Lab Demo - 5&6

5. Automated Weather Monitoring System (AWS)

Automated weather monitoring system (AWS) periodically measures various real-time metrological parameters and logs (stores) for future reference. AWS is permanently fixed to stationary known remote location under observation. AWS can automatically operate unattended for prolong period up to few years. The system necessarily has its own automatic maintenance free power generation and storage system to work uninterrupted. Low power consumption and smart power management are the most important features of the AWS since it utilizes minimum operating power resources. Precision metrological sensor with long-term stability is another prime feature of the AWS. Intelligent data-logger is required to manage power, acquire precision metrological data, store the data up to long time and transmit the data to desired location via, telecom landline, wireless link or satellite link to observatory. The AWS measures total 7 weather parameters listed in **Table 5.1.**

Table 5.1: Weather parameters measured by AWS

SNo	Weather Parameters	Measured Range	Accuracy
1	Air temperature	- 40 to $+60^0$C	$\pm 0.1^0$C
2	Atmospheric pressure	600 to 1100 mBar	±0.2%
3	Wind speed	0 to 60 m/sec	+2%
4	Relative humidity (RH)	0 to 100%	±3%
5	Wind direction	0 to 359^0 from North	$+3^0$
6	Rainfall	-	Better than 1 mm
7	Solar radiation	0 to 1500 W/m^2	~20μV/W/m^2 *

*Sensitivity

Components and Operational Principle:
The AWS is equipped with several numbers of precision metrological sensors for measuring the weather parameters. The schematic of the AWS setup is shown in Figure 5.1. The components (mainly sensors) of the AWS along with individual operational functions are as follows:

i) Temperature and Relative Humidity Sensor:
The sensor used for measurement is a resistance temperature detector (RTD). Here the resistance of the element varies with temperature (increases with temperature). The weather shield is provided to avoid direct heating of the sensor by the Sun's radiation and to protect it from rain and snow. Humidity sensor features an improved design to provide highly accurate and rapid measurements. The humidity sensor is a thin film capacitor element. A dielectric polymer absorbs water molecules from the air through a thin metal electrode and this causes a capacitance change proportional to humidity. A solid state electronic circuit is built in each probe to produce 0 to 1000mV output signal

corresponding to relative humidity value 0 to 100%. The response time for the humidity sensor is less than 10 sec.

ii) Atmospheric Pressure Sensor:

The pressure transducer of range 600-1100 mBar is of integral diaphragm type to measure absolute pressure variations in the atmosphere. Basic sensors are strain gauges bonded on the integral diaphragm. The pressure transducer is provided with built-in electronics for signal conditioning. The overall output signal is proportional to the input pressure. The response time for the humidity sensor is less than 1 sec. The sensor is well suited for remote field applications of AWS.

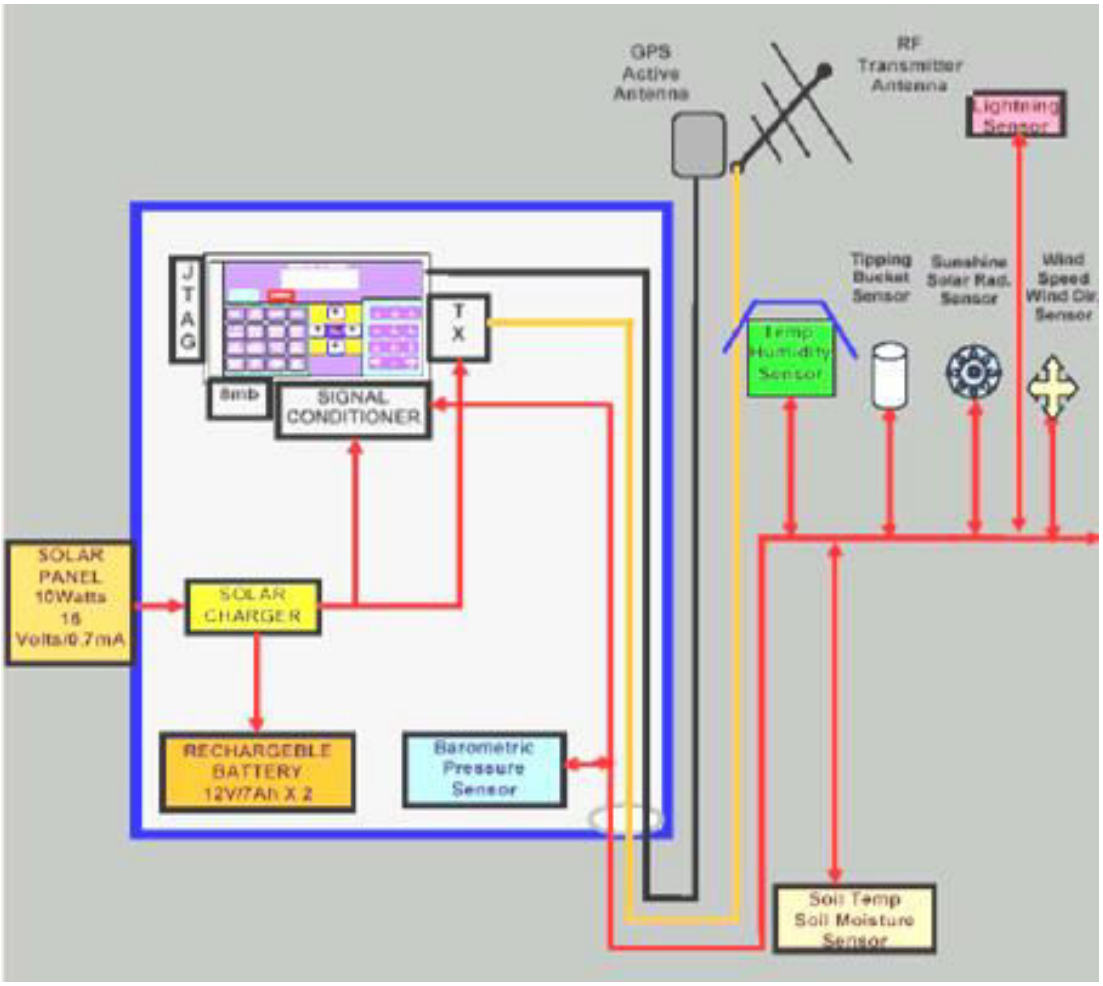

Figure 5.1: The Schematic of the AWS setup

iii) Wind Direction Sensor:

Wind direction measured by wind vane which is a counter balanced, low threshold wind vane. A linear wire wound endless potentiometer is coupled to the vane by a stainless steel shaft. As the vane turns, it rotates a stainless steel shaft which is coupled to the potentiometer. This potentiometer has excellent linearity, very low starting torque.

iv) Wind Speed Sensor:

Wind speed measured by anemometer which is a fast response, low threshold opto-electronic anemometer. When rotated by wind, a chopper on the anemometer shaft interrupts an infrared (IR) light source, generating pulses from a photo transistor. The signal is amplified and fed through a line driver. The frequency is proportional to wind speed. The anemometer is provided with a 3-pin connector for easy replacement and comes with 10 m of shielded cable.

v) Solar Radiation Sensor:

The dynamometer measures the radiation of the Sun by receiving radiation on a horizontal surface from both the Sun and the sky. When exposed to radiation, the temperature of the blackened horizontal surface rises. Heat is lost from the blackened surface by conduction, convection and radiation. The equilibrium temperature reached is a measure of the radiation. This temperature is measured by a thermopile. A thin metallic film blackened with a special paint (which absorbs energy completely in the range of 0.3 to 3 μm) is the sensor. A 72-element copper constantan thermopile is in thermal contact with this thin metal film. Alternate junctions of this thermopile are in thermal contact with the massive body of the instrument at ambient temperature which serves as the cold junction. This way a millivolt output proportional to the radiation received (about 4 mV/KW/m^2) develops across the thermopile. The instrument has a time constant less than 22 sec.

vi) Rainfall Sensor:

The tipping bucket rain gauge uses a tipping bucket mechanism to produce a contact closure every time it receives a predetermined quantity of rainfall. The body and funnel are made of fiber glass reinforced plastic (FRP); rim is made of gun metal. All parts having contact with water are made of stainless steel. Each tip of the bucket produces an on-off output when the magnet passes over the reed switch. Rainfall entering through funnel collector is directed to the tipping bucket assembly. When an incremental amount of precipitation has been collected, the bucket assembly tips and activates a magnetic reed switch. The sample is discharged through the base of the gauge. A momentary electrical contact closure is provided for each increment of rainfall. This contact closure is used to operate the event recorder or data acquisition systems. A level is provided on the base for correct positioning of the unit. The funnel has a screen to prevent debris from entering the gauge.

6. Determination of Noise Level

Sound travels through any medium as alternating pressure waves. We are mostly concerned with sound traveling through air since our ears are exposed to air. When these pressure waves fall on the eardrum, they cause an 'auditory sensation'. The stronger the amplitude of pressure waves, the higher the sound energy and the louder the human ear perceives the sound. Accurate measurement of sound is essential in establishing the existence of a noise problem, its character and severity, and its potential to harm people, and for its effective control.

Theory:

A relative measurement of the pressure due to sound wave is referred to as Sound Pressure Level (SPL). For this purpose, one reference pressure has been established which is 20 μPascal ($20x10^{-6}$ N/m^2). This is so fixed because a normal healthy person can hear a sound, intensity of which is not below 20 μPascal.

The unit of SPL is decibel (dB) which can be defined as:

$$\text{SPL in dB} = 20 \log_{10}\left(\frac{P_{rms}}{P_{ref}}\right)$$

Where, P_{rms} = Actual root mean square pressure in Pascal

P_{ref} = Reference pressure

= 20 μPascal.

By means of a Sound Level Meter, one can measure the SPL in decibel (dB).

Specification of Instrument:

- Measurement Range: 20 - 140dB in seven 60dB ranges with standard microphone. Model 1900 only: display range may be shifted upward in 10dB steps to 60 - 180dB by using optional microphones. The second peak detector operates over the range of -40 to +10dB relative to the top of the selected measurement range.
- Measurements Performed: Sound Pressure Level (SPL), Equivalent Level (LEQ or LAVG), Time Weighted Average (TWA), Maximum Level (LMAX), Minimum Level (LMIN), Percentile Levels (LN), Day/Night Level (LDN), Community Noise Exposure Level (CNEL), Overload Time (%OL), Exposure (PA2H), Sound Exposure Level (SEL), Taktmaximal (TAKM), and Run Time (RTxx). Optional C-A module allows simultaneous C-A weighted measurement of LEQ (or LAVG).
- Temperature Range: Operating: -10°C to +50°C. Accuracy is within +/- 0.5 dB. Storage (less batteries): -20°C to +60°C
- Do not exceed the Storage Temperature Range because possible damage to the unit may result.
- Operating Humidity: Over a range of 30 to 90% relative humidity, the accuracy is within +/- 0.5 dB. Do not exceed 95% relative humidity because possible damage to the unit may result.