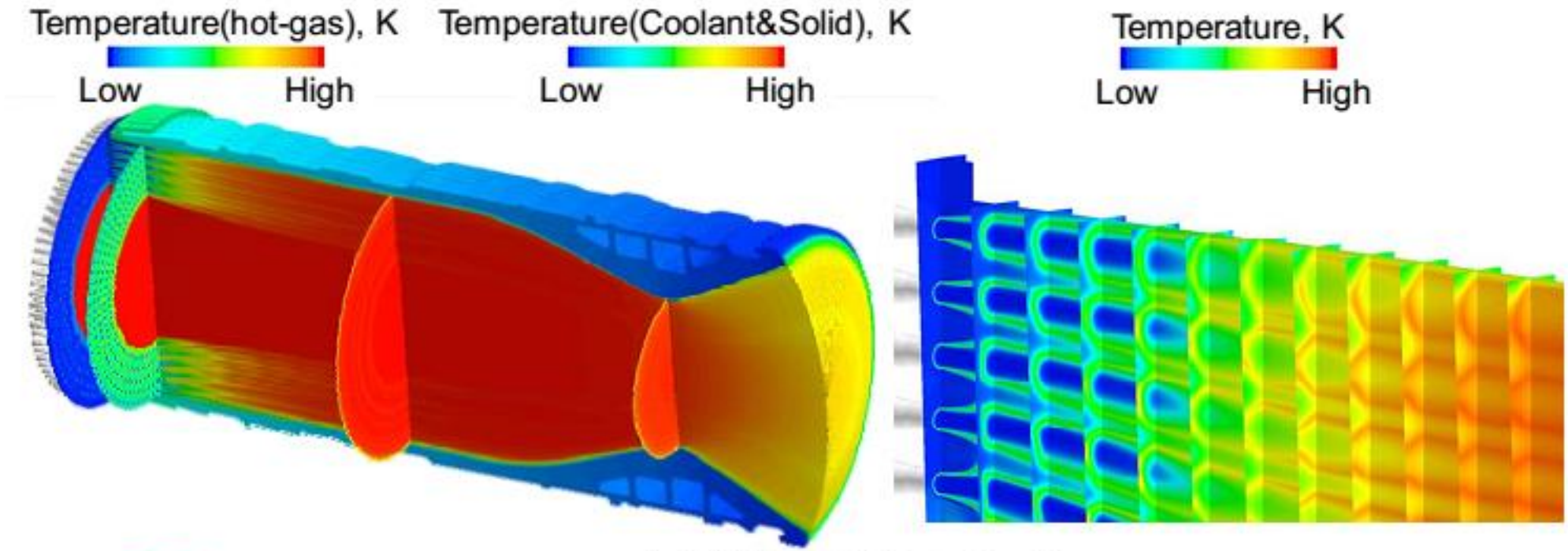
PARAMETERS WE NEED TO CONSIDER WHILE DESIGNING AVIONICS

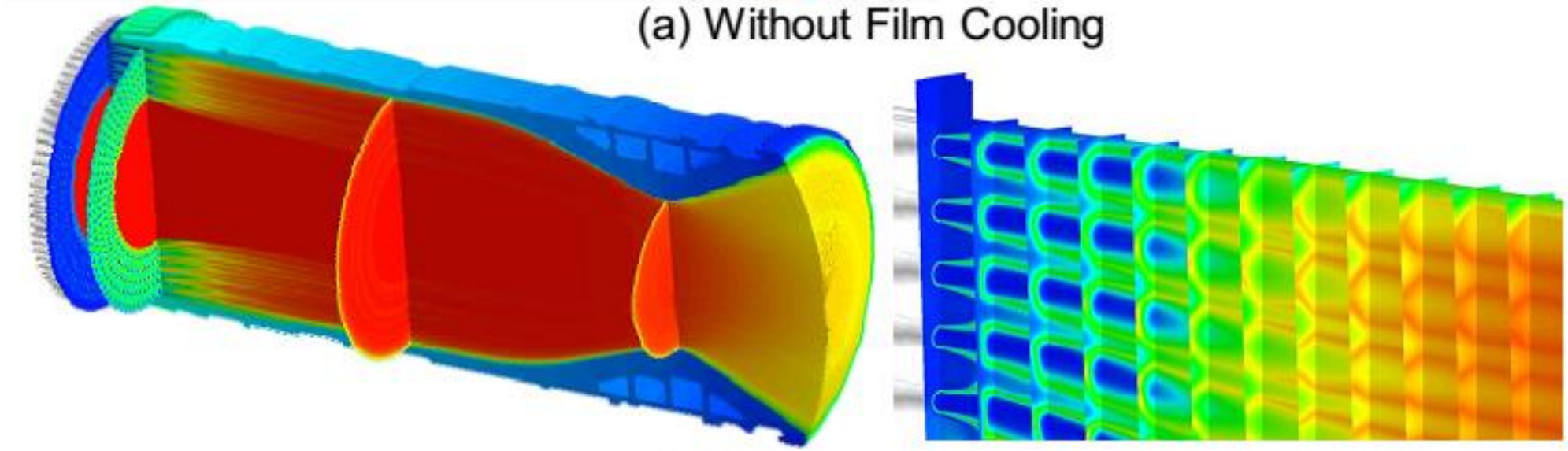
What parameters can be measured from the temperature sensed at different points of the rocket motor?

- The technique is called thermal analysis to analyse the time and temperature at which physical changes occur when a substance is heated or cooled.

- It can help us to consider the use of correct combination of material of rocket motor casing and different solid fuels to be used in it.



(a) Without Film Cooling



(b) With Film Cooling

How can we get all these?

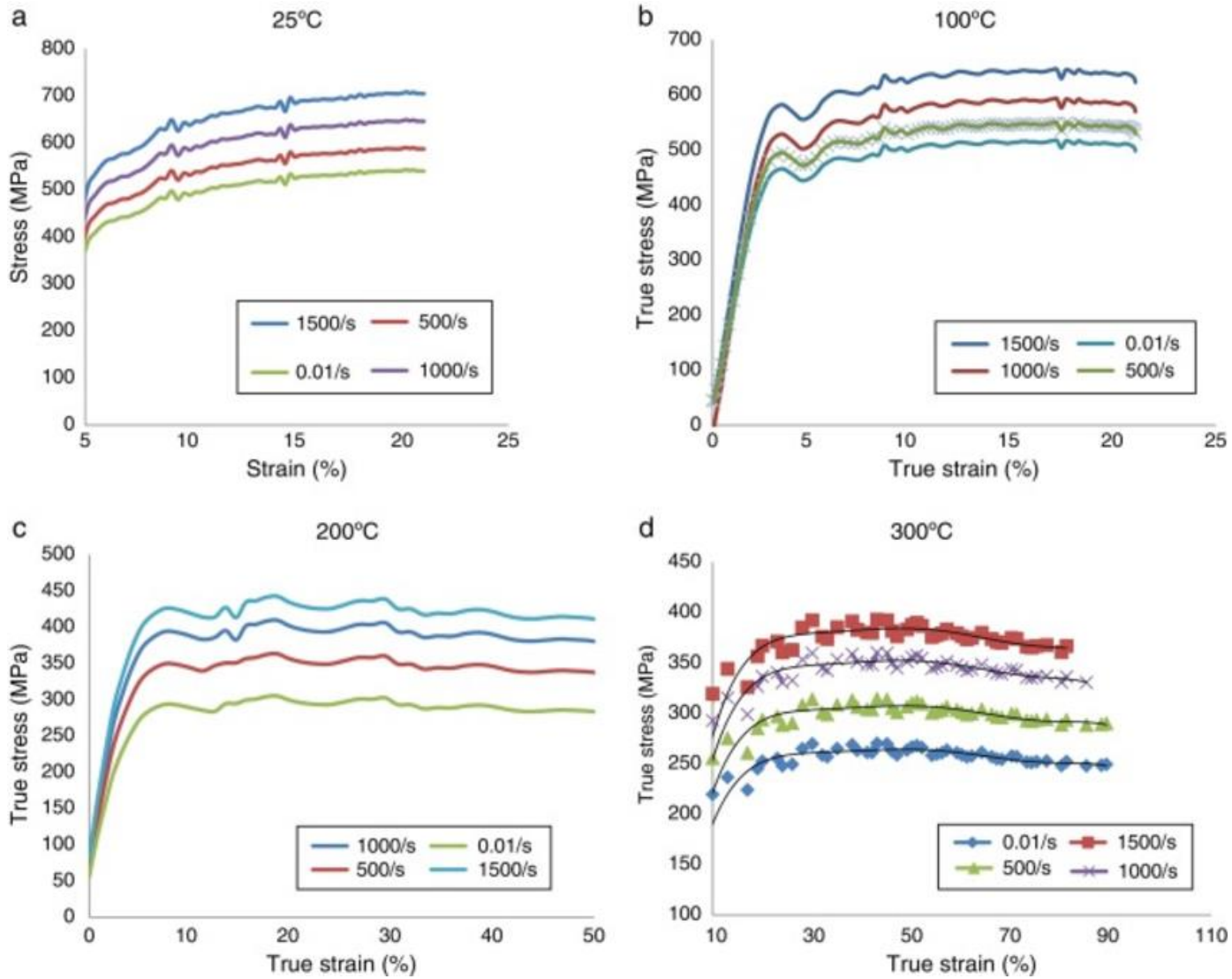
- Stress-strain diagnosis obtained at specific temperature.
- Graph can be plotted for different material stress with relative to the temperature obtained from sensors.
- Graphs can be compared from the other relative graphs.
- Thermal Stress=F/A=Y(alpha·changeintemp)/LO

Linear Coefficient of Thermal Expansion Values of Several Plastics

Polymer Name	Min Value (10^{-5}/°C)	Max Value (10^{-5}/°C)
PVC (Polyvinyl Chloride), 20% Glass Fiber-reinforced	2.00	4.00
PVC, Plasticized	**5.00**	**20.00**
PVC, Plasticized Filled	7.00	25.00
PVC Rigid	5.00	18.00

Polyvinyl chloride hard

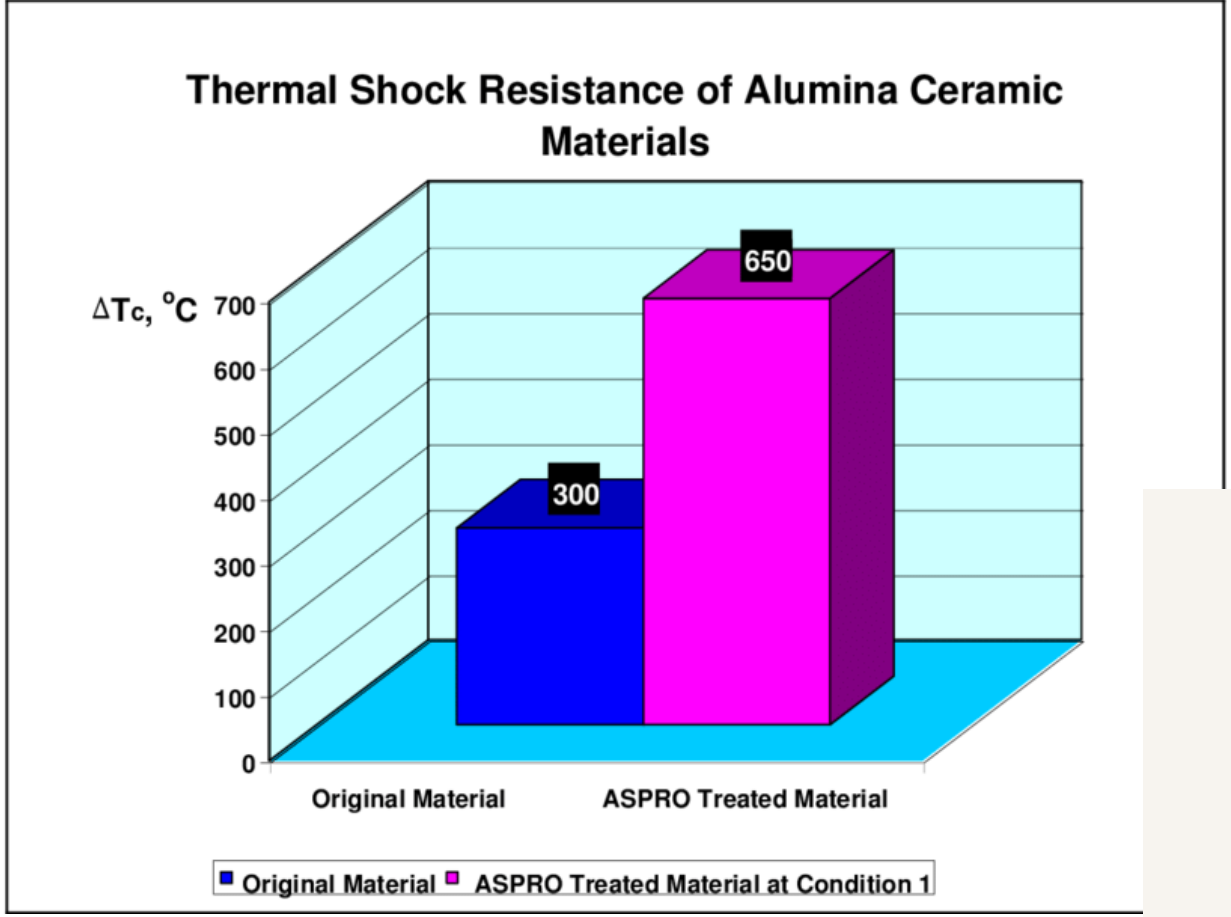
Young's modulus	**3275**	**MPa**
Melting temperature	Amorphou	°C
Glass temperature	85	°C
Minimum service temperature	-10	°C
Maximum service temperature	70	°C

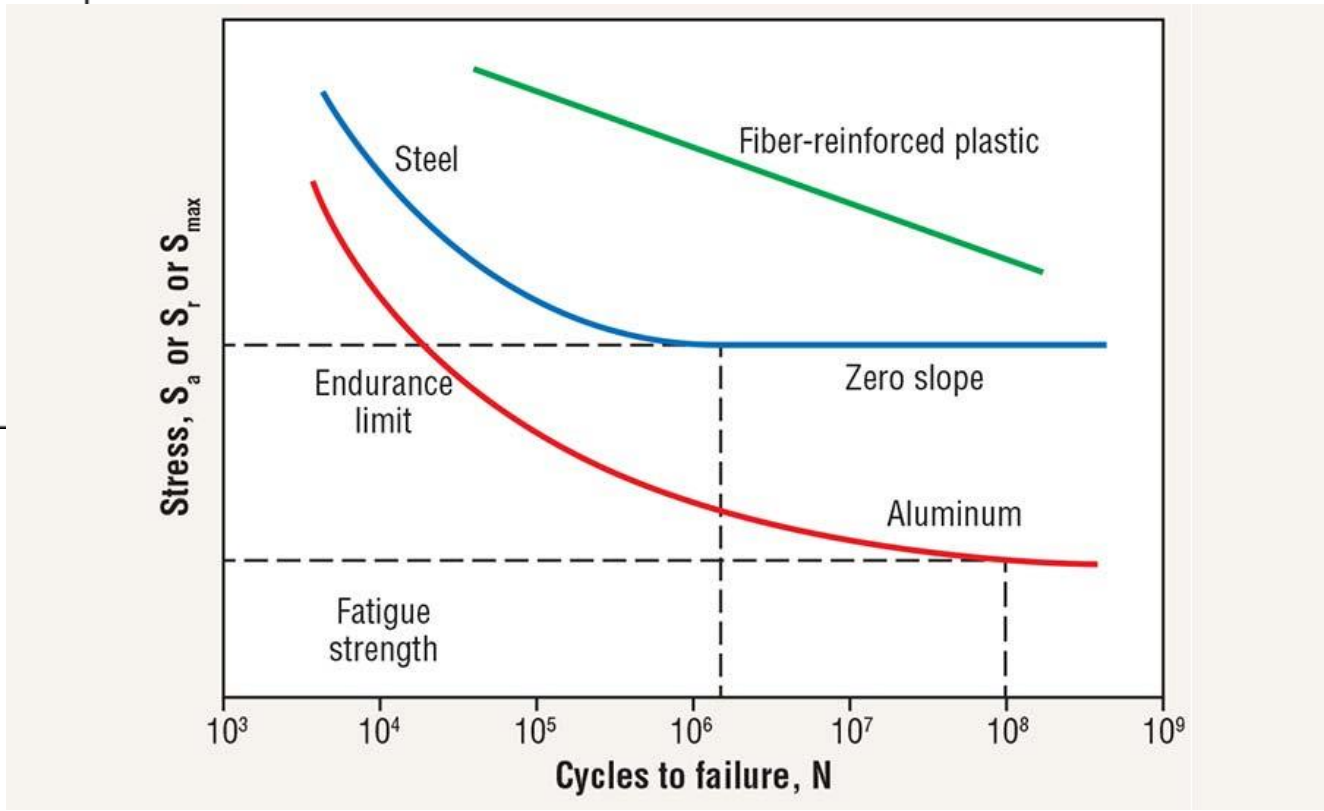

a
25°C
Stress (MPa)
Strain (%)
1500/s
500/s
0.01/s
1000/s
b
100°C
True stress (MPa)
True strain (%)
1500/s
0.01/s
1000/s
500/s
c
200°C
True stress (MPa)
True strain (%)
1000/s
0.01/s
500/s
1500/s
d
300°C
True stress (MPa)
True strain (%)
0.01/s
1500/s
500/s
1000/s

- Thermal shock ,i·e·, rapid coding on heating of an object usually at a defined rate of ,ex->+10degC/min, can be measured· Also thermal fatigue can be determined from data, comparison with the already researched data on materials·
- Scale of the graph

- A uniform body or linear change in temperature undergoes free thermal expansion and stress are not developed·

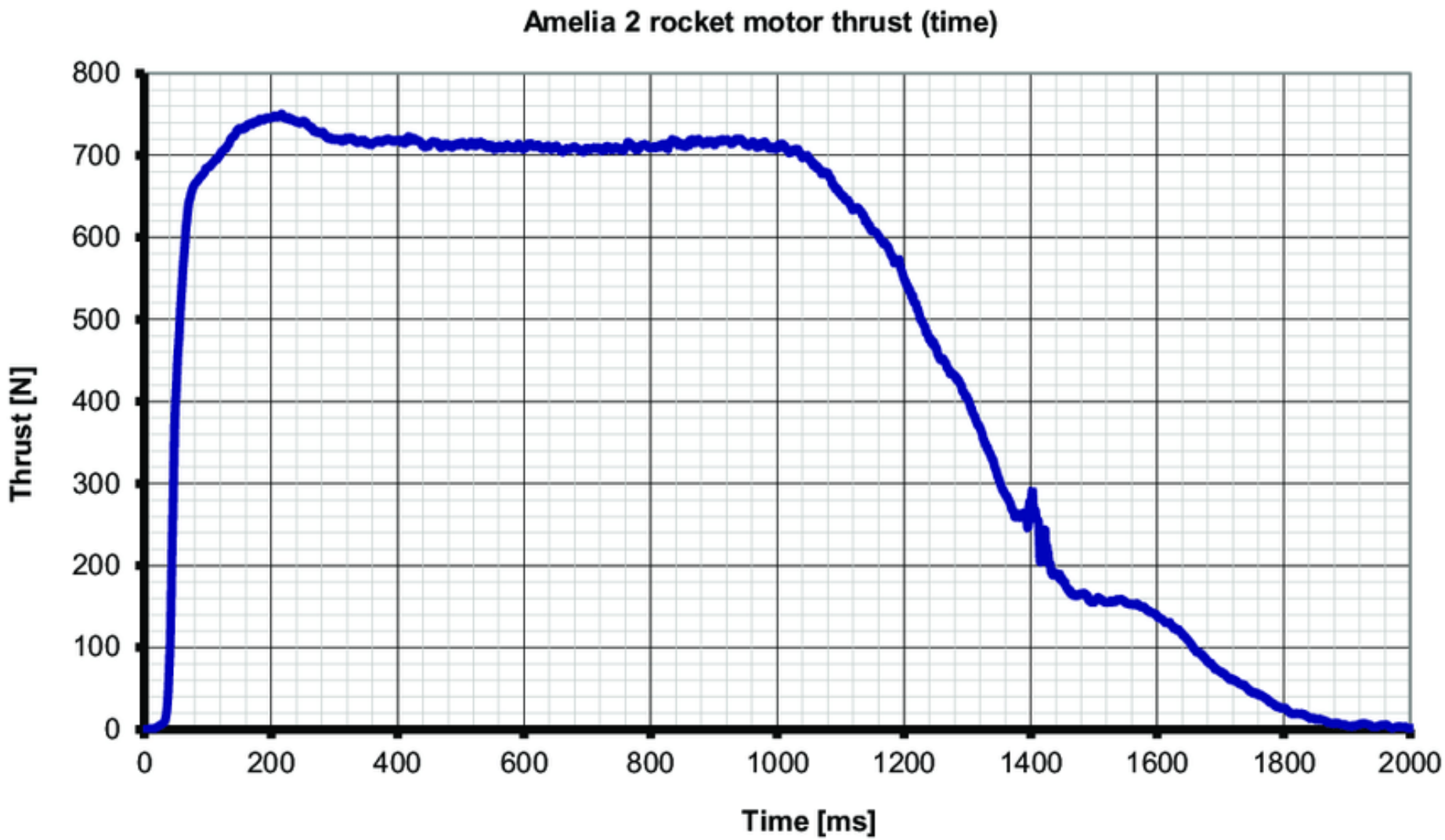
- Design a scale of rating of free thermal expansion


Thermal Shock Resistance of Alumina Ceramic Materials
ΔTc, °C
700
600
500
400
300
200
100
0
300
650
Original Material
ASPRO Treated Material
Original Material
ASPRO Treated Material at Condition 1


Stress, S_a or S_r or S_{max}
Steel
Fiber-reinforced plastic
Endurance limit
Zero slope
Aluminum
Fatigue strength
10^3
10^4
10^5
10^6
10^7
10^8
10^9
Cycles to failure, N

What all parameters can we obtain using load cell?

- Thrust can be measured along with the time a graph
- Specific impulse, impulse,etc calculation
- Effective burning of fuel being recorded by change of mass of rocket motor w·r·t to initial reading without fuel· Scale for error or difference in mass

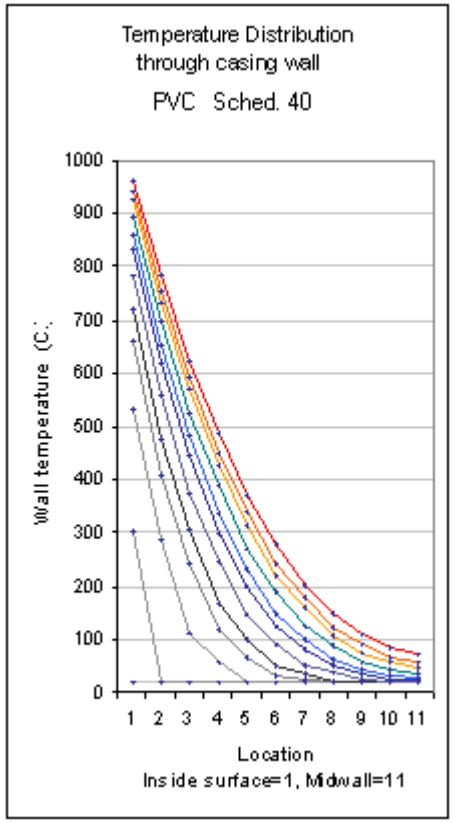

Amelia 2 rocket motor thrust (time)
Thrust [N]
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Time [ms]

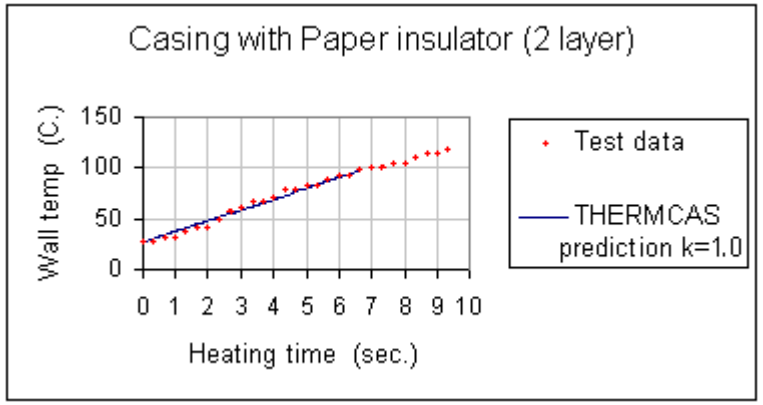
Parameters to choose temperature sensor

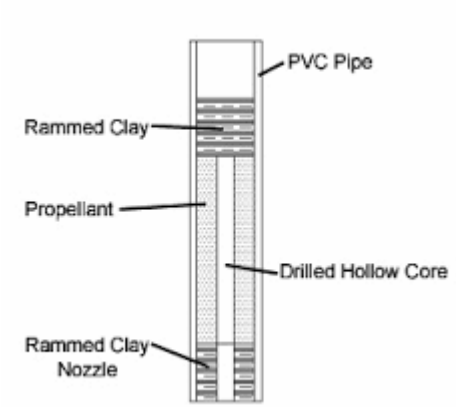
- Range of temperature changes in the material to be used
- Least count value
- Precision and efficiency
- Can be mounted to our processor (Arduino)
- Any other amplifier circuit required or other circuits.
- Heat transfer affect the sensor

What are the properties of Polyvinyl Chloride?

Property	Value
Technical Name	Polyvinyl Chloride (PVC)
Chemical Formula	(C2H3Cl)n
Melt Temperature	**212 - 500 °F (100 - 260°C)** ***
Heat Deflection Temperature (HDT)	92 °C (198 °F) **





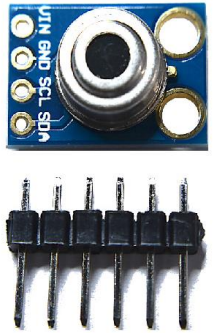


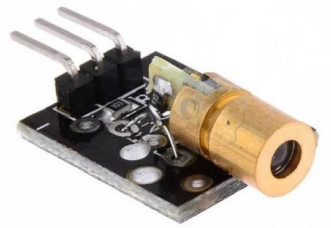
mlx90614 infrared temperature sensor & Laser Module 650NM

- The MLX90614 is factory calibrated in wide temperature ranges: -40 to 85°C for the ambient temperature and **-70 to 382.2°C for the object temperature**. The measured value is the average temperature of all objects in the Field Of View of the sensor.
- Surface temperature is the average temperature (within the optical cone of the sensor) of the surface the temperature is pointed at. The ambient temperature is the temperature of the air around the sensor itself.

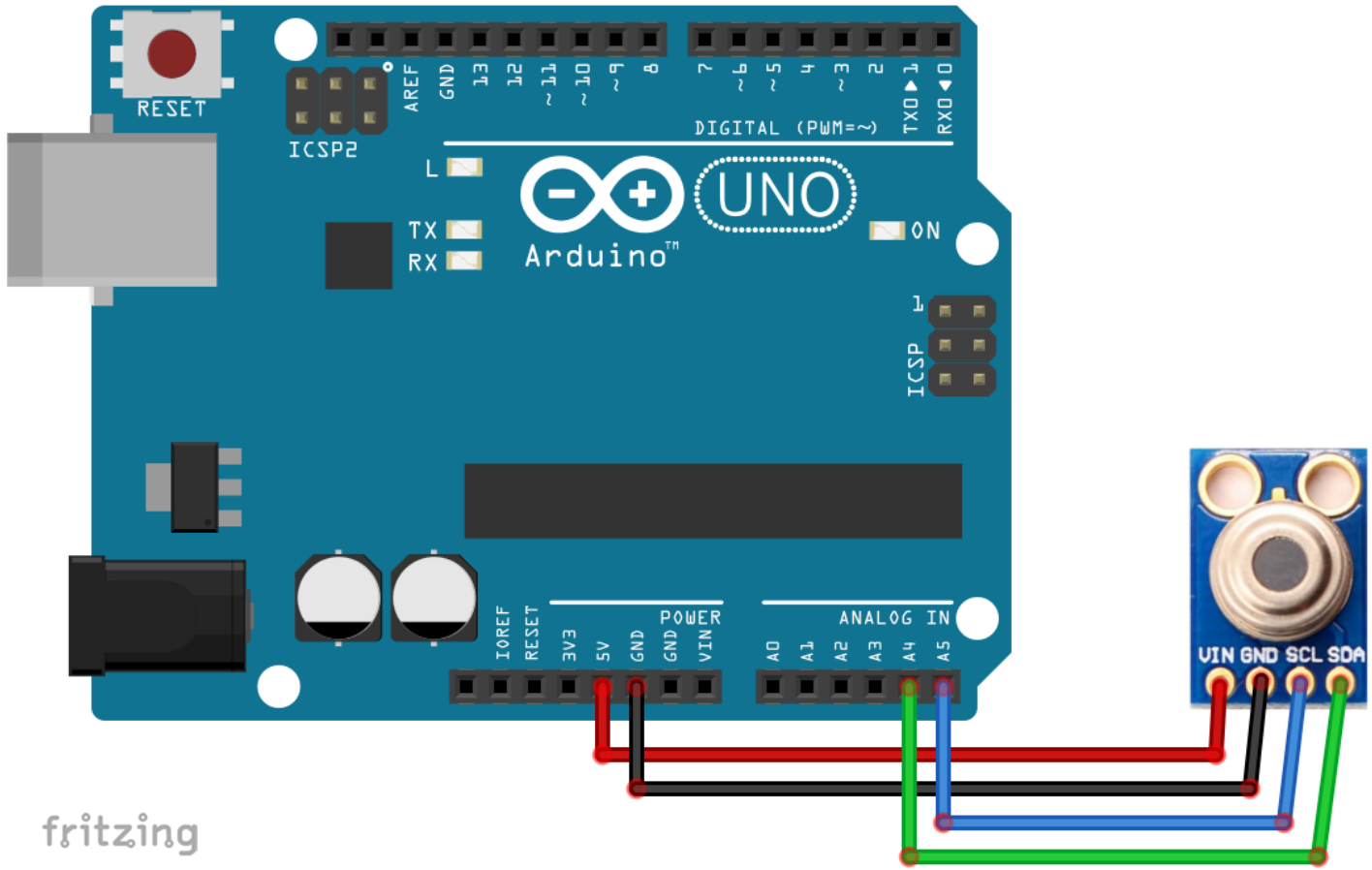
MLX90614 Temperature Sensor Specifications

•Operating Voltage: 3.6V to 5V (available in 3V and 5V version)
•Supply Current: 1.5mA
•Object Temperature Range: -70° C to 382.2°C
•Ambient Temperature Range: -40° C to 125°C
•Accuracy: 0.02°C
•Field of View: 80°
•Distance between object and sensor: 2cm-5cm (approx.)



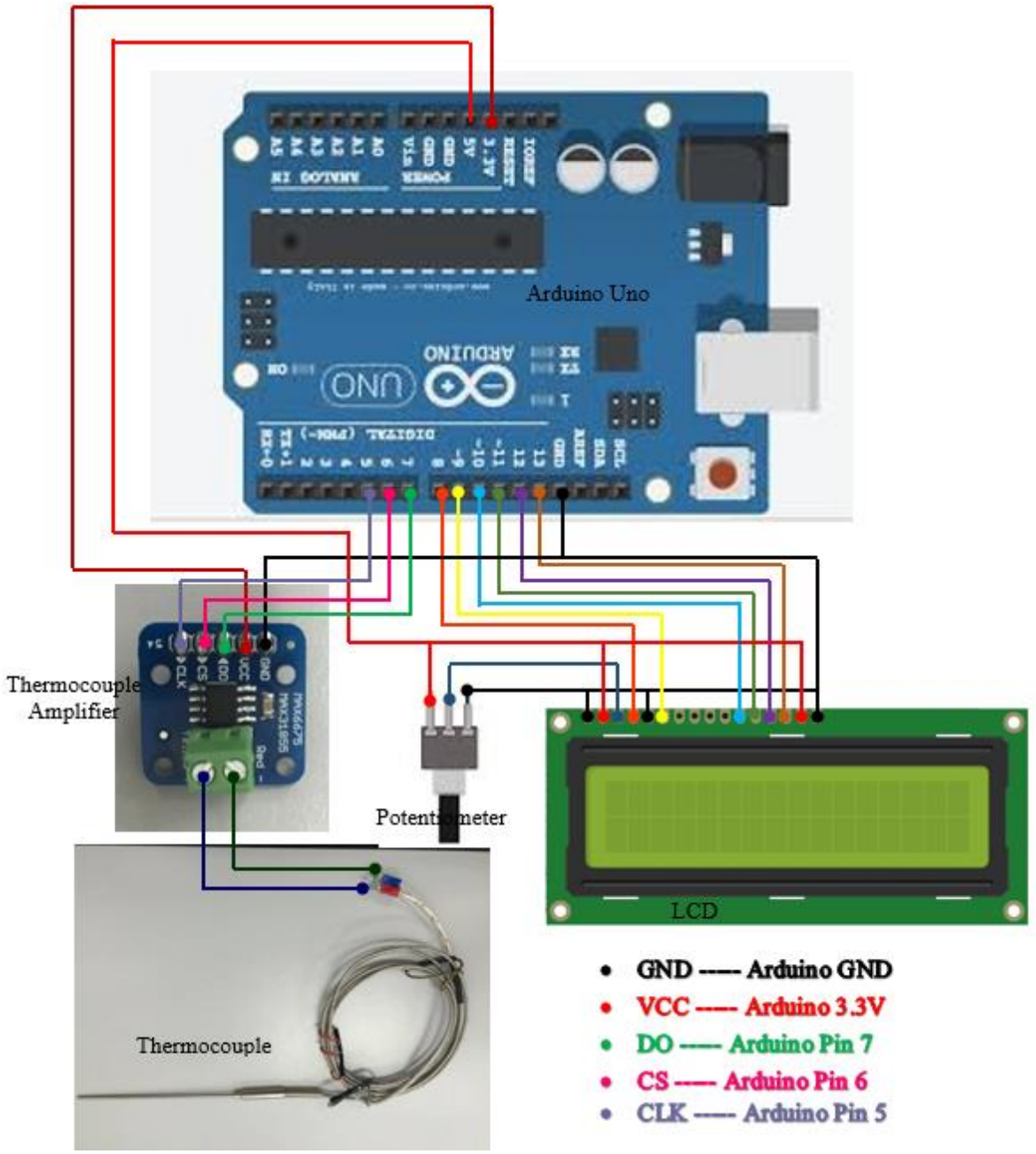


Mlx90614 with Arduino connection



Thermocouple

- Temp- 0 to 1300 degC
- Contact with the motor



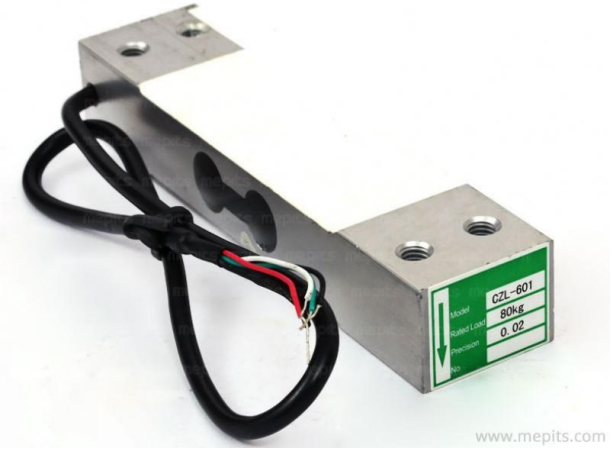
Parameters to choose load cell

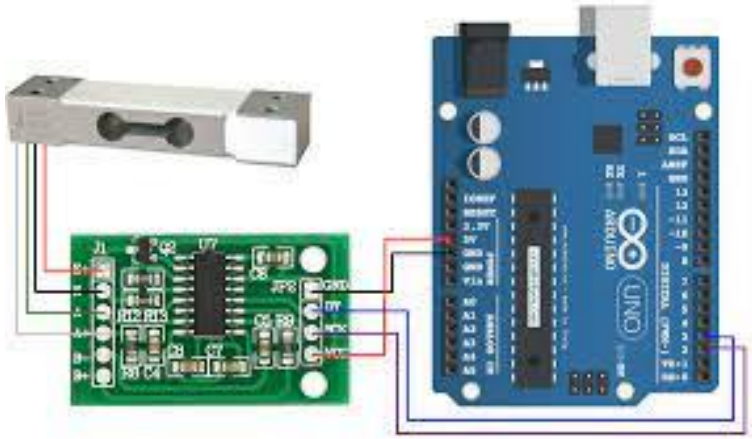
- Range of thrust produced by the class of motor to be tested.
- Least count value
- Precision and efficiency
- Can be used to receive data to our processor
- Any amplifier or other circuits required
- How does heating affect the metal
- Any method or material to be used to prevent heat or make it heat isolated

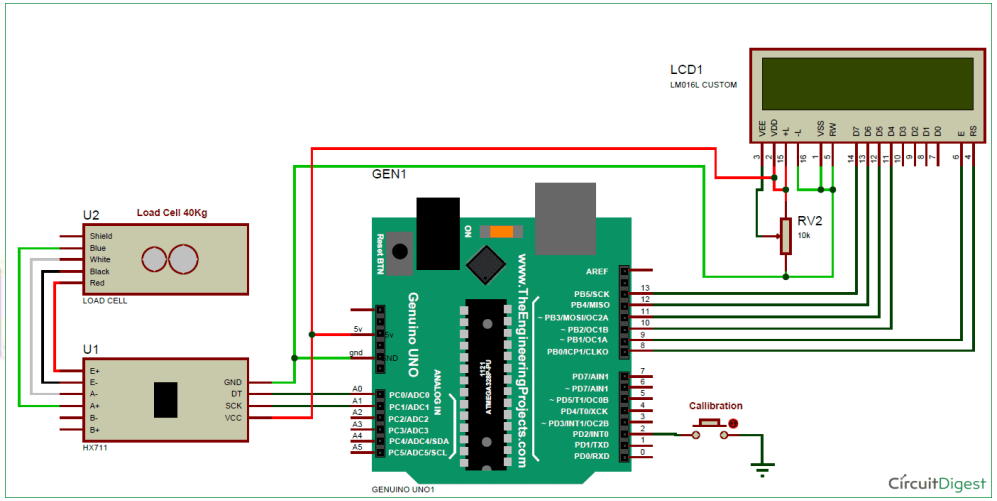
40kg load cell

Specifications:

Material	: Aluminum alloy
Rated load	: 40KG
Comprehensive error	: 0,03% F·S·
Rated output	: 2±0·02mV/V
Repeatability	: 0·01% Full scale
Zero Balance	: +/- 1% Full scale
Excitation Voltage	: 9~12V
Safe Load	: 120% of Rated Capacity
Ultimate Load	: 150% of Rated Capacity

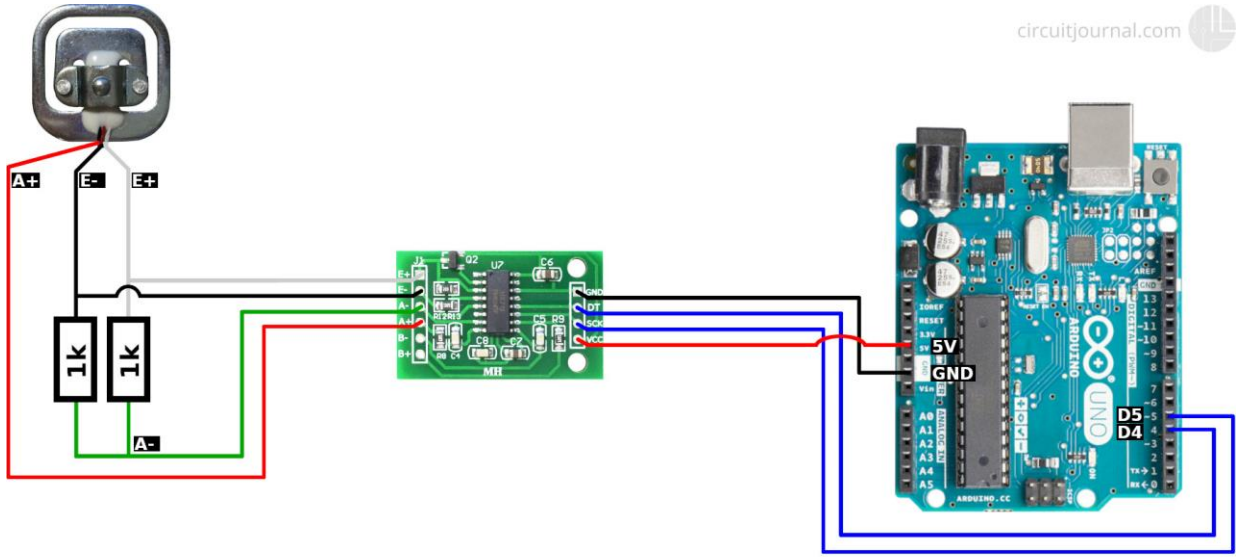






50kg Half-bridge Experiments Body Scale Load Cell Sensor

Capacity (Kg)	50
Output Sensitivity (mv/v)	1 ± 0.1
Nonlinearity (%FS)	0.03
Repeatability (%FS)	0.03
Input Resistance (Ω)	1000
Insulation Resistance (MΩ)	5000



IGNITION relay