Zhichuan Technology

ZCT-IPI-W1 Datalogger User's Manual

ZCT-IPI-W1 Datalogger

for In-place Inclinometers

<u>User's Manual</u>

1. Overview

Developed by Zhichuan Technology (Shanghai) Co., Ltd., ZCT-IPI-W1 is a highly flexible datalogger that collects readings from ZCT-CX200B / ZCT-CX300B in-place inclinometers (IPI's). Data from up to 64 probes on a single string are collected automatically at a pre-set interval and are immediately uploaded to user's FTP server via 4G cellular network. The datalogger can be locally set up via serial communication, or it can be remotely configured and reboot via the FTP server. The firmware of the datalogger can be locally or remotely upgraded as well.

2. Advantages

- Compact
- User-friendly
- Stable and reliable
- 4G wireless transmission
- FTP uploading/downloading
- Remote management via SMS

3. Applications

- Geotechnical instrumentation
  - Slope monitoring
  - Railway bed monitoring
  - Tailings mine monitoring
  - Foundation pit monitoring
  - Tunnel excavation monitoring

4. Technical specifications

(Unless otherwise specified, the following are typical values at room temperature of 25°C)

4.1   Electrical parameters

Parameters	Conditions	Min	Typical	Max	Unit
Power supply	DC	8	12	30	V
Operating current	Working mode, without probe, @ 12VDC		60	2000	mA
	Sleep mode, @ 12VDC		15	20	mA

4.2   Performance parameters

Parameters	Min	Typical	Max	Unit
Number of IPI probes	0		64	/
Collecting interval	1		10,080	minute
Capacity of local memory (NAND flash)		128		MB
		60,000		piece
RS485 communication rate	2,400	9,600	19,200	bps
4G network		LTE CAT1		/
Collection response time		200	1,000	ms
Power-on startup time		5	10	s
Operating temperature	-20		+60	℃
Storage temperature	-40		+80	℃
Dimensions		129.1*92* 127.2		mm

5. Workflow

The datalogger works according to a certain time cycle. It can also be activated by real-time events, such as local requests and SMS messages. The logger stays in sleep mode most of the time. When the right time comes for data collection, it automatically wakes up and performs below tasks one by one:

1. Wake-up: The logger wakes up from the sleep and performs a quick self-test.

2. Data collection: The logger collects data from all connected IPI probes and save them in the local memory.

3. Data uploading: The logger accesses the 4G cellular network, connects the remote FTP server and uploads data to the server.

4. FTP command check: When uploading is completed, the logger will check in turn the /firmware, /config and /reboot directory on the FTP server, downloading and executing any commands saved in the directories.

5. SMS processing (optional): If a new SMS message arrives with a command during this time, and if the SMS command function is enabled, the command will be executed.

6. Entering sleep mode: After completing all the above tasks, the logger will disconnect from the cellular network and enter sleep mode, waiting for the next data collection time point or a new triggering event.

6. Data processing
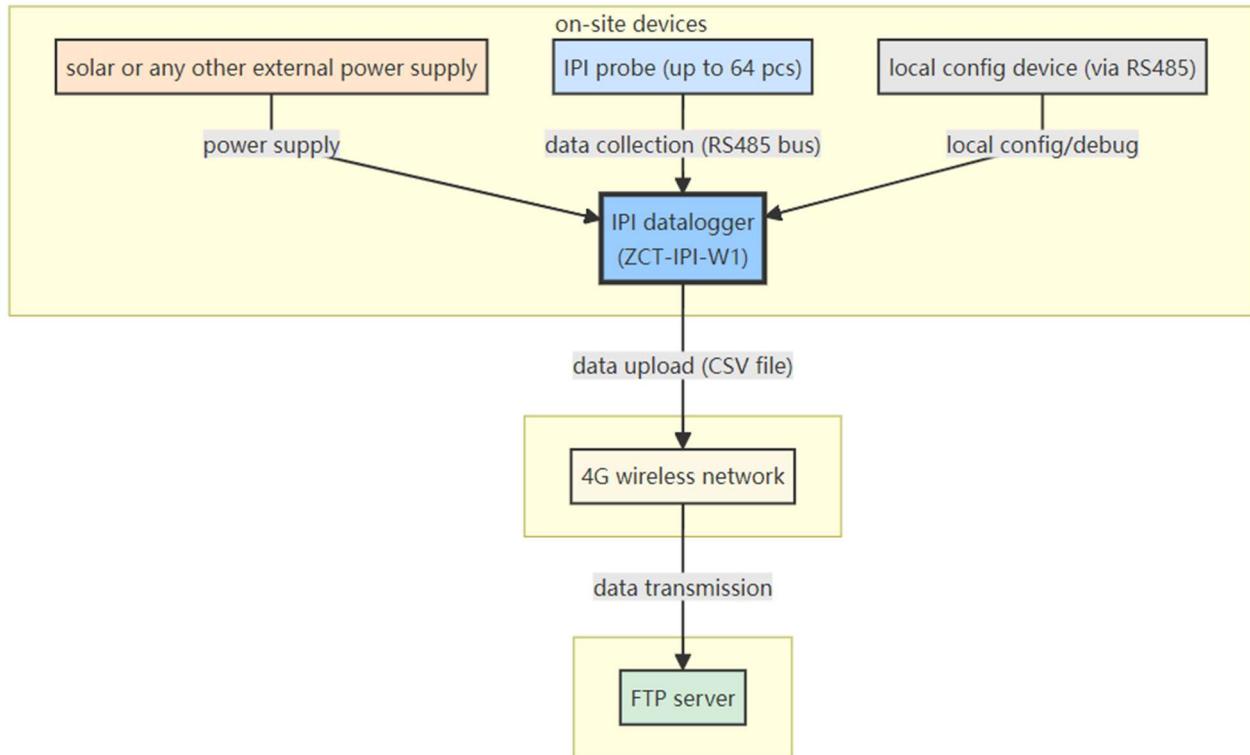
Note:

1.   Power supply ("8-30VDC" port): A solar panel or an external DC power supply provides electric power to the logger to ensure its steady operation at jobsites.

2.   Data collection ("SENSOR" port): In response to the commands from the logger, each IPI probe replies with its tilt angle on X and Y axis and, if needed, its internal sensor temperature via the RS485 bus.

3.   Local config/debugging ("CONFIG" port): In the office or on site, technicians can use a laptop to configure the logger and perform debugging via serial communication.

4.   Data uploading: The logger processes and formats the data received from the IPI probes, saves them in the local memory, and uploads them to the Internet through the built-in 4G CAT1 wireless communication module.

5.   Data transmission: The logger uploads the data files to the designated FTP server (IP or domain:21) for subsequent downloading, processing, and analysis.

7. Remote Management

The logger can not only upload data to the FTP server, but can receive and execute commands downloaded from the server as well. Administrators can configure and reboot the logger and can upgrade its firmware remotely via the server.
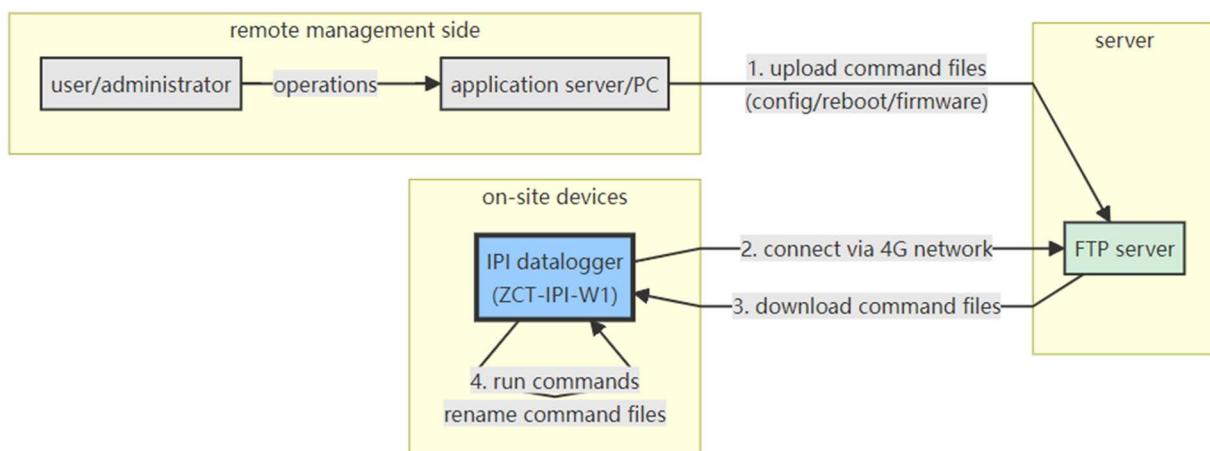

To realize such a two-way communication, the user needs to make sure that setting up directories at the FTP server by the logger as an FTP client is permitted in the first place. The logger will automatically navigate to the directory set up by the user (the "FTP directory" set using the IPI Datalogger Config Tool) and create 3 subdirectories (/config, /reboot, and /firmware) under it. Or, the user can directly create the directories on the FTP server by

himself. The directory structure is as follows:

<div align="center">

/FTP directory/data files
|- config/
|- reboot/
|- firmware/

</div>

7.1 Receiving data

The logger uploads data collected from the IPI probes to the designated directory of the FTP server at regular intervals. Data file name format:

{dtu_name}-{yyyyMMdd}-{HHmmss}.csv

Example: IPI-DTU-20250628-143000.csv

The data files are in *.csv format. The content includes logger name ("dtu"), timestamp ("datetime"), frame count ("count", sequence number of data frames uploaded), total number of probes ("total"), X-axis tilt angle ("n_X"), Y-axis tilt angle ("n_Y"), length of probe spacing/interval ("n_L"), and sensor temperature ("n_T"). For example:

dtu	datetime	count	total	1_X	2_X	3_X	1_Y	2_Y	3_Y	1_L	2_L	3_L	1_T	2_T	3_T
IPI-DTU	2025-6-28 14:30	155	3	-0.648	0.261	0.016	-0.003	-0.351	0.069	3	3	3	29	30	30

or

dtu	datetime	count	total	1_X	1_Y	1_L	1_T	2_X	2_Y	2_L	2_T	3_X	3_Y	3_L	3_T
IPI-DTU	2025-6-28 14:30	155	3	-0.648	-0.003	3	29	0.261	-0.351	3	30	0.016	0.069	3	30

7.2 Remote configuration

The user can change the data collection interval, frame count, data type (combination of parameters, i.e., X = X-axis tilt angle, Y = Y-axis tilt angle, L = length of probe spacing/interval, and T = sensor temperature), and data sorting order (by parameter or by probe ID). Follow the steps below:

a. Create a text file and name it "{dtu_name}-config.ini".

b. Edit its content according to "config-template.ini":

[COLLECT]
start_time=?   ? can be later than system time by up to 7 days
interval=?   ? can be 60 (1 minute) ~ 604800 (7 days); unit: second
frame_count=?   ? >=0

[PROBE]
data_type=?   ? can be 0 (=XYL), 1 (=XY), 2 (=XYT), or 3 (=XYLT)
data_arrange=?   ? can be 0 (=by parameter), or 1 (=by probe ID)

Omit the lines with parameters that should remain unchanged.

c. Save the file to directory /FTP directory/config/ on the FTP server.

    d. At the time of the next data transmission the command file will be downloaded to the logger and executed.

    e. After executing the commands, the logger will rename the original command file, adding a time stamp and the result. Example:

> ① Succeeded: IPI-DTU1-config_20250628143000_OK.ini
> ② Failed: IPI-DTU1-config_20250628143000_ERROR.ini

7.3   Remote rebooting

    a. Create a text file and name it "{dtu_name}-reboot.txt".

    b. Edit its content according to "reboot-template.txt":

[REBOOT]
Reboot=?   ? must be 1

    c. Save the file to directory /FTP directory/reboot/ on the FTP server.

    d. At the time of the next data transmission the command file will be downloaded to the logger and executed.

    e. After executing the commands, the logger will rename the original command file, adding a time stamp and the result. Example:

> ① Succeeded: IPI-DTU1-reboot_20250628143000_OK.txt
> ② Failed: IPI-DTU1-reboot_20250628143000_ERROR.txt

7.4 Remote firmware upgrade

The firmware of the logger can be upgraded locally via user's computer by means of serial communication, or it can be upgraded remotely by commands downloaded from the FTP server.

    a. Get the latest firmware file, in *.bin format, from Zhichuan sales.

    b. A text file named "{dtu_name}-firmware.txt" will also be provided.

    c. Save both files to directory /FTP directory/firmware/ on the FTP server.

d. At the time of the next data transmission the firmware file and the command file will be downloaded to the logger and executed. Installation of the new firmware may take several minutes, and the logger may reboot during the process.

e. After executing the commands, the logger will rename the original command file, adding a time stamp and the result. Example:

① Succeeded: IPI-DTU1-firmware_20250628143000_OK.txt
② Failed: IPI-DTU1-firmware_20250628143000_ERROR.txt

Important: Do not disconnect power supply to the logger during the firmware upgrade process!

8. Management via SMS

In an emergency or when network conditions do not allow management via FTP, the user can send below commands, which are basic and significant, to the logger via SMS. The commands start and end with #, and no result message will be returned.

8.1 Rebooting the logger

Command format: #REBOOT#
Action: After receiving this message, the logger will reboot.

8.2 Setting target FTP server

Command format: #FTP#server_address#port_number#username#password#
Example: #FTP#123.456.78.90#21#zclink#123456#
Note: The server address can be an IP or a domain name.

9. Local Configuration

9.1   Conditions and preparation

● Hardware conditions: Connect the computer to "CONFIG" (D+, D-) port of the logger using the RS485-USB converter provided by Zhichuan. Note: *If the RS485 connection isn't working, swap the data lines*.

● Software preparation: Install "ZC IPI Datalogger Config Tool", a software provided by Zhichuan, on the computer

IPICConfig
V1.15.0624.zip
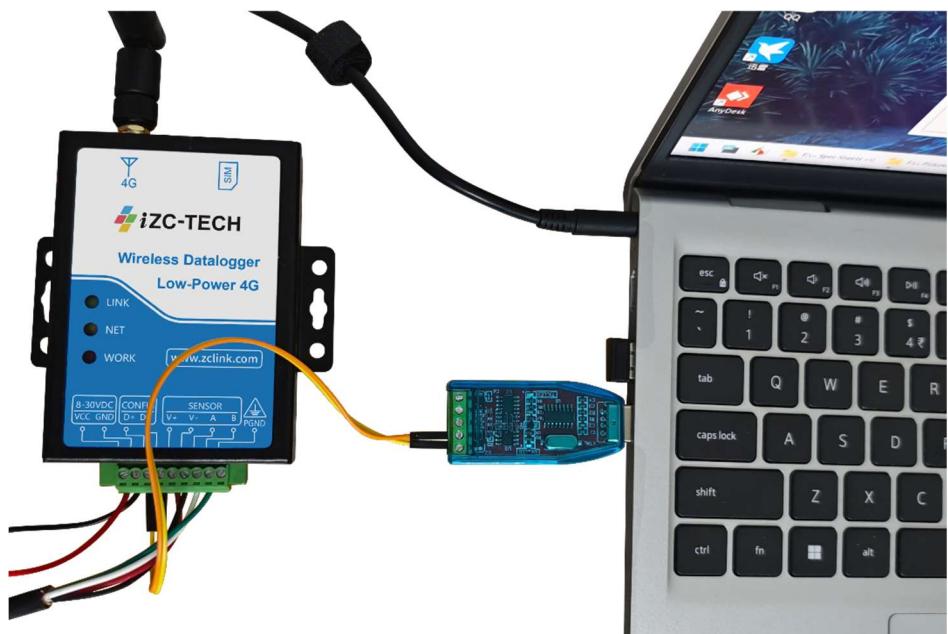
9.2 Connection

Open the config tool on the computer, refresh the serial port, and press "Connect". The default baudrate should be 256,000. When "Connect" is pressed, the config tool immediately tries to establish communication with the logger, and when communication is established, the logger will interrupt its current task, if it is in working mode, and enter configuration mode, in which the logger is ready to receive instructions from the config tool.

Note: When the logger enters configuration mode, the "WORK" indicator light will flash twice a second. If no valid data transmission is detected for 30 consecutive minutes, the logger will reboot and return to its normal working cycle, to avoid unintentional interruption of data uploading.
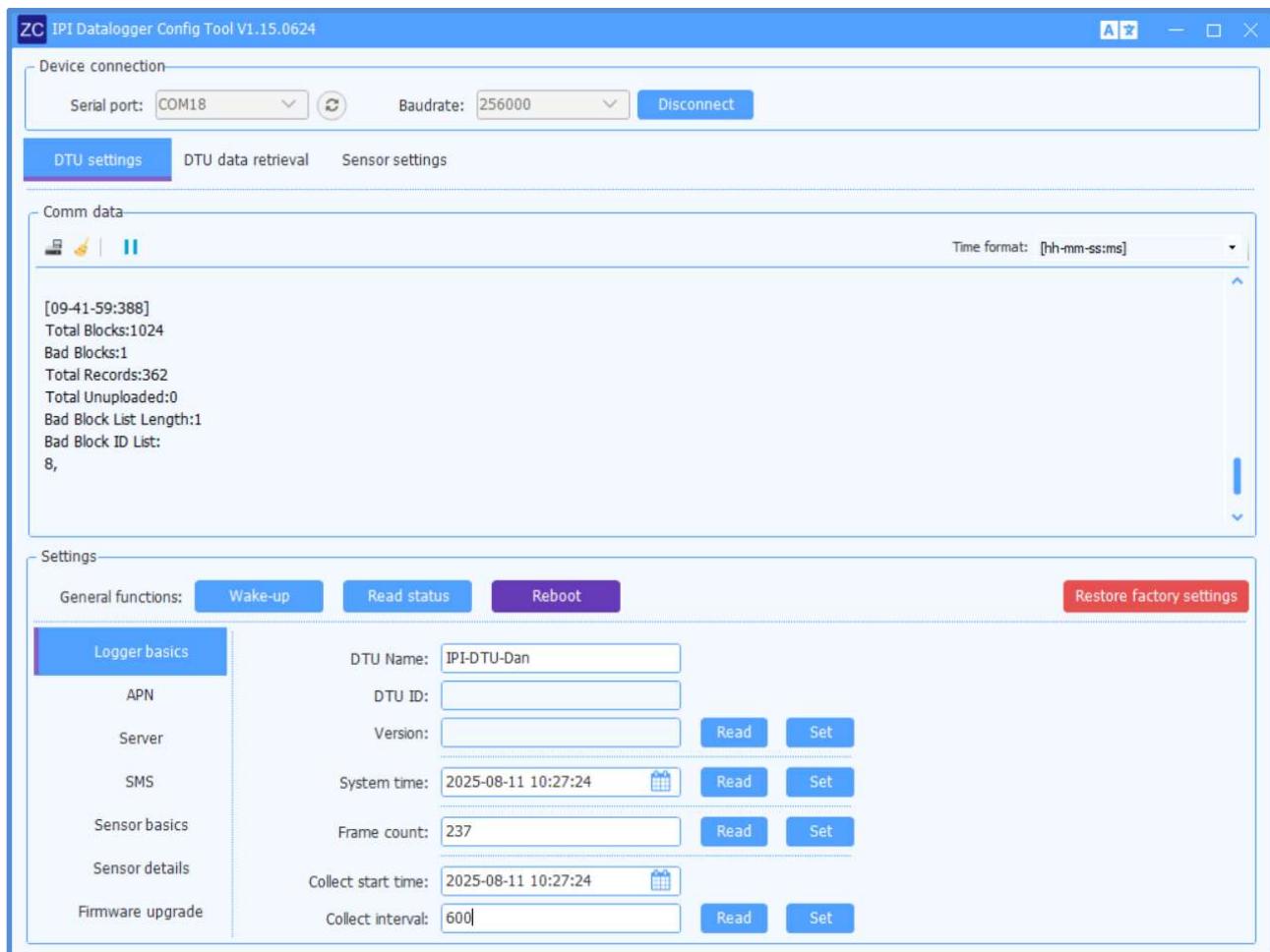
9.3 Functions

ZC IPI Datalogger Config Tool is a powerful software tool with three core function modules for local configuration and debugging, aiming to simplify on-site deployment of Zhichuan IPI's. The software supports switching between Chinese and English interfaces.

9.3.1 DTU settings

9.3.1.1   General functions

● Wake-up: wake up the logger, so it switches from sleep mode to configuration mode, and reactivate its communication with the computer

- Read status: Obtain real-time information of the logger, such as current working mode, cellular network status, memory status etc., with one click

- Reboot: Restart the logger

- Restore factory settings: Restore all parameters of the logger to factory settings, but will not clear the frame counter or data stored in the memory. **Important**: This will clear all custom configuration, so use it with caution.

9.3.1.2 **Parameter configuration operations**

- Logger basics: Basic logger parameters, such as "DTU Name" (given name of the logger), "System time", "Frame count", and "Collect interval" (time interval of data collection and uploading), can be set here.
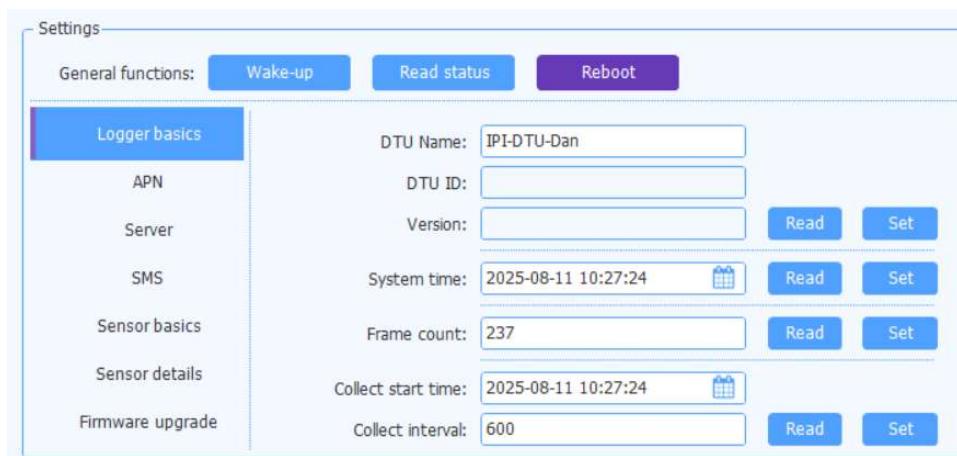
Note:
① The logger will automatically update the local time when connected to the cellular network.
② The interval of data collection can be as small as 1 minute (60s) and as big as 7 days (604,800s).
③ The user can also decide the "Collect start time", with precision of 1 second (example: 2025-08-11 10:27:24). The "Collect start time" can be the same as the "System time" or later than the "System time" by up to 7 days.

- APN (Access Point Name): In case of 4G communication, normally the user doesn't have to config these.

- Server: Address and port of the FTP server are set here. The address can be an IP or a domain name, and the port by default is 21. The user can create a directory on the server, under which the data files uploaded are stored, by filling out "FTP directory" here.

- SMS: function switch and SMS center number

- Sensor basics: The user doesn't need to config these.

Note:

① ZCT-CX300B (vertical type and the more commonly used type, to measure horizontal displacement) and ZCT-CX200B (horizontal type, to measure settlement) are the two IPI models that the logger is able to collect data from.

② "Power-on startup time" = 10s means that the logger waits for 10 seconds before collecting data from the IPI's each time it wakes up. The waiting time is for the IPI's to perform initialization, so the logger receives stable and reliable readings.

● Sensor details: This is about which IPI readings should be included in the data file to upload and how they are arranged. The combination can be

0 = only X-axis tilt angle, Y-axis tilt angle, and length of probe spacing are included
1 = only X-axis angle and Y-axis angle are included
2 = only X-axis angle, Y-axis angle, and sensor temperature are included
3 = X-axis angle, Y-axis angle, length as well as temperature are included

And, the data can be sorted by parameter (= 0) or by probe ID (= 1). The probe ID's are usually given and noted down by site staff during IPI installation.

● Firmware upgrade: Direct firmware upgrade for the logger is supported.

IPI-DTU-firmware.bin   IPI-DTU-firmware.txt

Use the *.bin file together with the *.txt file provided by Zhichuan sales, fill out the brackets with correct "Version", "Compilation date", "File size", "CRC32", and "Signature", and the firmware will be upgraded in several minutes.

9.3.2 DTU data retrieval
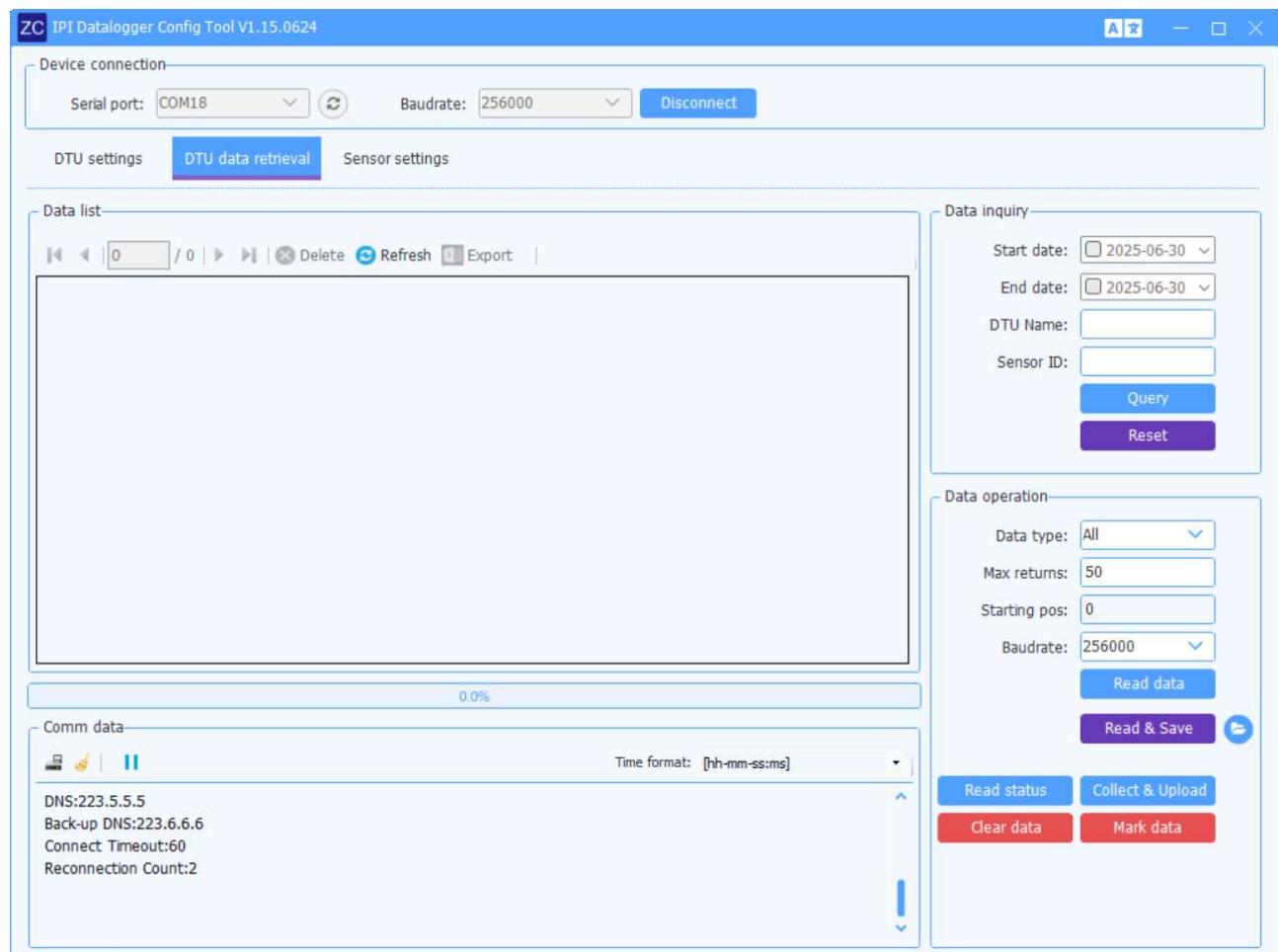
This function module enables the user to retrieve data files saved in his computer (Section A) as well as in the memory of the logger (Section B).

In section B,

- "Read data" / "Read & Save": The module supports one-click reading of all the records (data files) stored in the memory and reading of all the records that have not yet been uploaded due to communication failure. Built-in data filtering/query capability allows the user to quickly locate specific records.

- "Read status": The user can get the general storage status of the logger memory, including the total number of records, the number of unuploaded records, and a list of bad blocks. A bad block refers to a memory block that cannot perform read/write operations normally.

- "Collect & Upload": The user can manually trigger a complete data collection/uploading process to facilitate on-site verification of cellular network and server configuration.

- "Clear data": The module supports one-click clearing of all the records stored in the logger memory.

- "Mark data": The module allows marking unuploaded records as "uploaded", so the marked records will not be uploaded at any later time. The marking function helps synchronize data in some special circumstances.

9.3.3 Sensor settings

The function module provides a bottom-level debugging channel for direct communication with each IPI sensor probe connected.

- Connection to the probes and transparent transmission: With the probes connected to the logger, the function module allows the computer to establish communication with each probe, at a certain Modbus address, through the logger. The commands issued by the computer will be transparently transmitted to the probes, realizing direct query and configuration of the probes.

- Built-in CRC check: The function module automatically handles CRC16-Modbus check. When sending commands, the user only needs to enter the command body, and the function module will automatically attach the correct check bit to it, which greatly simplifies real-time communication with the probes.

- For communication protocol of ZCT-CX300B and ZCT-CX200B IPI, please read the corresponding datasheet.
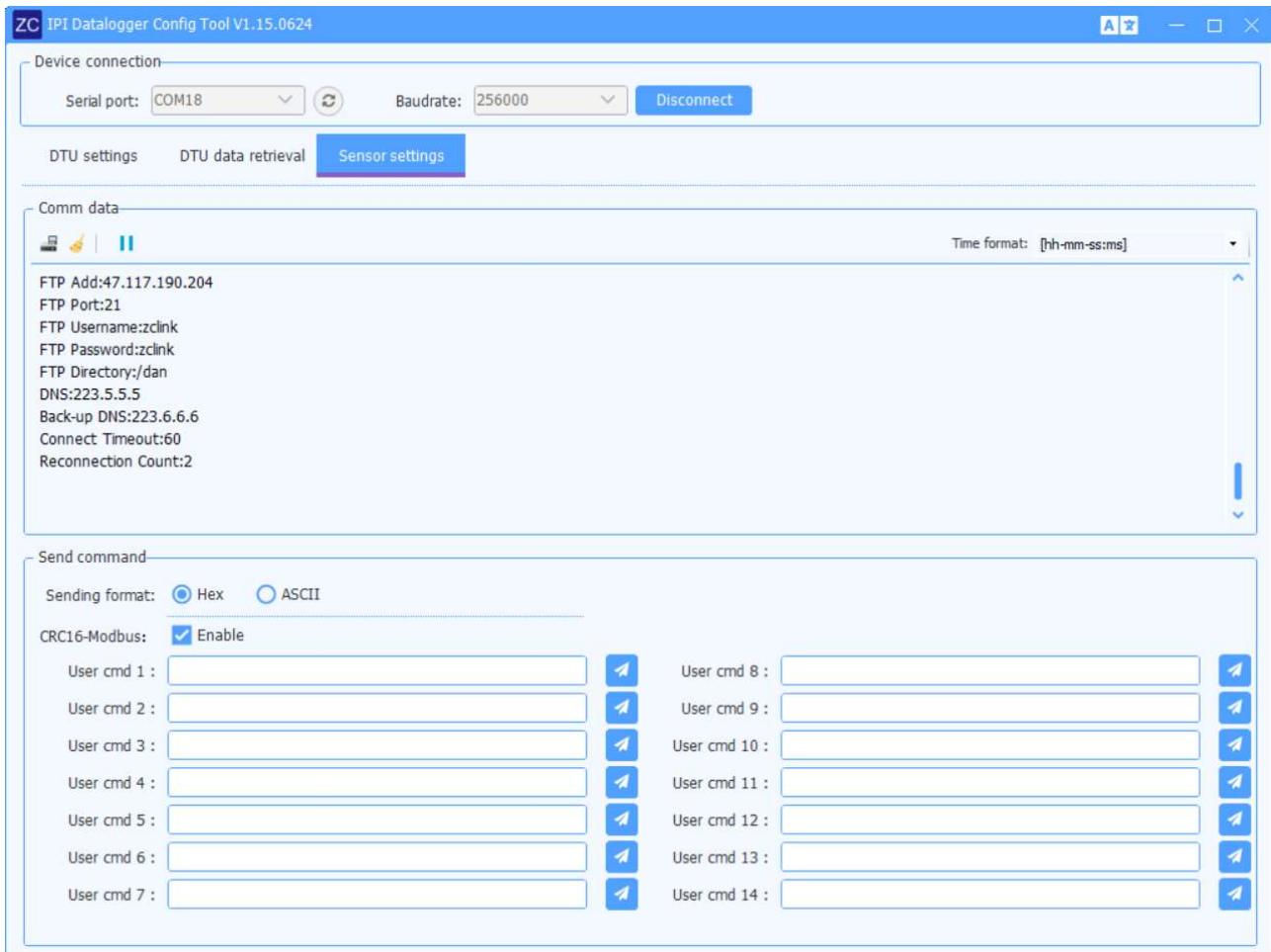
10. Indicator lights

The three LED indicator lights (WORK, NET, and LINK) on the panel can be used to quickly judge the working status of the logger.

LED	Color	Status	Meaning
WORK	*Red*	Flashes once a second	Logger in normal working mode
		Flashes twice a second	Logger in local configuration mode
		Flashes every 10s	Logger in sleep mode (low power consumption)
NET	*Yellow*	Flashes slowly (about once every 2s)	Searching for 4G network or 4G network registration failed
		Flashes quickly (about twice a second)	Connecting to 4G network while in sleep mode
		Flashes very quickly	Transmitting data (upload/download)
		Off	No network activity
LINK	*Green*	Shines steadily	Successfully registered to 4G network
		Off	Not registered to 4G network

## 11. Dimensions
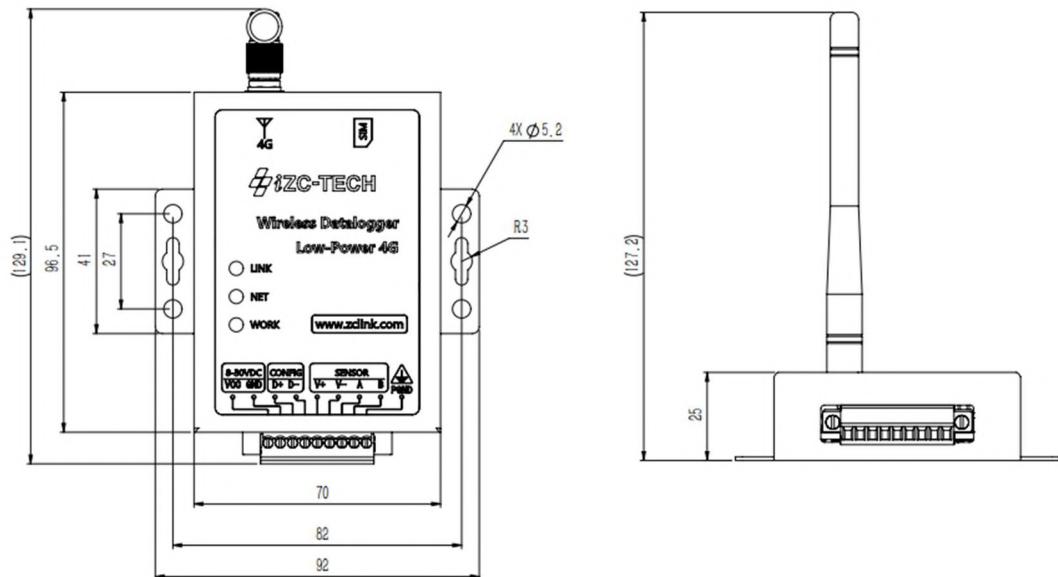
Caution: To take out the SIM card,
plastic tweezers can be used.

12. Wiring Definition

Pin No.	1	2	3	4	5	6	7	8	9
Definition	VCC	GND	D+	D-	V+	V-	A	B	PGND
Comment	Solar or any other external 8~30VDC power source		RS485 port for local config / debugging: D+: RS485_A D-: RS485_B		RS485 Modbus port for IPI connection: V+: (VCC-0.5) V (Note: VCC = logger power supply; no other external power supply required for the probes) V-: GND A: Probe RS485_A B: Probe RS485_B				Connected to the ground wire or left floating

Basic connection
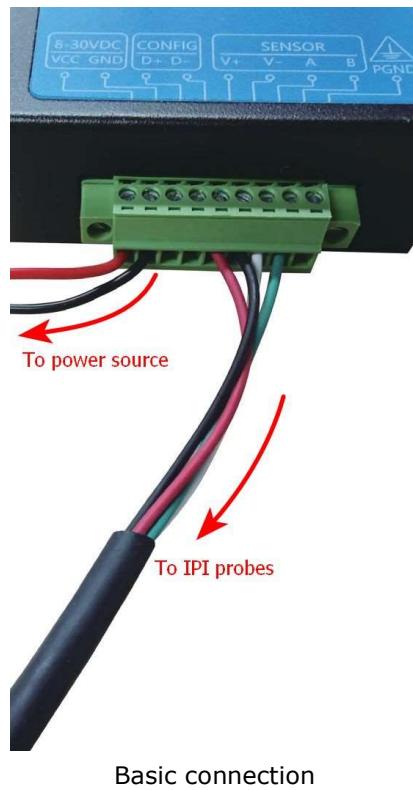
An example of solar panel as the power source:

13. Troubleshooting

Symptom	Possible causes	Solution
The indicator lights do not shine	The power supply is not connected or is abnormal.	Check if the power cord is properly connected. In case of solar or any other external power supply, check if the power source works properly.
The logger is unable to upload data to the FTP server	1. 4G signal is weak or there is no 4G service. 2. FTP server parameter error. 3. FTP server firewall or permission issue.	1. Check if the logger antenna is correctly mounted and try to move the logger to a location with better 4G signal. 2. Check FTP server settings and reconfigure it locally or via SMS. 3. Check user permissions and firewall settings of the FTP server to ensure access from the logger IP.
The remote management command files are not processed	1. The command file name or the file content is incorrectly written. 2. The logger must wait for the next data uploading time to act.	1. Check if the format of the command file name, name of the logger (DTU), and content of the command file are completely consistent with the format of the template. 2. Wait for the next data uploading time, during which the logger may process the command.
The SMS commands are not processed	1. The SIM card is in arrears or has no service. 2. The command format is incorrect.	1. Check if the SIM card is in normal conditions and has the SMS receiving function. 2. Check if the SMS command is completely consistent with the format.

14. Ordering Information

Consult Zhichuan sales if you have any questions about specifications of the datalogger and/or required accessories for it.

Device / Accessories	Datalogger	Foldable 4G antenna	Suction cup antenna	Solar power system	Screwdriver	SIM card	RS485-USB Converter
With / Without / Optional	/	With	Optional	Optional	With	Without	With
Specs	ZCT-IPI-W1	Full-band, SMA inner pin	Full-band, SMA inner pin	40W/12V /40Ah	Flat head, 2mm	4G (CAT-4 or -1)	/

Contact information of Zhichuan sales:

Phone: +86-21-6490-8095, -8096, -8097
Mobile: +86-135-0189-1288 (Whatsapp)
            +86-186-2150-6778 (Wechat)
Email: dan@zclink.com

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