Flowmeter circuit

Friday, January 21, 2022 12:01 AM

Flow meter

Parameters of a flow meter:

- 1/2 NPT pipe. Plastic body (poly propylene)
- Flow range: 1.5-20GPM
- Pipe connection size and style: NPT
- Flow range (GPM)
- Flow rate measurement: GPM to voltage
- Max water pressure
- Electronics: Voltage (typ 24V DC)

Flow Transmitter for Water
Polypropylene Plastic Body, 1/2 NPT Female, 1.5 to 20 gpm

$178.45 Each
In stock
9687K12

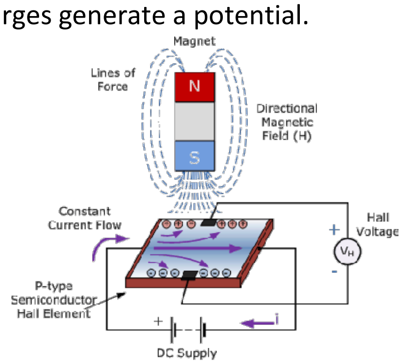
Each

ADD TO ORDER

For Use With	Water
Connection Type	Pipe
Pipe Connection Type	Threaded
Pipe Connections	1/2 NPT Female
End-to-End Length	3 1/16"
Flow Measurement Scale	Gallons per Minute
Flow Range	1.5 to 20 gpm
Accuracy	±15%
Maximum Pressure	100 psi @ 70° F
Temperature Range	33° to 180° F
Direction of Flow	Bottom to Top, Top to Bottom, Left to Right, Right to Left
Body Material	Polypropylene Plastic
Seal Material	Fluoroelastomer Rubber
Mounting Location	Inline
Mounting Orientation	Horizontal, Vertical
Output	
Signal Connection	Wire Leads
Signal	70 mA
Current	0.008 A @ 24 V DC
Wire Lead Length	24"
Wire Connection Type	Wire Leads
Electrical Connection Type	Hardwire

The flow meter uses hall effect:

- Hall sensor is a piece of p-type semiconductor material (eg. GaAs, InSb, InAs),with continuous current passing through it.
- Now placing it in a magnetic field: the magnetic flux exerts a Lorentz force which deflects the electrons and holes to either side of the semiconductor slab --> this separation of charges generate a potential.



- In a flowmeter, with each revolution of the wheel: a certain amount of (volume) of water passes through & the number of pulses generated per revolution is constant.

So we can establish the relation between Volume/rev and Number of pulses/rev (= Frequency)

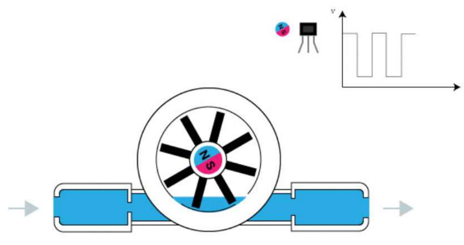


Figure 3. *Water flow sensor working principle*

Frequency to Voltage conversion

Example spec of above flow meter with flow range 1.5-20 gpm:

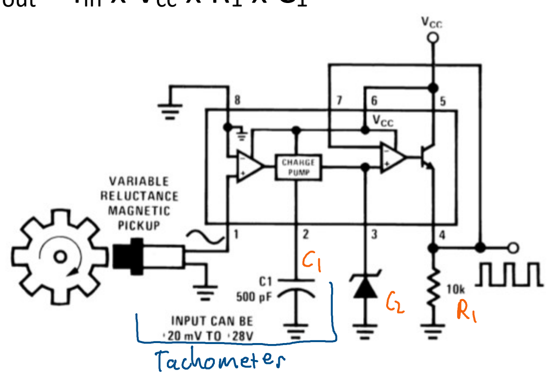
Flow rate (gpm)	Frequency Hz
1.5	17
4.0	34
20	220

And output voltage is the same as input voltage.

Flow meter outputs a frequency, and we need to convert that frequency to digital voltage to read.

We use a frequency-voltage converter LM2917:

$$V_{out} = f_{in} \times V_{cc} \times R_1 \times C_1$$



It uses a **charge pump** with a constant current source to charge small capacitors C1 to Vcc/2 during the Positive half of cycle of the input frequency signal, and then discharges during Negative part. This process is obviously proportional to the frequency of the input.

- Then a **comparator** (one input connected to ground) determines when signal is at positive/negative half of the cycle.
- Both the charging current & discharging current are mirrored as positive pulses into the output resistor R1. C2 is for smoothing out.

Calculations:

- When input signal changes state (pos <-->neg), the timing capacitor C1 is either charging or discharging linearly, between 2 voltages whose difference if Vcc/2.

Avg amount of current charged into/out of timing capacitor C1: $\bar{I}_c = \frac{\Delta Q}{T}$

Half cycle duration time $= \frac{1}{2f_{in}}$

$$\Rightarrow \bar{I}_c = \frac{(V_{cc}/2) \times C_1}{\frac{1}{2f_{in}}} = \underline{V_{cc} \times f_{in} \times C_1}$$

- Finally, output of circuit maps this current to voltage via an output resistor R_1:

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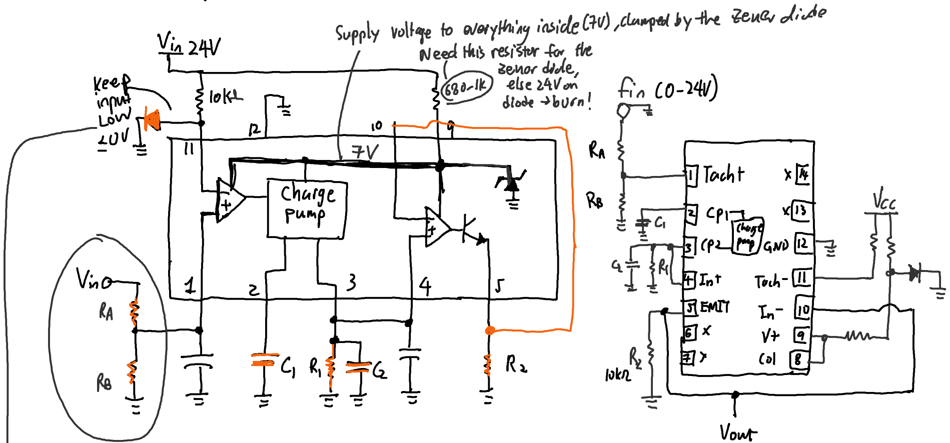
  $\Rightarrow V_{out} = I_c \times R_1 = \boxed{V_{cc} \times f_{in} \times C_1 \times R_1}$

  plus filtering capacitor C_2 to smooth out pulses of current

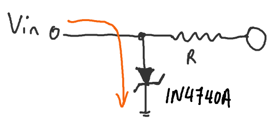
- Note on choosing R_1, C_1:
  - C_1 must be $> 500\,pF$ for accurate operations, because the capacitors also provides internal compensation for the charge pump.



Voltage divider to keep Tach+ ≥0.7V but <7V (Supply voltage for the comparator)

Using zener diode to pull voltage to be negative

Want voltage to be across the zener diode, Not resistor! After all, voltage across the diode is what is approx constant.



← Negative here
Voltage always $\leq 0.7V$

when Vin above 7V → Zener diode conducts

When Vin $\leq 0V$ → Zener diode can't conduct as it's reverse biased

∴ Get negative voltage that we wanted!

∴ either we get $\begin{cases} 0V \\ \text{negative voltage.} \end{cases}$

① We want to set $V_{tach+} < 7V$

$R_A = 33k\Omega$, $R_B = 10k\Omega$ $\Rightarrow V_{tach+} = V_{in} \cdot \frac{R_B}{R_A + R_B} = 0.23 \times V_{in}(24V) \Rightarrow \boxed{5.52V}$

② We want V_{out}

$V_{out} = V_{cc} \times f_{in} \times C_1 \times R_1$

Want (0-5V) ← map → (17-240)Hz flowmeter spec

If $C_1 = 10nF$, $R_1 = 100k\Omega$ $(C_2 = 10nF, R_2 = 10k\Omega)$

$$\Rightarrow V_{out} = \underset{24V}{V_{cc}} \times \begin{pmatrix} 17Hz \\ 220Hz \end{pmatrix} \times 10nF \times 100k\Omega = \begin{pmatrix} 17Hz : 0.4V \\ 220Hz . 5.28V \end{pmatrix}$$ ✓