User Manual

Inductive Loop Detector

ClairLup-V1

Version: 1.0

TraffiClair Technology Co., Ltd.

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1. Overview

The CLAIRLUP-V1 vehicle detection sensor utilizes a high-performance processor and stable, reliable circuit design. It incorporates advanced detection algorithms optimized for real-time detection, anti-interference, deadlock prevention, environmental status tracking, anomaly handling, and other aspects to ensure long-term maintenance-free operation. This significantly reduces user operational costs and enhances the value of user systems. The CLAIRLUP-V1 detector is widely applicable in systems such as electronic police, weighing, toll gate barriers, etc., on urban roads, highways, bridges, tunnels, and other road sections.



Figure 1: ClairLup-V1 inductive loop detector

2. Key Features

- Supports cascading multiple detectors, effectively eliminating interference between different detector loops.
- Response time is less than 10 milliseconds, ensuring reliable detection of vehicles traveling at high speeds on various roads.
- Supports advanced intelligent deadlock prevention algorithms, ensuring long-term maintenance-free operation.
- Supports software settings and queries for functions and parameters, facilitating networked management of devices.
- Supports real-time display of vehicle passing waveforms, allowing observation of all details of vehicle passage through the loop. This greatly facilitates on-site problem analysis and localization, making installation and environmental issues clear at a glance.
- Supports real-time loop fault detection and automatically returns to normal operation after fault elimination.
- Supports loop open and short circuit detection, with the ability to distinguish loop fault types through fault indication lights.
- Flexible I/O output capability, with configurable I/O output modes.
- Supports RS485 output of vehicle detection data, with customizable data protocols.

3. Interfaces and specifications

- 1 Loop Interface: Supports TVS (Transient Voltage Suppressor), transformer isolation, and other protective measures.
- 1 RS485 Serial Port: Baud rate can be set via dip switch and software.
- 2 Normally Open/Normally Closed Relay Output Interfaces: Support vehicle presence output, loop fault status output, and various pulse output modes.
- Supports 8 Levels of Sensitivity: Can be set via dip switch, and sensitivity can also be adjusted via software.
- Loop Inductance Range: 10~2000uH.
- 9~30VDC Input Power: Equipped with reverse polarity protection, rated power <1.5W.
- Operating Temperature: -40˚C to +85˚C, Operating Humidity: 10% to 95% (non-condensing).
- Dimensions: 102mm (L) * 72mm (W) * 26mm (H).

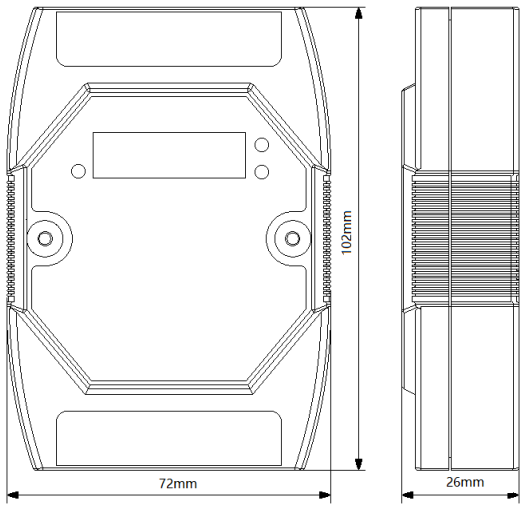


Figure 2: Dimensional diagram of CLAIRLUP-V1 vehicle detector

4. Panel and Interface Description

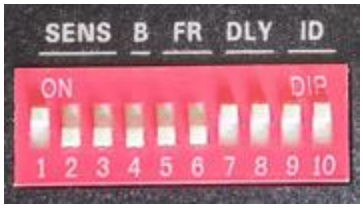
4.1 LED Indicator Description



LED Indicator Colors and Functions

LED Indicator	Color	Function Description
PWR	Green	Power Status Indicator
STA	Red/Green	• Red fast flashing (0.5 seconds on and off): Self-check failure • Red flashing (1 second on and off): Indicates a cascade connection failure when used alone or in cascade • Green flashing: System is operating normally • Alternating red and green: The vehicle detector enters waveform output mode
CH1	Red/Green	• Red solid: Loop open circuit or not connected • Red flashing: Loop short circuit or loop inductance too small • Green: Vehicle detected • Off: No vehicle detected

4.2 Dip Switch Explanation



Definitions and Functions of Each Dip Switch Position

SENS (1-3)	Sensitivity Setting Dip Switch, with three dip switches, 1 as the high bit and 3 as the low bit. The value range is from 000 to 111, where 000 represents the highest sensitivity and 111 represents the lowest sensitivity, with sensitivity decreasing incrementally from 000 to 111. It is typically recommended to use medium sensitivity settings such as "011" or "100". In environments with significant interference, low sensitivity settings should be used.
B (4)	Setting RS485 Baud Rate, with one dip switch: 0: 57600 1: Baud rate set by system software, configurable to 5 baud rates (9600, 19200, 38400, 57600, 115200), default is 115200
FR (5-6)	Loop Frequency Setting Dip Switch, with two dip switches, 5 as the high bit and 6 as the low bit. The definitions for FR (5~6) are as follows: 00: Low frequency 01/10: Medium frequency 11: High frequency Changing the loop frequency will automatically reset the device and quickly enter the working state.
DLY (7-8)	Output Delay Setting Dip Switch, with two dip switches, 7 as the high bit and 8 as the low bit. The definitions for DLY (7~8) are as follows: 00: Delay output time set by system software, default 200 milliseconds

	01: Delay output time 100 milliseconds 10: Delay output time 200 milliseconds 11: Delay output time 400 milliseconds
ID (9-10)	Device ID, with two dip switches, 9 as the high bit and 10 as the low bit. ID setting is mainly used for device cascading function. When the device is used independently, it can be configured as both master and slave modes. When set as a slave device, the STA indicator light flashes red, which is normal. The definitions for ID (9~10) are as follows: 00: Master Device 0 01: Slave Device 1 10: Slave Device 2 11: Slave Device 3

Note 1: "ON" corresponds to "0", and "OFF" corresponds to "1".

Note 2: All dip switch settings take effect immediately, and there is no need to reset the detector.

Note 3: When cascading devices, only one master device is allowed in the cascade. All others should be slave devices. Please refer to the cascade instructions for details.

4.3 Input Interface



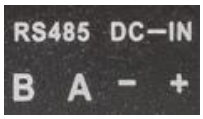
Terminals 1 and 2 are used to connect the detection loop.

4.4 Output Interface



The detector supports two channels of C-type relay output interface. Terminal 6 is the common terminal for output 1, and terminal 9 is the common terminal for output 2. By default, both output 1 and output 2 indicate the presence of a vehicle. The output function can be flexibly configured according to requirements. Please refer to the output function instructions in the configuration management client software for details.

4.5 RS485 and Power Input Interface



RS485 Interface: Used for communication with the host computer, outputting detection data, and configuring device operating parameters.

DC-IN Power Input Interface: Supports 9~30V DC power input (typically 12/24VDC), equipped with reverse polarity protection, and the overall power consumption is less than 1.5W.

4.6 Cascading Interface



When cascading devices, simply connect the corresponding terminals of the cascade devices. Connect the 1st terminal of all cascade devices together, do the same for the 2nd terminal, and similarly for the 3rd terminal.

4.7 N/C Terminals

N/C terminals are reserved for internal use. Please do not connect any wires to avoid

damaging the device.

5. The Configuration Management Client Introduction

5.1 Parameter Setting and Query



- Query Device Version: Obtain the current version information of the device.
- Query Loop Frequency: Retrieve the operating frequency of the loop. Adjusting loop frequencies can facilitate proper loop arrangement, ensuring that the frequency difference between adjacent loops is maximized to effectively reduce interference. When using multiple loops, it's recommended to use the cascading function to eliminate interference between loops.
- Output Delay Setting: Set the output delay time within the range of 0 to 1 second. The output delay applies to both presence and leave pulses. For instance, with presence output, the output will continue to hold after the vehicle leaves the loop until the specified delay time elapses. The default delay time is 200 milliseconds and can be adjusted as needed. Note that the delay time set by the client is only used when the DLY dip switch is set to

"00".

- Serial Port Baud Rate Setting: When the baud rate dip switch is set to "OFF", the RS485 interface uses the system-set baud rate, which includes five options: 9600/19200/38400/57600/115200, with 115200 as the default. When the baud rate dip switch is set to "ON", the baud rate is fixed at 57600.
- Output Function Setting: Both output interfaces 1 and 2 can be individually configured with four selectable functions:
  1) Presence Output: When a vehicle is detected on the loop, the relay is energized. After the vehicle leaves the loop and the set delay time elapses, the relay returns to its original state.
  2) Entry Pulse: When a vehicle enters the loop, a pulse signal with a width of 200 milliseconds is immediately outputted. This pulse signal can be used as a capture signal when a vehicle enters the loop.
  3) Exit Pulse: When a vehicle leaves the loop and the set delay time elapses, a 200-millisecond pulse signal is immediately outputted. This pulse signal can be used as a capture signal when a vehicle exits the loop.
  4) Fault Output: When there is a loop fault, the relay is energized. Otherwise, the relay returns to its normal state.
- Abnormal Recovery Parameter Setting: Abnormal recovery refers to situations where the loop parameters change due to large vibrations on the loop surface or other reasons, causing the detector to maintain the vehicle presence state even after the vehicle has left the loop. This abnormal state can be eliminated by setting the inductance offset and allowable duration. Normal vehicles stopping on the loop for extended periods will not lead to misjudgment.

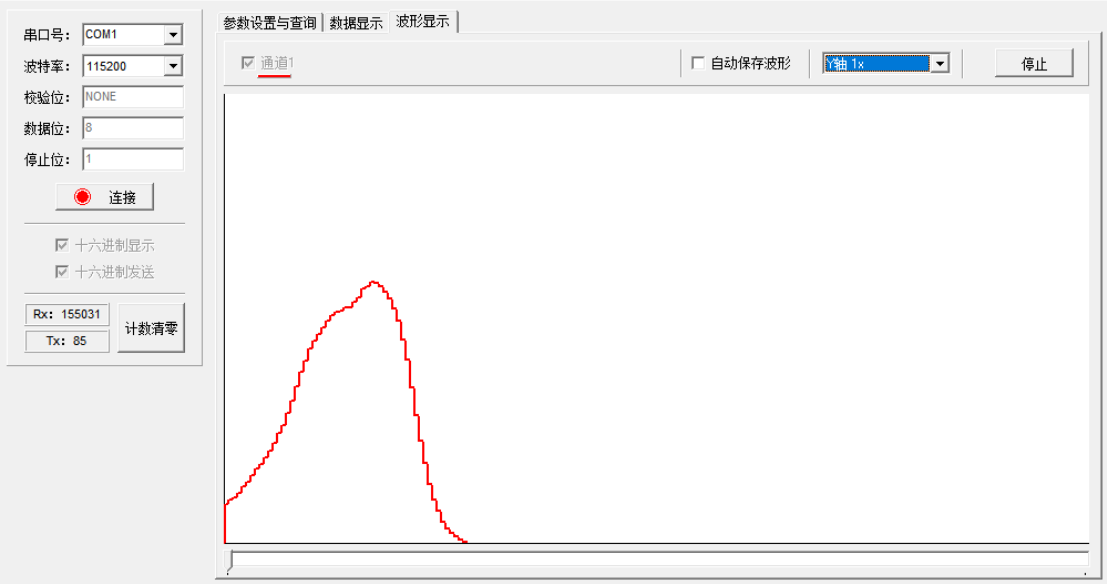
Note: Parameter settings are automatically saved upon successful configuration and are not lost during power outages.

5.2 Serial Port Data Display



This data window displays detection data and heartbeat data from the detector, facilitating protocol integration development.

5.3 Waveform Display



The waveform display interface records real-time changes in detection data when vehicles

pass through the corresponding loop. By continuously observing the waveform when vehicles pass through the loop, it greatly facilitates on-site problem analysis and location. Installation problems and environmental issues will be clearly visible. When the detector continuously outputs waveform data, the configuration management terminal will not execute any other setting or query commands until waveform output stops (when the vehicle leaves the detector loop or resets the detector), and only then can other operations be executed again.

6. Cascading Instructions

6.1 Cascading Wiring:

The CLAIRLUP-V1 detector supports cascading functionality, which can be connected via the three-wire cascade interface. The diagram below illustrates the cascade connection of three devices. When cascading more devices, simply follow the same connection pattern as shown in the diagram. Considering the drive capability and signal quality requirements, please do not cascade more than 8 devices.

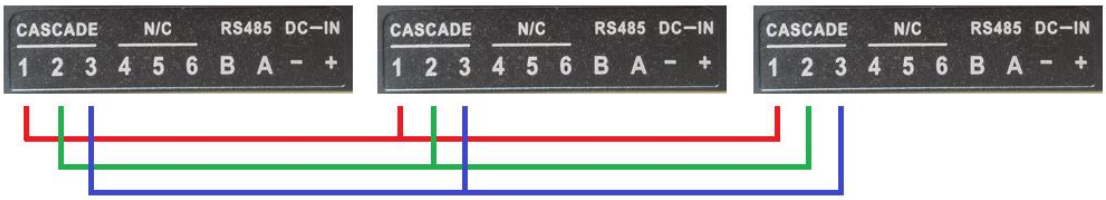


Figure 3: Cascading Wiring Diagram

6.2 Cascading Dip Switch Settings

Use the ID dip switches to set the master-slave mode of the cascaded devices. Only one device in the cascade network can be designated as the master device; all others are slave devices. The device ID dip switch definitions are as follows:

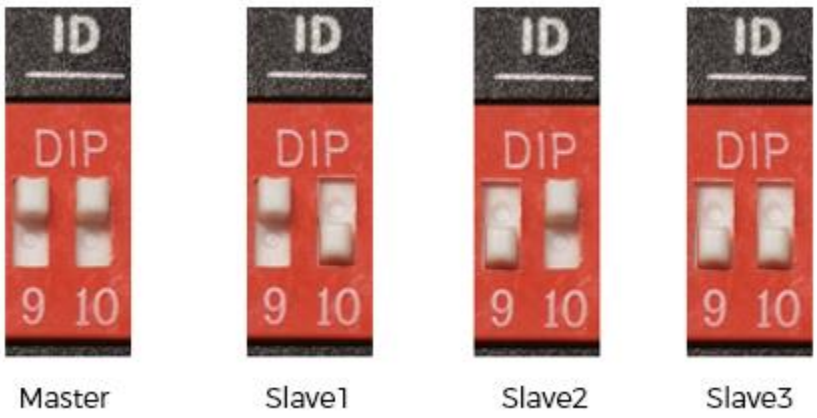


Figure 4: Cascaded Device ID Dip Switch Settings

6.3 Cascading Example

Taking 5 lanes as an example (or 5 loops on the same lane, arranged vertically in sequence), setting the device IDs and connecting the corresponding loop channels as shown in the diagram below will completely eliminate interference between all loops.

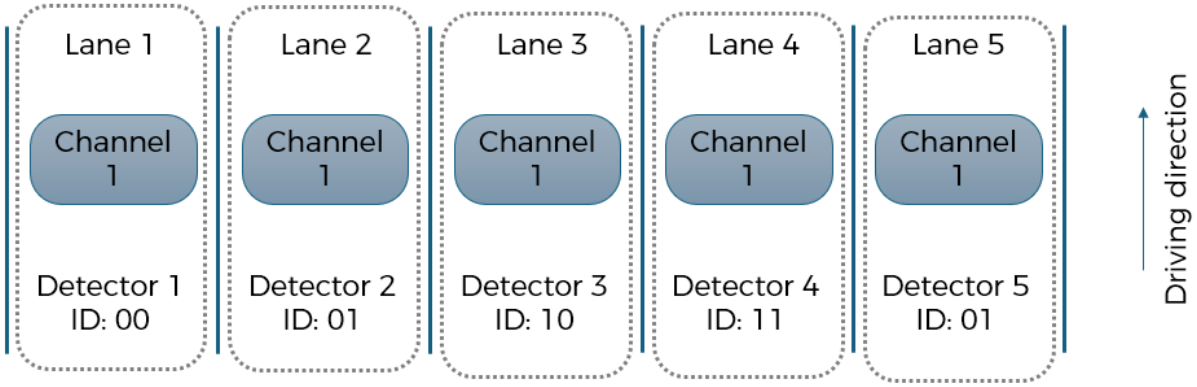


Figure 5: Cascaded Device ID Settings and Loop Layout Diagram for 5 Lanes

As shown in the above diagram, when multiple devices are cascaded, the IDs of the slave devices are set sequentially as 01/10/11/01/10/11…, and the corresponding loops are arranged in sequence.

Following the example above for device cascading and loop layout, the loops of adjacent lanes can be placed closely together, completely eliminating interference between the loops. This design reduces the difficulty of on-site loop debugging, enhances system stability and accuracy, and increases the overall system value.

7. Communication Protocol

7.1 Communication Protocol

This device adopts a custom RS485 communication protocol. The serial port settings and communication format are as follows:

Serial Port Definition

- Baud Rate: 57600, 115200 (selected by dip switch)
- Data Bits: 8
- Parity: None
- Stop Bits: 1

Protocol Format: (The same protocol format is used for both receiving and transmitting data.)

0x7E	CMD	LENGTH	DATA	CRC	0x7F

- 0x7E: Frame header
- CMD: Command byte (1 byte)
- LENGTH: Number of bytes in the DATA field (1 byte), range: 0 to 100
- DATA: Data field, can be empty, maximum length not exceeding 100 bytes
- CRC: CRC checksum value (CRC algorithm see appendix), 2 bytes, calculated range includes all bytes of CMD+LENGTH+DATA, with the high byte of CRC value first, followed by the low byte
- 0x7F: Frame tail

Note:

To distinguish special data contained in the actual transmitted data (CMD+LENGTH+DATA+CRC), such as frame header (0x7E), frame tail (0x7F), etc., an escape character 0x7D must be added before these data. Specifically, during transmission, if the data contains 0x7E, 0x7F, or 0x7D, add 0x7D before the data, then XOR the data with 0x20 before sending it. During reception, if 0x7D is received, remove 0x7D from the received buffer, then XOR the data immediately 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 an escape character is added, the length becomes 4, but the value of the LENGTH field remains 3.

7.2 Communication Protocol Detailed Description

When a vehicle enters the loop, the format of the information outputted by the vehicle detector's serial port is as follows:

Number of bytes	Meaning of bytes		Explanation
1	Frame header		0x7E
1	Command byte (CMD)		0xFA
1	Length of the data field (LENGTH)		1
1	Data field (DATA)	Channel number	The value range is from 1 to 2, corresponding to loop channels 1 to 2, indicating that a vehicle has entered the loop on the respective channel. For single-channel

			detectors, this value is fixed at 1.
2	CRC checksum		CRC checksum, the scope of verification is CMD+LENGTH+DATA
1	Frame tail		End character (0x7F)

When a vehicle leaves the loop, the format of the information outputted by the vehicle detector's serial port is as follows:

Number of bytes	Meaning of bytes		Explanation
1	Frame header		0x7E
1	Command byte (CMD)		0xFB
1	Length of the data field (LENGTH)		1
1	Data field (DATA)	Channel number	The value range is from 1 to 2, corresponding to loop channels 1 to 2, indicating that a vehicle has left the loop on the respective channel.
2	CRC checksum		CRC checksum, the scope of verification is CMD+LENGTH+DATA
1	Frame tail		End character (0x7F)

Heartbeat data, outputted every 5 seconds by the vehicle detector's serial port, has the following information format:

Number of bytes	Meaning of bytes	Explanation

1	Frame header		0x7E
1	Command byte (CMD)		0xFF
1	Length of the data field (LENGTH)		4
1	Data field (DATA)	Reserved	The value is 0
1		Number of loop channels	CLAIRLUP-V1 is fixed at 1; CLAIRLUP-V2 is fixed at 2.
1		Presence status	Bit[7~2]: Reserved, set to 0; Bit1: Presence status of Channel 2 Bit0: Presence status of Channel 1 When a vehicle is present, the corresponding bit is set to "1", otherwise it is "0".
1		Vehicle detector channel operational status	Bit[1~0]: Status of Channel 1 Bit[3~2]: Status of Channel 2 Loop channel status definitions are as follows, using Channel 1 as an example: Bit[1~0]: "00": Loop channel initialization failed "01": Loop open circuit or not connected "10": Loop short circuit or low inductance

			"11": Loop normal Bit[7~4]: Reserved, set to 0
2	CRC checksum		CRC checksum, the scope of verification is CMD+LENGTH+DATA
1	Frame tail		End character (0x7F)

7.3 Appendix: CRC Checksum Algorithm

The CRC error detection code adopts the recommendation of ITU-T V.41, using the polynomial $g(x)= x^{16} + x^{15} + x^{11}+x^8+x^6+x^5+x^4+x^3+x^2+1$ to generate the checksum, with the checksum word being 0xC4BF.

The scope of CRC verification: <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;
}
```