LoRaWAN® Solenoid Valve Controller

UC51x Series

Communication Protocol

Revision History

Date	Doc Version	Description
Feb. 29, 2024	V 4.0	Initial version based on hardware 4.x
Jan. 7, 2025	V 4.1	Support to report TSL version and reset event

Contents

1. Overview

UC51x Series use the standard Milesight IoT payload format based on IPSO. All data are based on following format, the Data field should follow little endian:

Channel1	Type1	Data1	Channel2	Type2	Data2	Channel 3	...
1 Byte	1 Byte	N Bytes	1 Byte	1 Byte	M Bytes	1 Byte	...

Note:

1) All explanations and examples in this document are based on HEX format.
2) For all Milesight IoT decoder examples please find files on https://github.com/Milesight-IoT/SensorDecoders

2. Uplink Payload

Uplink payloads of UC51x Series are made up of device information and sensor data.

2.1 Device Information

UC51x series will report basic device information every time it joins the network.

Item	Channel	Type	Byte	Description
Protocol Version	ff	01	1	01 => V1
Hardware Version		09	2	01 20 => V1.2
Firmware Version		0a	2	01 01 => V1.1
Power On		0b	1	Device is on
Device SN		16	8	16 digits
Device Type		0f	1	00: Class A, 01: Class B, 02: Class C, 03: Class C to B
TSL Version		ff	2	02 01 =>V2.1
Reset Event		fe	1	ff, only report when the device resets

Example:

ff0bff ff0101 ffff0401 ff166415a51585070020 ff090100 ff0a0101 ff0f00		
Channel	**Type**	**Value**
ff	0b (Power On)	ff
ff	01 (Protocol Version)	01 (V1)
ff	ff(TSL version)	04 01=>V4.1
ff	16 (Device SN)	6415a51585070020
ff	09 (Hardware Version)	0400 (V4.0)
ff	0a (Firmware Version)	0101 (V1.1)
ff	0f (Device Type)	02=Class A

2.2 Sensor Data

Item	Channel	Type	Description
Battery Level	01	75	UINT8, Unit: %
Valve 1	03	01	00 = closed, 01 = open
Counter 1 (GPIO1)	04	c8	UINT32
Valve 2	05	01	00 = closed, 01 = open
Counter 2 (GPIO2)	06	c8	UINT32
Digital Input (GPIO1)	07	01	00 = closed, 01 = open
Digital Input (GPIO2)	08	01	00 = closed, 01 = open

Examples:

1. Battery level packet:

1) Report once with periodic packet after joining the network;
2) Report every 6 hours for UC511 and every 12 hours for UC512.
3) Report once when the battery level is below 10%.

01 75 64		
Channel	**Type**	**Value**
01	75(Battery)	64 => 100%

2. **Periodic packet:** reports according to reporting interval. (360 minutes by default)

030101 04c84f000000 050100 080100					
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
03	01	01 => Open (Valve 1)	04	c8	Pulse counter of GPIO1: 4f 00 00 00 => 00 00 00 4f = 79
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
05	01	00 => Closed (Valve 2)	08	01	Digital input of GPIO2: 00 => Closed

3. **Valve change packet:** reports corresponding interface data when the valve status changes.

030101 04c84f000000 050100 080100					
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
03	01	01 =>Open (Valve 1)	04	c8	Pulse counter of GPIO1: 4f 00 00 00 => 00 00 00 4f = 79

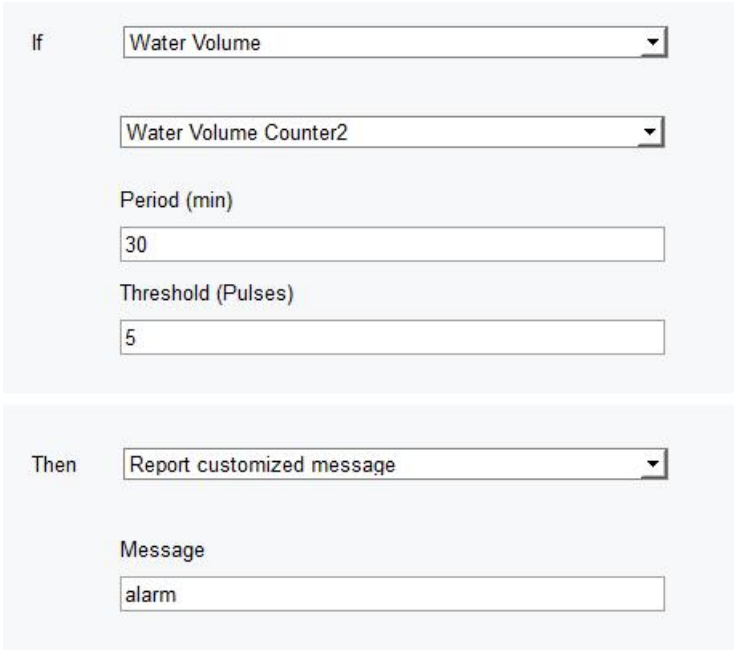
3.3 Alarm Message

UC51x series support to report custom alarm message according to water volume rule settings.

Item	Channel	Type	Description
Alarm Message	ff	12	ASCII characters, 1-8 Bytes

Example:

Add a rule as below:



The the water volume reaches the threshold, the device will report below alarm message:

ff12 616c61726d		
Channel	**Type**	**Value**
ff	12	Hex to Ascii: 61 6c 61 72 6d=>=alarm

3. Downlink Commands

Downlink is used for controlling the UC51x via network server remotely. Downlink port (Application port) is 85 by default and can be configured via ToolBox.

3.1 Valve Control

Basic format:

Channel	Type	Control Field	Sequence	Time Control (Option)	Flow Control (Option)
ff	1d	1 Byte	1 Byte (01 to ff or 00)	3 Bytes (Unit: s)	4 Bytes

Control Field:

Bit	7	6	5	4-2	1-0
Description	0: Disable time control 1: Enable time control	0: Disable flow control 1: Enable flow control	0: Valve close 1: Valve open	000	00: Valve 1 01: Valve 2

Note:

1) If you set the sequence as 01 to ff, the sequence should be increased after it has been used in one command sent to devices. For example, if you use command ff 1d 20 01 (sequence 01) to control the valve successfully, the next command should be ff 1d 20 02 (sequence 02). Wrong sequence will cause command invalid.

2) If the sequence is up to ff (255), please use sequence beginning as 01.

3) If the control command take effects, the device will report the status packet of corresponding interface; if control failed, the device will not report the packet.

Examples:

1. Open the valve 2 right away.

ff1d2100			
Channel	Type	Control Field	Sequence
ff	1d	21 => 0010 0001 Bit5: 1 => valve open Bit0-1: 01 => valve 2	00

2. Open the valve 1 for 60s.

ff1da0003c0000				
Channel	Type	Control Field	Sequence	Time Control
ff	1d	a0 => 1010 0000 Bit7: 1 => enable time control Bit5: 1 => valve open Bit0-1: 00 => valve 1	00	3c 00 00=>00 00 3c=60s

3. Open the valve 2 until the pulse counter 2 increases 16 pulses.

ff1d610010000000				
Channel	Type	Control Field	Sequence	Flow Control
ff	1d	61 => 0110 0001 Bit6: 1 => enable flow control Bit5: 1 => valve open Bit0-1: 01 => valve 2	00	10 00 00 00 => 00 00 00 10 = 16

4. Open the valve 1 until the 60s passes or pulse counter 1 increases 6 pulses.

ff1de0003c000006000000					
Channel	**Type**	**Control Field**	**Sequence**	**Time Control**	**Flow Control**
ff	1d	e0 => 1110 0000 Bit7: 1 => enable time control Bit6: 1 => enable flow control Bit5: 1 => valve open Bit0-1: 00 => valve 1	00	3c 00 00 => 00 00 3c = 60s	06 00 00 00 => 00 00 00 06 = 6

3.2 Basic Settings

Item	Channel	Type	Description
Collecting Interval	ff	02	UINT16, unit: s, range: 10-64800s
Reporting Interval		03	UINT16, unit: s, range: 10-64800s
Reboot		10	ff
UTC Time Zone		17	INT16/10
Enquire Time from Server		4a	ff **Note:** this only works when the LoRaWAN version of device and server is 1.0.3 or later.
Enquiry Current Data		28	ff
Data Storage		68	00: disable, 01: enable
Data Retransmission		69	00: disable, 01: enable
Data Retransmission Interval		6a	3 Bytes Byte 1: 00 Byte 2-3: interval time, unit:s range: 30~1200s (600s by default)
Auto-confirmed Mechanism		f3	00: disable, 01: enable
Response Time of Class A		1e	UINT32, unit: s, range: 0-64800s

Example:

1. Set reporting interval as 20 minutes.

ff03b004		
Channel	**Type**	**Value**
ff	03	b0 04 => 04 b0 = 1200s=20 minutes

2. Reboot the device.

ff10ff		
Channel	**Type**	**Value**
ff	10	ff

3. Set the time zone as UTC-2.

ff17ecff		
Channel	**Type**	**Value**
ff	17	ec ff => ff ec = -20 the time zone is UTC-2

3.3 GPIO Settings

Item	Channel	Type	Description
Counter Reset	ff	4e	GPIO 1 Counter: 0100 GPIO 2 Counter: 0200
Initial Value of Counter		92	Counter (1B) + Initial Value (4B, UINT32) Counter: GPIO1=01, GPIO2=02
Prevent Jitter Delay Time		46	UINT8, unit:s
Pulse Filter		52	0002+Filter Time(2B) Filter time: UINT16, unit: ms

Example:

1. Reset the counting value of GPIO1 when it works as pulse counter.

ff4e0100		
Channel	**Type**	**Value**
ff	4e	0100: counter 1

2. Set the initial counting value of GPIO2 when it works as pulse counter.

ff920210000000		
Channel	**Type**	**Value**
ff	92	02=GPIO2 10 00 00 00=> 00 00 00 10=16

3.4 Milesight D2D Settings

Item	Channel	Type	Description
Milesight D2D Key	ff	35	First 16 digits, last 16 digits are fixed as 0
Milesight D2D		84	00: disable, 01: enable

Note: about the D2D rule setting please refer to Set Rule.

Example:

1. Set Milesight D2D key as 12345678123456780000000000000000.

ff351234567812345678		
Channel	**Type**	**Value**
ff	35	12 34 56 78 12 34 56 78

3.5 Rule Setting

UC51x series supports setting schedule plan to open or close valves at specific time.

3.5.1 Set Rule

Basic format:

Channel	Type	Rule ID	Enable	Condition Field	Action Field
ff	55	01~10 (1~16)	00: disable 01: enable	13 Bytes	13 Bytes

1) Condition: Time

Condition Field:

Byte	1	2-5	6-9	10	11	12-13
Description	01	Start Time Stamps	End Time Stamps	Is Loop 00: disable 01: enable	Loop Period: 00=month, 01=day, 02=week	Month/day /week interval

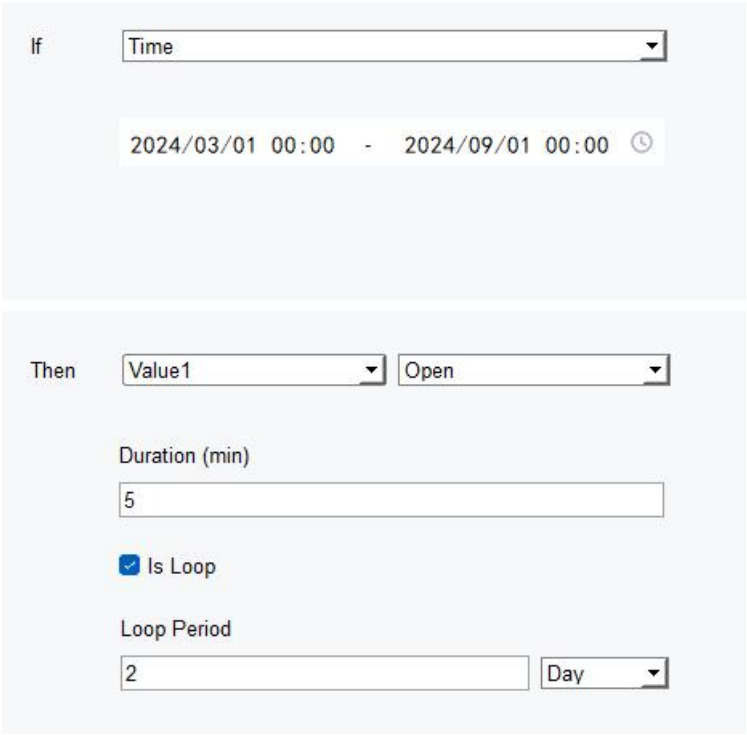
If loop period is week, Byte 12 is as below:

Bit	7	6	5	4	3	2	1	0
Repeat Week Day	0	Sunday	Saturday	Friday	Thursday	Wednesday	Tuesday	Monday
Description	When the corresponding bit is set as 1, the rule will execute every this day of the week							

Action Field:

Byte	1	2	3	4	5-8	9	10-13
Description	02	01: valve 1 02: valve 2	00: close 01: open	Time Control 00: disable 01: enable	Duration (s)	Flow Control 00: disable 01: enable	Water Volume (Pulse)

Example:



ff55 0101 0100aae065003ed36601010200 02010101 2c010000 0000000000					
Channel	**Type**	**Rule ID**	**Enable**	**Condition**	**Action**
ff	55	01=>1	01=enable	Start time: 00aae065=>65e0aa00 = 1709222400 =2024/03/01 00:00:00 End time:003ed366=>66d33e00=1725120000=2024/09/01 00:00:00 01=Is loop: enable Loop period: 01=day 02 00=>00 02=2 days	01=valve 1 01=open 01=time control enable 2c 01 00 00=>00 00 01 2c=300s=5 minutes

2) Condition: receive D2D command

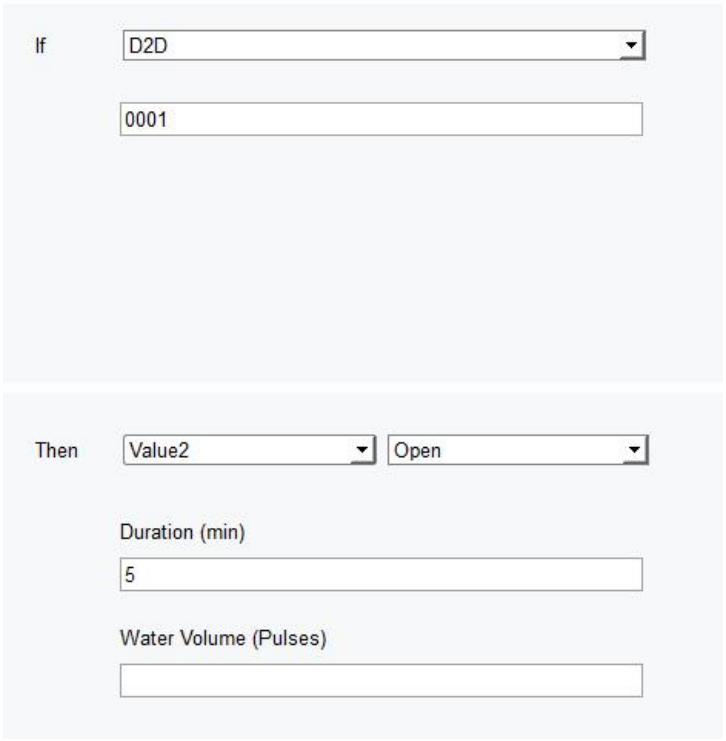
Condition Field:

Byte	1	2-3	4-13
Description	02	D2D Command	00....00

Action Field:

Byte	1	2	3	4	5-8	9	10-13
Description	01	01: valve 1 02: valve 2	00: close 01: open	Time Control 00: disable 01: enable	Duration (s)	Flow Control 00: disable 01: enable	Water Volume (Pulse)

Example:



ff55 0a01 02**0100**00000000000000000000 01**0201012c010000**0000000000					
Channel	**Type**	**Rule ID**	**Enable**	**Condition**	**Action**
ff	55	0a=>10	01=enable	0100=>00 01 D2D command is 0001	02=valve 2 01=open 01=time control enable 2c 01 00 00=>00 00 01 2c=300s=5 minutes

3) Condition: Water Volume

Condition Field:

Byte	1	2	3-4	5-8	9-13
Description	03	01: GPIO1 02: GPIO2	Period (min)	Threshold (Pulses)	00....00

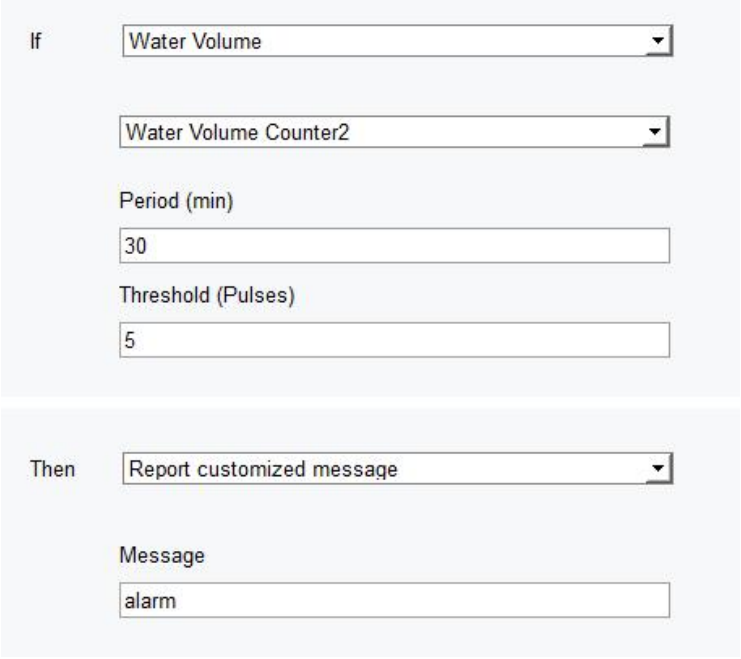
Action Field:

Byte	1	2	3-13
Description	03	01: Report Interface 1 Status 02: Report Interface 2 Status	00...00

Or

Byte	1	2	3-10	11-13
Description	03	03	Custom message content	000000

Example:



ff55 0500 03021c0005000000 0000000000 0303616c61726d000000000000					
Channel	**Type**	**Rule ID**	**Enable**	**Condition**	**Action**
ff	55	05=>5	00=disable	02=GPIO2 1c00=>00 1c=30 minutes 05 00 00 00=>00	Send message: 61 6c 61 72 6d=> 97 108 97 114 109=alarm (hex to ascii)

				00 00 05=5 pulses	

4) Condition: Every increase of water volume

Condition Field:

Byte	1	2	3-6	7-13
Description	04	01: GPIO1 02: GPIO2	Threshold (Pulses)	00....00

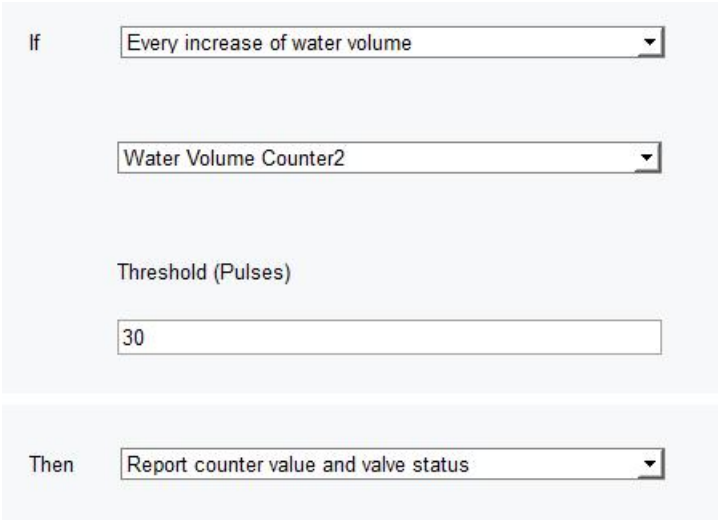
Action Field:

Byte	1	2	3-13
Description	03	01: Report Interface 1 Status 02: Report Interface 2 Status	00...00

Or

Byte	1	2	3-10	11-13
Description	03	03	Custom message content	000000

Example:



ff55 0600 04021c000000000000000000000 03020000000000000000000000					
Channel	**Type**	**Rule ID**	**Enable**	**Condition**	**Action**
ff	55	06=>6	00=disable	02=GPIO2 1c 00 00 00=>00 00 00 1c=30 pulses	02=Report Interface 2 Status

Note:

1) D2D rule has higher execute priority than types of rules.

2) When the device has multiple rules that are conflicted, the device will execute the rule with front number ID in priority.

3.5.2 Enquire Rule Content

Enquire format:

Channel	Type	Value
ff	53	Rule ID (range: 1-16)

Reply format:

Channel	Type	Rule ID	Enable	Condition Field	Action Field
fe	53	01~10 (1~16)	00: disable 01: enable	See Set Rule	See Set Rule

Example: Check rule 10 content.

ff530a		
Channel	**Type**	**Value**
ff	53	0a = rule 10

Reply:

fe53 0a01 02010000000000000000000000 01020101 2c010000000000000					
Channel	**Type**	**Rule ID**	**Enable**	**Condition**	**Action**
fe	53	0a=>10	01=enable	0100=>00 01 D2D command is 0001	02=valve 2 01=open 01=time control enable 2c 01 00 00=>00 00 01 2c=300s=5 minutes

3.5.3 Enquire and Set Rule Status

Basic format 1:

Channel	Type	Command	Value
ff	4b	00: get rule status 01: set rule status 02: delete rule	2 Bytes (16 bits) Every bit indicate one rule 1: enable ; 0: disable or delete

Basic format 2:

Channel	Type	Command	Rule ID	Enable
ff	4b	03: set one rule status 04: delete rule plan	1 Byte, 01 to 10 (1~16)	01: enable 00: disable or delete

Note: When the device has multiple schedule plan settings that are conflicted, the device will only execute one plan whose item number is largest.

Example:

1. Check rule enable or disable status.

ff4b000000			
Channel	**Type**	**Command**	**Value**
ff	4b	00 = get	0000

Reply:

fe4b000200			
Channel	**Type**	**Command**	**Value**
fe	4b	00 = get	02 00 => 00 02 = 0000 0000 0000 0010 Only rule 2 is enabled, other are disabled or do not have content

2. Set rule 2 as enable and others as disabled.

Type 1:

ff4b010200			
Channel	**Type**	**Command**	**Value**
ff	4b	01 = set	02 00 => 00 02 = 0000 0000 0000 0010 Rule 2 are enabled and other are disabled

Type 2:

ff4b030201				
Channel	**Type**	**Command**	**Number**	**Value**
ff	4b	03 = set	02	01 = enabled

3. Delete rule 10.

Type 1:

ff4b02fffd			
Channel	**Type**	**Command**	**Value**
ff	4b	02 = delete	ff fd => fd ff = 1111 1101 1111 1111 Bit10 = 0 means Delete plan 10

Type 2:

ff4b040a00				
Channel	**Type**	**Command**	**Number**	**Value**
ff	4b	04 = delete	0a = 10	00 = deleted

4. Historical Data Enquiry

UC51x series support sending downlink commands to enquire historical data for specified time point or time range. Before that, ensure the device time is correct and data storage feature was enabled to store the data.

Command format:

Channel	Type	Description
fd	6b (Enquire data in time point)	4 Bytes, unix timestamp
fd	6c (Enquire data in time range)	Start time (4 bytes) + End time (4 bytes), Unix timestamp
fd	6d (Stop query data report)	ff
ff	6a (Report Interval)	3 Bytes Byte 1: 01 Byte 2-3: interval time, unit:s range: 30~1200s (60s by default)

Reply format:

Channel	Type	Description
fc	6b/6c	00: data enquiry success 01: time point or time range invalid 02: no data in this time or time range
20	ce (Historical Data)	Data time stamp (4B) + Interface Status (1B) + Pulse Counter (4B)

Interface Status:

Bit	7-5	4	3	2	1	0
Description	000	0: valve 1 1: valve 2	1	DI status 0: closed, 1: open	Work Mode 0: Counter 1: DI	Valve Status 0: closed, 1: open

Note:

1. The device only uploads no more than 300 data records per range enquiry.
2. When enquiring the data in time point, it will upload the data which is closest to the search point within the reporting interval range. For example, if the device reporting interval is 10 minutes and users send command to search for 17:00's data, if the device find there is data stored in 17:00, it will upload this data; if not, it will search for data between 16:50 to 17:10 and upload the data which is closest to 17:00.

Example:

1. Enquire historical data between 2023/03/09 17:00:00 to 2023/03/09 17:10:40.

fd6c 10a00964 90a20964		
Channel	**Type**	**Value**
fd	6c (Enquire data in time range)	Start time: 10a00964 => 6409a010 = 1678352400 =2023/03/09 17:00:00 End time: 90a20964 => 6409a290 = 1678353040 =2023/03/09 17:10:40

Reply:

fc6c00		
Channel	**Type**	**Value**
fc	6c (Enquire data in time range)	00: data enquiry success

20ce 3fa10964 0098000000 20ce 3fa10964 1700000000			
Channel	**Type**	**Time Stamp**	**Value**
20	ce (Historical Data)	3fa10964 => 2023/03/09 17:05:00	00: Valve 1 close 98 00 00 00 => 00 00 00 98 = pulse counter of GPIO1 is 152 17=10111=>Valve 2 open, DI status of GPIO2 is open

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