

User Manual

Inductive Loop Vehicle Detector

ClairLup-V8

Version: 3.2

TraffiClair Technology Co., Ltd.

Content

1. Overview.....	4
2. Key Features.....	5
3. Interfaces and Specifications.....	6
4. Panel and Interface Description.....	7
4.1 LED Indicator Explanation.....	7
4.2 LED Indicator Colors and Functions.....	7
4.3 Description of DIP Switch.....	8
4.4 Definition and Function of Each DIP Switch Position.....	8
4.5 Multifunction Interface.....	9
4.6 Reset Button.....	9
4.7 Input Interface:.....	10
4.8 Output Interface:.....	10
4.9 IO, RS485, and power input interfaces.....	11
4.10 The grounding terminal.....	11
5. The configuration management client.....	12
5.1 Parameter setting and querying.....	12
5.2 Data display.....	14
5.3 Wave display.....	15
6. Wiring Instruction.....	16
6.1 The rear panel wiring instruction.....	16
The INPUT interface.....	16
The OUTPUT interface.....	16
IN Interface (Input function no longer supported in new versions):.....	17
RS485 interface.....	17
DC-IN interface.....	18
Protective ground.....	18

6.2 Wiring instruction.....	18
7. Communication Protocol	20
7.1 Communication Protocol	20
7.2 Detailed Explanation of the Communication Protocol	22
When a vehicle enters the loop, the vehicle detector serial port outputs information in the following format:	22
When a vehicle leaves the loop, the vehicle detector serial port outputs information in the following format:	22
Heartbeat data, output every 5 seconds, the vehicle detector serial port outputs information in the following format:	23
7.3 Appendix: CRC Checksum Algorithm.....	25

1. Overview

The CLAIRLUP-V8 inductive loop vehicle detector adopts a system architecture consisting of a 32-bit ARM core processor combined with FPGA technology. The core detection algorithm utilizes pure hardware techniques. The flexibility of ARM combined with the powerful processing capability of FPGA endows the system with characteristics such as fast response, high accuracy, strong anti-interference capability, and flexible expansion. It can be widely applied in traffic flow monitoring, electronic police systems, and security checkpoints on urban roads, highways, bridges, tunnels, and other road sections.



Figure1: ClairLup-V8 inductive loop detector

2. Key Features

- Single device supports 8-channel loop input, and cascading multiple devices enables flexible business expansion.
- Innovative polling + parallel detection mode ensures efficiency and anti-interference capability. Even when devices are cascaded, interference between loops of different devices can be effectively avoided.
- Response time of less than 5ms ensures real-time detection and measurement accuracy, fully supporting the use of traffic flow monitoring, electronic police, and security checkpoint systems.
- Quick and intelligent background frequency updates enable real-time tracking of environmental parameter changes.
- Supports advanced intelligent anti-lock algorithm to ensure long-term maintenance-free operation.
- Real-time waveform display of passing vehicles allows for detailed analysis of vehicle passage through the loop, greatly facilitating on-site problem analysis and troubleshooting.
- Real-time loop fault detection automatically restores normal operation after fault elimination.
- Supports detection of loop open circuit and short circuit, with fault indication lights to distinguish between different types of loop faults.
- The core detection unit adopts pure hardware detection technology, ensuring stable and reliable operation.

3. Interfaces and Specifications

- 8 loop interfaces supporting protection measures such as air discharge, TVS, and transformer isolation.
- 1 RS485 serial port with configurable baud rates (9600, 38400, 57600, 115200) via DIP switches.
- Expandable 10/100M Ethernet port.
- One custom multifunctional interface supporting device debugging, cascading, etc.
- 8 I/O output interfaces configurable in normally open/normally closed modes.
- Supports 8 levels of sensitivity configurable via DIP switches.
- Loop inductance range: 20~2000uH.
- 12/24VDC input power with reverse connection protection.
- Rated power <4W.
- Operating temperature: -40°C to +70°C.
- Operating humidity: 10% to 95% (non-condensing).
- Dimensions: 192mm (W) * 148mm (D) * 28mm (H).

4. Panel and Interface Description

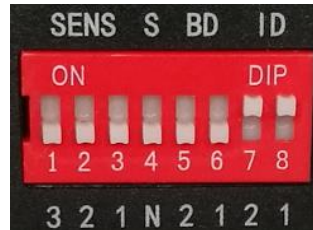
4.1 LED Indicator Explanation



4.2 LED Indicator Colors and Functions

LED	Color	Function Description
PWR	Green	Power supply indicator
STA	Red/Green	- Red rapid flashing (0.5 seconds on, 0.5 seconds off): Self-check failure. - Red flashing (1 second on, 1 second off): Indicates cascade connection failure when used as a slave device alone or in cascade. - Green flashing: Indicates normal operation of the system. - Alternating red and green flashing: Indicates that the vehicle detector has entered waveform output mode.
CH1-CH8	Red/Green	Solid Red: Indicates an open circuit or disconnected loop. Red Flash: Indicates a short circuit or the loop's inductance value being too small. Solid Green: Indicates the presence of a vehicle. Off: Indicates no vehicle detected.

4.3 Description of DIP Switch



4.4 Definition and Function of Each DIP Switch Position

Dip switch	Functions
SENS (3~1) refers to the silk screen labeling on the chassis, not on the dip switch.	The sensitivity setting dip switch consists of 3 switches, where 3 represents the high bit and 1 represents the low bit. The value range is from 000 to 111, where 000 corresponds to the highest sensitivity and 111 corresponds to the lowest sensitivity. All 8 channels use the same sensitivity setting.
S/N	Select Data Channel: - S: RS485 Serial Port - N: 10/100M Ethernet Port If the Ethernet port is not configured, this dip switch is invalid.
BD(2-1)	Set RS485 Baud Rate: - Two dip switches are used, where 2 represents the high bit and 1 represents the low bit. - Options: - 00: 9600 - 01: 38400 - 10: 57600 (Recommended normal working baud rate) - 11: 115200 (Recommended baud rate for waveform output)

ID(2-1)	Device ID: - Two dip switches are used, where 2 represents the high bit and 1 represents the low bit. - Options: - 00: Master device - Other values: Slave device
---------	---

Note 1: Setting to "ON" corresponds to the value "0", while setting to "OFF" corresponds to the value "1".

Note 2: When devices are cascaded, one of them should be configured as the master device, while all others should be set as slave devices (IDs other than "00").

Note 3: All dip switch settings take effect immediately without the need to reset the detector.

4.5 Multifunction Interface



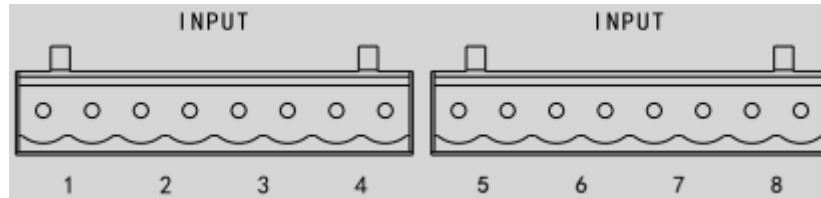
This interface supports device debugging, cascading, and other functions. When cascading, terminals 4 and 5 of all cascaded devices should be connected one-to-one. Other terminals do not need to be connected. It supports cascading of no fewer than 4 devices.

4.6 Reset Button

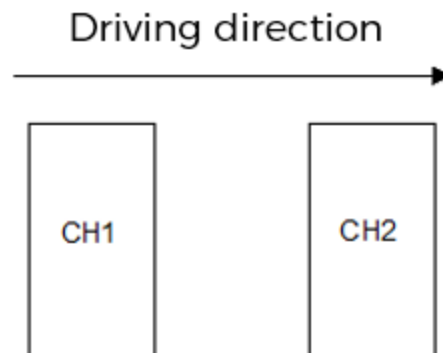


The reset button is used to reset the detector, but under normal circumstances, users do not need to reset the device.

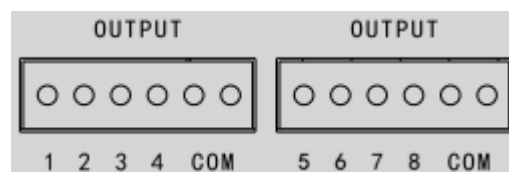
4.7 Input Interface:



The 1~8 terminals are used to connect 8 detection loops. Terminals 1/2, 3/4, 5/6, and 7/8 correspond to four lanes respectively. When connecting the loops, as shown in the diagram, according to the direction of travel, CH1 connects to the front loop, and CH2 connects to the rear loop, and so on for the rest of the channels.



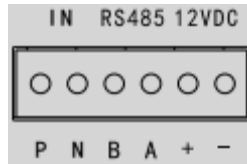
4.8 Output Interface:



Terminals 1 to 8 are 8 output interfaces. The output mode can be configured as normally open or normally closed, with the default setting being normally open. COM is the common

terminal (all COM terminals are internally connected in the device). The 8 output I/O interfaces correspond to the presence mode output of the 8 detection channels respectively.

4.9 IO, RS485, and power input interfaces



IO Input Interface (New versions no longer support input interface): Supports 1 channel of switch input, used to detect the on/off information of the switch and upload it to the upper computer in real time.

RS485 Interface: Communicates with the upper computer, outputs detection data, and configures device operating parameters.

Power Input Interface: Supports 12V (or 24V) DC power input, with reverse connection protection, and the total power consumption of the device is less than 4W.

4.10 The grounding terminal



Inductive loops are highly susceptible to lightning strikes. During normal operation, it is crucial that the grounding terminal of the vehicle detector is reliably connected to the cabinet ground. When multiple devices are cascaded, each device must be individually grounded to ensure system stability and safety.

5. The configuration management client

5.1 Parameter setting and querying

ClairLup-V8 Loop Detector Configuration Management Client V1.0

Serial Port NO. [Dropdown]
 Baud Rate 115200 [Dropdown]
 Parity Bit NONE [Dropdown]
 Data Bit 8 [Dropdown]
 Stop Bit 1 [Dropdown]
 [Radio] Disconnected
☐ HEX Display
☐ HEX Transmission
 Rx: 0 [Text] Tx: 0 [Text] Clear Count [Button]

Parameter Setting and Querying | Data Display | Waveform Display

L1+L2 settings	L3+L4 settings	L5+L6 settings	L7+L8 settings
Direction NO. 1 [Dropdown]	Direction NO. 1 [Dropdown]	Direction NO. 1 [Dropdown]	Direction NO. 1 [Dropdown]
Lane NO. 1 [Dropdown]	Lane NO. 2 [Dropdown]	Lane NO. 3 [Dropdown]	Lane NO. 4 [Dropdown]
Front loop-len 10 (dm)	Front loop-len 10 (dm)	Front loop-len 10 (dm)	Front loop-len 10 (dm)
Rear loop-len 10 (dm)	Rear loop-len 10 (dm)	Rear loop-len 10 (dm)	Rear loop-len 10 (dm)
Loop distance 50 (dm)	Loop distance 50 (dm)	Loop distance 50 (dm)	Loop distance 50 (dm)
Speeding-th 120 (km/h)	Speeding-th 120 (km/h)	Speeding-th 120 (km/h)	Speeding-th 120 (km/h)

[Query Parameters] [Write Parameters]

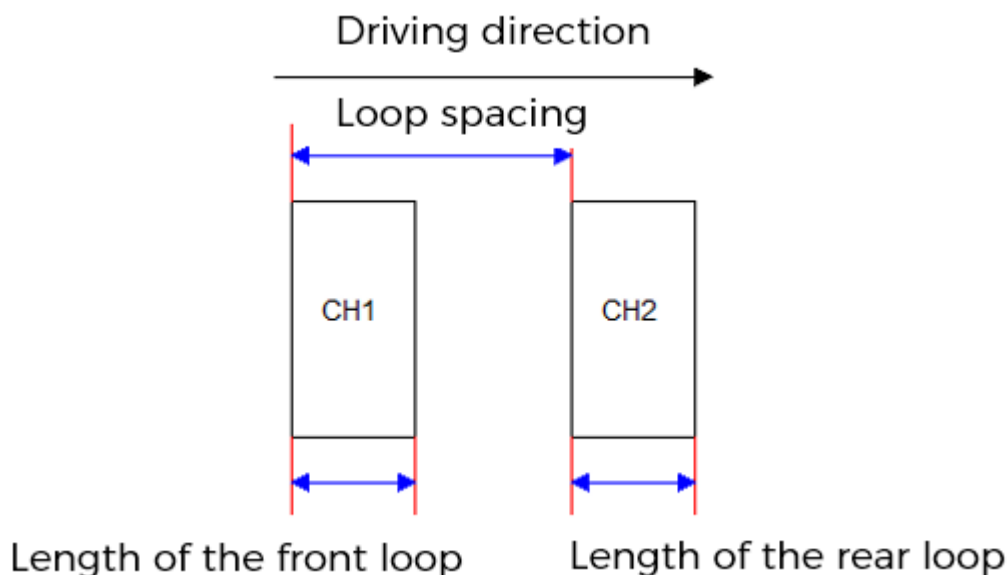
Output Delay Tim [Dropdown] x10(ms) | Interference Filtering Pulse Width 1 [Dropdown] | Output setting [Radio] NO [Radio] NC | Presence output mode [Radio] Normal [Radio] Combination | Leave Interval Tim 2 [Dropdown] x10(ms)

Other Parameter Settings
 Offset 20 [Dropdown] | Range 12 [Dropdown] | Amplitude 5 [Dropdown] | Ratio 8 [Dropdown] | Loop mode [Radio] Single loop [Radio] Dual loops [Radio] Speeding detection

[Query Parameters] [Write Parameters]

[Query Version] [Query Frequency]

- Basic loop parameters setting includes direction/lane, loop length, loop center distance, and overspeed threshold, as measured in the following diagram:



Note: All length units are in decimeters. When the lengths of the front and rear loops are consistent or similar, the loop spacing can be measured according to the diagram above. These parameters do not need to be set for non-speed measurement applications.

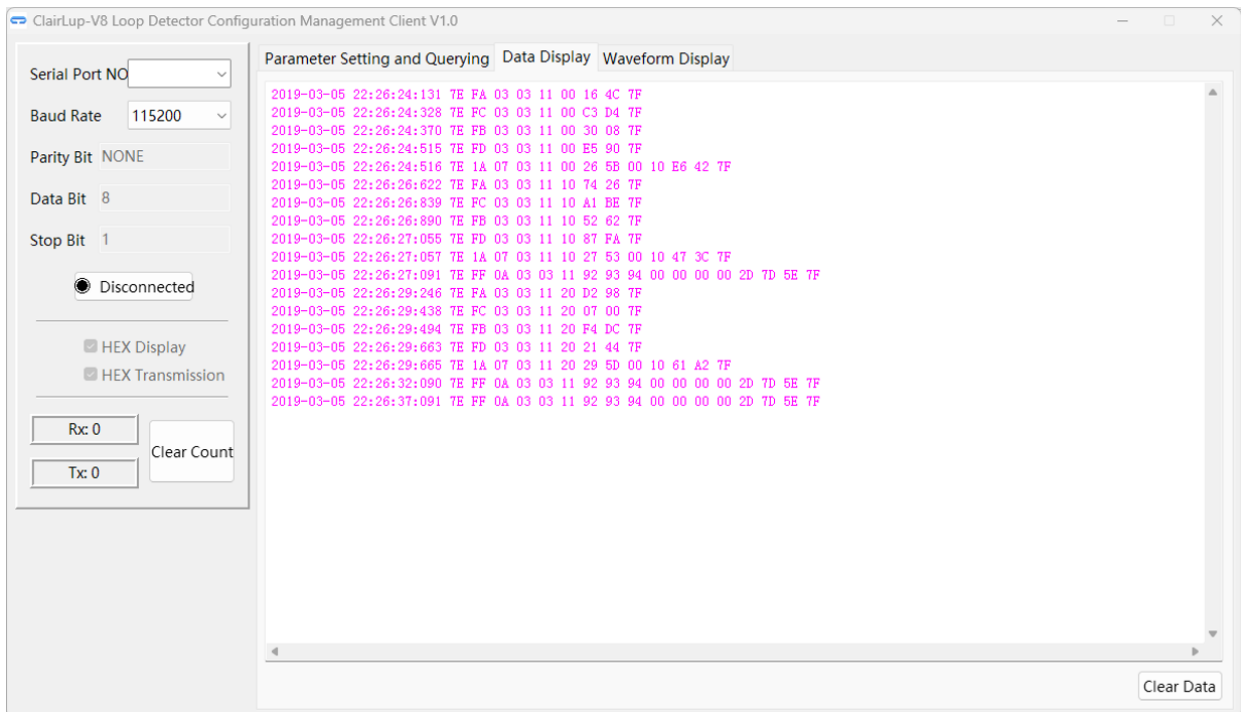
- Existence output delay setting: Set the output delay time for loop channels 1 to 8, with a delay time range of 0 to 1 second. The existence output will continue to hold after the vehicle leaves the loop until the delay time elapses.
- Existence output mode setting: Configure as normally open/normally closed, simultaneously applicable to all 8 outputs. Default setting is normally open mode.
- Enable/disable overspeed detection.
- RS485 data output control: If protocol integration is not required and only IO output is used, it is recommended to disable serial port output to reduce serial port output time consumption and further improve detector response real-time performance. Serial port output functionality is disabled by default. When serial port functionality is enabled, the data display window will show real-time detection data received by the serial port.
- Abnormal end parameter setting: Abnormal end refers to the situation where the detector maintains the existence status of the vehicle even after the vehicle has left the loop due to loop vibration or other reasons causing changes in loop parameters. This is

addressed by setting the inductance offset and allowable duration to eliminate such abnormal states, ensuring that vehicles parked in the loop for extended periods do not cause false detection.

- Query device version: Obtain the current software version information of the device.
- Query loop frequency: Obtain the working frequency of all channels.

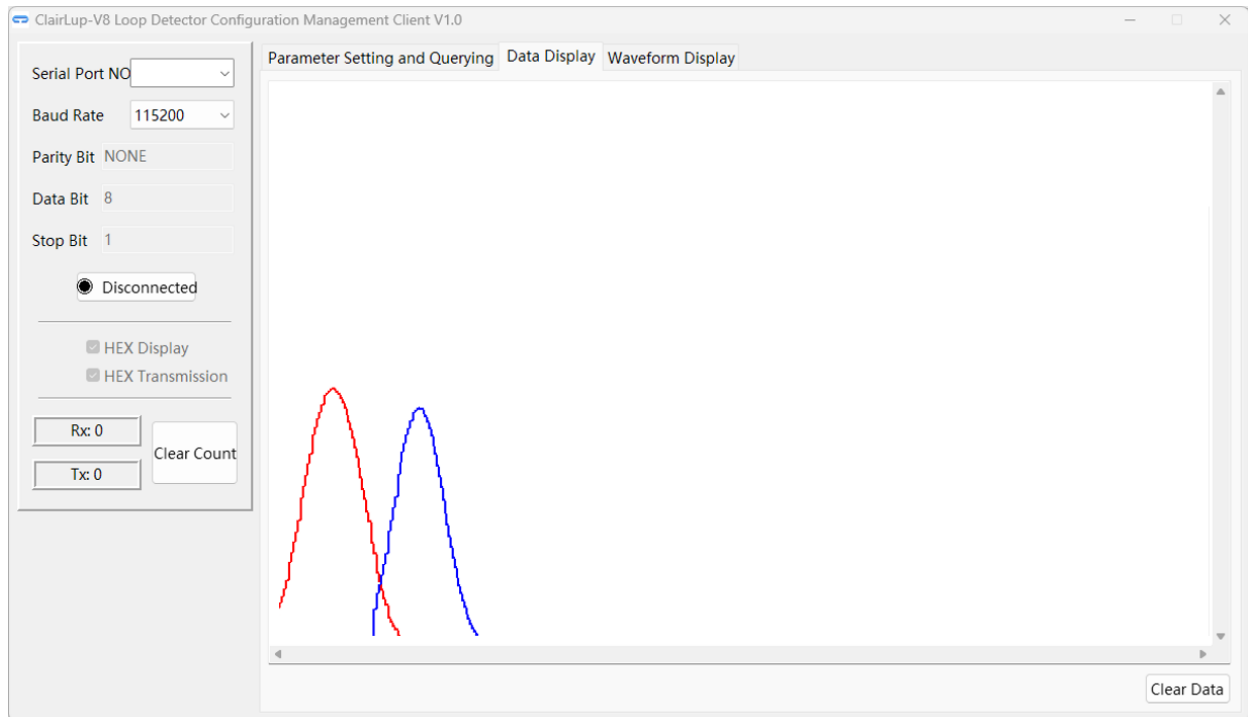
Note: Parameter settings are automatically saved and will not be lost during power outages.

5.2 Data display



When RS485 output functionality is enabled, the data display interface will continuously record all detection data packets output by the vehicle detector in real-time. Please note that the date and time will be based on the PC's time and not on the vehicle detector's output data. This feature can be utilized to analyze the time intervals between data packets.

5.3 Wave display



The waveform display interface provides real-time recording of the detection data changes when a vehicle passes through the corresponding loop. By continuously observing the waveform when a vehicle passes through the loop, it greatly facilitates on-site problem analysis and localization. Installation issues and environmental issues can be easily identified. When the detector continuously outputs waveform data, the configuration management terminal will not execute any other settings or query commands until the waveform output stops (all channels have vehicles leave the detector loop or the detector is reset), and only then can other operations be performed again. This feature ensures that the waveform data can be captured and analyzed effectively without interruption.

6. Wiring Instruction

6.1 The rear panel wiring instruction

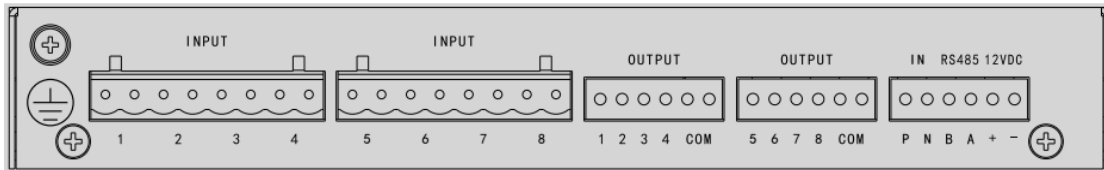


Figure3: Device rear panel

The INPUT interface

The 1/2/3/4/5/6/7/8 input interfaces are connected to 8 detection loops. The loop turns are typically between 4 to 5 turns. However, when the loops are installed on reinforced mesh road surfaces, it is recommended to have 6 to 8 turns. The loop leads must be twisted in pairs, with no less than 20 twists per meter.

The OUTPUT interface

The OUTPUT interface consists of two 6-pin terminals. Taking the left terminal as an example, terminals 1/2/3/4 correspond to the presence output of 4 detection loops respectively. COM serves as the common terminal, with the two terminals internally connected within the device.

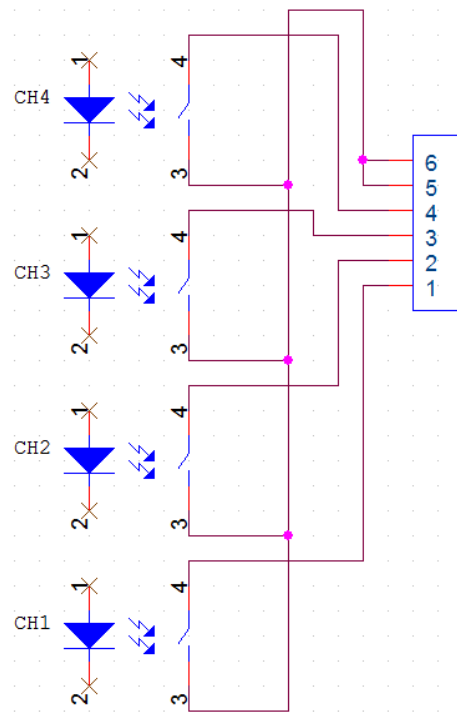


Figure 4: Schematic diagram of detector output interface (solid-state relay output)

IN Interface (Input function no longer supported in new versions):

The detector provides one I/O input interface, supporting either switch or level input (based on 5V level standard). Please connect the corresponding positive (P) and negative (N) poles if the docking signal has polarity.

RS485 interface

The RS485 interface is used to configure and query the working parameters of the detector, as well as to output detection data according to the protocol. When wiring, it is recommended to use shielded twisted pair cable to connect to the opposite device. Connect

terminal A to terminal A and terminal B to terminal B on the opposite device. The shielding layer of the cable should be connected to the equipment chassis or protective ground. When using the RS485 interface, it is important to ensure that the baud rates of both devices at each end of the interface are set to the same value.

DC-IN interface

The DC-IN is the direct current power input interface, operating at voltages of 12VDC or 24VDC. The positive and negative terminals of the power source can be connected arbitrarily.

Protective ground

When wiring, simply connect the protective ground to the protective ground of the equipment cabinet using a wire.

6.2 Wiring instruction

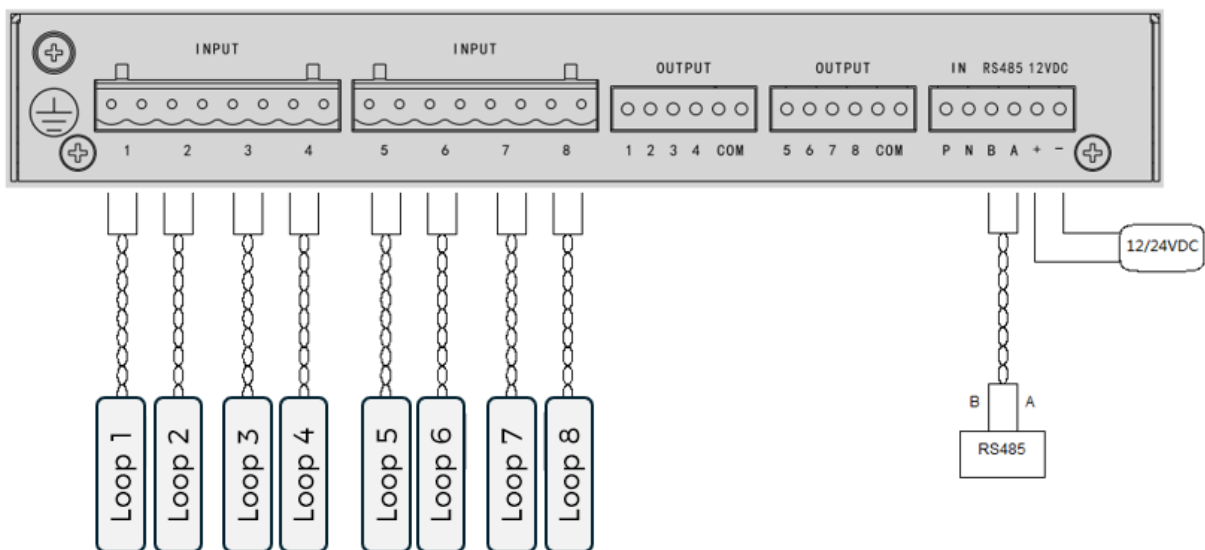


Figure 5: Schematic diagram of loop, RS485, and power supply wiring

7. Communication Protocol

7.1 Communication Protocol

This device uses the RS485 custom communication protocol, and the serial port settings and communication format are as follows.

1. Serial Port Configuration

Baud Rates: 9600, 38400, 57600, 115200 (selected via dip switches)

Data Bits: 8

Parity: None

Stop Bits: 1

2. The protocol format is as follows (the same protocol format is used for both receiving and sending data):

0x7E	CMD	LENGTH	DATA	CRC	0x7F
------	-----	--------	------	-----	------

- **0x7E**: Frame header
- **CMD**: Command byte, 1 byte
- **LENGTH**: Number of bytes in the DATA section, 1 byte, ranging from 0 to 100
- **DATA**: Data section, which can be empty and has a maximum size of 100 bytes
- **CRC**: CRC checksum value (CRC algorithm as described in the appendix), 2 bytes, calculated over all bytes including CMD, LENGTH, and all bytes in DATA; the high byte of CRC comes first, followed by the low byte
- **0x7F**: Frame footer

Note: In order to distinguish special data, such as frame header (0x7E) and frame footer

(0x7F), contained within the actual transmitted data (CMD+LENGTH+DATA+CRC), an escape character 0x7D must be added before such data. The specific procedure is as follows: during transmission, if the data contains 0x7E, 0x7F, or 0x7D, prepend 0x7D to that data, then XOR that data with 0x20 before sending it. During reception, if 0x7D is received, remove it from the received buffer and XOR the next byte following 0x7D with 0x20 to obtain the original value of that data. The LENGTH field represents the value before adding escape characters. For example, if the original length of DATA is 3, and you add one escape character, the length becomes 4, but the LENGTH field value remains 3.

7.2 Detailed Explanation of the Communication Protocol

When a vehicle enters the loop, the vehicle detector serial port outputs information in the following format:

Number of Bytes	Meaning of Bytes		Description
1	Frame header		0x7E
1	Command byte (CMD)		0xFA
1	Number of bytes in the DATA section (LENGTH)		5
1	Data section (DATA)	Channel Number	The value range is 1 to 8, corresponding to loop channels 1 to 8, indicating that a vehicle has entered the current channel.
2	CRC checksum value		CRC Check, Check Range is: CMD+LENGTH+DATA
1	Frame footer		End Character (0x7F)

When a vehicle leaves the loop, the vehicle detector serial port outputs information in the following format:

Number of Bytes	Meaning of Bytes		Description
1	Frame header		0x7E
1	Command byte (CMD)		0xFB

1	Number of bytes in the DATA section (LENGTH)		5
1	Data section (DATA)	Channel Number	The value range is 1 to 8, corresponding to loop channels 1 to 8, indicating that a vehicle has left the current channel.
2	CRC checksum value		CRC Check, Check Range is: CMD+LENGTH+DATA
1	Frame footer		End Character (0x7F)

Heartbeat data, output every 5 seconds, the vehicle detector serial port outputs information in the following format:

Number of Bytes	Meaning of Bytes		Description
1	Frame header		0x7E
1	Command byte (CMD)		0xFF
1	Number of bytes in the DATA section (LENGTH)		4
1	Data section (DATA)	Reserved	The value is 0
1		Number of Loop Channels	Fixed at 8
2		The working states of a vehicle detector channel	16-bit loop status, with the high byte first followed by the low byte; Bit[15:14] Loop status of Channel 8... Bit[1:0] Loop status of Channel 1; Taking Channel 1

			as an example, the loop status is defined as follows: Bit[1:0]: "00" - Unknown fault; "01" - Loop open circuit; "10" - Loop short circuit or inductance value too low; "11" - Loop normal.
2	CRC checksum value		CRC Check, Check Range is: CMD+LENGTH+DATA
1	Frame footer		End Character (0x7F)

Note: The time information refers to the system uptime, which ranges from 0 to 0xFFFFFFFF and repeats cyclically. The time unit is milliseconds. With this time information, the precise timing relationship between vehicle entry and exit from each loop channel can be calculated. This can be used for functions such as speed measurement and calculating time occupancy rates. Please note that the system time will flip approximately every 50 days. Handling this in software can prevent calculation errors at the time of the time flip.

7.3 Appendix: CRC Checksum Algorithm

CRC checksum algorithm adopts ITU-TV.41's advises and using $g(x) = x^{16} + x^{15} + x^{11} + x^8 + x^6 + x^5 + x^4 + x^3 + x^2 + 1$ to generate a checksum for your data. The CRC checksum value for the given data is `0xC4BF`.

CRC check range: <CMD> <LENGTH> <DATA>

The CRC verification function is as follows.

```
SINT GetCRCWord(UCHAR *pMsg, UINT iMsgLen)
{
    UCHAR cTmp;
    UINT i,j;
    UINT wCRCRet=0;
    for (i=0;i<iMsgLen;i++)
    {
        cTmp = *pMsg++;
        for (j=0;j<8;j++)
        {
            if (wCRCRet & 0x8000)
            {
                wCRCRet ^= CON_CRC;
            }
            wCRCRet <<=1;
            if (cTmp & 0x80)
            {
                wCRCRet++;
            }
            cTmp <<=1;
        }
    }
    for (i=0;i<2;i++)
    {
        for (j=0;j<8;j++)
        {
            if (wCRCRet & 0x8000)
            {
                wCRCRet ^= CON_CRC;
            }
        }
    }
}
```

```
        }  
        wCRCRet <=<=1;  
    }  
}  
return wCRCRet;  
}
```