Circuit Design for RPM Detection Using an Inductive Sensor

Introduction

Detecting the RPM (Revolutions Per Minute) of a gasoline engine can be achieved by capturing the ignition pulses from the spark plug wire using an inductive sensor. The sensor produces a 0-12V analog signal that corresponds to the ignition events. However, this signal may contain noise and irregularities due to the engine's electrical environment. To accurately measure RPM, we need to convert this analog signal into a clean digital 0-12V square wave while filtering out noise.

Proposed Solution

To achieve a clean digital signal from the analog input, we will design a circuit that includes:

1. **Input Filtering**: An RC low-pass filter to attenuate high-frequency noise.
2. **Voltage Protection**: Clamping diodes to protect downstream components from voltage spikes.
3. **Signal Conditioning**: A comparator with hysteresis (Schmitt trigger) to convert the analog signal into a digital pulse.
4. **Output Stage**: An open-collector output with a pull-up resistor to produce a 0-12V square wave.

Circuit Components

- **R1**: Input resistor (10 kΩ)
- **C1**: Filtering capacitor (1 nF)
- **D1 & D2**: Clamping diodes (1N4148)
- **R2 & R3**: Voltage divider resistors (10 kΩ each)
- **R4**: Hysteresis resistor (100 kΩ)
- **Comparator**: LM393 or LM311
- **Pull-up Resistor**: R5 (10 kΩ connected to 12V)

Circuit Explanation

1. Input Filtering

The resistor **R1** and capacitor **C1** form an RC low-pass filter that reduces high-frequency noise from the sensor signal.

2. Voltage Protection

Clamping diodes **D1** and **D2** protect the comparator inputs from voltage spikes by limiting the voltage to within the supply rails.

3. Signal Conditioning

The filtered signal is fed into the non-inverting input of the comparator. A voltage divider using **R2** and **R3** sets a reference voltage at the inverting input, typically at half the supply voltage (6V). The hysteresis resistor **R4** provides positive feedback to create a Schmitt trigger effect, which helps in clean switching by introducing two different threshold voltages for rising and falling edges.

4. Output Stage

The comparator's open-collector output requires a pull-up resistor **R5** to 12V. The output swings between 0V (ground) and 12V, producing a clean square wave corresponding to the engine's RPM.

Circuit Schematic

The schematic below illustrates the circuit design: