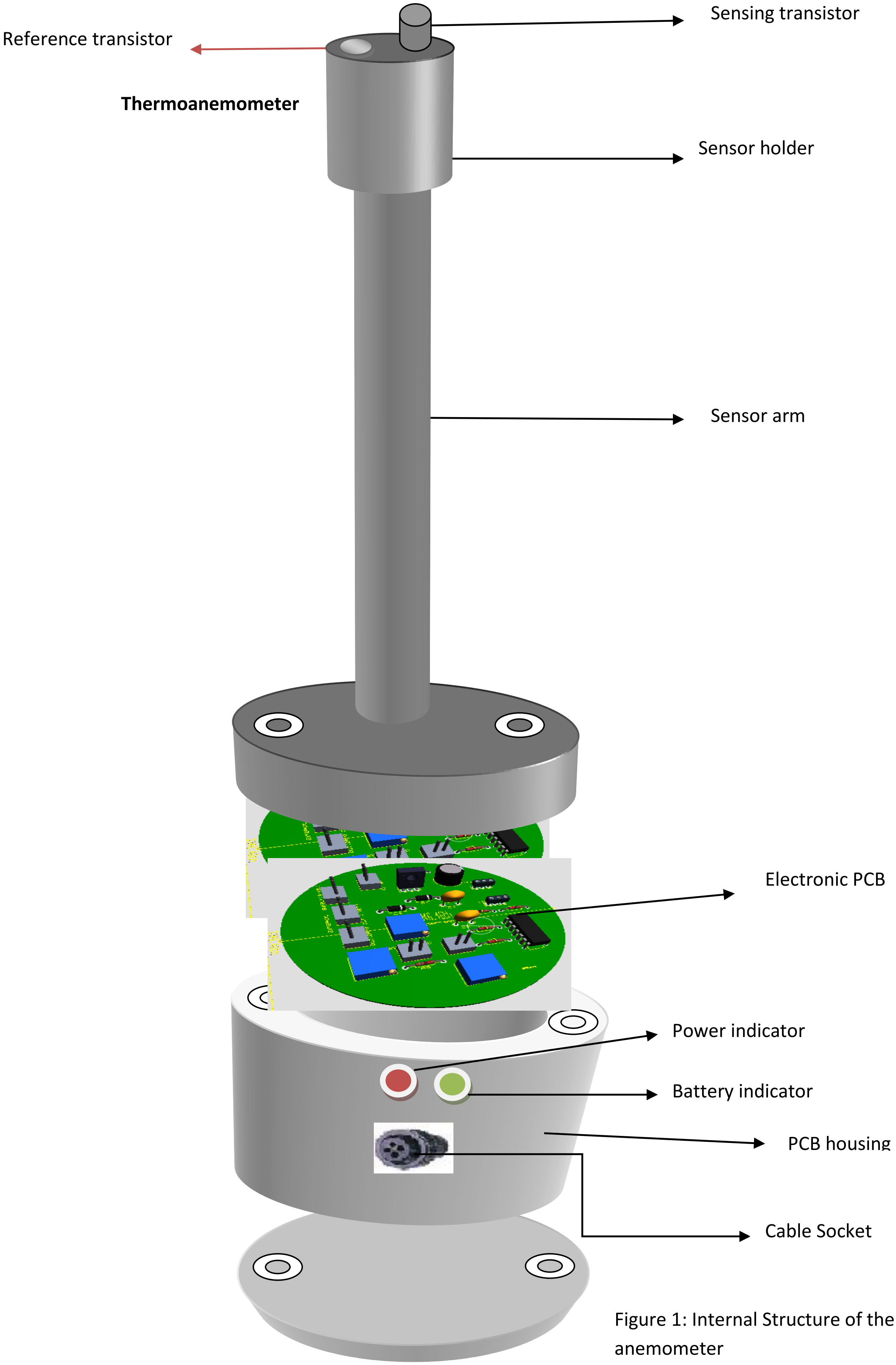

Figure 1: Internal Structure of thermo anemometer

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Thermo Anemometer

A sensitive and reliable way to measure wind speed is to take advantage of the predictable relationship between heat dissipation and the speed of wind. The principle of thermal anemometer relies on King's Law, which dictates that the power required maintaining a fixed differential between the surface of a heated sensor and the ambient flow temperature increases as the square root of speed of flow. The popular hot-wire anemometer exploits this principle, but it suffers from the disadvantage of using a specialized and fragile metallic filament, the hot wire, as the flow sensor. The circuit in Figure 2a avoids this disadvantage by using a pair of robust and inexpensive transistors instead of a flimsy wire for flow-speed sensing. The Q_1/Q_2 front end of the circuit are use to determine the flow rate by the influence of potential difference as temperature of Q_1 falls when fluid flow over it at a steady rate. The circuit in Figure 1 works by continuously maintaining the condition $V_{Q1}=V_{Q2}$. To perform this task, the circuit must keep Q_1 approximately 50°C hotter than Q_2.

V_{BE} balance requires this temperature difference, because Q_1's collector current, I_{Q1}, is 100 times greater than that of Q_2, I_{Q2}. If Q_1 and Q_2 were at the same temperature, this ratio would result in V_{Q1}'s being greater than V_{Q2} by approximately 100 mV. Proper control of I_{Q1} establishes differential heating that makes Q_1 hotter than Q_2. The method thus exploits the approximate –2-mV/°C temperature coefficient of V_{BE} to force V_Q balance. The resulting average, I_{Q1}, proportional to the average power dissipated in Q_1, is the heat-input measurement that forms the basis for the thermal flow-speed measurement. Calibration of the sensor begins with adjustment of the R_1 zero-adjust trim. You adjust R_1 such that, at zero airflow, $V_{Q1}=V_{Q2}$ with no help from Q_3. Then, when moving air hits the transistors and increases the heat-loss rate, V_{Q1} increases and causes comparator IC_1 to release the reset on C_1. C_1 then charges until IC_2 turns on, generating a drive pulse to Q_1 through Q_3.

The resulting squirt of collector current generates a pulse of heating in Q_1, driving the transistor's temperature and V_{BE} back toward balance. Proper adjustment of R_2 calibrates the magnitude of the I_{Q1}-induced heating pulses to establish an accurate correspondence between pulse rate and flow speed. Now, consider measurement linearization. The square-root relationship of King's Law makes the relationship between heat loss and flow speed nonlinear.

The circuit in Figure 2b provides both linearity and a digital output. The average heat the pulses deposit in Q_1 is $H=5V\times I\times F\times W$, where I is the amplitude of the Q_1 current pulses (adjusted with R_2), F is the output frequency, and W is the pulse width. W is inversely proportional to I_D, the discharge current that ramps down V_{C1} and controls the on-time of IC_2. Q_4 and Q_7 average the output duty cycle to generate a control voltage for Q_5 and thus make W a function of F. In fact, the feedback loop this arrangement establishes implicitly makes $W=K/(W\times F)$, where K is a calibration constant determined by the component values. Therefore, $W^2=K/F$, and $H=5\times I\times F/\sqrt{K/F}$. This expression yields $F=(H/5I)^2/K$, making F the desired function of H^2 and thus linearizing the relationship between frequency and flow speed. (Woodward, 1996(a and b).

Frequency to Voltage Converter

The frequency generated from the output of the transistor linearly digitizes wind speed system in figure 1, linked with frequency to voltage of figure 2b. It converts the frequency from 0 Hz to 1 kHz. In the figure 2b, a pulse input at f_{IN} is differentiated by a C-R network and the negative-going edge at pin 6 causes the input comparator to trigger the timer circuit. The average current flowing out of pin 1 is $I_{AVERAGE} = i \times (1.1\ RtCt) \times f$. In the frequency to voltage circuit of Figure 2b, this current is filtered in the network RL = 100 kΩ and 1 µF. The ripple will be less than 10 mV peak, but the response will be slow, with a 0.1 second time constant, and settling of 0.7 second to 0.1% accuracy.The output voltage at each sensing frequency will be given by equation 1. (Fairchild Semiconductor) The complete circuit of the fluid flow system is shown on

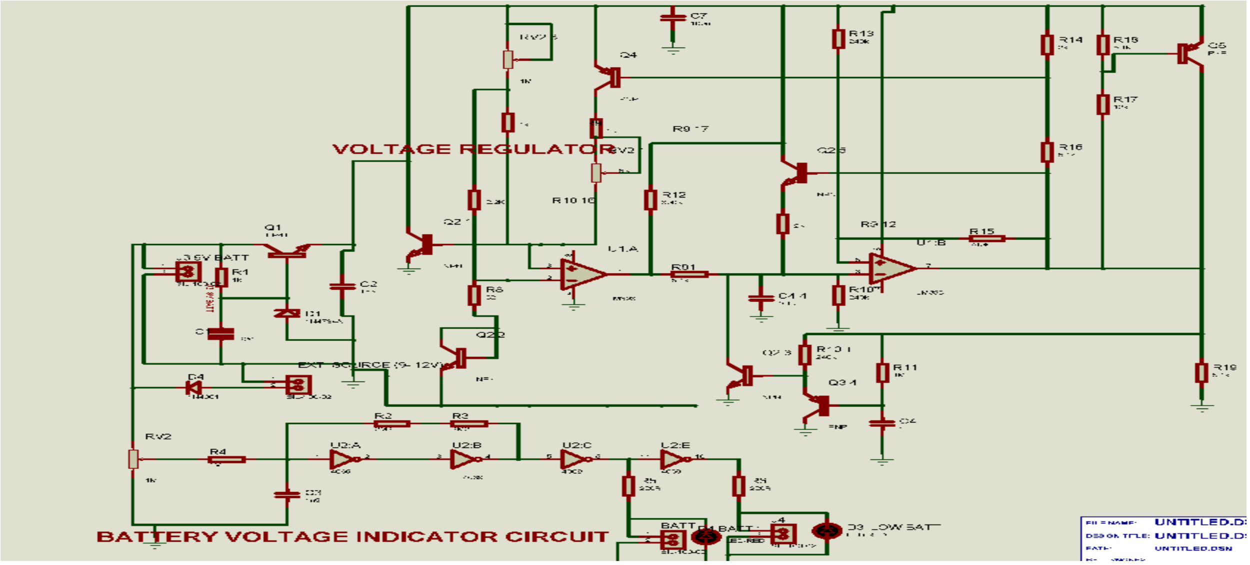


Figure 2a: Circuit Diagram

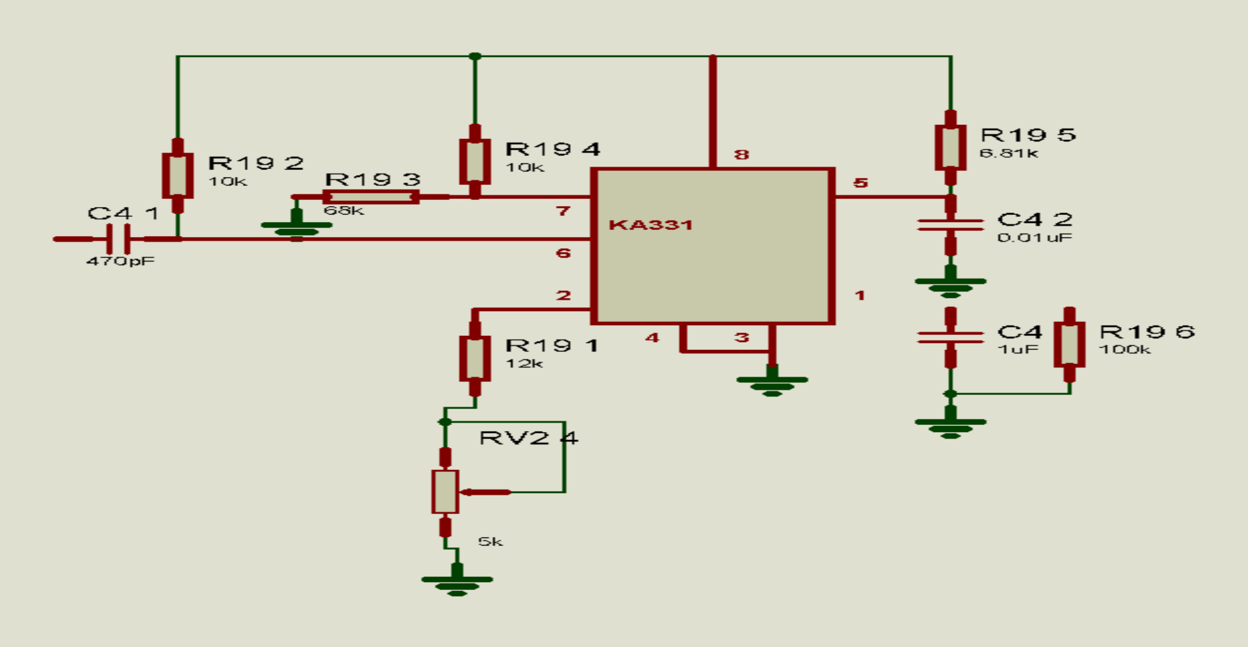


Figure 2b: Frequency to voltage converter circuit.

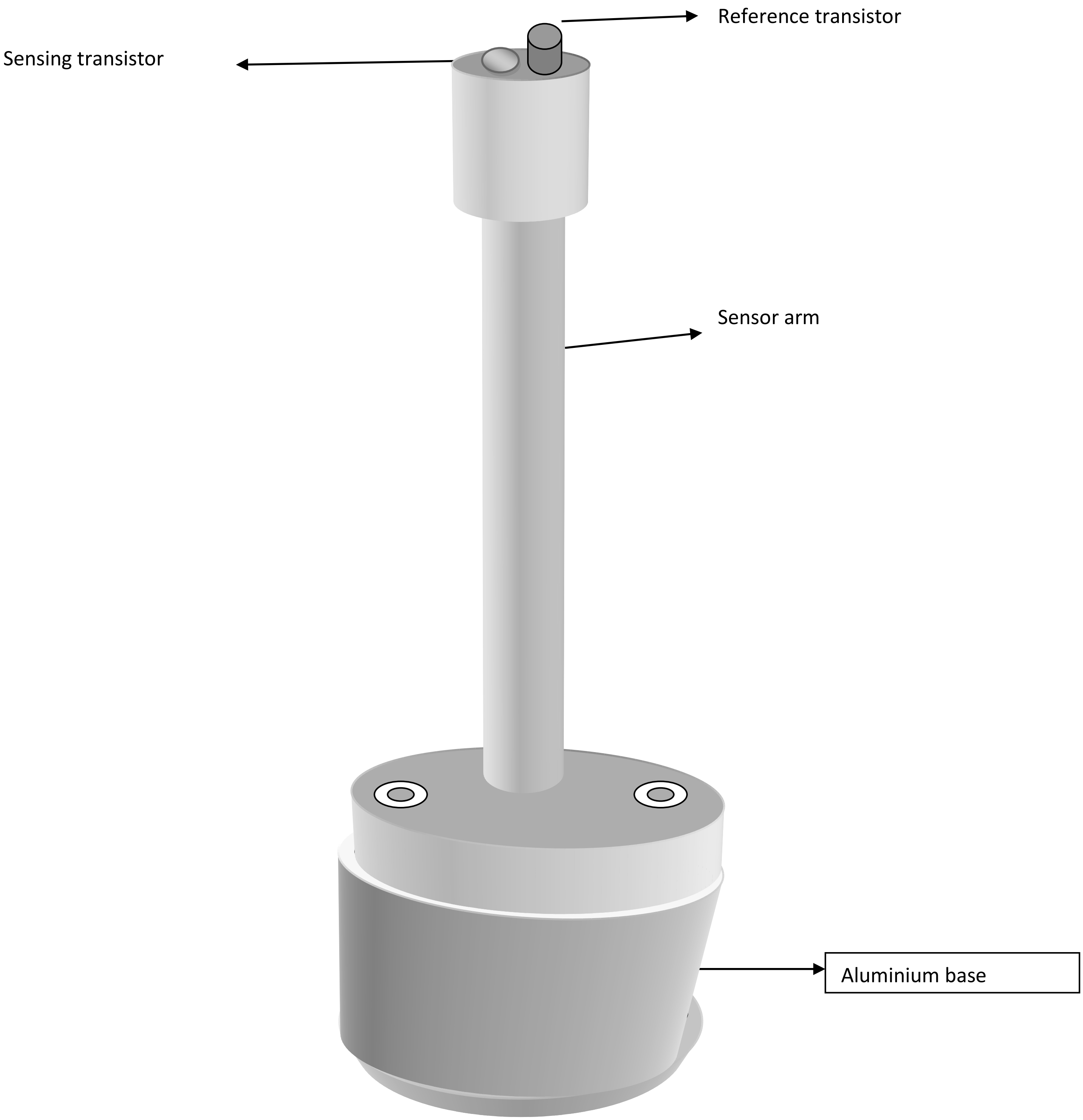
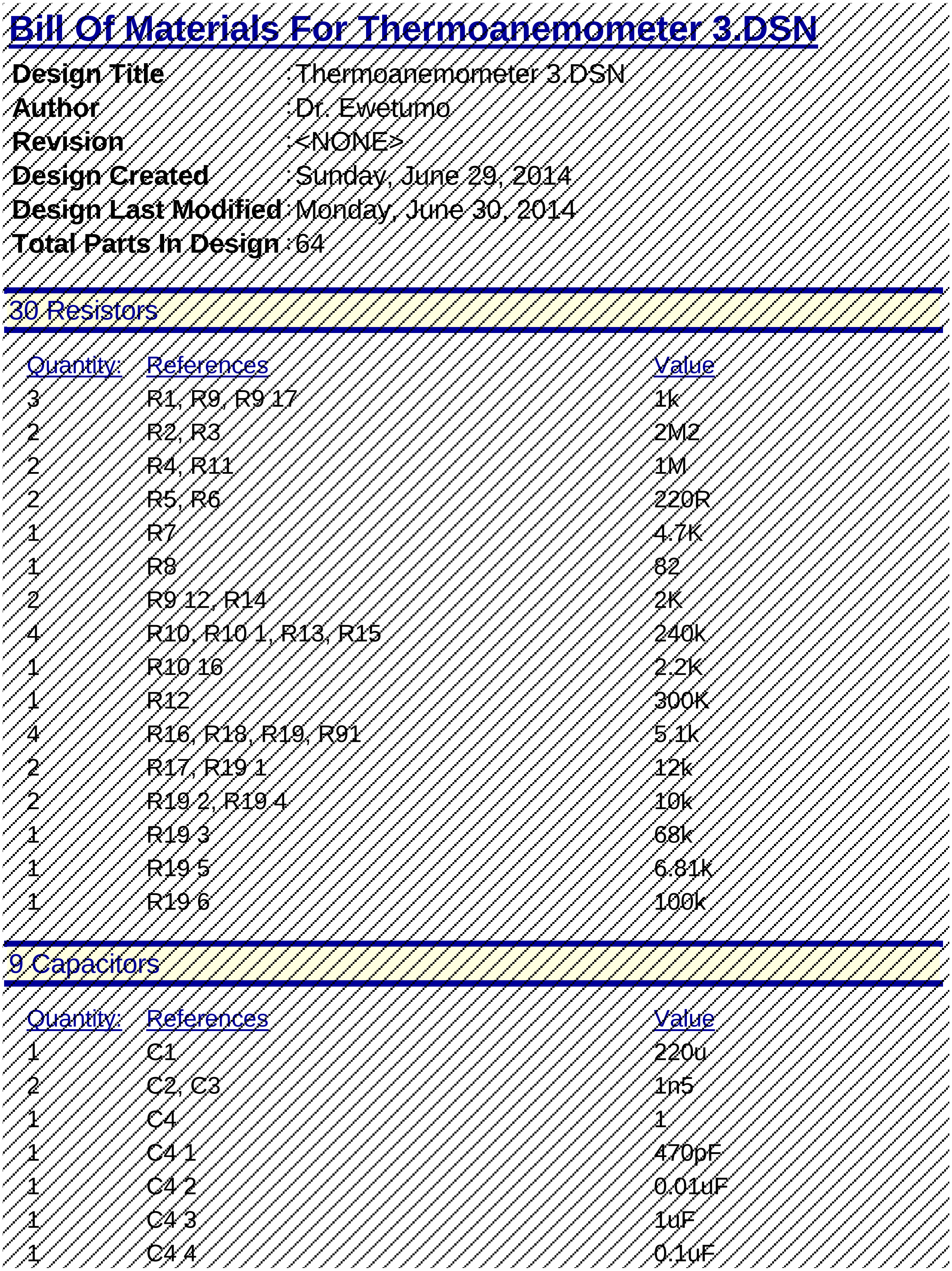


Figure 3: Physical Structure of Anemometer



Bill Of Materials For Thermoanemometer 3.DSN

Design Title	:Thermoanemometer 3.DSN
Author	:Dr. Ewetumo
Revision	:<NONE>
Design Created	:Sunday, June 29, 2014
Design Last Modified	:Monday, June 30, 2014
Total Parts In Design	:64

30 Resistors

Quantity:	References	Value
3	R1, R9, R9 17	1k
2	R2, R3	2M2
2	R4, R11	1M
2	R5, R6	220R
1	R7	4.7K
1	R8	82
2	R9 12, R14	2K
4	R10, R10 1, R13, R15	240k
1	R10 16	2.2K
1	R12	300K
4	R16, R18, R19, R91	5.1k
2	R17, R19 1	12k
2	R19 2, R19 4	10k
1	R19 3	68k
1	R19 5	6.81k
1	R19 6	100k

9 Capacitors

Quantity:	References	Value
1	C1	220u
2	C2, C3	1n5
1	C4	1
1	C4 1	470pF
1	C4 2	0.01uF
1	C4 3	1uF
1	C4 4	0.1uF

1	4 way cable mnt skt recptcl.series 2, 7.5A
1	5m screen cable