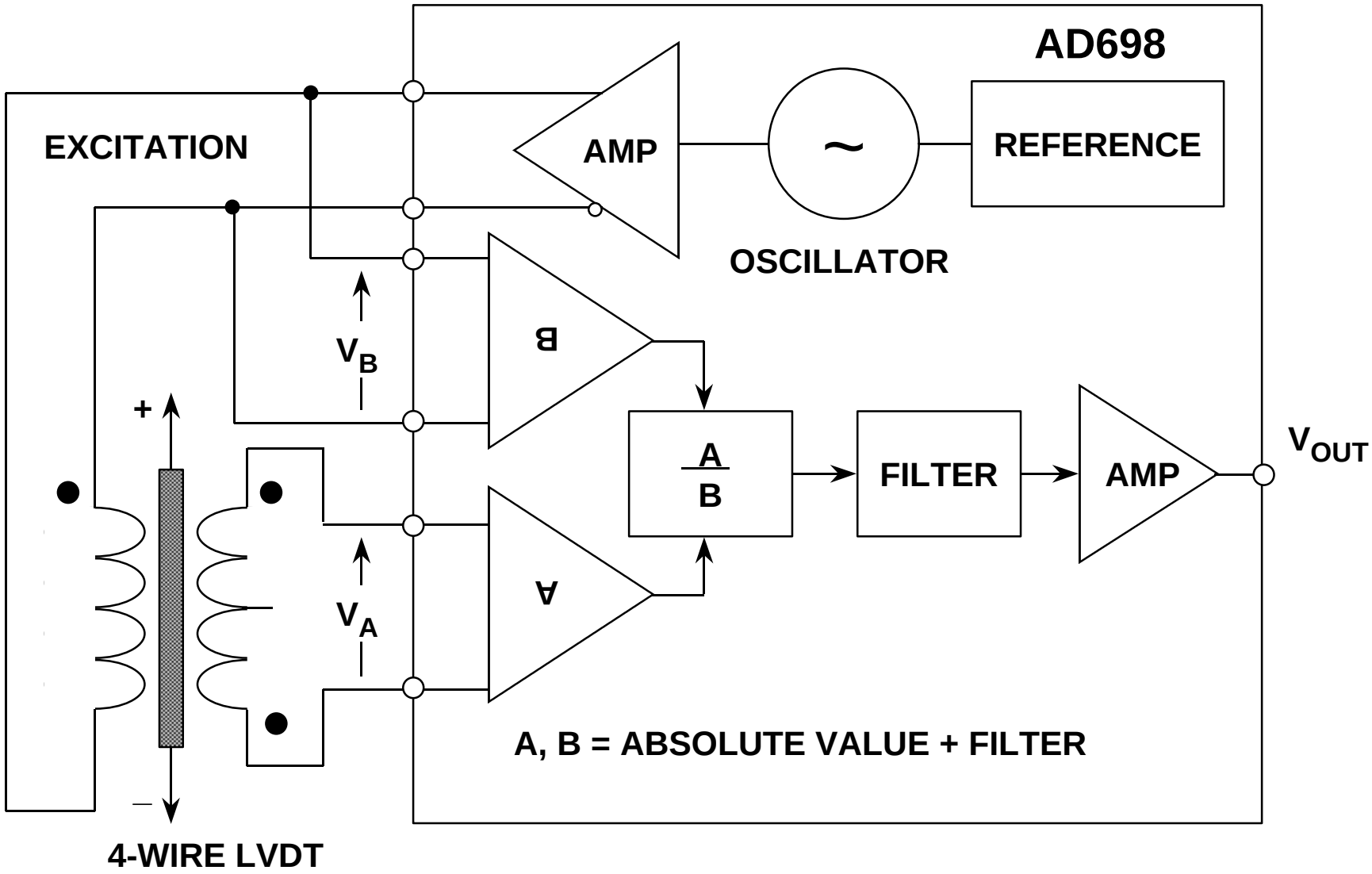
AD698 LVDT SIGNAL CONDITIONER (SIMPLIFIED)



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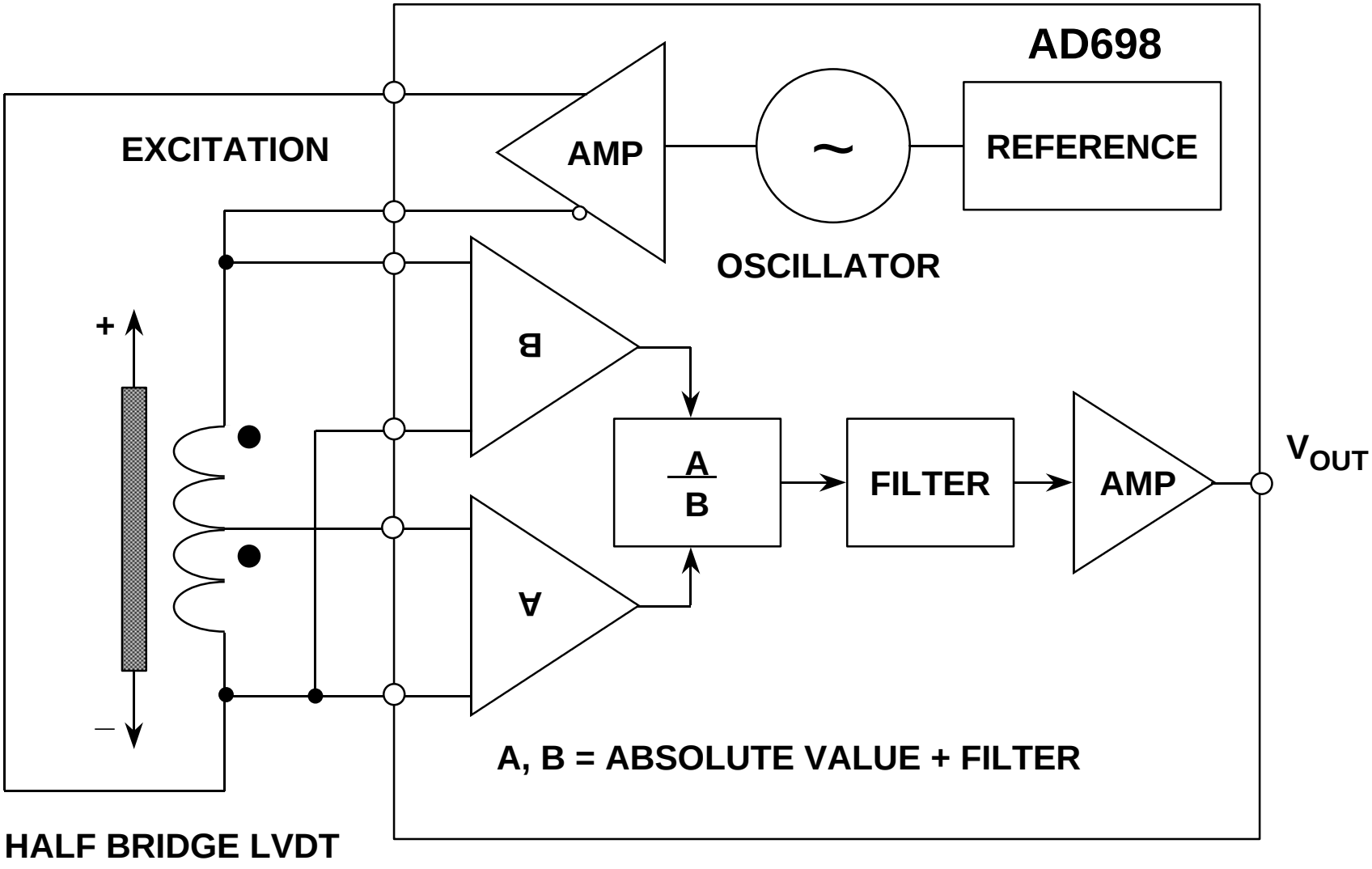
HALF-BRIDGE LVDT CONFIGURATION



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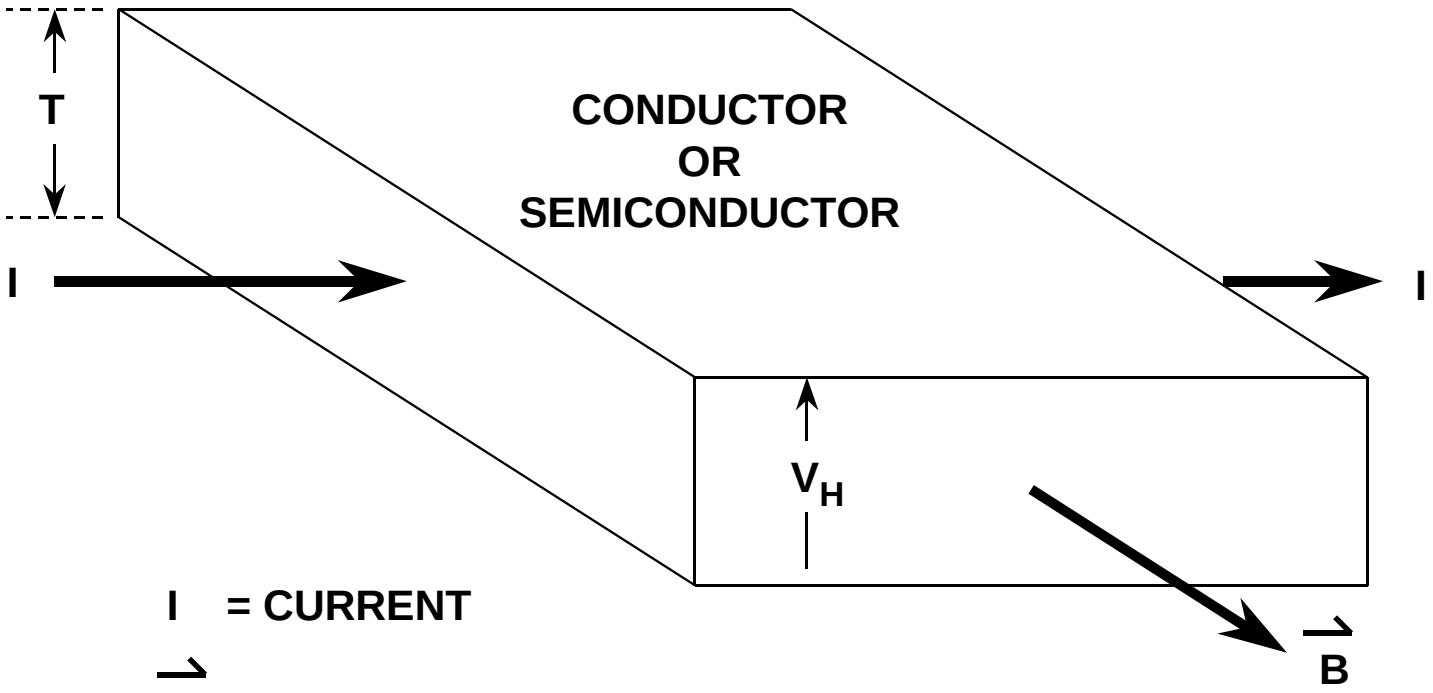
HALL EFFECT SENSORS



I = CURRENT

$\vec{B}$ = MAGNETIC FIELD

T = THICKNESS

V_H = HALL VOLTAGE

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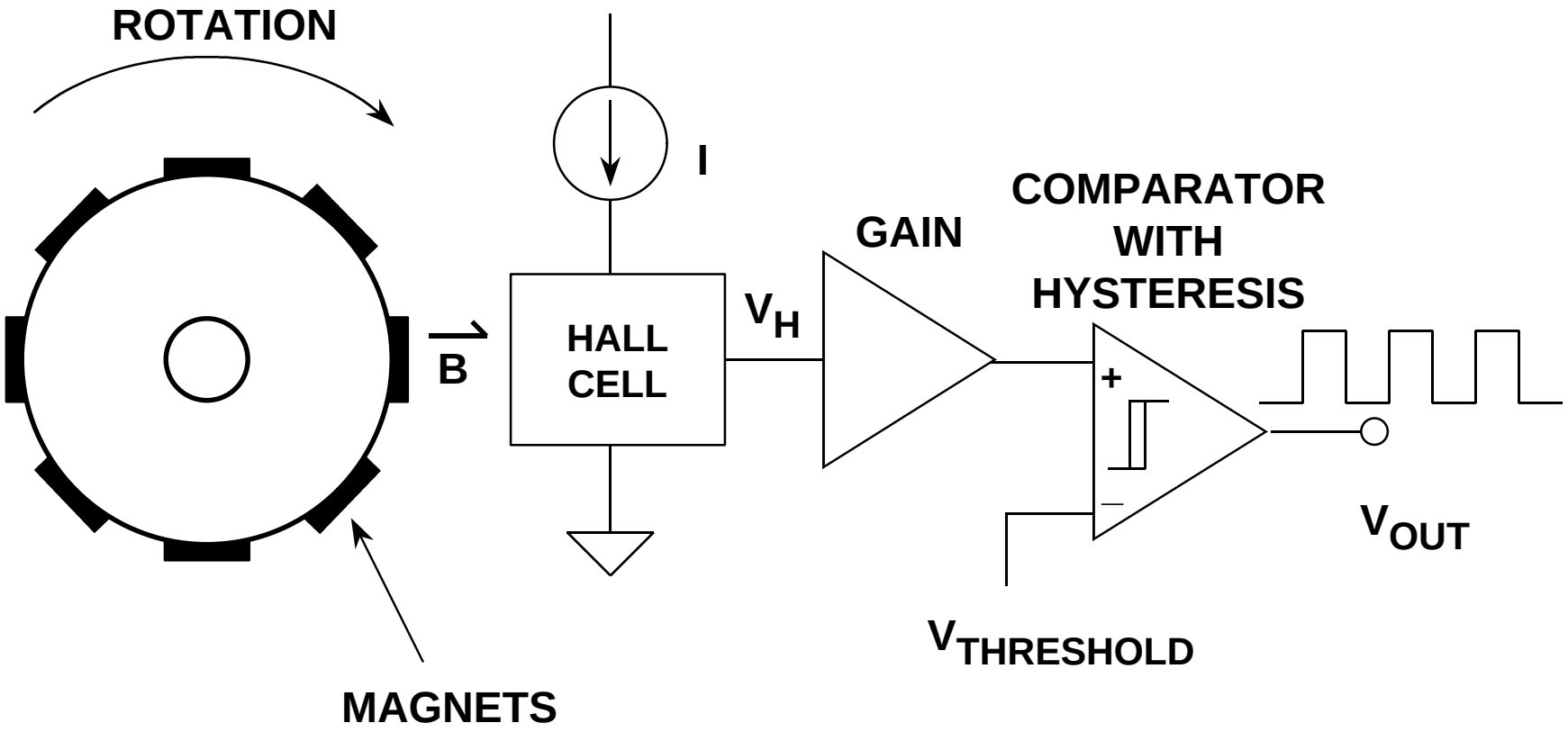
HALL EFFECT SENSOR USED AS A ROTATION SENSOR



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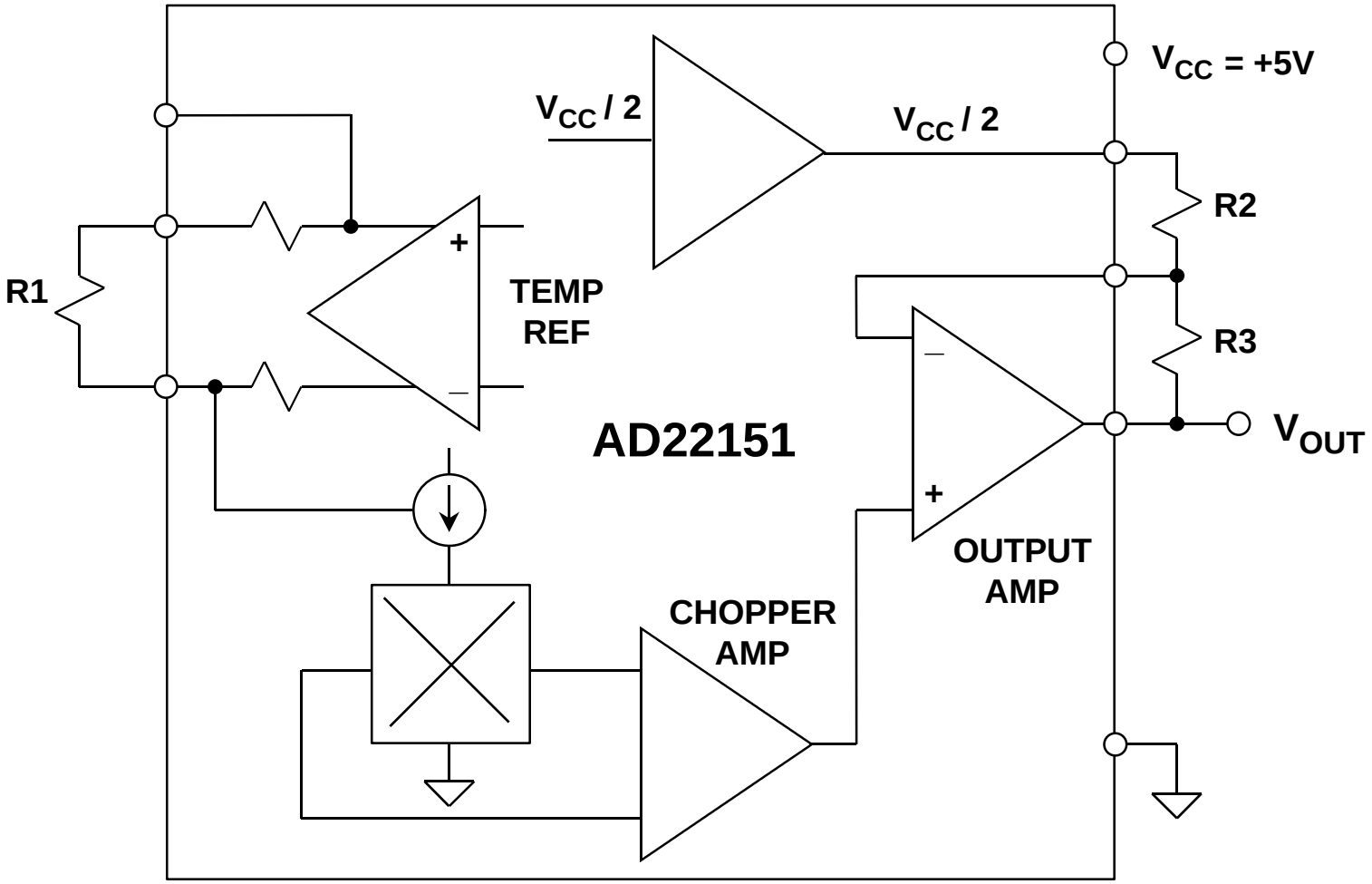
AD22151 LINEAR OUTPUT MAGNETIC FIELD SENSOR



$$V_{OUT} = \left[1 + \frac{R3}{R2}\right]\left[0.4mV\right] / Gauss$$

NONLINEARITY = 0.1% FS

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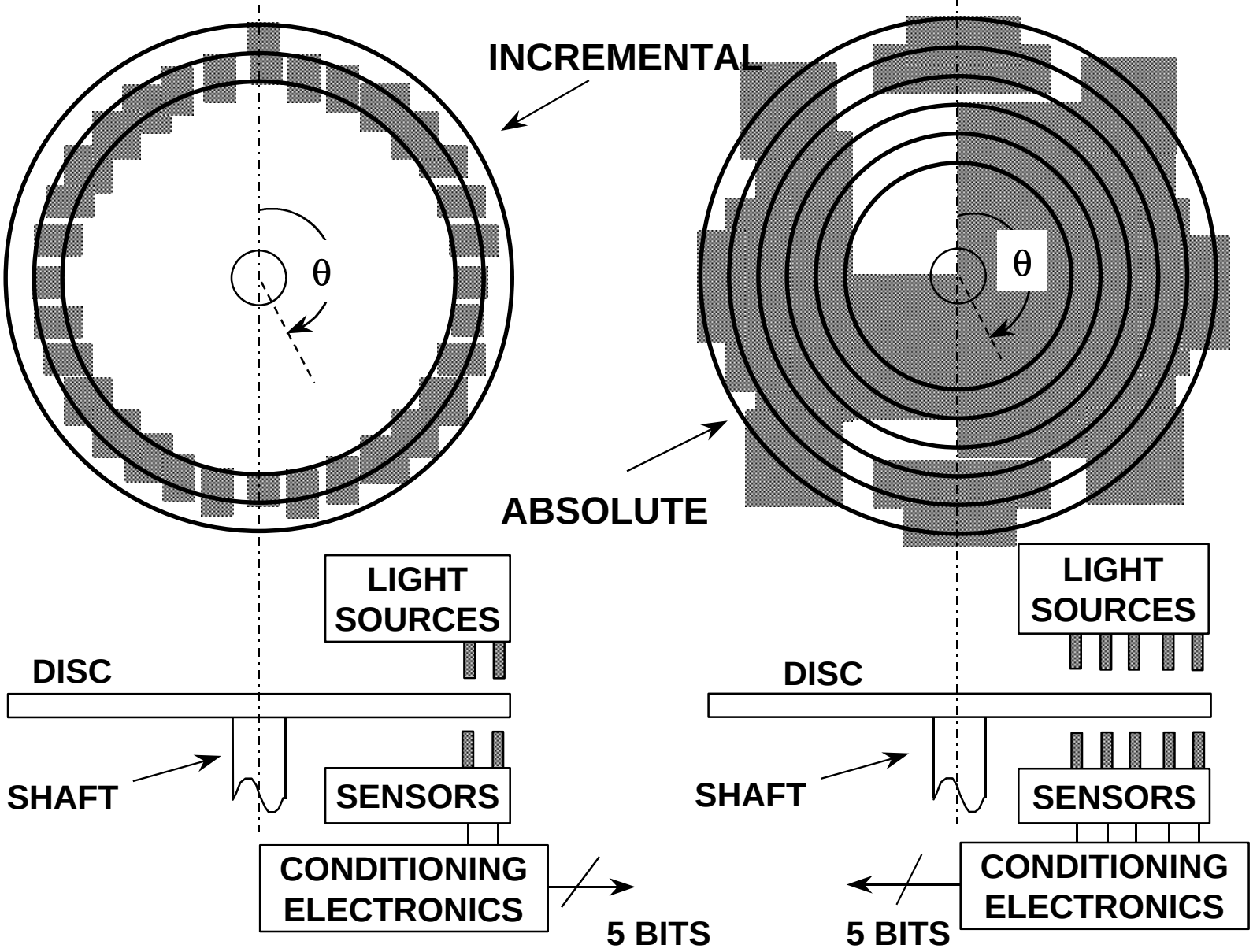
INCREMENTAL AND ABSOLUTE OPTICAL ENCODERS



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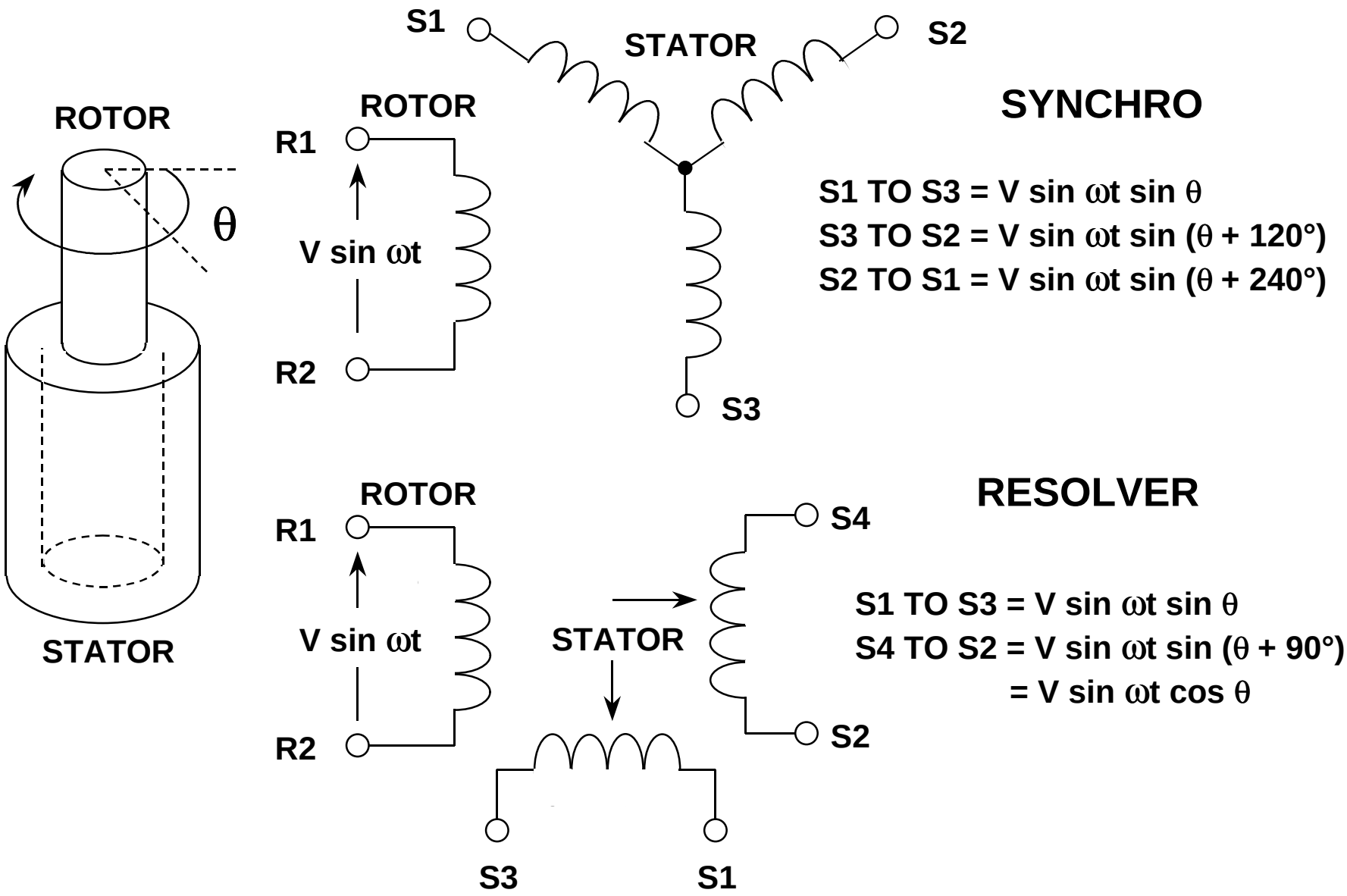
SYNCHROS AND RESOLVERS



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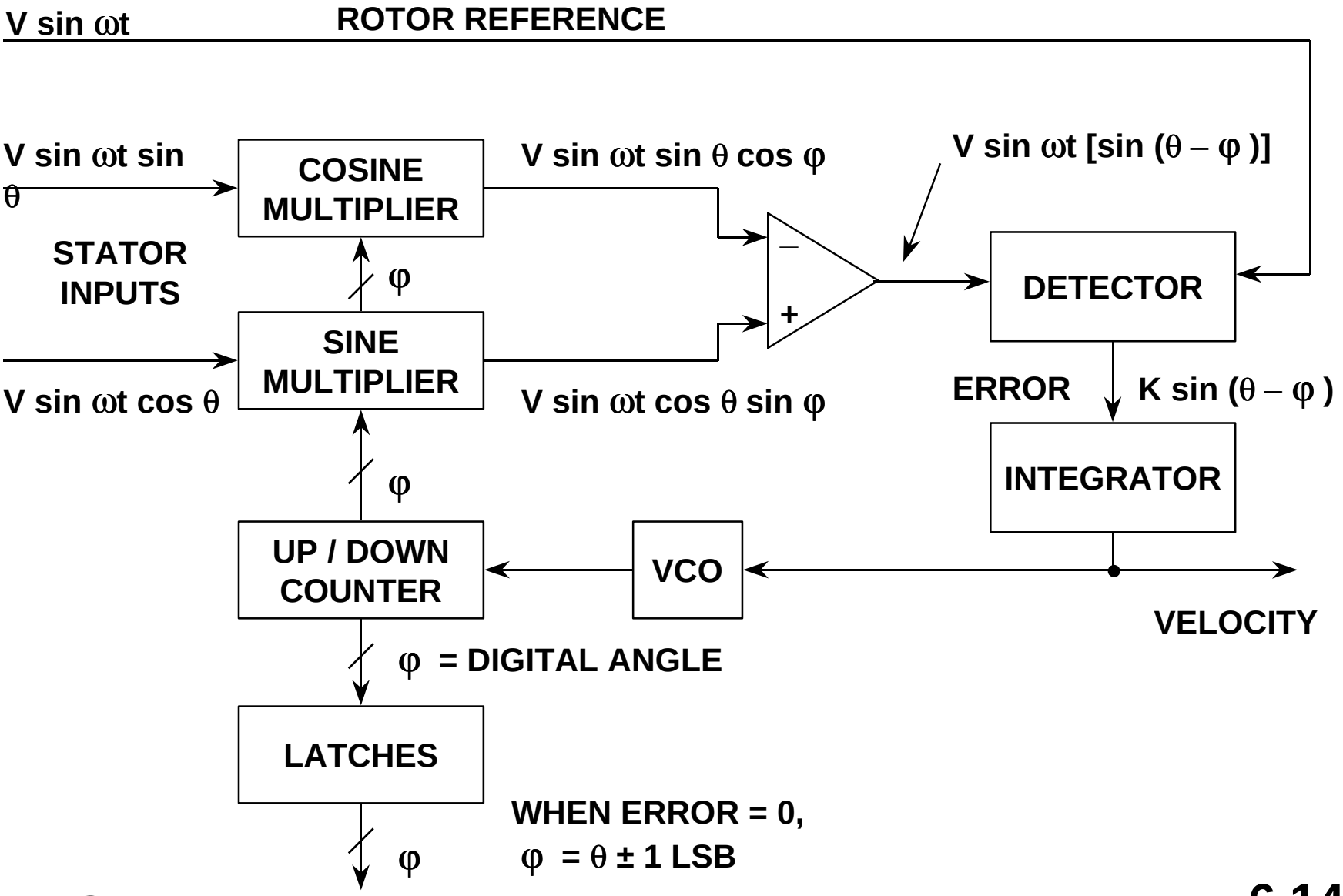
RESOLVER-TO-DIGITAL CONVERTER (RTD)



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PERFORMANCE CHARACTERISTICS FOR AD2S90 RESOLVER-TO-DIGITAL CONVERTER

- 12-Bit Resolution (1 LSB = 0.08° = 5.3 arc min)
- Inputs: 2V RMS ± 10%, 3kHz to 20kHz
- Angular Accuracy: 10.6 arc min ± 1 LSB
- Maximum Tracking Rate: 375 revolutions per second
- Maximum VCO Clock Rate: 1.536MHz
- Settling Time:
  - 1° Step: 7ms
  - 179° Step: 20ms
- Differential Inputs
- Serial Output Interface
- ± 5V Supplies, 50mW Power Dissipation
- 20 Pin PLCC

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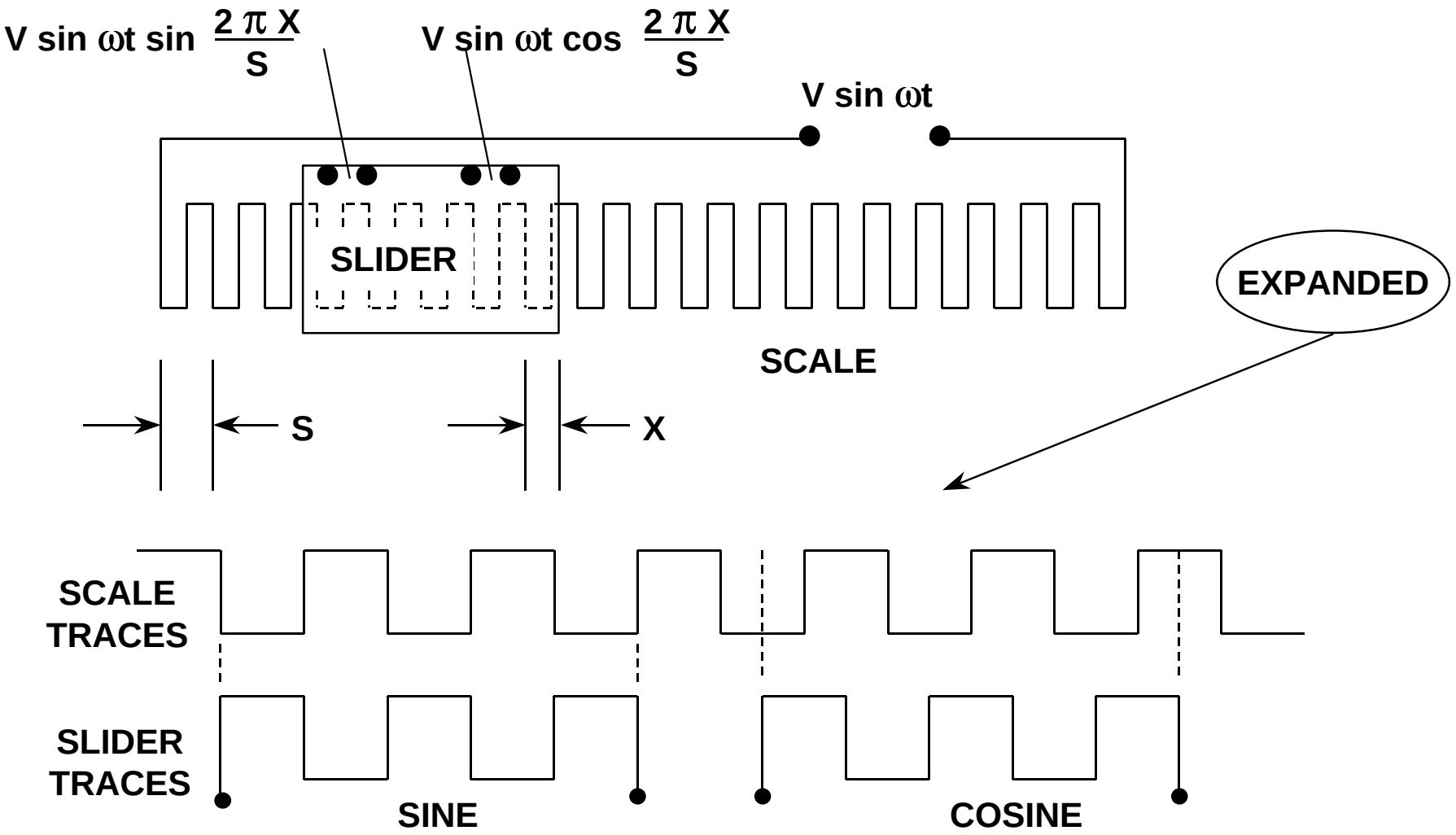
LINEAR INDUCTOSYN



TWO WINDINGS SHIFTED
BY 1/4 PERIOD (90°)

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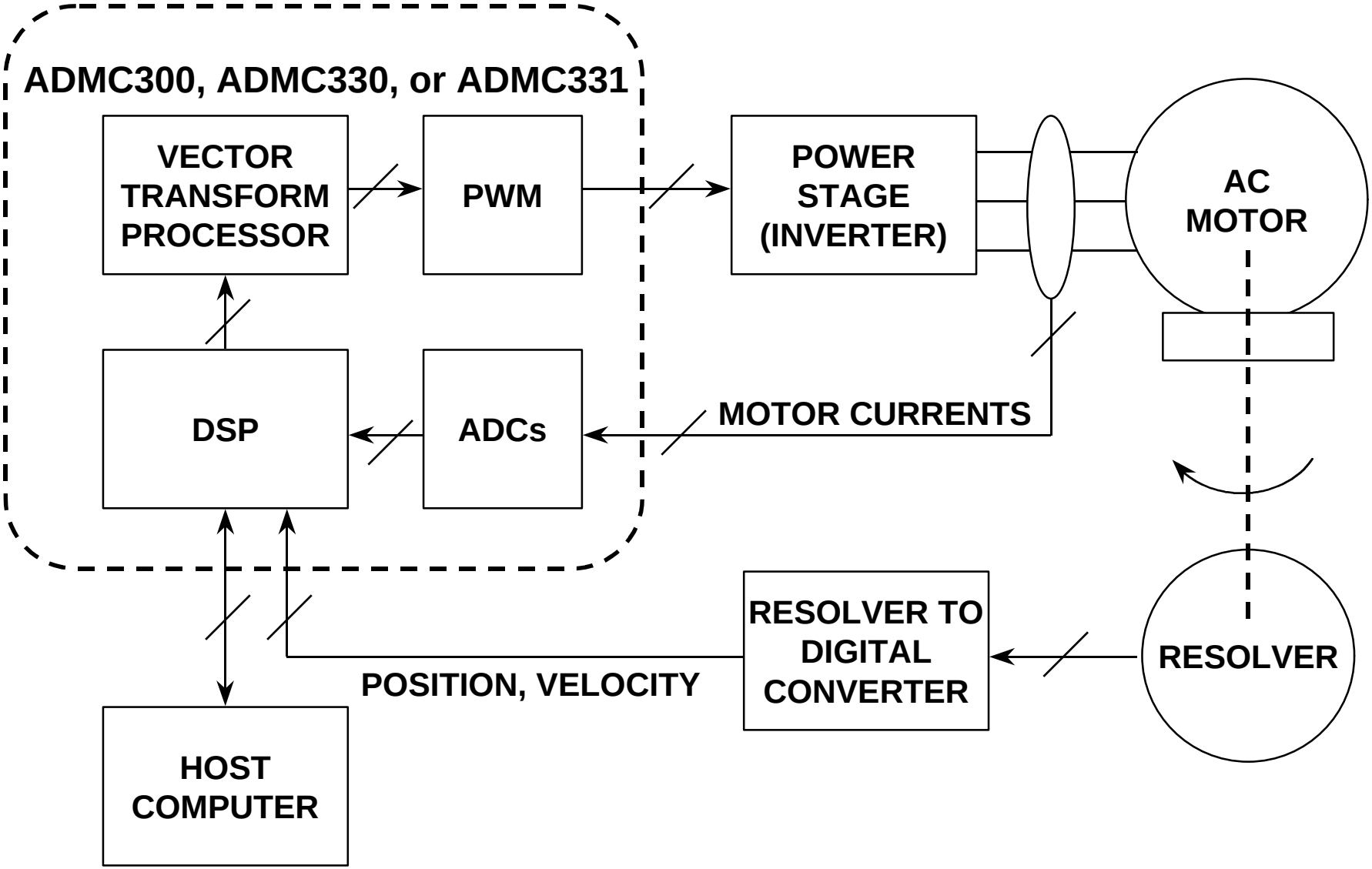
AC INDUCTION MOTOR CONTROL APPLICATION



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ACCELEROMETER APPLICATIONS

- **Tilt or Inclination**
  - **Car Alarms**
  - **Patient Monitors**
- **Inertial Forces**
  - **Laptop Computer Disc Drive Protection**
  - **Airbag Crash Sensors**
  - **Car Navigation systems**
  - **Elevator Controls**
- **Shock or Vibration**
  - **Machine Monitoring**
  - **Control of Shaker Tables**
- **ADI Accelerometer Fullscale g-Range: ± 2g to ± 100g**
- **ADI Accelerometer Frequency Range: DC to 1kHz**

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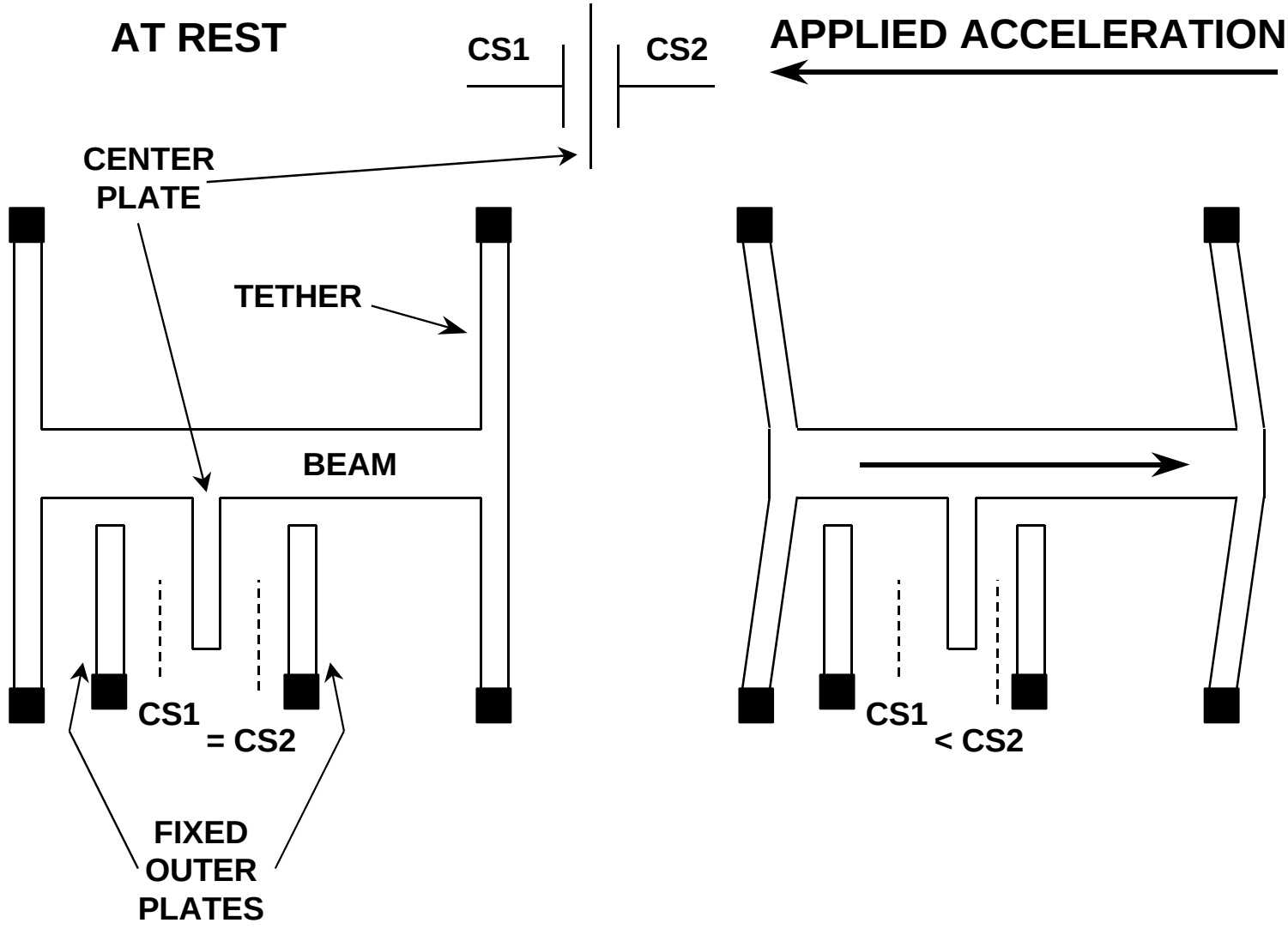
ADXL-FAMILY MICROMACHINED ACCELEROMETERS (TOP VIEW OF IC)



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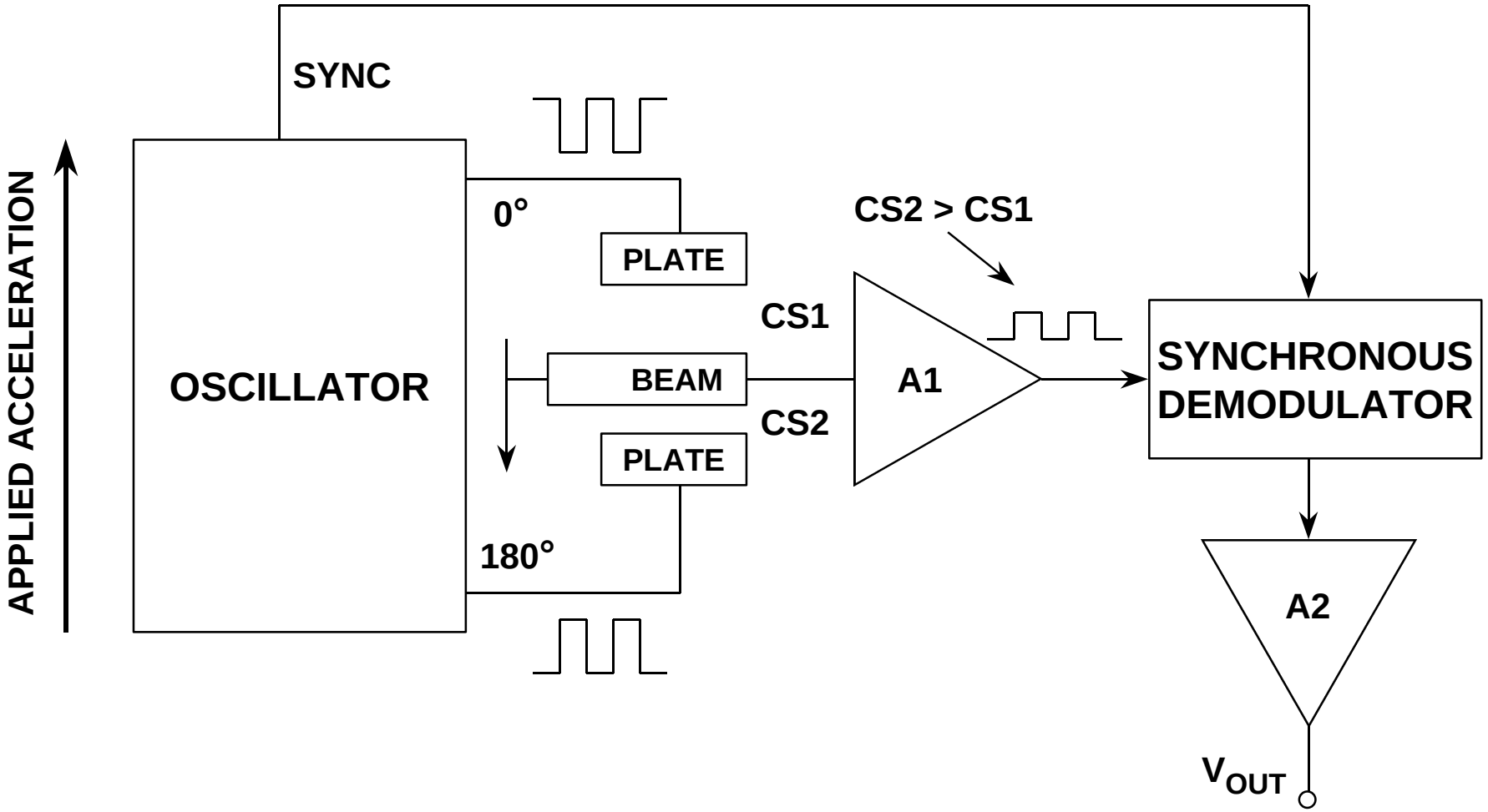
ADXL-FAMILY ACCELEROMETERS
INTERNAL SIGNAL CONDITIONING



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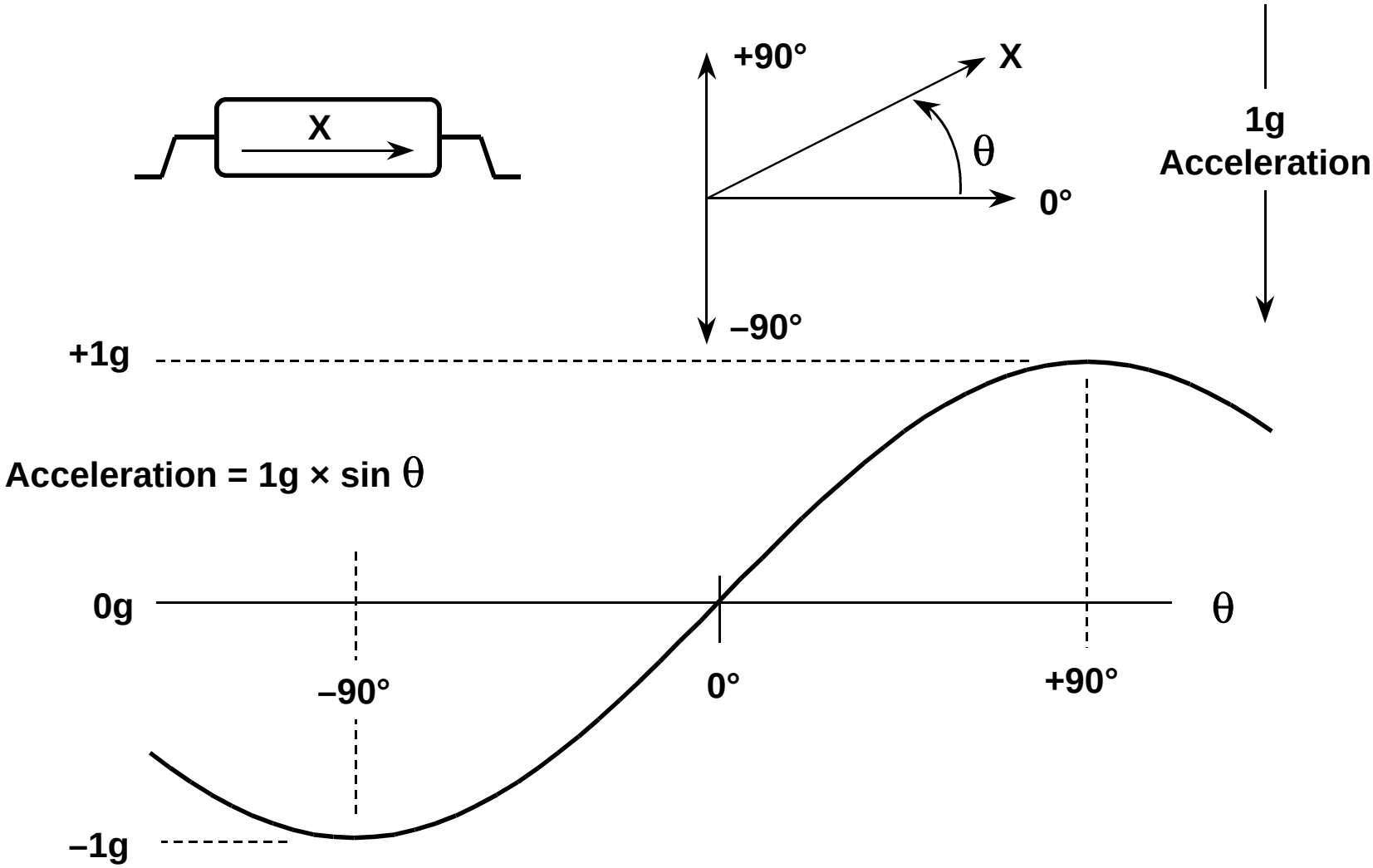
USING AN ACCELEROMETER TO MEASURE TILT



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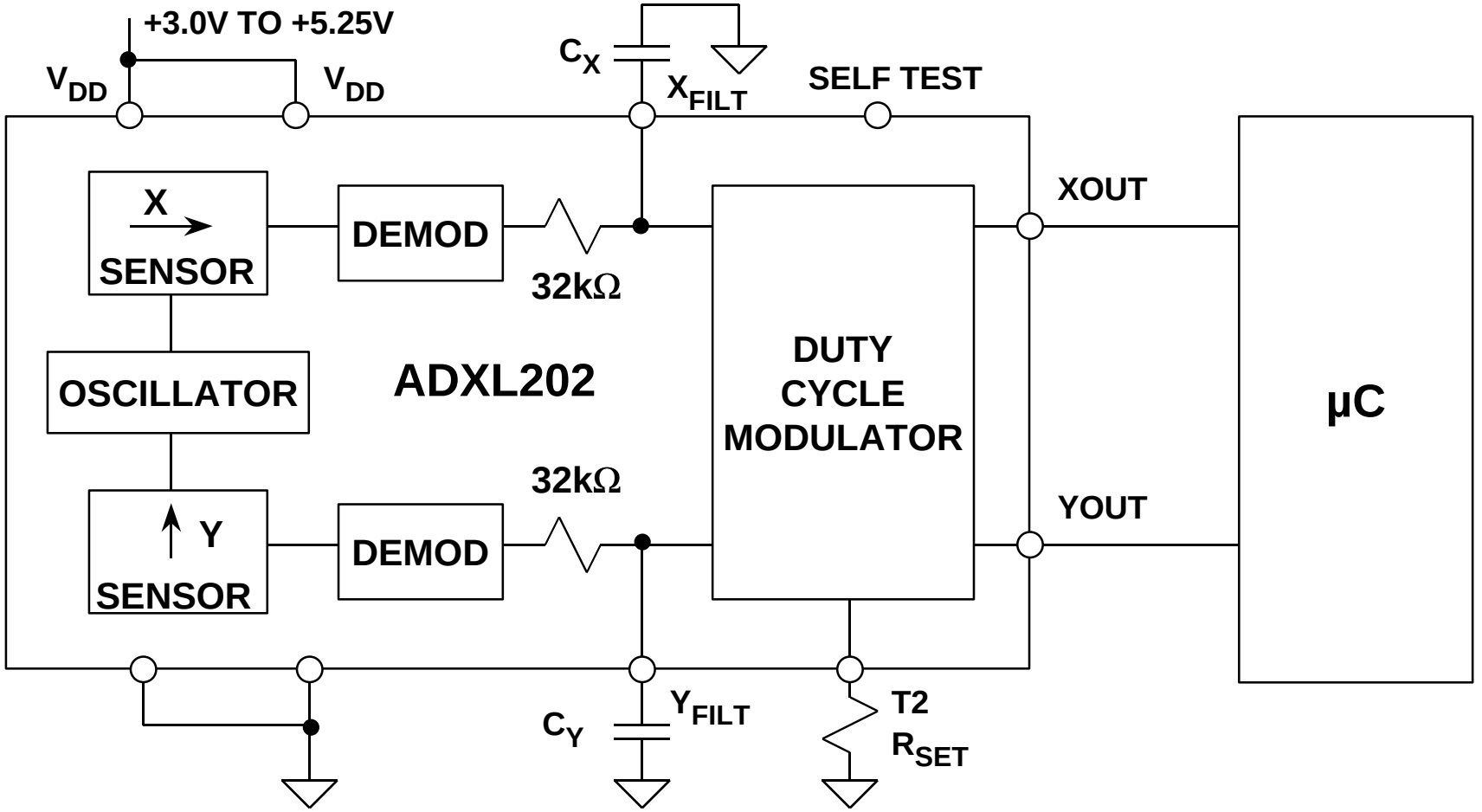
ADXL202 ±2g DUAL AXIS ACCELEROMETER



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ADXL FAMILY OF ACCELEROMETERS

	g RANGE	NOISE DENSITY	SINGLE/ DUAL AXIS	VOLTAGE/ DUTY CYCLE OUTPUT
ADXL202	±2g	0.5mg/√Hz	Dual	Duty Cycle
ADXL05	±5g	0.5mg/√Hz	Single	Voltage
ADXL210	±10g	0.5mg/√Hz	Dual	Duty Cycle
ADXL150	±50g	1mg/√Hz	Single	Voltage
ADXL250	±50g	1mg/√Hz	Dual	Voltage
ADXL190	±100g	4mg/√Hz	Single	Voltage

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