MICROTHERMAL DATA ACQUISITION SYSTEM FOR PROSPECTIVE SITES FOR SOLAR TELESCOPES

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Aim

- To characterize the seeing conditions of a site through the measurement of random spatial and temporal variation in temperature.
- Calibrate the results with the S-DIMM & SHABAR instruments.
- And also to find the height of the temperature inversion.

Theory of Seeing

- Turbulence in the atmosphere causes random changes in its refractive index at any given position.
- Turbulence in the atmosphere can be characterized by the random spatial and temporal variation in temperature.

The temperature function $D_T(r, h)$ at points P1 & P2 at the same level h, separated by r is given as

$$D_T(r, h) = < (T(P1) - T(P2))^2 >$$

- The thermal structure of air characterized by its isotropic temperature structure parameter

$$C_T^2 = < (T(P1) - T(P2))^2 > / r^{2/3}$$

where r = separation between the MT probes

Theory of Seeing cont…

- An image formed undergoes fluctuations in intensity and position through refractive index changes caused by the temperature fluctuations. The refractive index structure constant is related to the temperature structure parameter as below.

  $C_N^2\ (h) = (80*10^{-6} * P(h)/T^2(h))^2\ C_T^2\ (h)$

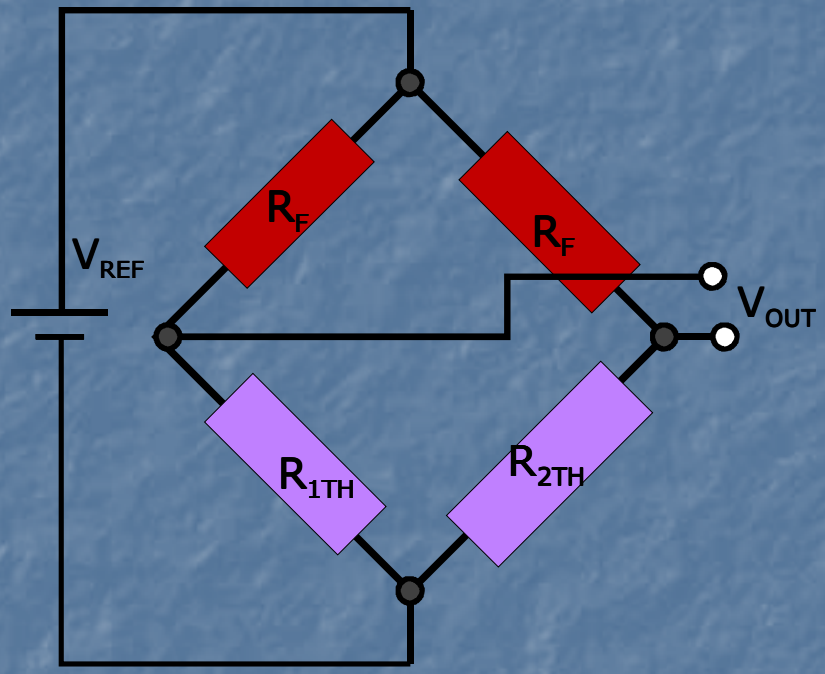
- Fried has given the relationship between the fried parameter r_0 and $C_N^2\ (h)$ as

  $r_0 = (16.7\ \lambda^{-2} \int C_N^2\ (h)\ dh)^{-3/5}$

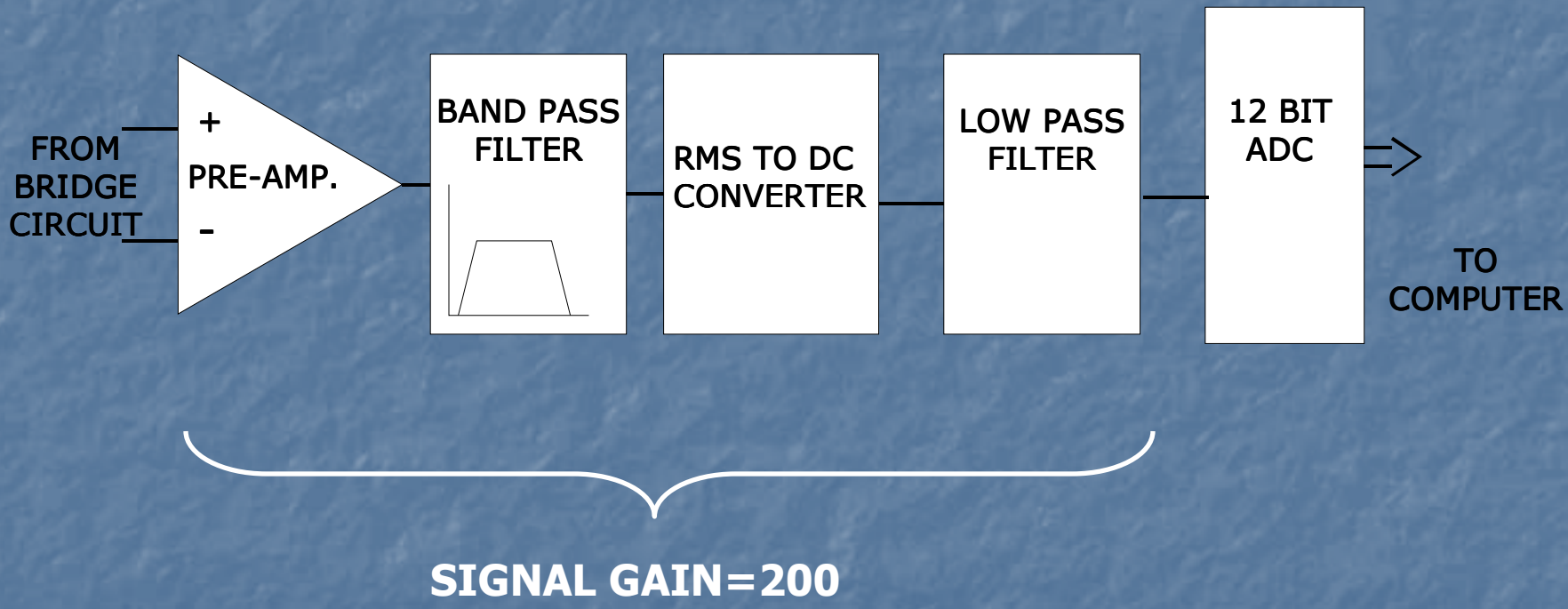
- The resolution of a large telescope is defined according to the Strehl Criterion as

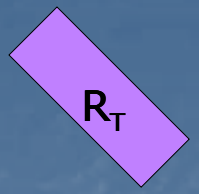
  $\theta = (4/\pi)\ \lambda/r_0$

The principle of T measurement



Preamplifier & signal condition





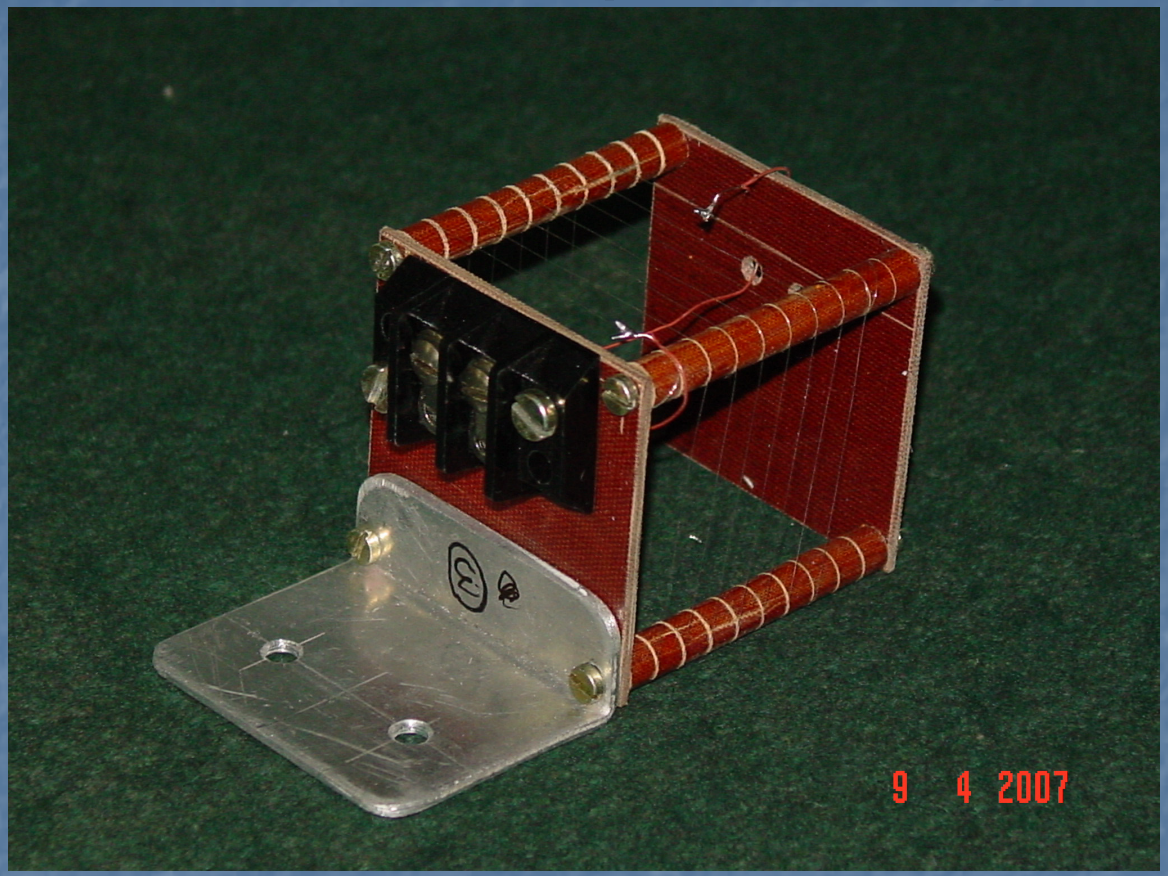
Implementation

- Nickel wire is chosen for the probe.
  - Temperature coefficient is 0.00672/degC/Ohm
  -25micron diameter. Good enough mechanical strength and light in thermal mass.
  -250 Ohm nominal resistance at room temperature for approximately 1.4m of length
- It is wound on a 50mm cube bakelite former.
- The bridge excite current is kept 1mA to avoid self heating probe.
- The Bridge gives a difference voltage output of 1.68mV/degC difference between the probes.

Range & resolution

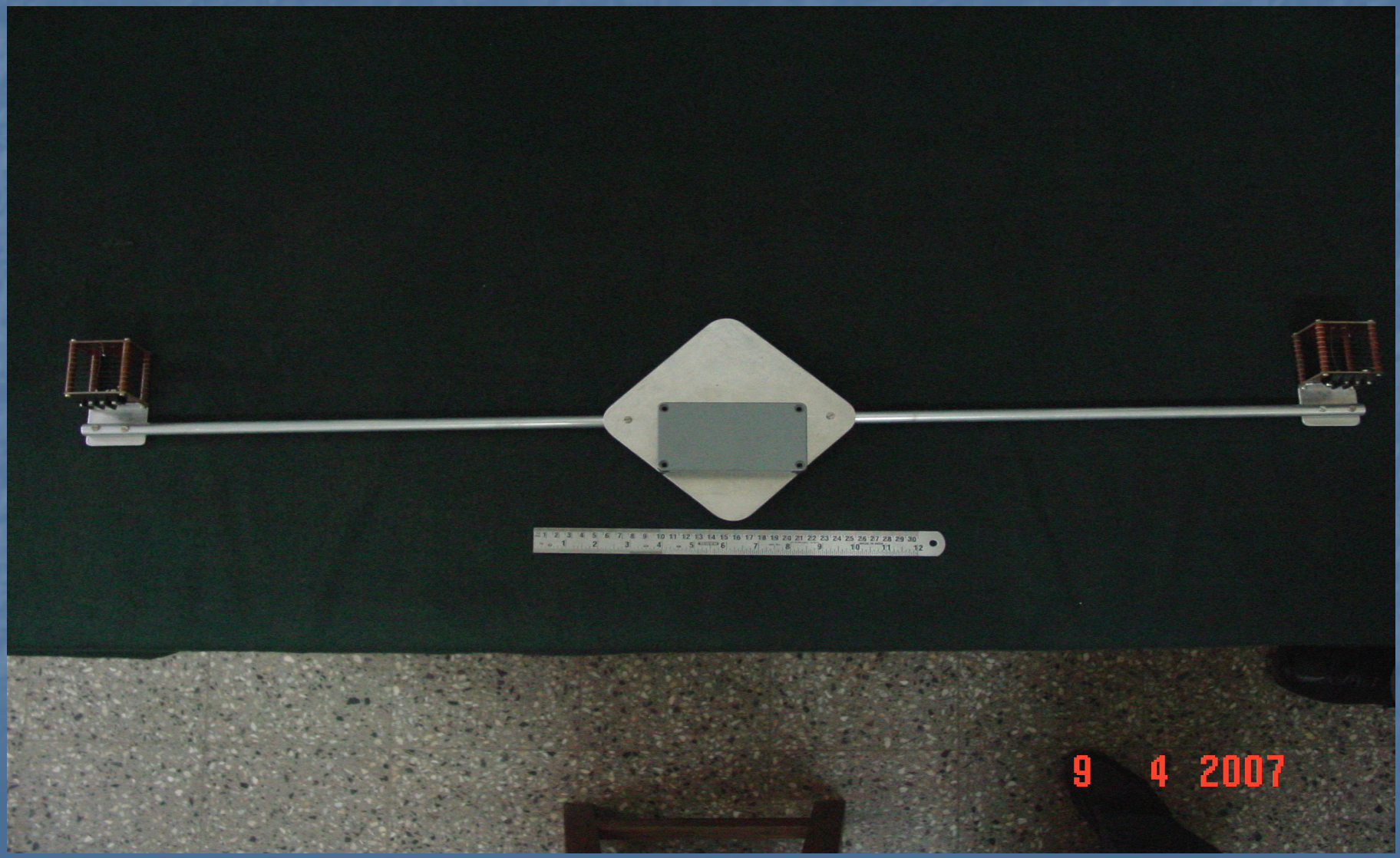
- Gain of the signal chain is set at 200
- The 12 bit ADC range set to 0 - 5V
- With these settings one ADU represents about 4m Deg.C,.
- The range = 4096 * 4mDeg C = 16 Deg.C approximately.

Nickel wire temperature probe.

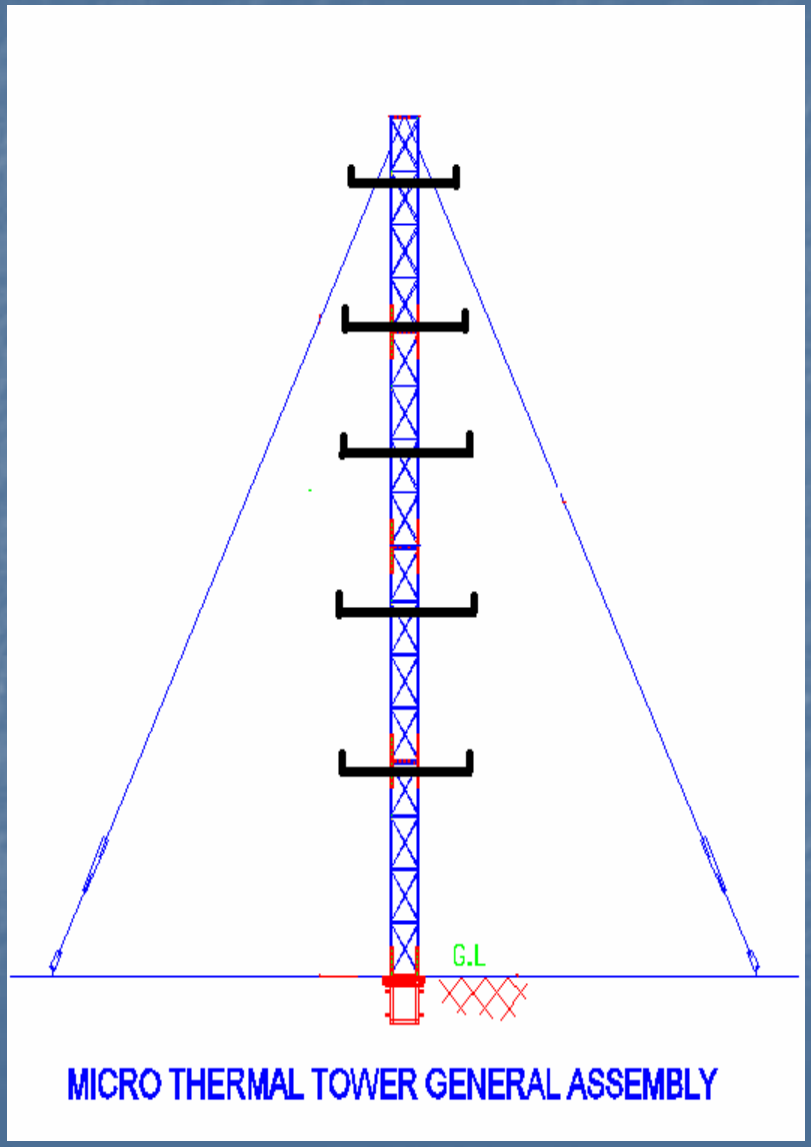


To avoid the thermal load from the connecting cables, the Nickel wire is buffered both the ends with constantan wire.

Two probes at 1.5m apart with pre-amplifier at the center.



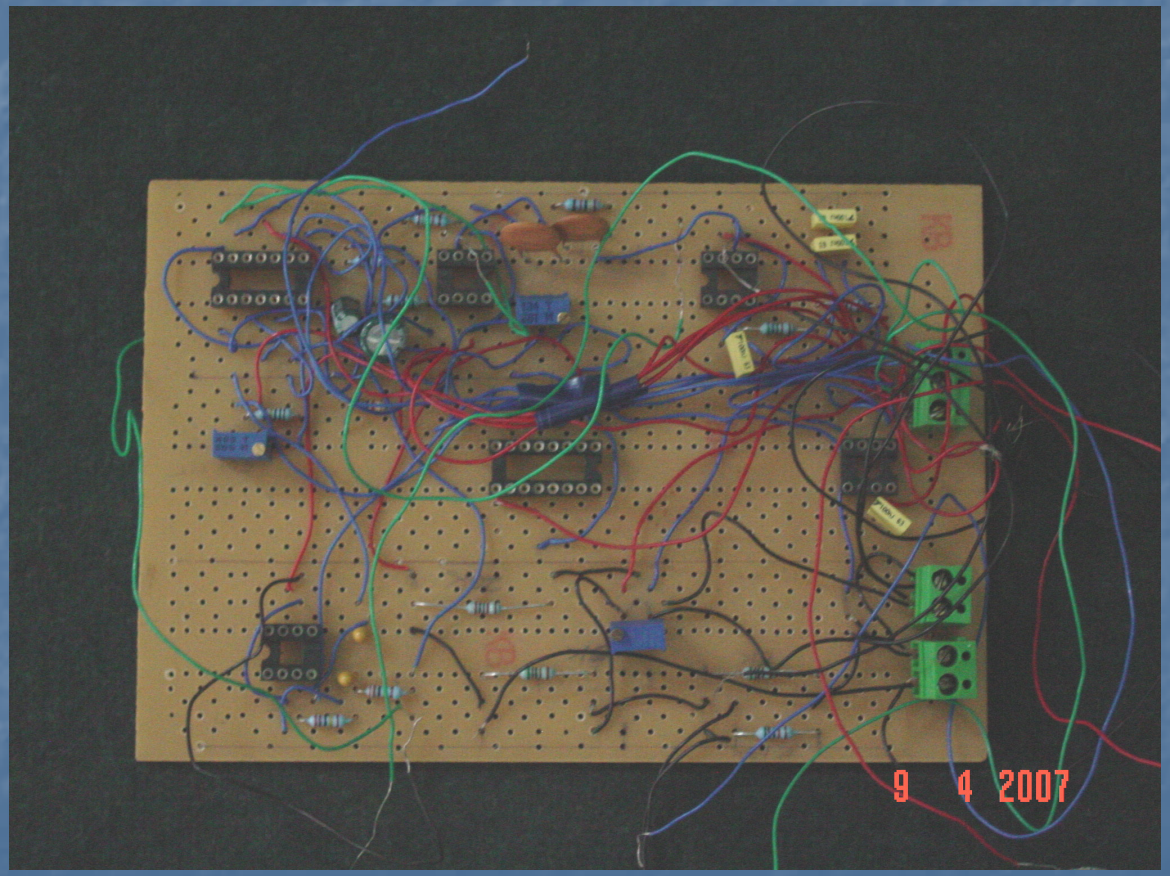
Tower for placing the probes at different heights



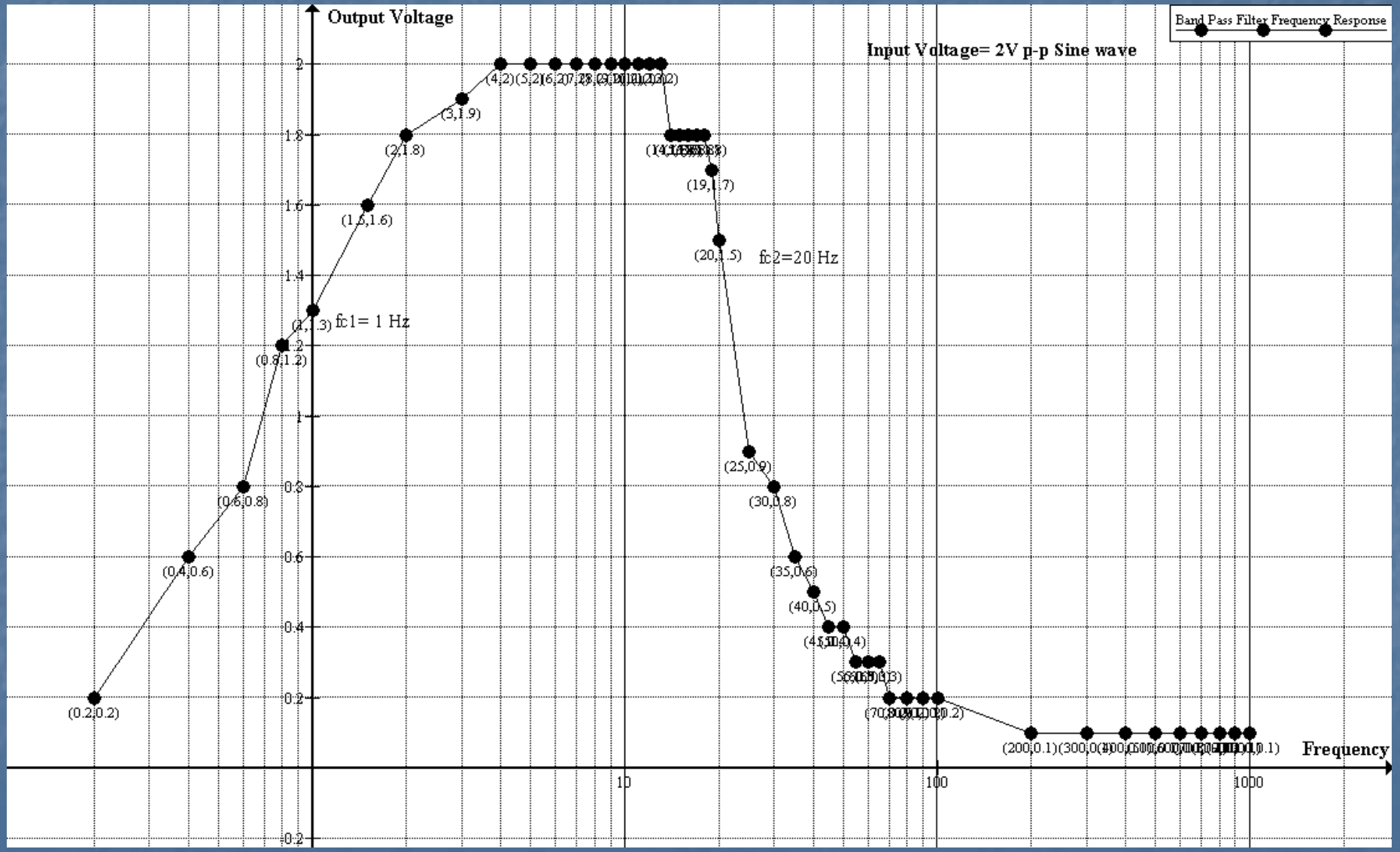
The signal conditioning chain

- Pre- amplifier is a low noise precision instrumentation amplifier from Analog Devices (AD624)
- Voltage reference for the bridge excitation (AD584)
- RMS-to-DC converter from Analog Devices (AD637).
- The pass band is from 1Hz to 20Hz.
- Two shunt resistors across the fixed resister arm of the bridge are provided through a relay contacts for on site calibration.

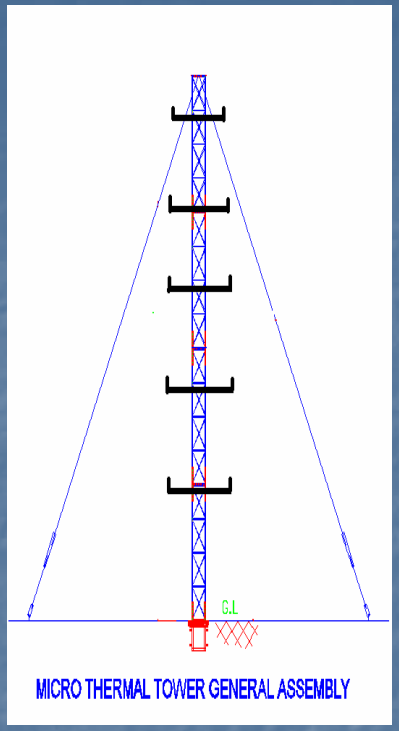
Prototype board

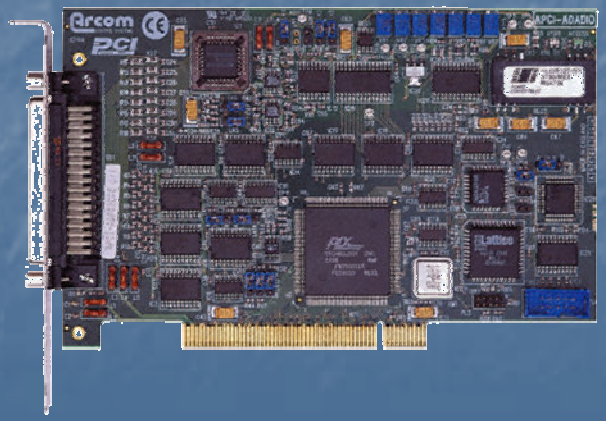


Band pass filter response



The set-up


G.L
MICRO THERMAL TOWER GENERAL ASSEMBLY

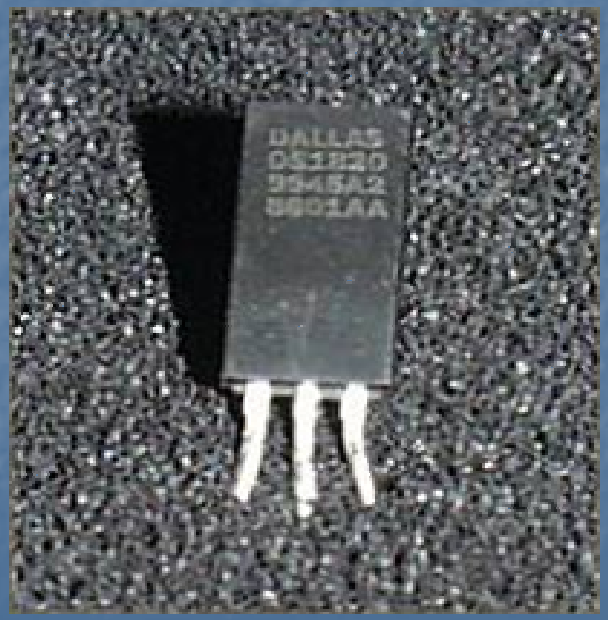

Arcom
PCI
APCI-ADA8D

Lab calibration set-up

- We are planning a set-up to calibrate the bridge along with signal chain by creating a known temperature difference between the probes under controlled environment.

Temperature inversion measurement

- It is carried out with a pre calibrated semiconductor digital sensor,DS1820.
- It is tiny device with computer compatibility
- The temperature range is -10 to 85 with +/- 0.5 Deg C.
- Sensors can be networked.



Thank you