DATA COLLECTION PLATFORM FOR RTDAS

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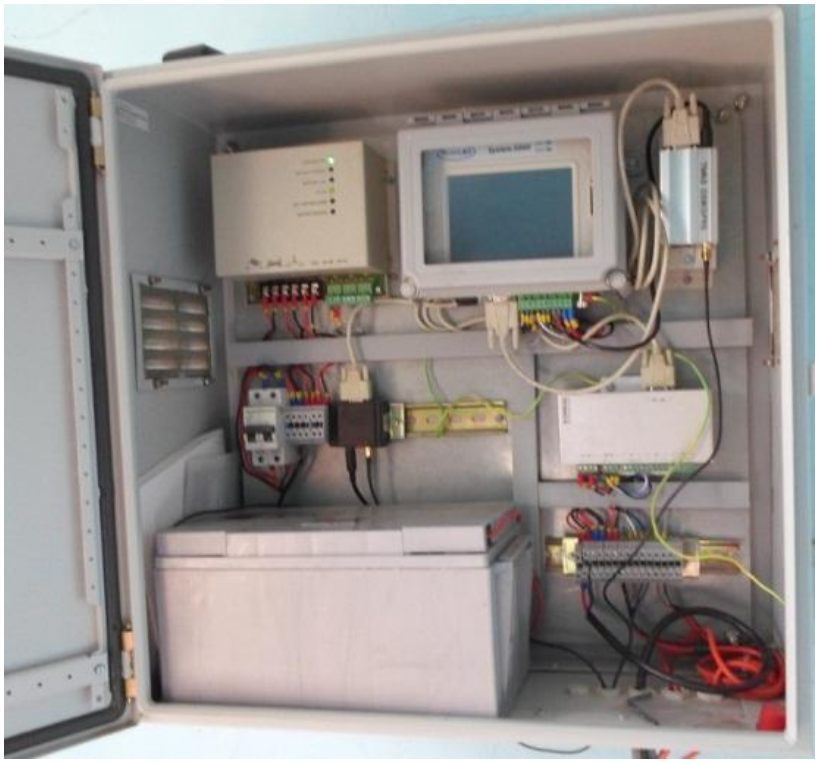
- Any such reference / example matching to any case /person/equipment/event will be merely coincidence.

Data Collection Platform

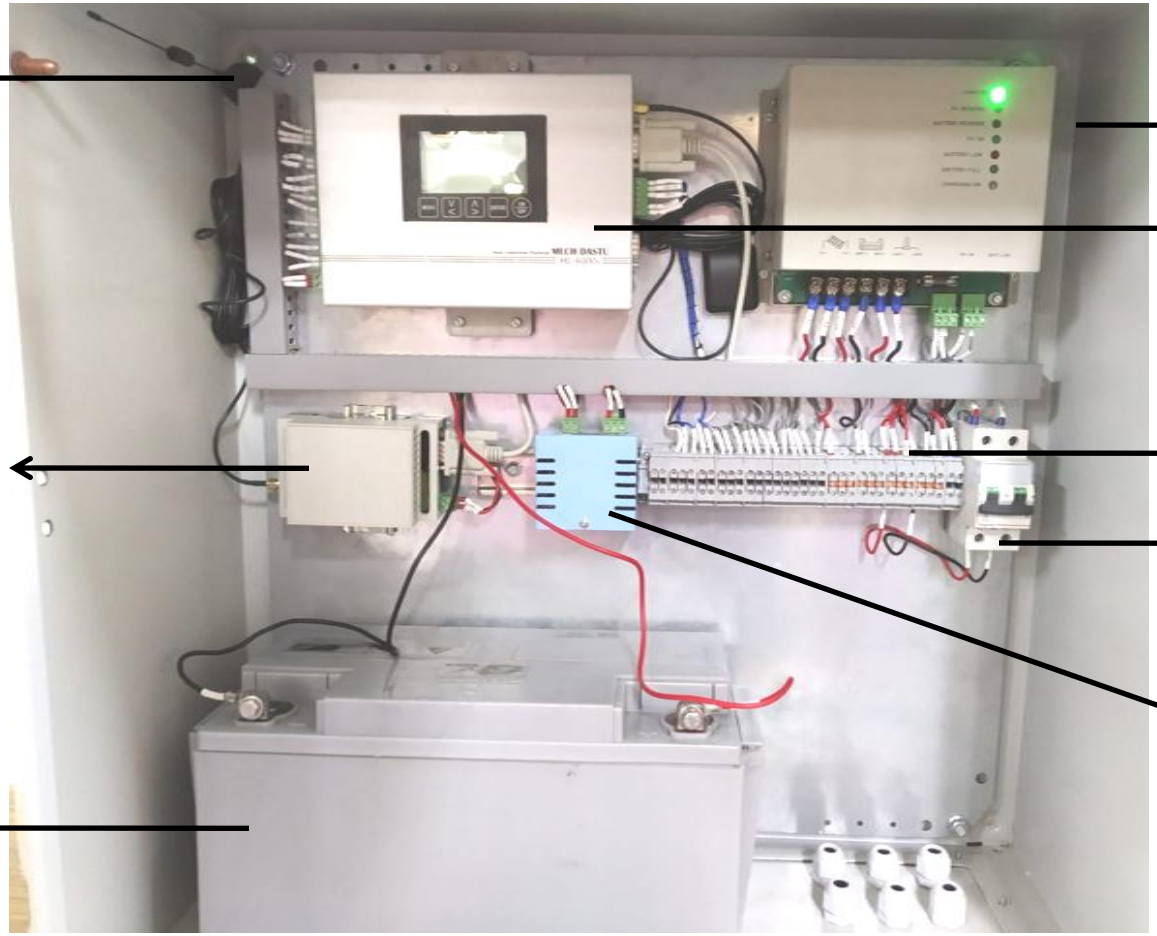
Data Collection Platform (DCP) is a central part of any telemetric hydro-meteorological monitoring system. The DCP acquires data from various Hydro_Met sensors, stores, analyze and transmit the same to Data centers. The DCP comprises following parts

- Data Logger
- Solar Panel and Battery
- Solar charge controller
- Enclosure
- Modem and Antenna for Telemetry
- pole to mount the sensors and DCP
- Earthing and Lightening Protection

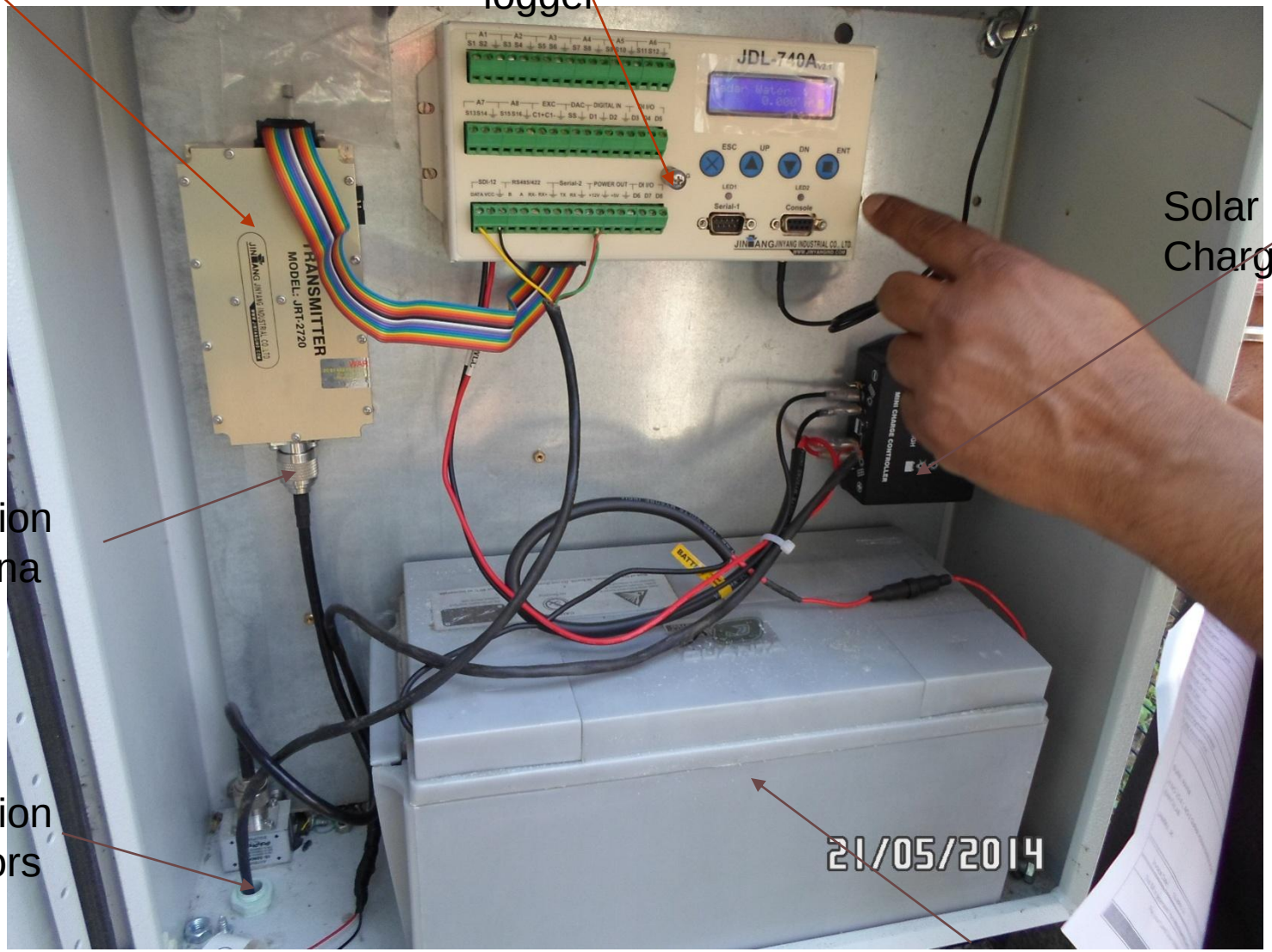
Data Collection Platform



Data Collection Platform



Inside the Box (NEMA BOX)



Data Logger

- A data logger is an electronic instrument that records environmental parameters such as temperature, relative humidity, wind speed and direction, light intensity, rain fall, water level and water quality over time.

- Typically, data loggers are compact, battery-powered devices that are equipped with micro processor, Input-Output channels, data storage and telemetry.

Data Logger

It performs various functions in the system such as

- providing power supply to the sensors
- interrogating the data at specified intervals
- storing the data
- Maintaining the system time
- providing the trigger for data transmission
- providing the data to the transmitter
- Responding to user queries either through telemetry or on site.

Typical Data Loggers

Temperature Data Logger

Central Water & Power Research Station

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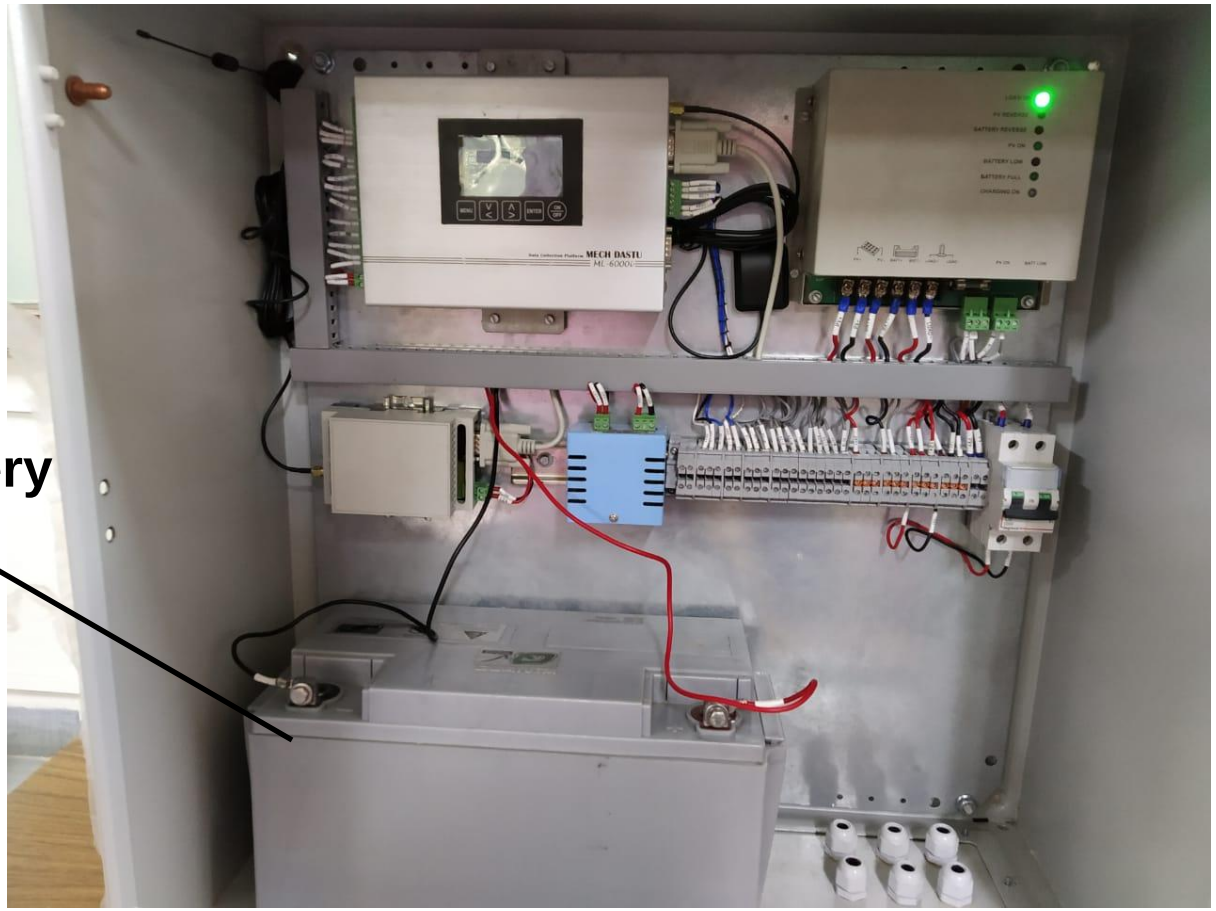
Current Date:2018-12-21 19:16:06 pm

SL. No.	Date	Time	Temperature in ℃	Temperrature in °F
2949	2018-12-21	11:38:25	24.7	76.5
2948	2018-12-21	11:38:21	24.8	76.5
2947	2018-12-21	11:38:17	24.7	76.4
2946	2018-12-21	11:38:14	24.7	76.4
2945	2018-12-21	11:38:10	24.7	76.4
2944	2018-12-21	11:38:07	24.7	76.4
2943	2018-12-21	11:38:03	24.7	76.4
2942	2018-12-21	11:38:00	24.7	76.4
2941	2018-12-21	11:37:56	24.7	76.2
2940	2018-12-21	11:37:35	24.8	76.5
2939	2018-12-21	11:37:32	24.7	76.5
2938	2018-12-21	11:37:28	24.7	76.5
2937	2018-12-21	11:37:24	24.8	76.5
2936	2018-12-21	11:37:21	24.7	76.2
2935	2018-12-21	11:37:17	24.6	76.2
2934	2018-12-21	11:37:14	24.8	76.5
2933	2018-12-21	11:37:11	24.6	76.3
2932	2018-12-21	11:37:07	24.8	76.4
2931	2018-12-21	11:37:04	24.7	76.3
2930	2018-12-21	11:37:01	24.6	76.4

Power Supply - Battery



BATTERY

- For unattended operation, the Data Collection Platform runs on sealed maintenance-free battery, rechargeable through a solar panel.
- The battery is capable to run the system for minimum of 15 days during total cloudy/no charging conditions.
- Most data loggers require a 12 VDC power source
- Charge controller is used to prevent over charging and deep discharge

Types of Batteries

- Primary-Non rechargeable Batteries

  Alkaline Batteries, Lithium Batteries

- Seondary - Rechargeable batteries

  Lead-acid batteries are the cheapest rechargeable batteries and can produce much power. They contain toxic lead, though, and should be recycled. They are wet cells, and the dangerous acid can spill out.

  Sealed lead acid batteries are batteries where the sulfuric acid is in a gel which stays in, even when the battery is turned up side down.

Rechargeable Batteries

- A rechargeable battery, storage battery, can be charged, discharged into a load, and recharged many times.
- It is composed of one or more electrochemical cells. It accumulates and stores energy through reversible electrochemical reaction
- Rechargeable batteries typically initially cost more than disposable batteries, but have a much lower total cost of ownership and environmental impact, as they can be recharged inexpensively many times before they need replacing.

Charge Controller

- The solar panel is connected to charge controller to recharge the battery. Most data loggers require a 12 VDC power source which is supplied by the battery.
- Some water level sensors require 24 VDC power supply. For that a 12 to 24 V DC converter is provided separately.
- The charge controller avoids over charging as well as deep discharge of the battery which in turn increases the battery life.

Weatherproof Enclosure

- Data loggers are usually installed in remote and harsh locations.
- Intrusion of moisture into the data logger circuitry is a primary cause of failures.
- The enclosure shall be used to hold the Data logger, Battery and other components. The enclosure shall be NEMA type 4 or equivalent type (IP65) enclosure of steel or fiberglass to prevent water and insects from entering the enclosure.
- The enclosures would provide protection from dust, humidity, precipitation, sunlight, and environmental pollution.

IP ENCLOSURE

- IP65 Enclosure - IP rated as "dust tight" and protected against water projected from a nozzle.
- IP66 Enclosure - IP rated as "dust tight" and protected against heavy seas or powerful jets of water.
- IP 67 Enclosures - IP rated as "dust tight" and protected against immersion.
- IP 68 Enclosures - IP rated as "dust tight" and protected against *complete, continuous submersion in water*.

IP Ratings - what they mean.

First Digit (intrusion protection)

1. No special protection<
2. Protection from a large part of the body such as a hand (but no protection from deliberate access); from solid objects greater than 50mm in diameter.
3. Protection against fingers or other object not greater than 80mm in length and 12mm in diameter.
4. Protection from entry by tools, wires etc, with a diameter of 2.5 mm or more.
5. Protection against solid bodies larger than 1mm (e.g. fine tools/small etc).
6. Protected against dust that may harm equipment.
7. Totally dust tight.

Second Digit (moisture protection)

1. No protection.
2. Protection against condensation
3. Protection against water droplets deflected up to 15° from vertical
4. Protected against spray up to 60° from vertical.
5. Protected against water spray from all directions.
6. Protection against low pressure water jets (all directions)
7. Protection against strong water jets and waves.
8. Protected against temporary immersion.
9. Protected against prolonged effects of immersion under pressure.

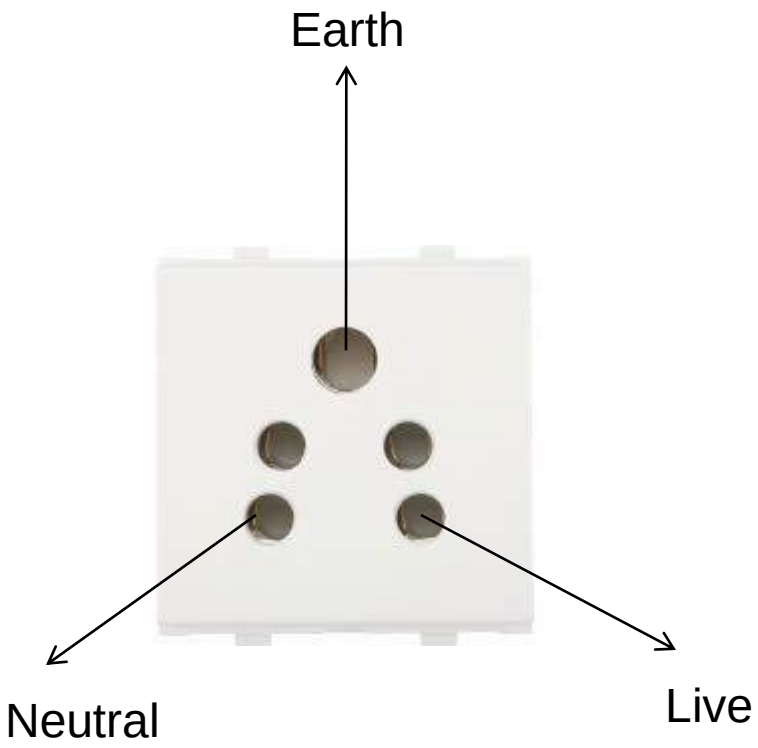
Modem and Antenna for Telemetry

- The data stored in the Data Logger is transmitted to the Data Center through GSM/GPRS or VSAT /INSAT.
- In case of GSM/GPRS transmission the modem and antenna are enclosed in the DCP Enclosure.
- In case of VSAT/INSAT transmission the transmitter is enclosed in DCP Enclosure while the antenna is mounted on top of nearby structure above height of 2m

Pole to mount the sensors and DCP

- Triangular Tower of 10m height with guy rope support & required mounting hardware is used to mount the DCP.
- The DCP is installed so that sensitive equipment such as the data logger, batteries, telemetry radios, and antennas are located well above expected high water.

Earthing



Check Earthing

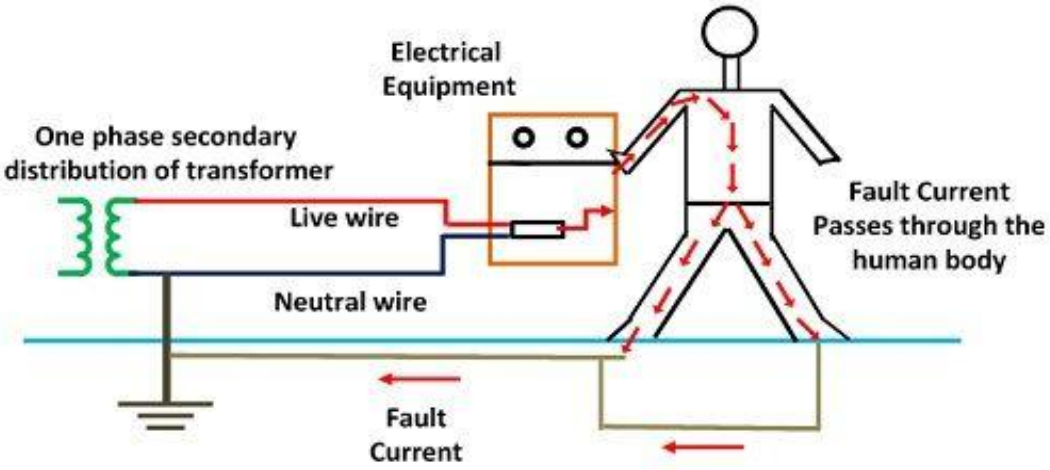
Live –Neutral ~ 230V

Live –Earth ~ 230V

Earth-Neutral ~ Ideally 0V

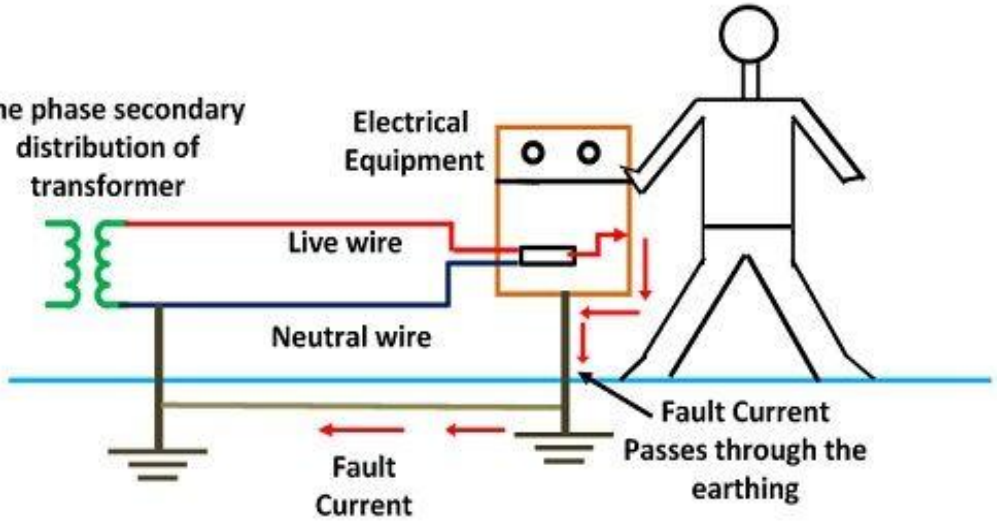
Practically<1V

What is Earthing



Electrical System Without Earthing

The earthing protects the apparatus and personnel from the high voltage surges and lightning discharge

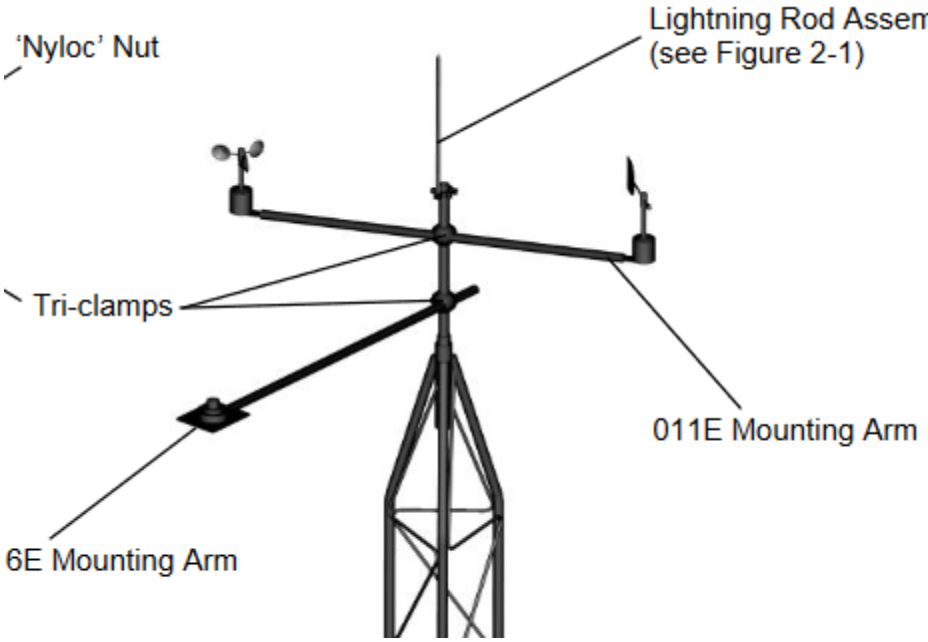


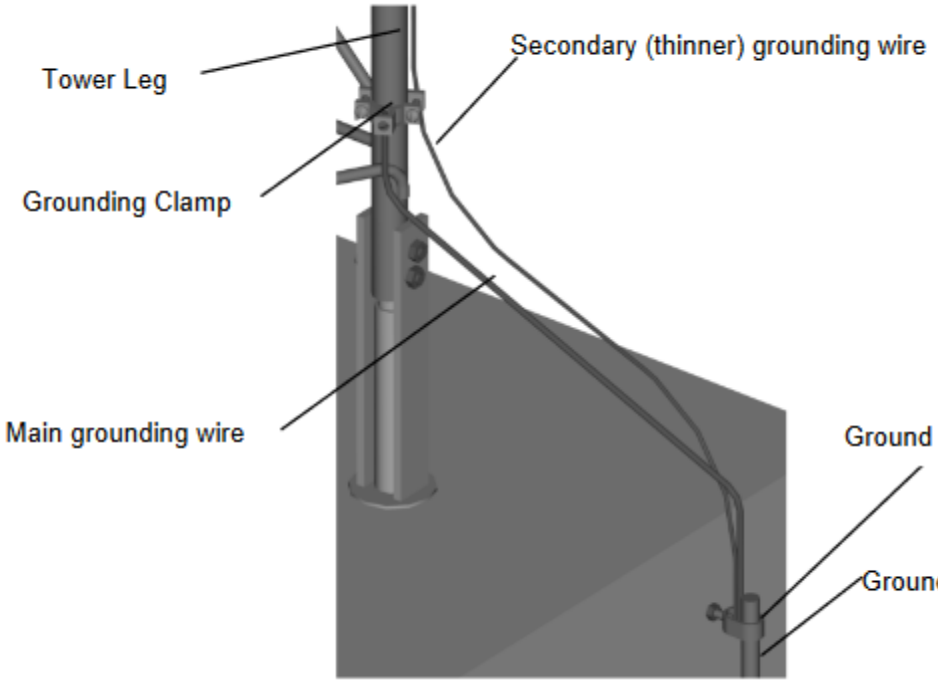
Electrical System With Earthing

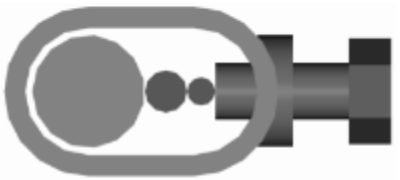
Earthing

- Local Earthing with speified design should be provided for DCP Enclosure
- The earthing for the equipment's should be done separately and should have a minimum distance of 2.5 meter from the earthing done for lightning rod. In no case both the earths should be done in the same earthing rod.
- As a part of the maintenance, the earthing equipment shall be inspected on a yearly basis for its conductivity and effectiveness. Such inspection shall be carried out in the pre-monsoon period and any faults noticed shall be rectified

Lightning Protection







Lightning Protection

- The entire unit has to be adequately protected against lightning and build of static charges.
- The lightning rod should protrude 1 m above the highest point (Antenna) and should be placed in the center of the pole.
- The mast should be electrically grounded by following the prescribed earthing procedures.
- As a part of the maintenance, the earthing equipment shall be inspected on a yearly basis for its conductivity and effectiveness. Such inspection shall be carried out in the pre-monsoon period and any faults noticed shall be rectified.

Lightning Protection

- The lightning arrestor rod is made of copper which is mounted on the top most part of the Mast / Tripod /tower.
- It should be of thickness 12 mm and of one meter length with a connected copper wire of 6mm thickness (gauge).
- At the other end of copper wire is the Earthing rod of dimensions 15mm thickness and 1.8 meter length, which is buried into the ground.
- On the bottom of earthing rod, one copper plate of dimensions 300mm x 300mm should be connected.

Lightning Protection

- A pit of 4-5 feet depth, 2’ X 2’ wide at bottom (like a cone shaped pit) has to be dug.
- After leveling the bottom of the pit, uniform layer in the sequence of 6 inches of Salt + 6 inches Charcoal + 6 inches Sand is filled.
- Such sequence is repeated 3 times till the earth pit is filled to the top.
- The copper earthing rod is placed in the center of the pit. The pit is closed and leveled.

Key Features of Data Logger

- Input Channels- Analog, Digital, 4-20 mA, SDI-12
- Output Channels – Analog,Digital, RS232,USB
- ADC Resolution/Accuracy - Minimum 12 bit
- Input range selection - (e.g. +/- 1, 5, 10 V or mA)
- Recording interval / Sampling Interval
- Firmware operating system
- Inbuilt memory (Flash/Nonvolatile) expandable
- Digital Display device for measured parameters
- Display Features - Running, Large Screen Display
- USB Port on Data Logger for Data Transfer on Pen Drive
- Keypad for configuration
- Power supply
- Battery (internal/external)

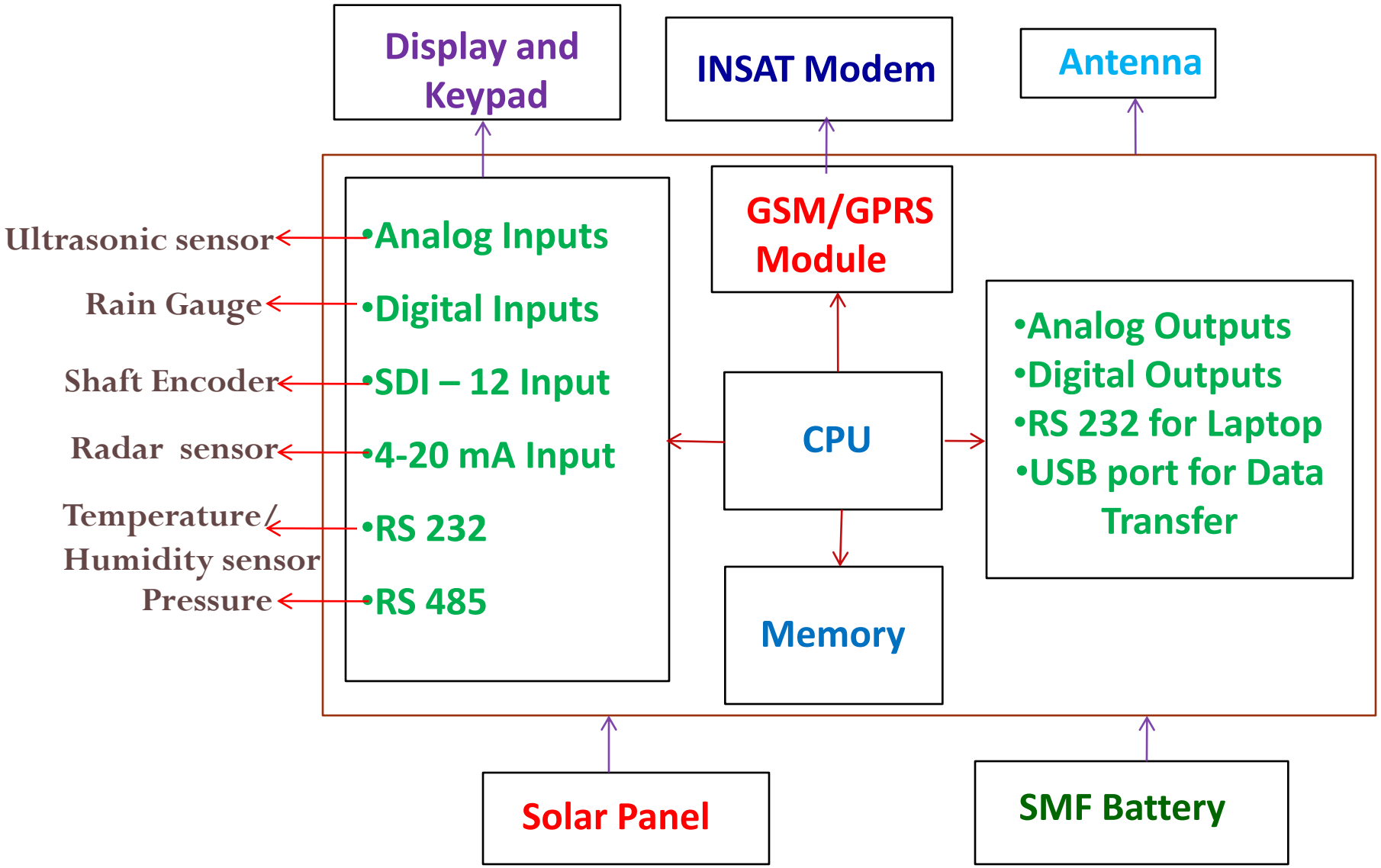
Key Features of Data Logger – contd.

- Synchronization of internal time clock
- Cables and connectors of ISO standards
- User login facility
- System integrity check procedure
- Ability to add or remove sensors
- Reconfiguration of parameters.
- Passwords for different operating Level.
- Testing of Battery - Monitoring of Battery Voltage, Life of Battery

Key Features of Data Logger.

- Power Consumption.
- Display Features - Running, Large Screen Display
- Data Analysis / Features
- Statistical data analysis (min/max, Cumulative, Instantaneous etc.
- Data transfer Protocol (https/ftp)
- Data transfer methodology
- Polling Method
- Pull Method
- Output Data file Format
- csv,xml,mdb
- Enclosure Testing

Block Diagram



Analog Channel

- Analog means a mechanism in which data is represented by continuously variable physical quantities.
- Analog channels are the most common types of input channel found on multi-channel data loggers since most sensors have an analog output.
- Temperature Output Voltage 4 bit Binary Equiv.

0 deg C	0 volts	0000
50 deg C	2.5 volts	1000
100 deg C	5 volts	1111

Digital Channel

- A digital signal is a signal that is being used to represent data as a sequence of discrete values
- Revolutions per Minute Wind Speed

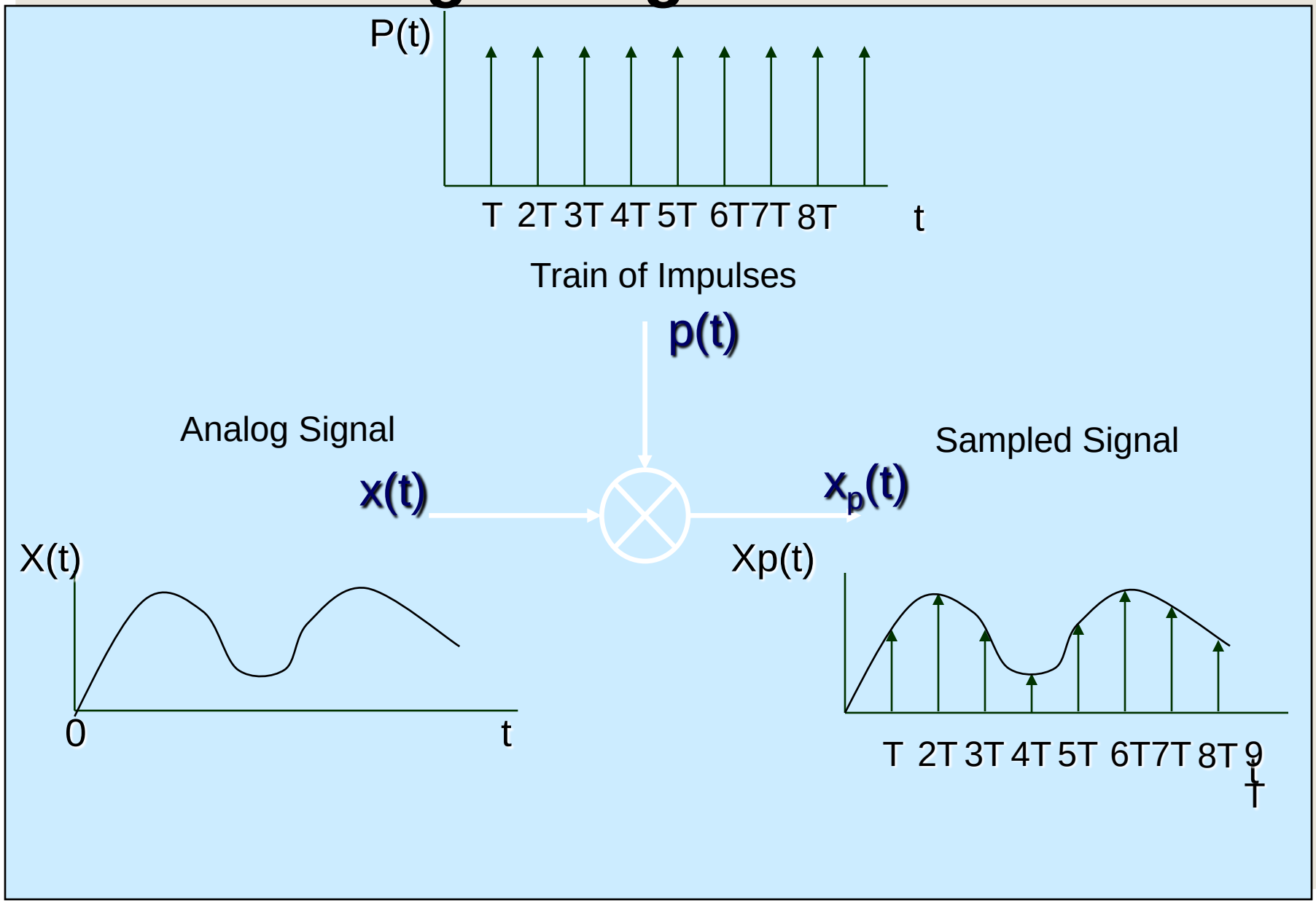
  100 5 km/hr

  200 10 km/hr
- Typical digital sensors include:

  Wind Speed Sensor

  Tipping Bucket Rain Gauge

Analog to Digital Conversion



Resolution of A to D Converter

V_{range}=Input Voltage Range

n= # bits of ADC

$$resolution = V_{range}/(2^n - 1)$$

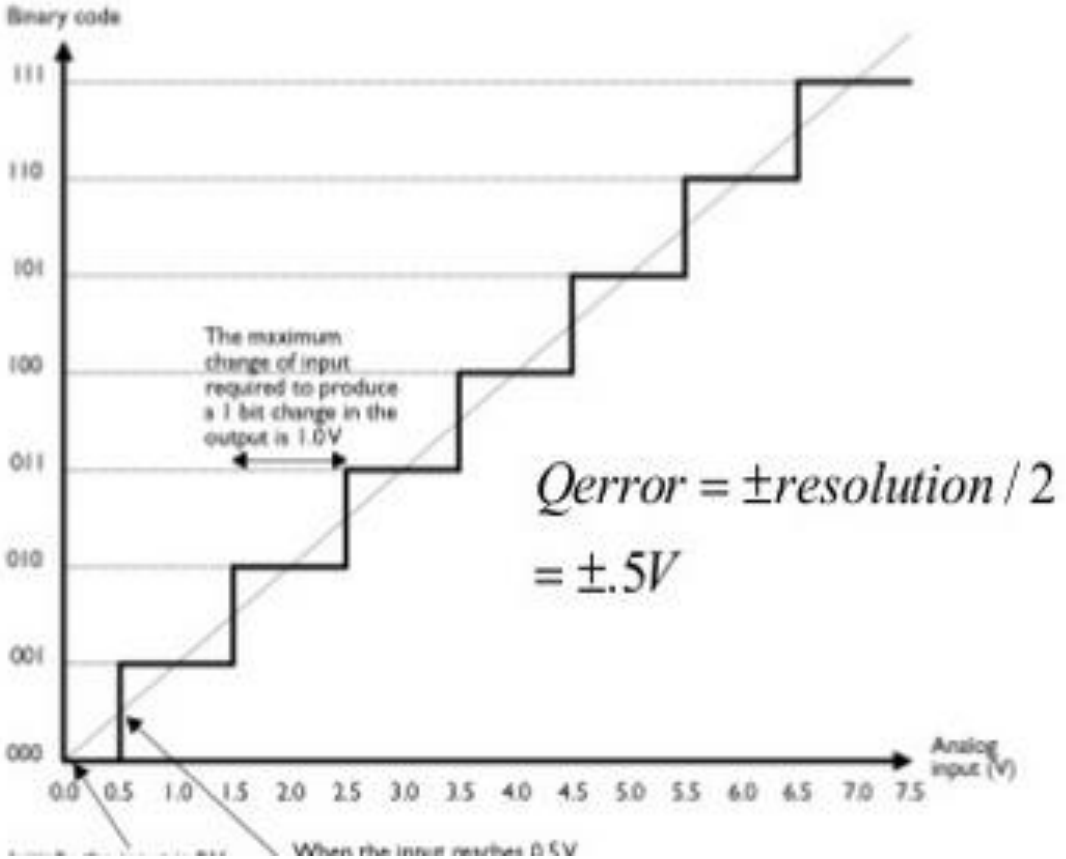
Example:

$$V_{range} = 7.0V$$

$$n = 3$$

$$1V = 7V/(2^3 - 1)$$

Resolution



$$Qerror = \pm resolution/2$$

$$= \pm .5V$$

ACCURACY

- The ADC accuracy is expressed in percentage of particular input range or in Least Significant bit (LSB).
- For Example We are using 12 bit ADC then

  0.1% Accuracy for 5V Input Range = 5mv

  0.1% Accuracy for 10V Input Range = 10mv

  Whereas

  $\pm$1 LSB Accuracy for 5V Range = 5V/ (2^{12} -1) = 2.4mV

  $\pm$1 LSB Accuracy for 10V Range = 10 V/ (2^{12} -1) = 4.8mV

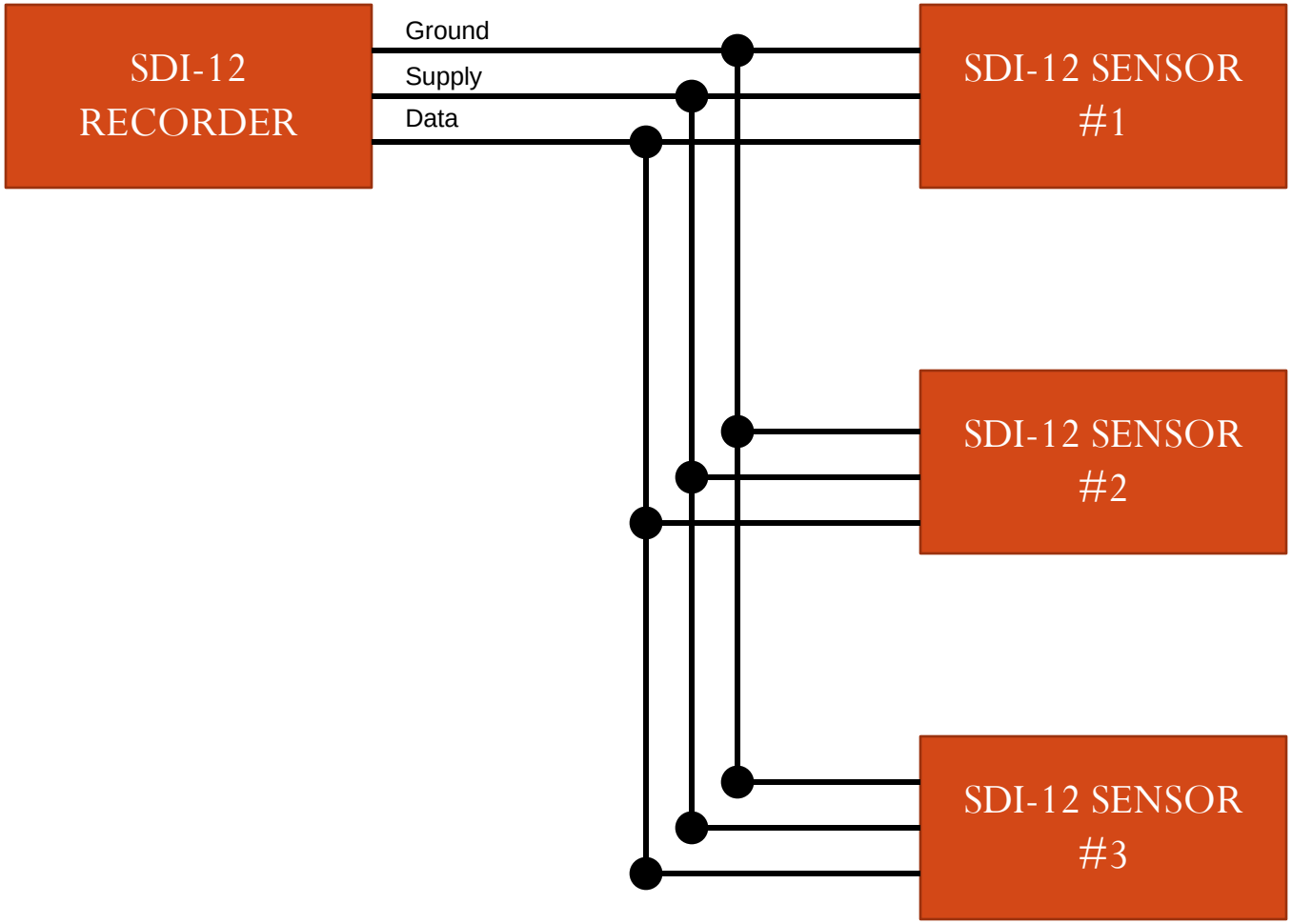
SDI-12 (Serial Digital Interface)

- Serial Digital Interface at 1200 baud (bits/sec).
- It is an asynchronous serial communications protocol for intelligent sensors that monitor environment data.
- These instruments are typically low-power (12 volts), are used at remote locations,
- The protocol follows a master-slave configuration whereby a data logger (SDI-12 recorder) requests data from the intelligent sensors (SDI-12 sensors), each identified with a unique address

SDI-12 (Serial Digital Interface)

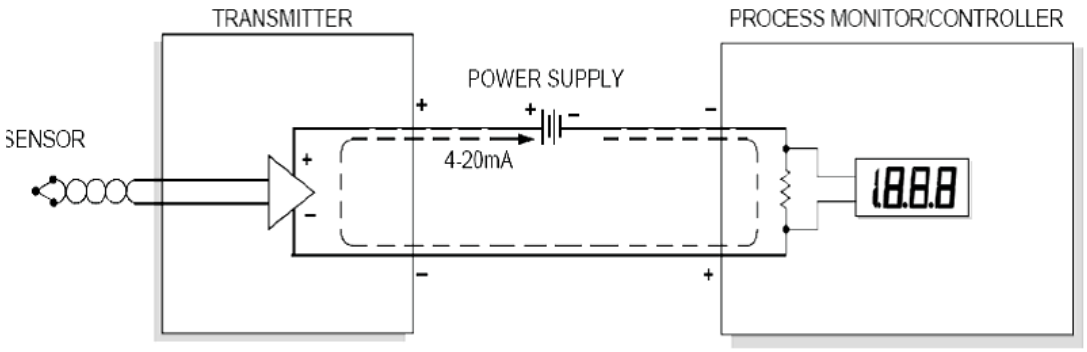
- A micro-processor in the sensor may calibrate the sensor, control sensor measurements, convert raw sensor readings into engineering units, and uses the SDI-12 protocol to transfer reading to the data logger.
- For example, a SDI-12 pressure sensor may take a series of pressure measurements, average them, and then output pressure in psi, inches of mercury, bars, millibars, or torr to the data logger.
- Widely Used By USGS & Other Surface/Groundwater Monitoring Agencies

SD-12 Protocol Overview

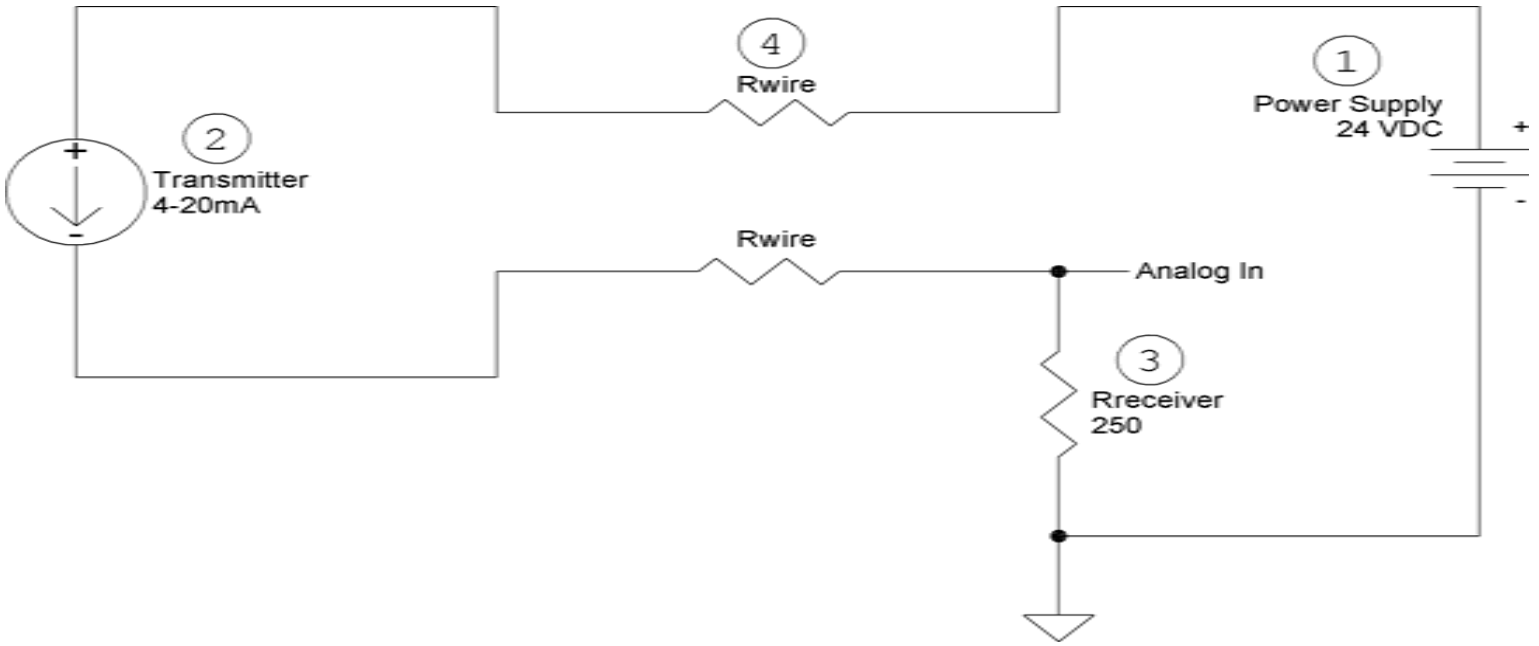


4-20 mA Protocol

- The 4 to 20mA current loop is a very robust sensor signaling standard.



4-20 mA Protocol



1. D.C.Power Supply
2. Transmitter
3. Receiver Resistor converts current signal into Voltage
4. Wire interconnects all.

4-20 mA Protocol

- It can be run over long distances with minimal signal losses compared to voltage type signals
- A varying current loop load impedance or supply voltage will not significantly affect the signal.
- Rugged signal with low electromagnetic susceptibility
- Saves cable length because it needs only 2 wires to function
- Live zero reading verifies sensor is electrically functional

4-20 mA Protocol – Disadvantages

- High power consumption compared to other analogue signal types
- Elevated output at zero reading
- Supply not isolated from output

Data Output Port (RS-232 Port)

- Data loggers communicate with a PC via a serial port which allows data to be transmitted in a series (one after the other).
- Data can be sent in both direction
- 9600 baud is a standard communication speed.

Universal Serial Bus - USB

- Serial bus standard for connecting devices, usually to a computer, but it also is in use on other devices such as set-top boxes, game consoles and PDAs.
- USB Port on Data Logger for Data Transfer on Pen Drive

Sample Interval

- Sample Interval is user selectable for each channel separately from 1 sec to 24 hours
- Generally data is transmitted hourly
- Data is also transmitted in special events such as reaching the threshold level.

Internal Memory

- RAM (Random Access Memory)

  -Data logger can use RAM to store data (readings from the input channel)

  - Inexpensive but must be battery backed up in order to retain the data.

- EEPROM (Electronically Erasable & Programmable Read Only Memory)

  - EEPROM memory does not need to be backed up by a battery.

  -Storing the operating system of the microprocessor, as well as for data storage

- FLASH Memory

  - Type of non volatile, re-writable memory used for data storage and data transfer. It retains data for extended time regardless the device is powered On or OFF

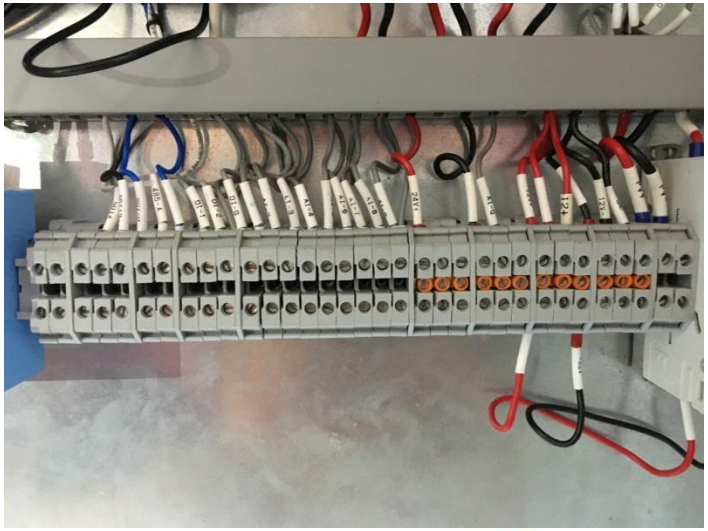
Software

- The software/firmware, operating system and application programs are preinstalled in the Data Logger.
- It firmware is easily programmable through Laptop connected to RS232 port
- Multitasking operating system is used for real time data logging, data storage and transmission at same time.
- Software for system configuration and troubleshooting

.CSV (Comma separated Values) FILE FORMAT

TIME	DATE	TEMP	BATTERY PERCENTAGE
02:10:05	20/11/2019	23.0 C	78.9%
02:10:10	20/11/2019	23.3 C	78.7%
02:10:15	20/11/2019	23.5 C	78.6%
02:10:20	20/11/2019	23.6 C	78.5%
02:10:25	20/11/2019	23.8 C	78.4%
02:10:30	20/11/2019	23.8 C	78.3%

Types of Connectors



Wire terminal Connectors

9 Pin RS232 serial connector

Types of Connectors

SDI 12 Output cable with connector

BNC Connector

Types of Connectors

USB Connectors

RJ 45 Connector


Thank you