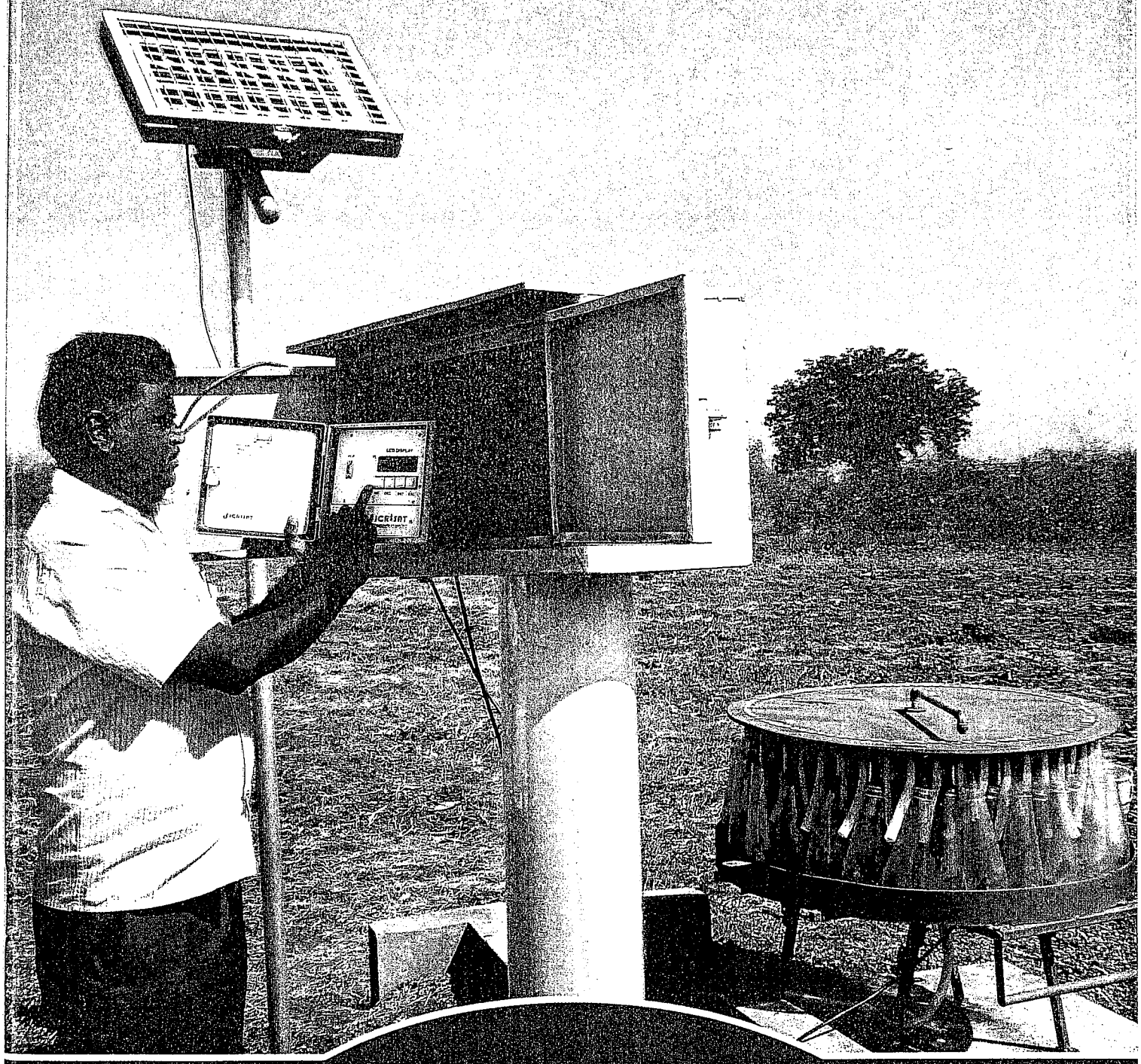
Technical Description and Operating Manual

Integrated Digital Runoff and Soil Loss Monitoring Unit (IDRSMU)



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International Crops Research Institute for the Semi-Arid Tropics

Technical Descriptions and Operating Manual

Integrated Digital Runoff and Soil Loss Monitoring Unit (IDRSMU)

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Contents

Integrated Digital Runoff and Soil Loss Monitoring Unit (IDRSMU)

1. Salient features of IDRSMU

- It monitors both the runoff and soil loss.
- It is low-cost yet highly accurate equipment.
- It is suitable even for remotely located gauging stations as it requires minimum supervision and maintenance.
- It has programmable setting of runoff sampling and data logging intervals ranging from 1 minute to 24 hours.
- It has high storage capacity of upto 130000 measured data that can be stored in the logger (sufficient to store full one year runoff data).
- Its main unit (data logger and micro-processor controller) is quite compact and light weight.
- Since it is integrated runoff and soil loss monitoring unit, this makes the calculation of soil loss easy, fast and accurate
- Its unit can measure as low as 1 mm and as high as 25 meters depth of runoff flow. Its range can be increased substantially by simply changing the pulley size
- It has very low power consumption; can function on built in 6V,4Ah battery for 6 to 7 months for recording runoff without any recharging.
- It retains the recorded data even if all batteries are fully discharged. Data can be retrieved once battery is recharged or replaced with new battery.
- Pumping time, runoff sampling intervals and other parameters can be programmed at site to suit the requirements using key board. The PC or laptop is not necessary.
- It maintains date and time that can be set any time matching to IST and the Real Time Clock can be adjusted to run accurately.
- It allows browsing of all the stored data through LCD Display and key board. Thus having a PC or laptop is not necessary to glance the stored data.
- It allows entering location name and code through PC or laptop-interface.
- Stored records can be down loaded into PC or laptop using standard accessories and can be converted into a database file (excel-file) for further processing.

2. Introduction

The integrated digital runoff and soil loss monitoring unit (IDRSMU) can be used to measure the runoff and soil loss from the fields and watersheds. Since it is an integrated unit, the analysis of the soil loss is much faster and more accurate. Moreover, the unit can be used to measure groundwater level and any open channel water flow viz. water flow in irrigation cannel. The entire runoff and sediment sampling operations are fully automatic and controlled by the data logger cum microprocessor control unit. Besides soil loss analysis, the unit can be used to measure the nutrients, pesticides or any other chemicals flow in runoff from the agricultural fields and watersheds. This unit is also suitable for studies that require more detailed information on total as well as temporal changes in sediment, nutrient and pesticides movements during the runoff hydrographs.

3. Basic Functioning of IDRSMU

3.1 Runoff recording

The data logger cum microprocessor control unit of IDRSMU (DLCMCI) continuously measures the runoff water levels in the channel/drains through a float-operated shaft encoder along with data logger (Fig. 1). Changes in the water level are transferred via a float cable counter weight system to the float pulley on the encoder unit (Fig. 2). The rotation caused by this action is converted to an electrical signal,

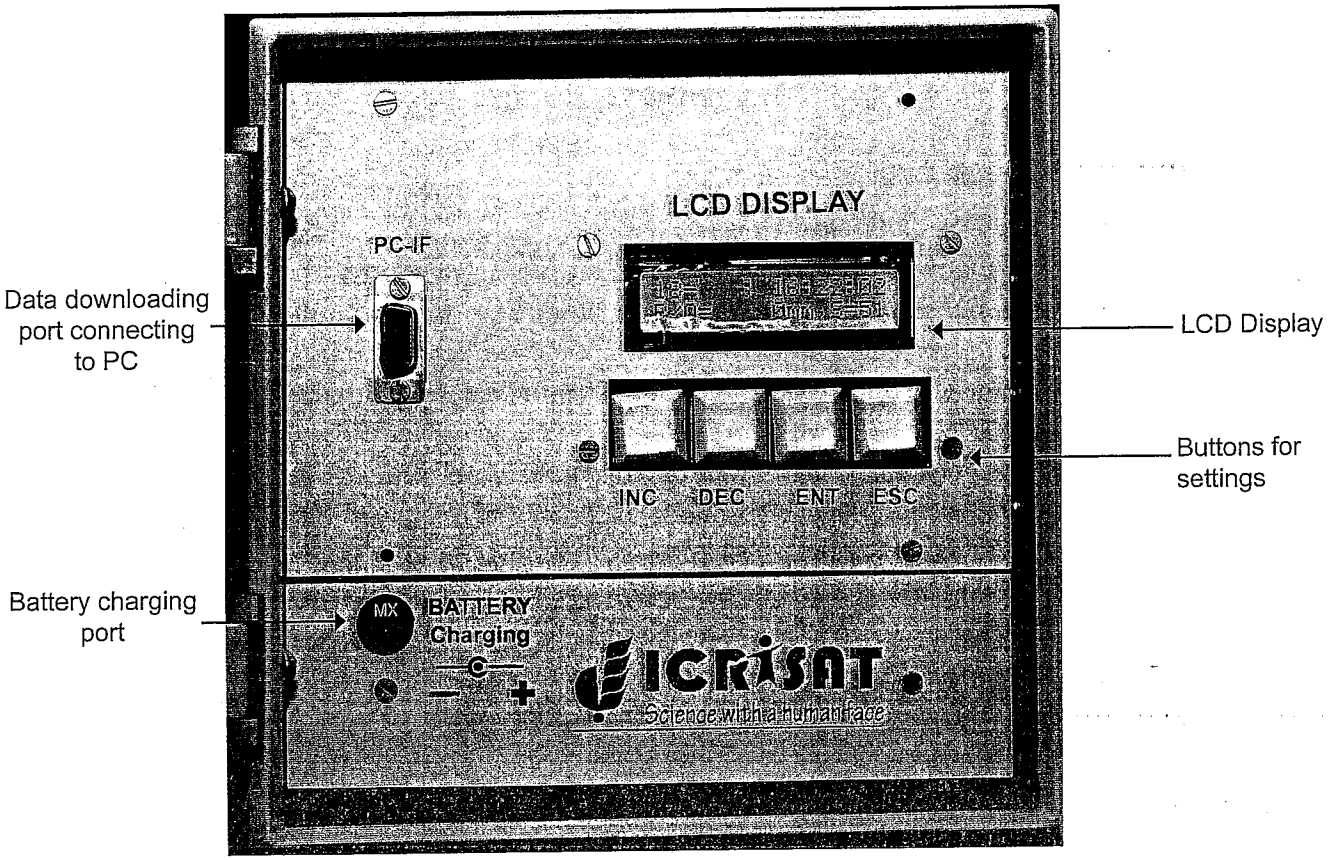


Figure 1. Data logger cum microprocessor control unit of IDRSMU (front view sowing key parts).

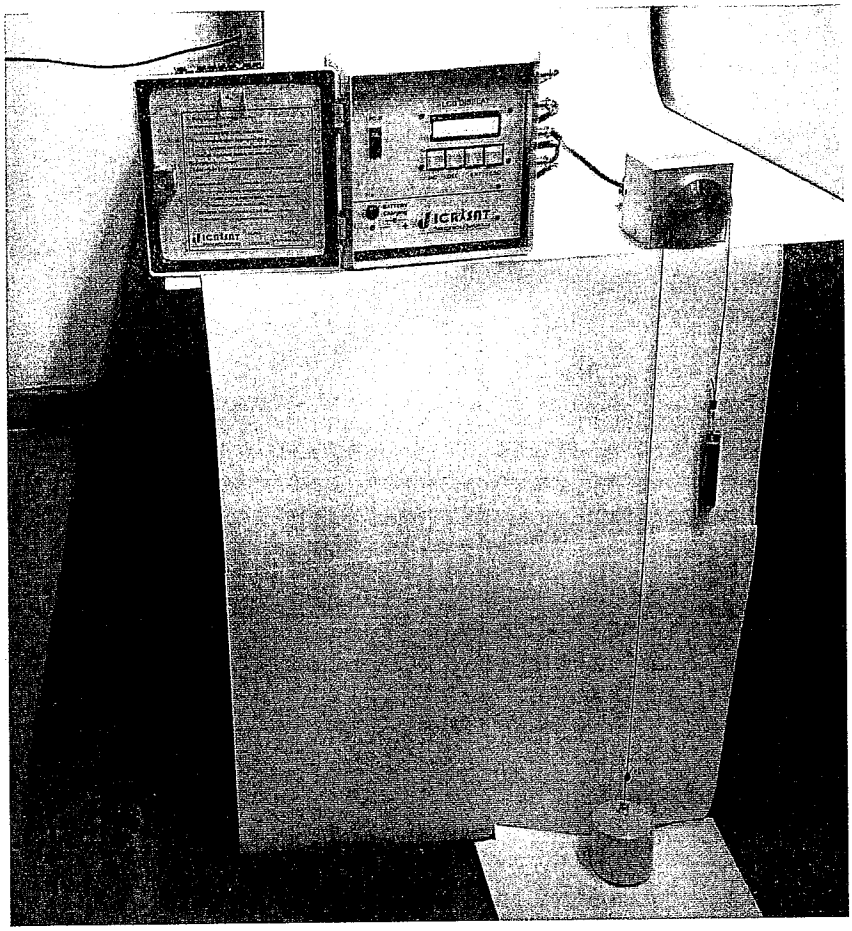


Figure 2. Data logger cum microprocessor control unit of IDRSMU along with shaft encoder, float and counter weight.

which is transferred by the transducer cable to the data logger and then saved as a measured value. A rugged servo potentiometer is used in the shaft encoder for measuring the runoff water level with a least count of 1 mm. The pulley drives a servo potentiometer. The micro-controller reads the signal from the servo-potentiometer, converts it to measured "runoff water level" in mm. A real time clock (RTC) has been built in it which keeps the time of the day and provides time of measurement of runoff water levels. Every two seconds

IDRSMU measures the runoff water levels. It calculates the average of 30 such runoff water level readings in one minute. When the average runoff water level exceeds the "set_record_runoff_min" set in the system, it stores this runoff water level in its 1MB flash memory along with date and time. When average runoff water level remains in excess of "set_record_runoff_min" and if this minutes average runoff water level is varying from the last stored average runoff value by 2 mm or above it again stores new runoff water level value with date and time. This process continues until the runoff water level falls below "set_record_runoff_min". About 130000 such records can be stored in 1MB flash memory. Thus, we can get a record of variation in runoff water level against date and time at every 2 mm interval as long as it is in excess of "set_record_runoff_min". The value of "set_record_runoff_min" can be set between 3 and 255 mm at a resolution of 1 mm using key board.

3.2 Sediment sampling for soil loss

The microprocessor-based IDRSMU automatically collects the runoff samples at specified time intervals for further analysis to estimate soil, nutrients and pesticides losses (Fig. 3). Under idle conditions, the entire system draws a minimum current of about 60 mA. The uninterrupted program enables it to keep scanning for the runoff water level in the channel. DLCMCI unit, which when initialized by the set runoff water level, operates the system, first by purging the pipe to clean off the old water sample,

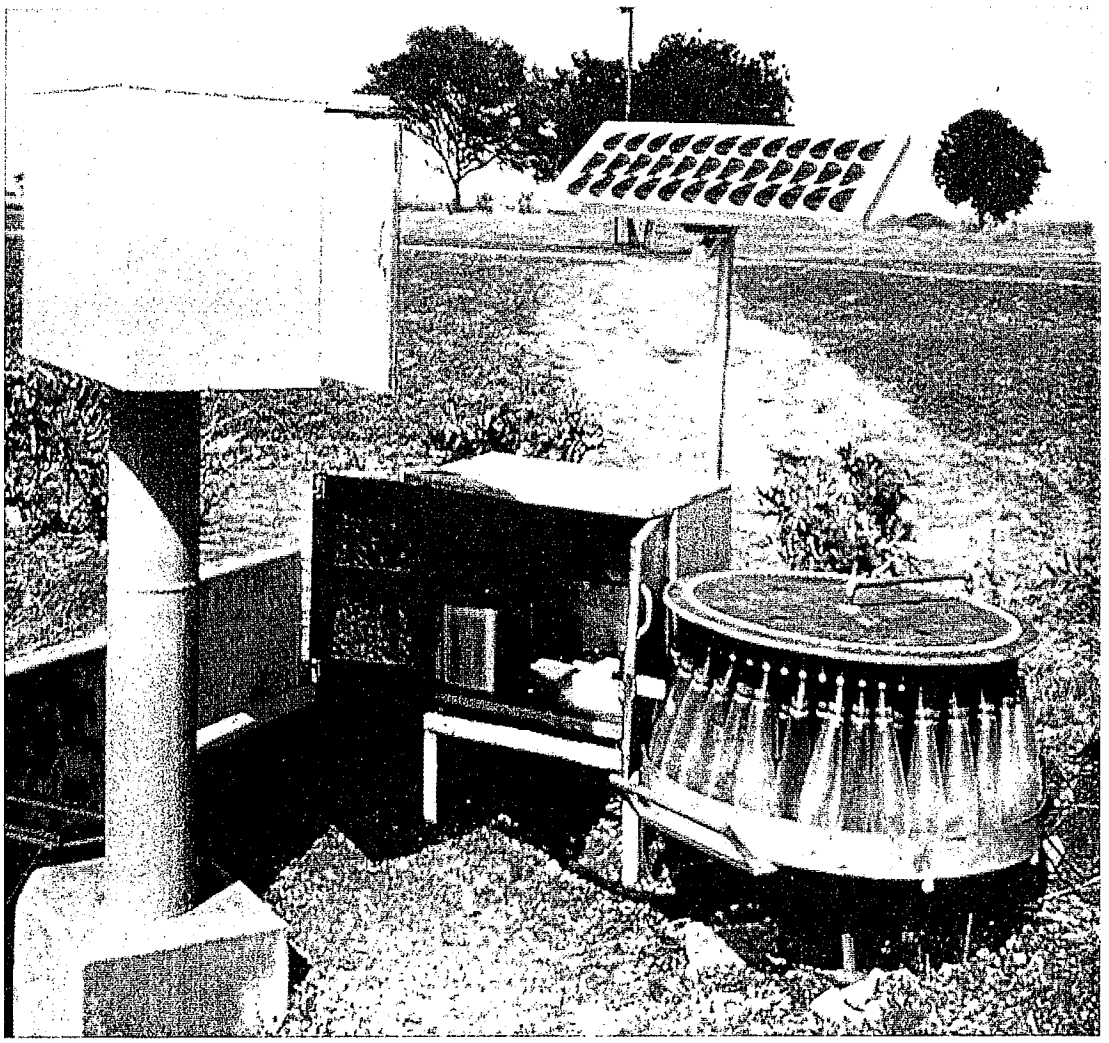


Figure 3. Integrated digital runoff and soil loss monitoring unit (with all the components)

positions the nozzle on sample hole and then pumps the sample water into a bottle and positions the nozzle on to the next purge hole. The pump is kept in the channel, completely immersed in the flowing water. About 750 ml of runoff water is pumped into each bottle.

Sediment sampling for estimating soil loss can be enabled by inserting a jumper at JP2 at the right top corner of the microprocessor PCB (Fig. 4). If JP2 jumper is kept open there will not be any sediment sampling. The sediment sampling process is initiated when sediment sampling is enabled, and runoff

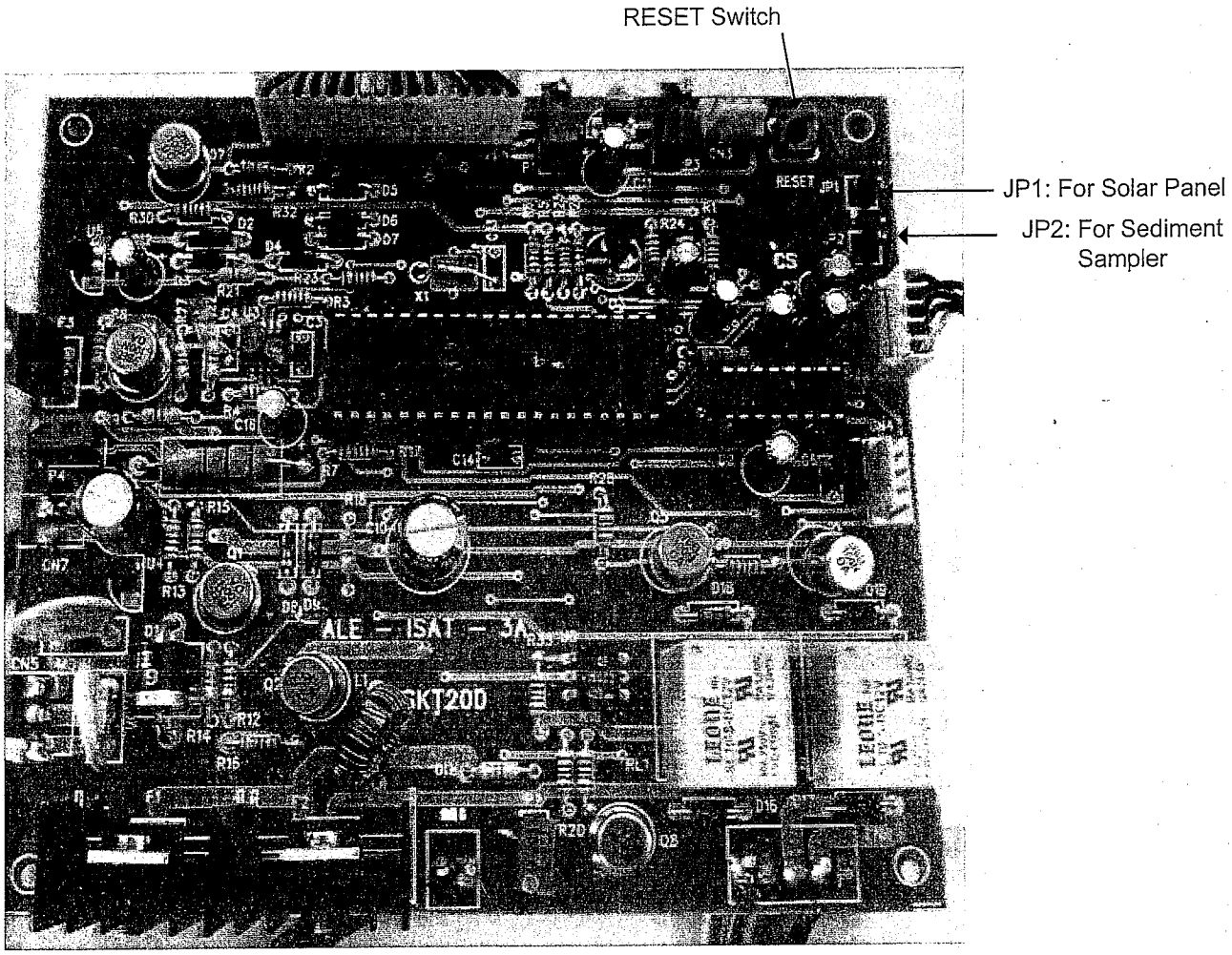


Figure 4. The circuit diagram of IDRSMU main PC Board showing reset, JP1 & JP2 switches locations

water level exceeds the set value. The main sediment sampler collecting unit with bottles fitted with DC shunt motor is shown in Fig. 5. The entire sediment sampling process has following four steps.

Step 1: The sampling pump is switched on for "pumping_time_setting" (this can be set between 4 and 100 seconds using data logger cum microprocessor control unit of IDRSMU (DLCMCI) key board). Once pumping runoff water, the pump is switched off.

Step 2: The sampler nozzle arm driving motor is switched on. The motor keeps running until the limit switch gives feed back signal that the nozzle arm has moved by one step forward. Then the motor is switched off.

Step 3: Again the sampling pump is switched on for "pumping_time_setting" (this can be set see the first step). After filling the bottle, the pump is switched off.

Step 4: The sampler driving motor is switched on. The motor keeps running until the limit switch gives feed back signal that the nozzle arm has moved by one step forward. Then the motor is switched off. Sediment sample is collected with the "sample number" along with date and time. The system keeps track of the sample number. Next sampling is taken again after a time "set_sampling_time_gap" (this can be set between 5 and 255 minutes using the DLCMCI key board) elapses and if the measured

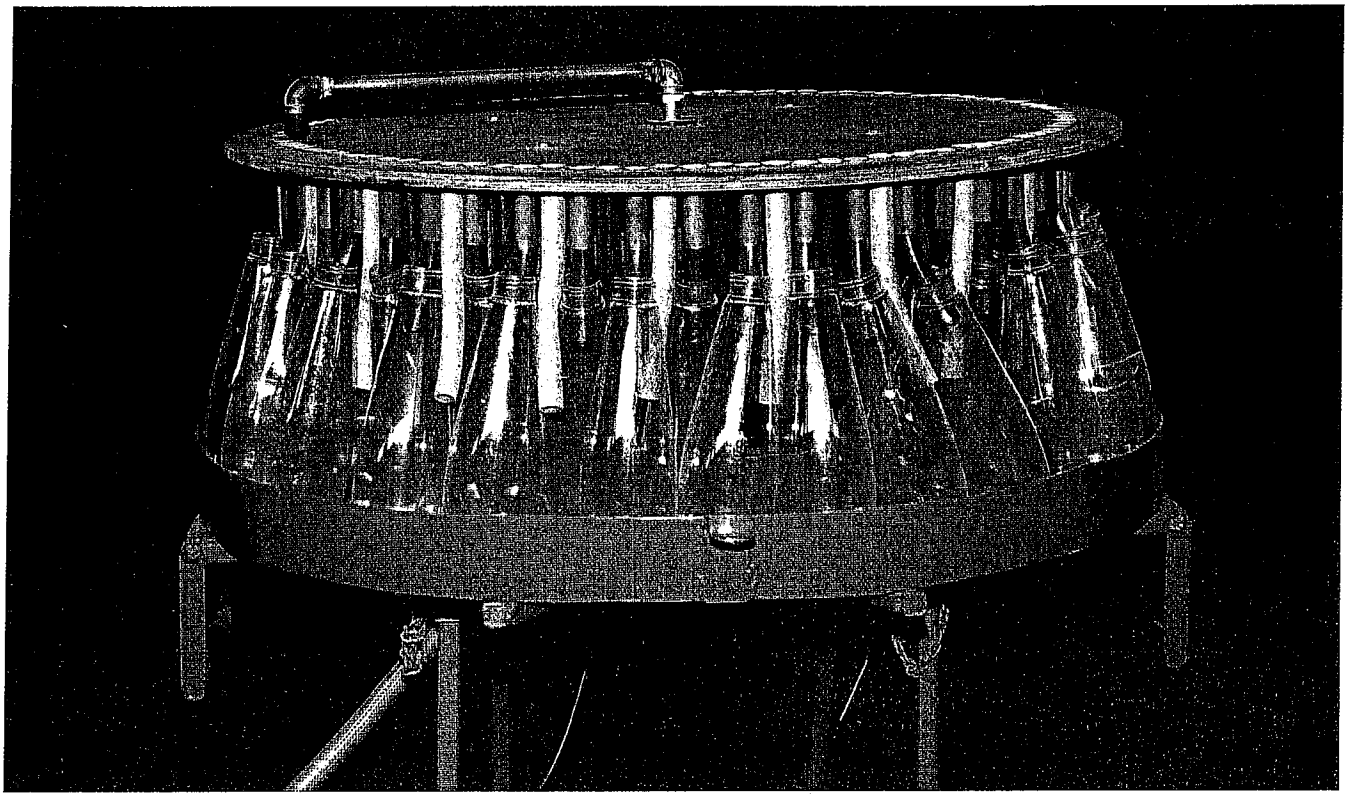


Figure 5. Circular sediment sample collection unit with bottles fitted with DC shunt motor

runoff water level at that time is more than set runoff water level value. In one go, maximum of 50 sediment samples can be collected by the sampling unit. Once sampling number reaches 51, sampling is stopped.

At this stage, all the sample bottles should be replaced with fresh empty bottles and the sample number should be reset to 1 by using data logger cum microprocessor control unit of IDRSMU (DLCMCI) key board as explained in later sections.

Situation when sediment sampling is not taken :

- when Jumper JP2 is kept open;
- when attempt is being made to change any of the operating parameters mentioned above by using DLCMCI key board. However, as soon as the parameter is set to a new value, the sampling will start automatically;
- when sample number is 51, it means all the sample bottles are filled.

Similarly, when sampling process is initiated and if at that time, the LCD display is on and some body is working with key board, then a special message will appear on LCD as "Sampling stated, wait till it ends". Functioning of all keys will be halted during this time and will restored once sampling is completed. Thus, a record of samples collected with date and time, sample no as well as runoff water level value when these samples were taken will be available in 1MB flash RAM.

3.3 Real Time Clock

A crystal controlled real time clock (RTC) is built in the electronic circuit. This provides date and time for recoding events. Date and Time can be set through key board and display or can be set through PC-interface. If RTC is found to be running fast or slow in longer periods (say in a month or so) it can made to run faster or slower by adjusting "RTC_Correction" through menu no. 12. If "RTC_Correction" is set =10, then DLCMCI advances its RTC by 10 seconds a day. Similarly if "RTC Correction" is set =-15 (minus 15), then DLCMCI slows down its RTC by 15 seconds a day. "RTV_Correction" can be set between minus 120 and plus 120 seconds a day.

3.4 Key board and LCD display

Various parameters of DLCMCI can be set and seen through a "2x16 character backlit alphanumeric LCD display" and "4 key key-pad" (Fig. 1).

Following 12 menus are available in DLCMCI unit, which allow viewing and setting various parameters.

Menu no.	Display on LCD
1:	Date & time, water level, next sample bottle number
2:	Main battery voltage, emergency battery voltage, status of both batteries
3:	To watch the stored data one by one starting from the latest. **<in the above 3 mode nothing is modifiable>**
4:	Date & time setting of real time clock
5:	To reset the sample bottle number to 1 whenever necessary
6.	Setting "set_record_runoff_minimum" in mm (1-255)
7:	Setting "set_sampling_runoff_minimum" in mm (1-255)
8:	Setting "set_sampling_time gap" in minutes
9:	Setting "set_pumping_time" in seconds (1-255)
10:	Setting "mm per_10 revolutions" in mm (300-9000)
11:	Real time clock correction: To make it advance by set value secs/day **(set value can be between -125 to +125 secs /day)**
12:	Switching on/off of PC-interface port

3.5 PC-interface

A provision has been given to download the data stored in 1MB flash RAM into PC via 9-pin female D-connector (RS232C) located adjacent to LCD display (PC-IF).

The following operations can be done by this PC-interface.

- Setting date and time.
- Erasing all existing records.
- Entering location name and other details in DLCMCI unit (max 32 letters).
- Down loading records into PC.
- Switching OFF the PC-interface after completion of job.

3.6 Power Management in IDRSMU

When installed, the solar panel will generally keep both the batteries B1 and B2 charged depending on the solar radiation. The DLCMCI unit goes into "SLEEP" mode most of the time. It wakes up every 2 seconds, performs all the operations necessary and again goes into "SLEEP" mode. As long as LCD display or PC-interface are on then it does not go into "SLEEP" mode.

If LCD or PC-interface are kept on but are inactive for more than 2 minutes it switches them OFF to save power consumption. Main Battery B1 carries all functions including sediment sampling as long as it is not isolated to prevent deep discharge. It also charges B2 battery when required with a charging current of about 100mA until it is fully charged.

Emergency battery B2 can keep runoff recorder running. It consumes about 0.7mA during normal operation. No sediment sampling takes place on B2 battery. A fully charged B2 battery can record runoff for about 6 to 7 months.

3.7 Charge Controller

The DLCMCI unit can be connected to a solar panel, and main battery (B1). A 6V, 4Ah battery (B2) is provided in the enclosure as an emergency power source.

Charging of both batteries B1 and B2 is controlled by Charge Controller. It functions with the following features.

- It charges B1 from solar panel (if installed) until B1 battery voltage rises above 14.4V (120%) and cuts off charging beyond this voltage to prevent overcharging of B1 battery. It restores charging of B1 battery again when its voltage drops below 11.4V (95%).
- It prevents deep discharge of B1 battery by isolating it from the loads when B1 voltage drops below 9.6V (80%) and reconnects it to loads as soon as it rises above 12.5V.
- Charges B2 battery from B1 and/or solar panel until B2 voltage rises above 7.2V (120%) and reconnects charging of B2 when B2 voltage falls below 6V.
- However no changes in the charging status of B1 or B2 are made when sediment sampling process is in progress or when PC-interface job is in progress, so that these two operations are unaffected.

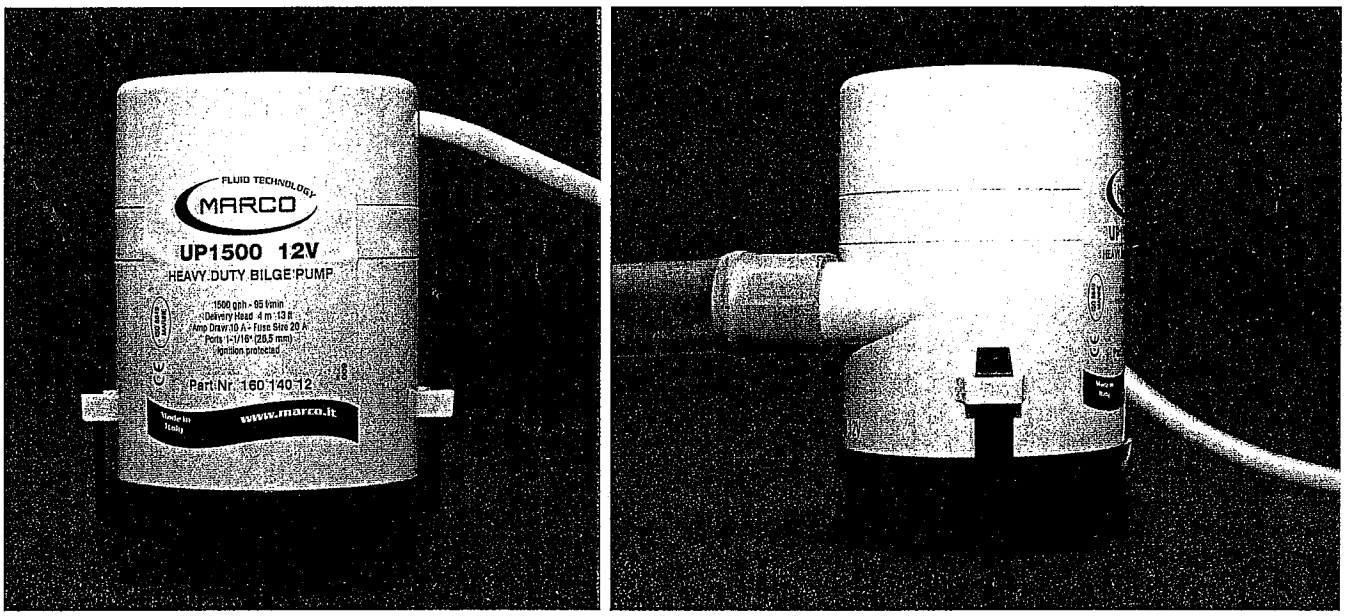
It should be noted that if solar panel is installed, then Jumper JP1 located at the top right corner of controller PCB is to be shorted (Fig. 4).

(When ever this Jumper JP1 status is changed it is necessary to press "RESET" push button located near to it to implement the new jumper status).

4. Installation and commissioning

IDRSMU consists of the following components:

1. Data logger cum microprocessor control unit of IDRSMU (DLCMCI) (200 x 200 x 120 mm) - 1 no.
2. Door opening key for above enclosure - 1 no.
3. Shaft encoder and pulley attached - 1 no.



Front view showing pump specifications

Pump connected with delivery hose pipe

Figure 6. Bilge submergible pump for pumping the runoff water into the bottles of main sediment sampling unit of IDRSMU.

4. Float - 1 no.
5. Counter weight - 1 no.
6. Steel wire of 4mtrs length & two lugs - 1 set.
7. Battery charger for 6V, 4Ah emergency battery.
8. Circular sample collection unit (mechanical unit)
   - 50 bottles of 750 ml fitted with windscreen wiper motor (DC shunt motor)
   - Size - 60 cm dia x 40 cm height
9. Bilge submergible pump (Fig. 6):
   - Power requirement - 12 v, 2.6 amp
   - Discharge - 3550 l/hr at 1m
   - Size - 15 x 10 x 10 cm
10. Power supply: 12 v 55 Ah main battery and emergency battery 6v 4Ah
11. Solar Panel: For recharging the battery
12. Electrical wires and clamps

Front view showing pump specifications Pump connected with delivery hose pipe

The layout and electrical wiring of different components/parts of IDRSMU is shown in Figure 7. The relative portions of different parts can be adjusted as per the availability of space at the monitoring site.

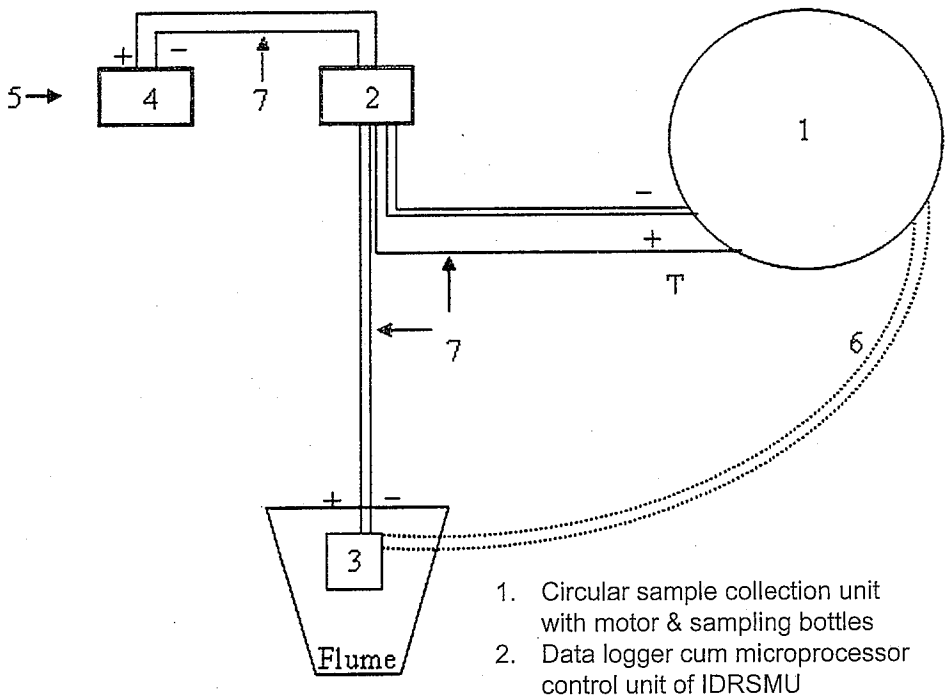


Figure 7. Layout and electrical wiring of different parts/ components of IDRSMU

Some of the steps involved in the installation are:

1. Mount the data logger cum microprocessor control unit of IDRSMU (DLCMCI) firmly in suitable box.
2. Mount the water level sensor (shaft encoder) unit firmly and insert its connector to DLCMCI (Fig. 8 showing 4-pin connector for shaft encoder).
3. If main battery is to be installed: Prepare connection to main battery (B1) observing proper polarity (+ and -). **Note: Reverse connection of battery B1 may damage DLCMCI.** However, in the new DLCMCI unit one fuse and one small LED bulb (Fig. 8) have been provided to protect the unit from the wrong electrical connections. Insert the connector to DLCMCI. Watch on LCD display B1 voltage. It should be about 12V (Fig. 9).

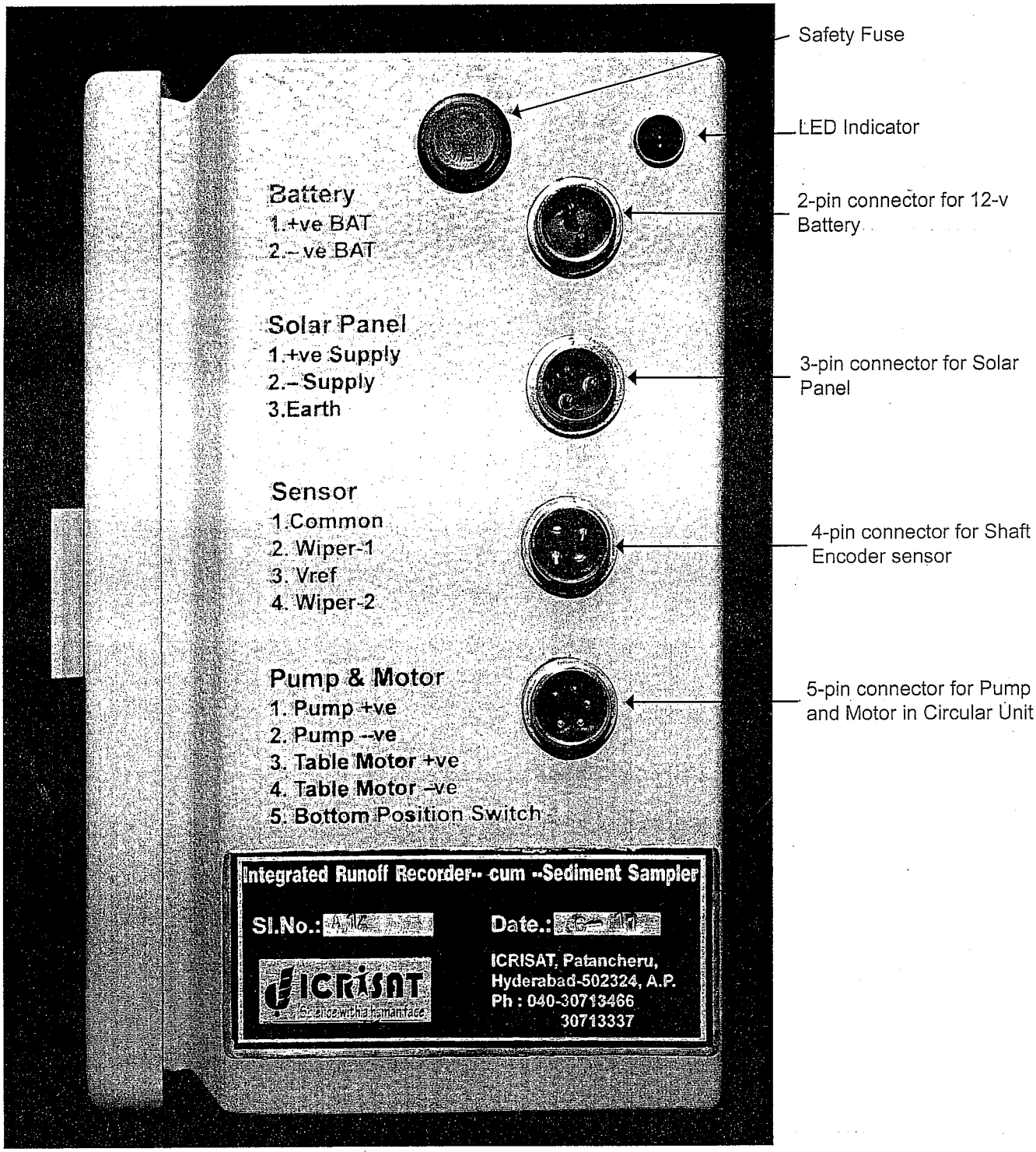


Figure 8. Side view showing key parts of data logger cum microprocessor control unit of IDRSMU

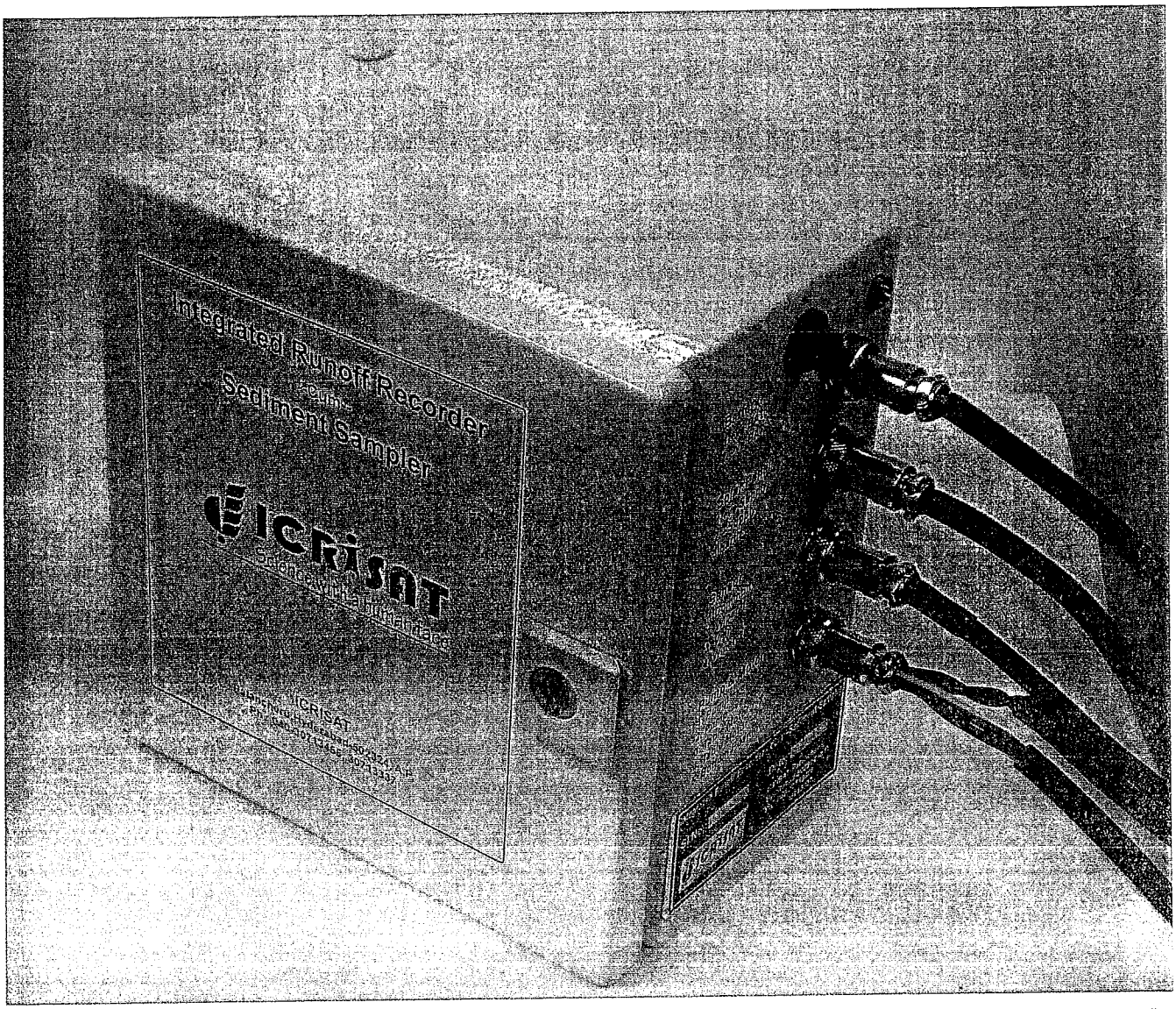


Figure 9. Side view showing various connectors of data logger cum microprocessor control unit of IDRSMU

4. If solar panel is to be installed, prepare connection to Solar Panel to observe proper polarity (Fig. 9 showing the 3-pin connector for solar panel).

   Note: Improper connection of Solar Panel may damage DLCMCI. Insert the connector to DLCMCI. Watch on LCD display B1 voltage. It should be about 12V.

5. Use the key and open the door of DLCMCI unit.
6. Press INC or DEC or ENT key until LCD display becomes ON. Press ESC key to show the first menu which displays date, time, runoff, sample bottle no.
7. While observing runoff water level reading, rotate the pulley of the sensor slowly. The runoff water level reading displayed on screen will vary according to pulley rotation. By rotating pulley very slowly bring the reading on screen to 0 mm. **Note: Clockwise rotation of pulley increases the runoff water level reading, and anti-clockwise rotation of pulley decreases the runoff water level reading.**
8. Go to menu no-2, which shows voltages of B1 and B2 batteries. B1 should be at about 12V, and B2 should be about 6V.
9. Attach the steel wire with float on one end and counter weight on the other end. The length of the wire has to be selected according to the requirement. To find out the length of steel wire required for the monitoring site, first determine the distance between minimum (deepest) water level

and upper edge of the pulley and then add appropriate 75 cm to this value. This will give you the length of steel wire required for monitoring site. ***Place the steel wire in the groove of the pulley such that the float is on the left hand side and the counter weight is on the right hand side when you are facing the pulley. When float rises, the runoff reading should increase.*** Also, after placing the float and counter weight wire over the pulley, allow the float unit to stabilize.

10. Install the main sediment sample collection unit with bottles and DC shunt motor (Fig. 10) on the flat cemented platform. The top part of the sediment sampler should be perfectly level. This is essential for the proper sampling of runoff water into the bottles. Also install the bilge pump at the appropriate place of runoff measuring structure or channel (Fig. 10). Provide the necessary electrical and water pipe connections between the sampling unit and bilge pump.

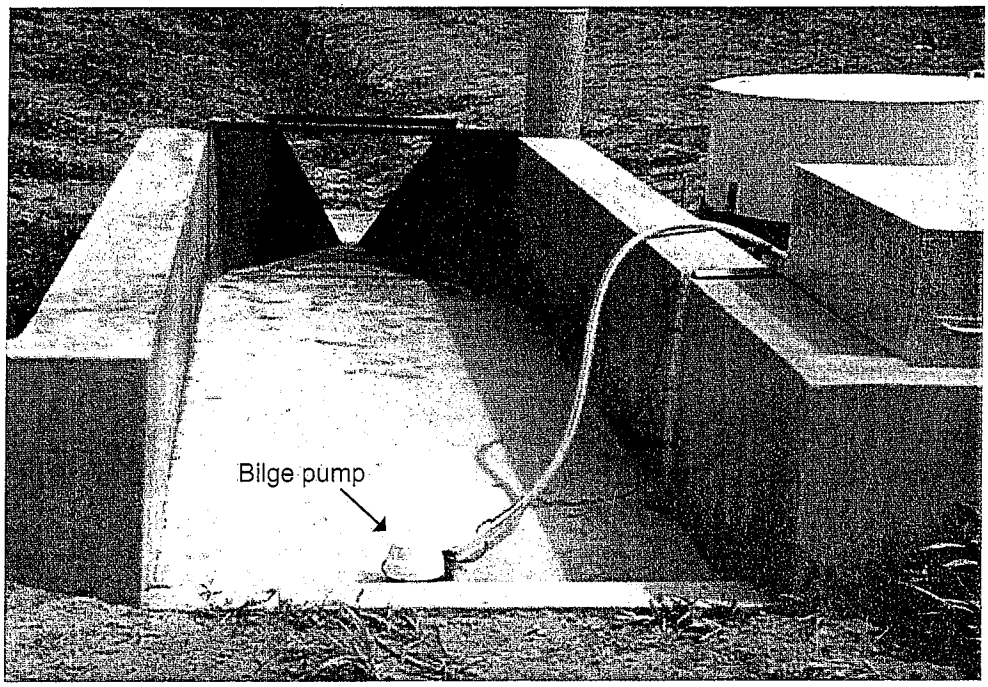


Figure 10. Bilge pump installed at runoff measuring structure (H-Flume)

11. Go to menu no-4, which allows setting of real time clock date and time. If what is on screen is not correct, then adjust the date and time.
12. If sediment sampler is installed (Jumper JP2 in the main PCB should have been inserted), go to menu no-5, which allows resetting of sample bottle number to 1. If it is not=1, then press ENT key, DEC key and again ENT key. Sample bottle number becomes =1.
13. Go to menu no-6, which allows setting of "set_record_runoff_min". If what is on screen is not correct, then to changing it to desired value, press ENT key, bring it to desired value by using INC and DEC keys and then finally press ENT again. The new value will be stored.
14. Go to menu no-7, which allows setting of "set_sampling_runoff_min". If what is on screen is not correct, then to change it to desired value, press ENT key, bring it to desired value by using INC and DEC keys and then finally press ENT again. The new value will be stored.
15. Go to menu no-8, which allows setting of "set_sampling_time_gap". If what is on screen is not correct, to change it to desired value, press ENT key, bring it to desired value by using INC and DEC keys and then finally press ENT again. The new value will be stored.
16. Go to menu no-9, which allows setting of "set_pumping_time". If what is on screen is not correct, to change it to desired value, press ENT key, bring it to desired value by using INC and DEC keys and then finally press ENT again. The new value will be stored.
17. Go to menu no-10, which allows setting of "mm_per_10_revs". If what is on screen is not correct, to change it to desired value, press ENT key, bring it to desired value by using INC and DEC

keys and then finally press ENT again. The new value will be stored. **For the pulley, this value should be 2020 mm.**

18. Go to menu no-11, which allows setting of "rtc_correction". This value is seconds by which Real Time Clock will be advanced (if the value is positive) or slowed down (if the value is negative) every day. On the day of installation, better leave it as it is. You may use this after observing the RTC for a few days. How to use this has been given under section "Navigation among Displayed Menus and Viewing/Setting Parameter". However if what is on screen is not correct, to change it to desired value, press ENT key, bring it to desired value by using INC and DEC keys and then finally press ENT again. The new value will be stored.
19. Go to menu no-12, which allows switching on PC-Interface. Following the procedure mentioned under "Operation from PC and how to do them", enter the location name as desired, erase all old records if you desire so, enter date and time if required. Finally,don't forget to switch off the PC-Interface.
20. Go to menu no-1. If sediment sampler is installed, raise the float very slowly as if runoff started until the Runoff reading above "set_sampling_runoff_min". This will initate the sediment sampling process. After completing the sampling in one bottle, go to step no-20. If sediment sampler is not installed, skip the next step.
21. Go to menu no-3, press ENT key, using INC and DEC keys to see if some records are stored in 1MB flash with current date, time, runoff water level values and sample bottle numbers.
22. Go to menu no-1. Press ESC key for 5 seconds to switch off LCD.

5. Setting of operational parameters

5.1 Settings available

1. "set_record_runoff_min": <1-255mm> The average runoff water level above which storing process of runoff water level will start and remain on until the average runoff water level falls below this minimum setting. Also, whenever the average runoff water level changes by this amount, only then runoff data is stored.
2. "set_sampling_runoff_min": <1-255mm> The runoff water level above which sediment sampling process starts and will remain on until the runoff water level falls below this minimum setting. Sampling and storing of sampled runoff and sample number will take place at periodic intervals as set by "set_sampling_time_gap".
3. "set_sampling_time_gap": <9-255> It is the time interval between sediment samplings in minutes.
4. "set_pumping_time":<1-255> The time in seconds for which pump will run for sediment sampling.
5. "mm per_10 revolutions":<300-9000> Length in mm by which the steel wire moves when the pulley rotates 10 revolutions continuously in the same direction. This is equal to the perimeter of the pulley-slot multiplied by ten. It is selected for ten revolutions so that we get a higher accuracy of the setting by 0.1mm per revolution.
6. Location Name: The name of the site or watershed is to be entered here. The name can contain all alphabets and other usually typed characters but limited to 32 letters at maximum. When data is downloaded by PC or laptop, this name will appear on top of the data.

5.2 Menus available for setting the operational parameters

The following display menus can be navigated through the 4 keys DLCMCI unit, namely INC (increment), DEC (decrement), ENT (enter) and ESC (escape).

In "SLEEP" mode the LCD screen will be off to conserve power.

- To make LCD on, press INC or DEC or ENT keys for about two seconds.
- To make it off, press ESC key for about five seconds until the LCD display is off.

At any time when ESC is pressed, the first menu will appear on the LCD screen and the key-pad mode is set to "Menu Navigating Mode" (MNM). INC and DEC keys will help to navigate among 12 available menus. In any mode, if a changes in the displayed data is needed- then ENT key has to be pressed. Then the key-pad goes into "Data Navigating Mode" (DNM) and INC and DEC keys will change the displayed data. After selecting proper data, if ENT is pressed, then the displayed data for the selected parameter on the display will be stored in the internal EEPROM of micon and the mode shifts back to MNM. When more than one parameter is on display like date and time- then the parameter which is modifiable by INC and DEC keys will keep flashing at 0.5Hz to identify itself. In such cases, pressing ENT key will take the control to the next parameter to be modified. After all, parameters on the display are modified and the last ENT key stroke will store all the parameters and take display back to MNM.

In the DLCMCI unit following menus are available for changing and modifying the operational parameters:

Menu No	Displays on LCD (parameters/data which could be changed)
1.	Date and time, true runoff, next sample bottle number
2.	Main battery voltage, emergency battery voltage, status of both batteries: In this menu, battery voltages and their statuses are shown. The top line of the display shows B1 battery voltage and B2 battery voltages. The bottom line shows the status of B1 and B2 batteries, as explained below: • **"B1-Full"**: It means B1 battery is fully charged, so it is cut-off from the installed solar Panel. • **"B1->DD"**: It means B1 battery voltage has dropped to very low and hence it has been isolated from all the loads to prevent it from deep discharge (DD). Such events are recorded in flash memory as ->DD with date and time. This can happen only when either solar panel has not been installed and B1 battery was not recharged recently; or solar panel is installed but not charging battery because of some technical problems viz. loose connection; or B1 battery condition is bad and is not able to retain charge and needs replacement; or there is some problem in IDRSMU charge controller. • **"B1<--SP;")**; It means B1 battery is getting charged from solar panel. • **"B1-Alone")**; It means solar panel is not installed and B1 battery alone is feeding loads. • **"B2 <--B1")**; It means now B2 battery is getting charged from B1 battery. • **"B2x<--B1")**; It means B2 battery is fully charged.
3.	To see the stored records/data one by one starting from latest record. The stored records/data can be browsed by using INC or DEC keys. DEC key gives the previous record and INC key gives the next record. If there is no record stored it will display "no record stored".
4.	Date & time setting of "Real Time Clock".
5.	To reset the sample bottle number to 1 whenever necessary.
6.	Setting "set_record_runoff_minimum" in mm (1-255)
7.	Setting "set_sampling_runoff_minimum" in mm. (1-255)
8.	Setting "set_sampling_time gap" in minutes
9.	Setting "set_pumping_time" in seconds (1-255)
10.	Setting "mm per_10 revolutions" in mm (300-9000)

Menu No	Displays on LCD (parameters/data which could be changed)
11.	Real Time Clock (RTC) correction: To make Real Time Clock advance by set value seconds/day (set value can be between -125 and +125 secsonds day^{-1}); For example, this "RTC_correction" is set to 34, it advances the RTC by 34 seconds day^{-1}. Similarly if it is set= -34 (minus 34) it slows down the RTC by 34 seconds day^{-1}. On any date, set the RTC date and time correctly according to a standard watch. Note the date and time on which this is done. Again after some days preferably (7 days or more) note by how many seconds the IDRSMU's RTC is fast or slow with respect to the same standard watch. If you observe that it is fast by "46" secs for the period in days between end day and start day (For example if it is 20 days 6 hours=20.25 days), then "RTC_CCorrection" should be reduced by 46/20.25=2.27 (rounded of to 2). If existing "RTC_Correction" is say 13, then make it 11 and store. Similarly, if it was found to be running slow by 46 seconds for the same period, then "RTC_correction" should be increased by 2, thus making it 15 from 13.
12.	Switching ON/OFF of PC/Laptop -interface port.

6. Operations from PC

Five operations are possible from PC through PC Interface and these are:

- setting date and time
- erasing all existing records/data
- entering location name (max 32 letters)
- downloading the records, starting from the latest record in to PC as **xxx.txt** file
- Switching off the PC-interface after completion of job

For making PC operations possible, it is first necessary to enable PC Interface through menu no-12 by pressing ENT key. Once PC interface is enabled, INC, DEC and ESC keys will not function. You can exit from this mode only by ENT key again or by giving <CLS=100> command from PC. If PC-interface is on, both the runoff recording and sediment sampling observation will operate normally. After completing all PC operations, the PC Interface should be put off either by issuing "CLS=" command from PC or by pressing ENT key again. Inadvertently if LCD or PC-interface is left on and there is no activity by way of pressing any keys, then it will get off automatically, to conserve power. Of course, it can be made on again when needed as has been done previously.

6.1 Setting date and time

With the following command, correct time and date can be set in the DLCMCI unit. For this enter Command in PC:- "DAT=yy-mm-dd-hh-mm", then press "ENTER" key of PC keyboard. "yy, mm, dd, hh, mm" should be only two digits.

For example:

To enter the date and time for 21st January 2010, 13-05 hours: the command should be "DAT=10-01-21-13-05" followed by "ENTER". The DLCMCI unit will validate the entered date and time and accept if it is correct. If the entered date and time is accepted, then DLCMCI unit will show "d" on the PC screen. If entered date and time is not valid, then it will show "f". If the command itself is not correct, then it will show "e".

6.2 Erasing of all stored records

With the following command old records stored in the flash RAM can be erased.

For this, enter Command in PC:- "ERA=100", and then press "ENTER" key of PC keyboard. The DLCMCI, on receiving this command, starts erasing all the stored records. This may take about 40 seconds. After erasing all old records successfully, the DLCMCI unit will show "d" on the PC screen. If the command is not correct, it shows "e".

NOTE: High care should be exercised while using this command. Once the records are erased means all old data is permanently lost and there is absolutely no way these can be retrieved.

6.3 Entering the Location Name

With this command, the name of the location can be entered in DLCMCI.

For this, enter Command in PC:- "LON=<name of the location>", then press "ENTER" key of PC keyboard. "<name of the location >" can consist of a maximum of 32 characters. After storing the entered name, DLCMCI shows "d" on the PC screen. If the command itself is not correct, it shows "e".

6.4 Downloading of Records to PC

Desired number of records can be downloaded into PC starting from the latest record backwards. A maximum of 1,30,000 records can be stored in 1MB flash memory of DLCMCI. Once it is completely full, it automatically starts deleting the oldest record to store the new record.

For this, enter Command in PC:- "DWL=<desired number of records>", then press "ENTER" key of PC keyboard. Ex: "DWL=5" or "DWL=50000". After receiving the command, DLCMCI starts sending the records to PC until either all the desired number of records are sent or all existing records are sent whichever occurs first. If it encounters any problem, while reading and sending data to PC, the message "Further Reading Stopped. IC-Fail" appears on screen. After completion of data transfer the IDRSMU sends message "DownLoaded nnnn records" <nnnn being the number of records sent>. If the command itself is not correct it shows "e".

For example if we want to download 10 or 1000 data points then enter in PC "DWL=10" or DWL=1000" and then press ENTER key of PC key board. Also suppose the latest record is 5207th one, if 1000 records are downloaded, the list sent to PC contains 5007th to 4007th records. That is latest 1000 records but chronologically increasing with date and time.

6.5 Switching PC-Interface OFF from PC

For this, enter Command in PC:- "CLS=100", then press "ENTER" key of PC keyboard. If DLCMCI receives the command properly, it switches PC-interface off, the LCD display menu goes to 1st menu.

6.6 Recommended method to store data into PC

Connect PC communication port (COM1 or COM2) to the DLCMCI unit and Switch on LCD and PC. Open hyper-terminal in PC and make settings as explained below:

- Type "DWL=5" and press ENTER key of PC keyboard.
- You will read on PC monitor as

  Location: ----------

  Date: ----------

  DownLoaded 5 records
- By repeating the above command with different number of records, you may decide how many records you want to download. The oldest requested records will appear on top of the list and the latest will appear on the bottom. Once you identified the number of records you want to download, click on "TRANSFER" menu on top of the monitor, then "Capture text" menu. When it asks for the file name, enter the file name and directory in which you want to save the down loaded file, then click on "Start". Now what ever is downloaded will be save in the above file.
- Type "DWL=nnnnn" "ENTER" nnnnn= number of records you want to down load. You may enter any five digit number for nnnnn, but if the number is more than 1,30,000 (which is the maximum number of records), the unit takes it as 1,30,000. Immediately the screen on the monitor runs with a series of records and stops giving the number of records downloaded. Sometimes the screen may halt for a few seconds and this is when there are any empty records in between. However it will download all the requested or available records.
- Now you can go to "TRANSFER" menu on top of the window and "STOP" the capturing.

- You may minimize the Hyperterminal window and open the downloaded and saved file in Notepad mode, edit it as required and save it either with the same name or with another name.
- You may save the downloaded file as an EXCEL file by opening it from EXCELL and converting it.

7. Trouble shooting guide

Problem	Condition	Probable causes	Remedies
B1 battery goes to Deep Discharge ("B1<-DD")	Solar Panel not installed and sediment sampling enabled	Cable connecting B1 battery to IDRSMU is open/loose contact	Rectify loose connection/cable
	-	B1 battery is not charged (if needs to changed every month)	Charge B1 battery and refit
	Solar Panel is installed	Cable from Solar Panel to IDRSMU is open/loose contact	Rectify connection/cable
	-	Solar panel direction is not proper	Reorient solar panel with respect to sun trajectory to get maximum exposure to sun light
B2 battery voltage is showing <6V always	B1 battery or Solar Panel is not installed	B2 battery is not charged recently	Recharge B2 battery
	B1 battery installed but not Solar panel	B1 battery may be in Deep Discharge	Follow the remedies given under problem "B1<-DD"
Runoff water level readings are not changing even when water level changes but changes when the pulley is rotated manually	-	Wire is slipping on pulley	Remove any oil or grease on the wire or in pulley groove
Runoff water level readings are not changing even when the pulley is rotated manually	-	Pulley mounting screw may be loose. Only the pulley is rotating but not the shaft on which it is mounted	Tighten the screws on the back side of the pulley to make a firm grip of the pulley on the shaft. Use proper Ellen key to tighten.
	-	The connector from the shaft encoder to IDRSMU is open/loose contact	Rectify the connection
Sediment sampling is not taking place	Runoff water level is above the level required for sampling	Sediment sampling is not selected by inserting JP2 on the main PCB (Fig. 4)	Insert the jumper and press RESET switch on the Main PCB
	-	Sample number =51	Reset Sample number to 1
Sample number becomes 51 as soon as sample process is completed	-	There is problem in the feed back signal from sampling unit. May be a loose contact at IDRSMU's sampling connector or at sampler's connector	Rectify the connection, reset sample no to 1 and wait for next sampling time
	-	Problem in the sampler's operation- motor jammed or bottle sensing switch malfunctioning	Rectify the problem on the sampling unit, reset sample no to 1 and wait for the next sampling time
Burning smell or smoke coming out from the main electronic IDRSMU unit	-	Battery connection are wrongly done	

Problem	Condition	Probable causes	Remedies
	Disconnect the battery immediately and check the (+ve and –ve) connections on battery and control unit. Connect +ve and –ve terminals of the battery to the +ve and –ve on control unit respectively.		
	-	Due to rusting of moving parts, main IDRSMU unit gets heated	If the water sample distributor rotating pipe or wiper motor is struck due to rusting, greece it and clean the rust and other materials from all moving parts.
Burning smell or smoke comes out from the DC shunt (wiper) motor fitted in the circular sample collection unit		Battery connections are wrongly done	
	Disconnect the battery immediately and check the electrical (+ve and –ve) connections on battery and control unit. Connect +ve and –ve terminals of the battery to the +ve and –ve on control unit respectively.		
		Due to rusting of moving parts like gear set and bearings	DC shunt (wiper) motor is struck due to rusting, Greece it and clean the rust and other materials from all moving parts like gear set and bearings (Fig. 11)
Nozzle in sediment sampler is not moving		The spring on the gear set in the circular sampler unit is damaged or lost its spring action	Replace the spring
Sediment sampler functions even after the runoff event or even when there is no runoff water flow.		The minimum runoff water level for sampling is wrongly set for very low level	Go to menu "Set_sampling_ runoff" minimum. Follow the instructions given in the manual. Increase the minimum runoff water level value for sampling
		Defective main DLCMCI unit	Change the defective unit
All connections are OK, but still sediment sampler is not functioning		Wires may have got damaged by rodents or worn out	Check for all the wiring connections that are concealed in soil for continuity. If there is any damage to the wires replace it.
		The main DLCMCI unit is out of order	Check the DLCMCI unit, if necessary replace the unit
All electrical connections are correct, still pump is not pumping water or pumping small quantity of water into the bottles		Pumping height is more than 1.5m.	

Problem	Condition	Probable causes	Remedies
	Reduce the pumping height by folding the sediment sampler stand and keep the sampler on platform this reduces 45 cm or make a cement pit to place the sampler to bring down the pumping height to 1.2-1.5 m		
		Mud or Debris struck in the pump.	Clean the pump, and remove any debris struck in pump.
		Lengthy pipe connecting pump and sampling unit	Avoid lengthy pipe (maximum 3-4 m)
Pump appears to be working but it is not pumping water		Pump impeller is rotating in reverse direction due to wrong wire connection (i.e. +ve wire of pump is connected to -ve on IDRSMU control unit and –ve wire of pump to +ve on IDRSMU control unit).	Rectify electrical connections i.e. +ve and –ve wires of pump must be connected to +ve and –ve on IDRSMU control unit respectively.
		The plastic pipe connecting the pump with the sampling unit may be blocked	Clean the plastic pipe
Remove any sharp bend in the plastic pipe			

8. Precautions and other important periodic maintenance points

1. Do not connect battery until all the other connections are completed and checked.
2. The data logger cum microprocessor control unit of IDRSMU is the most sensitive part. It must be well protected from rain, dust, high temperature and insects. It should be kept inside a good box that can provide sufficient protection.
3. Avoid excessive lengthy wires, joints in wires and/or pump suction pipe and keep the suction height of pumping maximum up to 1.5 m.
4. Replace insulation tapes of junctions every year.
5. Grease the gear set/saw plate, shaft and bearing of sediment sampler periodically for free movement of nozzle without any obstruction (Fig. 11).
6. The pump should be periodically cleaned with clean water. Over the time, there is considerable deposition of mud and debris in the bottom of pump. Care should be taken to see that pump is not resting on the base of the trough, to avoid the pump from touching the bed-load.
7. Pump should be wrapped in a mesh to avoid grass or other debris from being sucked into pump.
8. For runoff recording, there is only one moving part in IDRSMU, and it is the pulley of the shaft encoder. Too much of dust accumulation on the shaft of the pulley will increase the friction and may cause error in water level readings. Therefore, depending on the dust in the environment at the location, it may be cleaned at regular intervals.
9. The float, counter weight and the steel wire are made of steel. Generally they should not rust. However, if found rusted these may be cleaned. It must be ensured that the float is not rusted and develop holes. If holes develop, then major error may occur in runoff measurement. Annual painting of float is recommended.
10. The electronic portion of IDRSMU i.e. DLCMCI unit does not need much maintenance. However batteries B1 and B2 are simple solid lead acid batteries which have life time of 3 to 4 years. They may need complete replacement after 3-4 years.

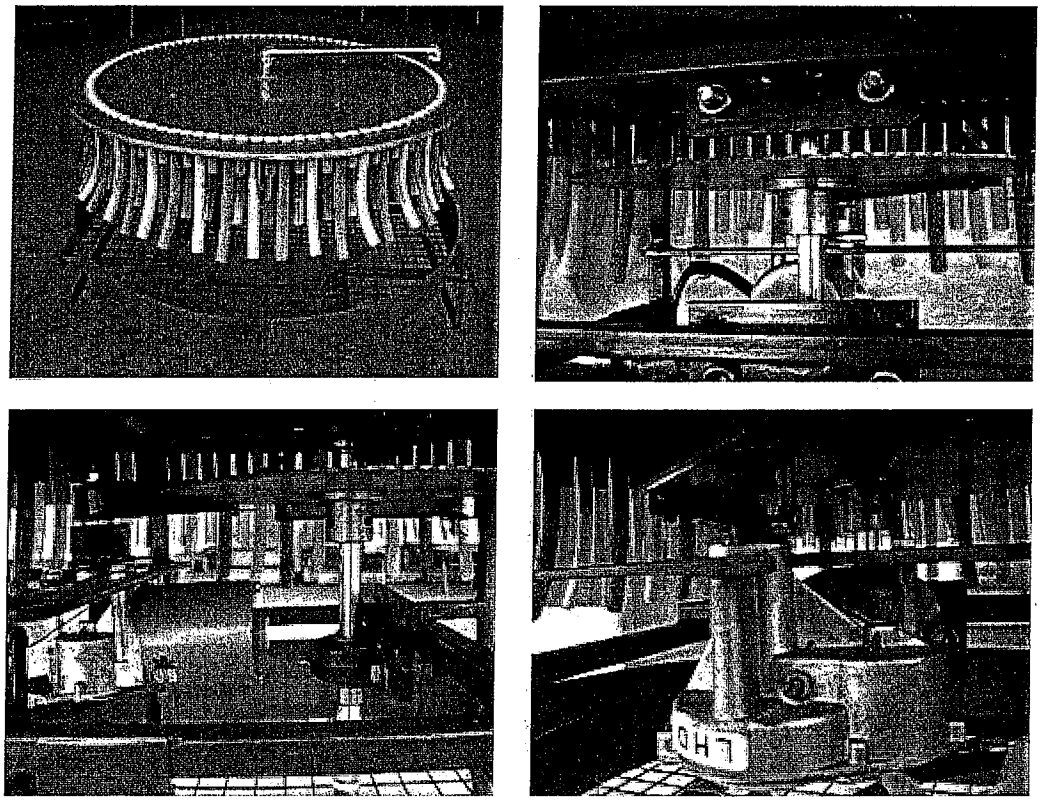


Figure 11. Sediment sample collection unit showing the key parts which needs annual greasing (as shown by the arrow mark).

11. The B1 battery is protected against overcharging by solar panel and deep discharging by loads. However B2 battery is protected only against over charging but not against deep discharging. Therefore, charge B2 battery through the given charger once in an year for 14 hours.
12. If the equipment is not going to be used, say for next 6 months or a year. The B2 battery should be charged fully by supplied battery charger for 14 hours, before keeping in store.
13. If solar panel is installed, clean the solar panel periodically.
14. If solar panel is not installed, then charge B1 battery regularly.
15. If B1 battery is not installed and IDRSMU is used only for runoff recording, then charge B2 battery through the supplied battery charger once every 3 to 4 months.

(Note: B2 battery can be charged through the supplied battery charger. If 220V AC supply is available close to IDRSMU, then simply plug the charger to 220V AC main and charger output to charging socket on the front panel of IDRSMU. This can be done even when the equipment is running. Recommended charging time is about 14 hours. In case 220V AC main is not available close by IDRSMU, then disconnect all connectors of IDRSMU and take the unit to a nearby 220V AC mains source and charge B2battery through supplied charger).

9. Technical specifications

Integrated Digital Runoff and Soil loss Monitoring Unit (IDRSMU)

1. Data logger cum microprocessor control unit of IDRSMU (DLCMCI) (data logger, runoff recorder, microprocessor control unit for sediment sampling and control unit for solar charging)(Size: 200 x 200 120 mm metal box)
   - Display: LCD
   - Flash memory: 1 MB

- Measured value memory: 130000 values can be stored
- Interfaces: RS 232 C serial

2. Shaft encoder with pulley attached (204 mm circumference)
3. Float and counter weight with 1 mm thick steel wire
4. Power supply: 12 v 55 Ah main battery
5. Power supply: built-in battery 6V, 4 Ah battery
6. Circular sample collection unit (mechanical unit)
   - 50 bottles of 750 ml fitted with windscreen wiper motor (DC shunt motor)
   - Size -60 cm dia x 40 cm height
7. Bilge submergible pump:
   - Power requirement - 12 v, 2.6 amp
   - Discharge - 3550 l/hr at 1m
   - Size - 15 x 10 x 10 cm
8. Solar panel For recharging the battery

Total weight of equipment: 53 kg (app.)

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About ICRISAT

ICRISAT
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The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development in Asia and sub-Saharan Africa with a wide array of partners throughout the world. Covering 6.5 million square kilometers of land in 55 countries, the semi-arid tropics have over 2 billion people, and 644 million of these are the poorest of the poor. ICRISAT and its partners help empower these poor people to overcome poverty, hunger, malnutrition and a degraded environment through better and more resilient agriculture.

ICRISAT is headquartered in Hyderabad, Andhra Pradesh, India, with two regional hubs and four country offices in sub-Saharan Africa. It belongs to the Consortium of Centers supported by the Consultative Group on International Agricultural Research (CGIAR).

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