Embedded low power radio modem

SLR-434M

Smart RF modem

Serial communication

Operation Guide

Version 1.1 (Sep. 2018)

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1. Summary

The smart RF modem SLR-434M enables you to send and receive data or contact signal wirelessly, with various parameters set via the serial port of a PC using proprietary commands.
This operation guide explains how to operate the SLR-434M using the commands.
For the details of the SLR-434M, refer to the operation guide *"SLR-434M"*.

2. Control commands and control responses

2.1 Basic format of control commands and control responses

• Control command basic format

Prefix + command name + value + [CR] + [LF]

Prefix: '@'=40h, a code that indicates the start of the command string.
Command name: A code of 2 ASCII characters.
Values: A code of 2 ASCII characters corresponding to each command.

• Control response basic format

Prefix + command name + [=] + value + [CR] + [LF]

Prefix: '*' = 2Ah, a code that indicates the start of the response string.
Command name: A code of 2 ASCII characters for the received command.
Values: A code of 2 ASCII characters corresponding to each command.

/W option

Values set with the commands can also be saved.
If the value set for each command is saved, the set value becomes the initial value next time the power is switched on.
To save the value, add "/W" to the basic command format above.

Prefix + command name + value + [/] + [W] + [CR] + [LF]

If you save the values set with the commands, the following response is output before the response basic format above.

[*] + [W] + [R] + [=] + [P] + [S] + [CR] + [LF]

If you save the value set, wait for the "*WR=PS" response before switching the power off.

Acquiring the currently set value

If you did not add a value in the command basic format, the currently set value is output in accordance with the response basic format.

2.2 “@CH” Set frequency channel

Sets the frequency channel to be used.
The default setting at shipment is ‘4’'A’ (434.000 MHz).
Input the 2-character ASCII code after ‘@CH’ to set the channel.

Values: ‘0’ ‘0' - ‘8’ ‘8’ (A hexadecimal ASCII code showing channels from 0 to 136)

Example: Change to 0Eh (change to channel 14)
Control command: @CH0E
Control response: *CH=0E

* Refer to the channel table in “*10. Channel plan*”.

2.3 “@MO” Set radio communication mode

Sets the wireless communication mode.
There are the following 5 types of wireless communication mode.

Mode	Content	Value
FSK binary mode	A mode with FSK modulation for use as a transparent modem.	00
FSK command mode	A mode with FSK modulation for sending and receiving data using proprietary commands.	01
LoRa binary mode	A mode with LoRa modulation for use as a transparent modem.	02
LoRa command mode	A mode with LoRa modulation for sending and receiving data using proprietary commands.	03
Air monitor mode	A mode for measuring the RSSI level of each channel. *a separate application is needed.	04

The default setting at shipment is ‘0’ ‘3’ (LoRa command mode).

Input the 2-character ASCII code after ‘@MO’ to set the communication mode.

Values: ‘0’ ‘0’: FSK binary mode
‘0’ ‘1’: FSK command mode
‘0’ ‘2’: LoRa binary mode
‘0’ ‘3’: LoRa command mode
‘0’ ‘4’: Air monitor mode

Example: Change to 01h (Change to the FSK command mode)
Control command: @MO01
Control response: *WR=PS
*MO=01

*If a wireless communication mode is set, the setting is automatically saved and the device restarts. (Even if the "/W" option is not used, the response "*WR＝PS" is returned.)

After restarting, the following string is output to the serial port.

"FSK BIN MODE": When set to the FSK binary mode

"FSK CMD MODE": When set to the FSK command mode

"LORA BIN MODE": When set to the LoRa binary mode

"LORA CMD MODE": When set to the LoRa command mode

"AIR MONITOR MODE": When set to the air monitor mode

*When set to the FSK binary mode or the LoRa binary mode, commands are not accepted as the SLR-434M works as a transparent modem.
If you want to change the mode, set the INI terminal of the SLR-434M to Low for at least 3 seconds (See *"SLR-434M"* operation guide).

* When you changed the communication mode, wait for the string such as "LORA CMD MODE" that is output after restarting before you turn off the power.

2.4 "@SF" Set the number of chips (spreading factor) with LoRa modulation

Sets the number of chips for LoRa modulation.

The default setting at shipment is '0' '0' (128 chips).

Input the 2-character ASCII code after '@SF' to set the number of chips.

Values: '0' '0': 128 chips (Spreading factor: 7, Measured value: 245 bps)
'0' '1': 256 chips (Spreading factor: 8, Measured value: 146 bps)
'0' '2': 512 chips (Spreading factor: 9, Measured value: 86 bps)
'0' '3': 1024 chips (Spreading factor: 10, Measured value: 49 bps)
'0' '4': 2048 chips (Spreading factor: 11, Measured value: 27 bps)
'0' '5': 4096 chips (Spreading factor: 12, Measured value: 15 bps)

Example: Set to 00h (LoRa 128 chips)
Control command: @SF00
Control response: *SF=00

*As the number of chips increases, the impact of the Doppler effect becomes greater when moving around, and communication becomes less reliable.

2.5 "@EI" Set Equipment ID

Sets the individual ID for each device.
The default setting at shipment is '0' '1'.
Input the 2-character ASCII code after '@EI' to set the ID.

Values: '0' '0' - 'F' 'F' (A hexadecimal ASCII code showing values from 0 to 255)

Example: Change to 0Ah (Set the Equipment ID to 10)
Control command: @EI0A
Control response: *EI=0A

2.6 “@DI” Set Target station ID

Specifies the target station to communicate with.
The default setting at shipment is ‘0’ ‘1’.
Input the Equipment ID of the target station after ‘@DI’ with the 2-character ASCII code.

Values: ‘0’ ‘0' - ‘F’ ‘F’ (A hexadecimal ASCII code showing values from 0 to 255)

Example: Change to 0Ah (Set the Target station ID to 10)
Control command: @DI0A
Control response: *DI=0A

*If the Target station ID is set to ‘0’ ‘0’ and transmitted, communication changes to multi-address calling within the Group.

*When performing communication with one base unit and several slave units (1:N communication), the base unit can communicate with a specific slave unit by specifying the Equipment ID set for the slave unit as the target station with the @DI command..

See “*2.14 Building a communication system between radio stations*” for details.

2.7 “@GI” Set Group ID

The Group ID is the ID that identifies a group in the user system. Set the same Group ID for all the radio stations within the group. Maintain Group IDs as identification numbers when building other systems.
The default setting at shipment is ‘0’ ‘0’.
Input the 2-character ASCII code after ‘@GI’ to set the ID.

Values: ‘0’ ‘0' - ‘F’ ‘F’ (A hexadecimal ASCII code showing values from 0 to 255)

Example: Change to 0Ah (set the Group ID to 10)
Control command: @GI0A
Control response: *GI=0A

2.8 “@UI” Set User ID

User identification ID assigned to a user. Communication is not possible unless all equipment within the user system is set with the same User ID. When a single user builds multiple systems, they are identified with a Group ID.

The setting command is ‘@UI + User ID + ‘,’ + password.

The default setting at shipment is ‘0’ ‘0’ ‘0’ ‘0’.

It can be used without User IDs, however, we recommend that you set a User ID to prevent radio interference within a given area. If you require User IDs, please contact Circuit Design, Inc.

Input the 4-character ASCII code after ‘@UI’ to set the ID, and after ‘,’ enter a 4-character ASCII code password.

Example: Control command: @UI0000,XXXX (XXXX is the password part)
Control response: *WR=PS
*UI=0000 (To set back to 0000, input 2367 for password.)

* When the UI command is issued, the setting is automatically saved and the device restarts. (Even if the "/W" option is not used, a *WR response is returned.)

2.9 “@RS” Acquire RSSI for the last data received

If this command is implemented immediately after receiving data, you can acquire the Received Signal Strength Indicator (RSSI) value when the data was received. The output format for the RSSI value is as follows.

*RS=###dBm (The ### part is the RSSI value when the data was received)

Example: Control command: @RS

Control response: *RS=-82dBm

2.10 “@RA” Acquire the current RSSI value

Acquires the current Received Signal Strength Indicator (RSSI) value of the channel set.

*RA=###dBm (The ### part is the RSSI value when the data was received)

Example: Control command: @RA

Control response: *RA=-122dBm

2.11 “@CI” RSSI output on/off during carrier sensing (LoRa command mode only)

Sets whether to output the RSSI value automatically to the UART during carrier sensing.

When set to "Output", the RSSI value is output following the usual response when wireless transmission is performed with the command such as @DT. For more details, see *"6.2 Response to carrier sensing"*.

The default setting at shipment is ‘0’ ‘0’ (No output).

Input the 2-character ASCII code after ‘@CR’ to set the status.

Values: ‘0’ ‘0’: No output to the UART

‘0’ ‘1’: Output to the UART

Example: Change to 01 (Output to the UART)

Control command: @CI01

Control response: *CI=01

Important note:

If the SLR-434M receives interference signal of more than -40 dBm from other radio devices, even if the receiving frequencies are different, correct RSSI values may not be acquired and also carrier sensing may determine that transmission is not possible.
When setting up the radio devices, try to keep the distance between them as long as possible.

The RSSI value acquired with the @CI command may be different from the value acquired with the @RA command. This is because the RSSI acquisition with the @CI uses a process to alleviate the influence of interference.

2.12 “@FV”, “@VR” Acquire firmware version

You can acquire the firmware version.

Example 1: Control command: @FV

Control response: *FV = #.###,SLR-434M (The version goes in the #.### part.)

Example 2: Control command: @VR

Control response: *VR = SLR-434M_V#R###, (The version goes in the # ### part.)

2.13 “@SN” Acquire Serial Number

You can acquire the Serial Number.

Example: Control command: @SN

Control response: *SN = $######## (The $######## part is the serial number consisting of 1-digit alphabet and 7-digit numbers.)

2.14 Building a communication system between radio stations

The SLR-434M can be used for building 1:1, 1:N, and M:N systems.
Equipment IDs from 01h to FFh can be specified, and a maximum of 255 units can be connected in 1 group.
With 1:1 (1:N) communication, specify the Target station ID with the @DI command and send data with the @DT command.

- 1:1 system for communication within a group
  By setting the same Group ID and setting the Target station ID and Equipment ID as a pair, you can create a 1:1 system.
  *Set the Target station ID to something other than 00h.

  Setting example:

Each ID	Device 1	Device 2
Group ID	02h	02h
Target station ID	03h	05h
Equipment ID	05h	03h

- 1:N and M:N systems for communication within a group
  If the Group IDs are set the same and the Target station ID specified for the local station and the Equipment ID of the target station match, data is output to the target station.
  In a 1:N system, it is also possible to build an M:N system in which all the units have an equal relationship.

  Setting example: Settings for communication between a master unit and 3 slave units.

Each ID	Master	Slave 1	Slave 2	Slave 3
Group ID	02h	02h	02h	02h
Target station ID	02h, 03h, 04h*	01h	01h	01h
Equipment ID	01h	02h	03h	04h

*In this example, the master unit specifies one of the three slave units for each transmission. Before sending data with the data transmission command, specify the Equipment ID set for each slave unit with the Target station ID setting command.

- Multi-address calling within a group
  If the Target station ID is specified as 00h at the master station and data is transmitted, all target stations in the group will receive the data at the same time, irrespective of the Equipment ID.

- Communication between groups
  When several groups are created with the same Target station ID and Equipment ID set as pairs, it is possible to communicate with another group by changing the Group ID when transmitting.

  Setting example 1:
  Group 1

Each ID	Device 1	Device 2
Group ID	02h	02h
Target station ID	05h	03h
Equipment ID	03h	05h

  Group 2

Each ID	Device 1	Device 2
Group ID	03h	03h
Target station ID	05h	03h
Equipment ID	03h	05h

  Setting example 2:
  Group 1

Each ID	Master	Slave 1	Slave 2	Slave 3
Group ID	02h	02h	02h	02h
Target station ID	02h, 03h, 04h*	01h	01h	01h
Equipment ID	01h	02h	03h	04h

  Group 2

Each ID	Master	Slave 1	Slave 2	Slave 3
Group ID	03h	03h	03h	03h
Target station ID	02h, 03h, 04h*	01h	01h	01h
Equipment ID	01h	02h	03h	04h

  *In this example, the master unit specifies one of the three slave units for each transmission. Before sending data with the data transmission command, specify the Equipment ID set for each slave unit with the Target station ID setting command.

3. Error responses to control commands

3.1 Basic format of error responses

Prefix + error string + [=] + error code + [CR] + [LF]

Prefix: '*' = 2Ah, a code that indicates the start of the error response string.
Error string: 'E' 'R', a code of 2 ASCII characters.
Error code: A code of 2 ASCII characters representing an error code corresponding to each command.

Example: [*] + [E] + [R] + [=] + [0] + [4] + [CR] + [LF]

3.2 Error code for "@CH" frequency channel setting command

There are the following 3 types of error code.

Error code	Content
"02"	Output if an undefined channel is specified.
"03"	Output if the format of the frequency channel setting command is wrong.
"01"	Output when the error code is not "02" or "03".

3.3 Error code for "@MO" communication mode setting command

There are the following 3 types of error code.

Error code	Content
"02"	Output if an undefined communication mode is specified.
"03"	Output if the format of the communication mode setting command is wrong.
"01"	Output when the error code is not "02" or "03".

3.4 Error code for "@SF" number of chips setting command

There are the following 3 types of error code.

Error code	Content
"02"	Output if an undefined number of chips is specified.
"03"	Output if the format of the number of chips setting command is wrong.
"01"	Output when the error code is not "02" or "03".

3.5 Error code for "@EI" Equipment ID setting command

There are the following 2 types of error code.

Error code	Content
"03"	Output if the format of the Equipment ID setting command is wrong.
"01"	Output when the error code is not "03".

3.6 Error code for "@DI" Target station ID setting command

There are the following 2 types of error code.

Error code	Content
"03"	Output if the format of the Target station ID setting command is wrong.
"01"	Output when the error code is not "03".

3.7 Error code for “@GI” Group ID setting command

There are the following 2 types of error code.

Error code	Content
“03”	Output if the format of the Group ID setting command is wrong.
“01”	Output when the error code is not “03”.

3.8 Error code for “@UI” User ID setting command

There are the following 2 types of error code.

Error code	Content
“03”	Output if the format of the User ID setting command is wrong.
“04”	Output if the password does not match.

3.9 Error code for “@RA” Current RSSI acquisition command

There is the following error code.

Error code	Content
“05”	Output if the SLR-434M is not in receiving state.

3.10 Error code for the “@CI” RSSI output on/off during carrier sensing

There are the following 3 types of error code.

Error code	Content
“02”	Output if an undefined setting value is specified.
“03”	Output if the format of the setting command is wrong.
“01”	Output when the error code is not “02” or “03”.

3.11 Other

If there is an undefined control command, the error code “01” is output.

4. Wireless data transmission commands and data transmission responses

Using data transmission commands, you can send any data you want wirelessly.
If the transmission data is set correctly, a data transmission response is returned.

4.1 Basic format of data transmission commands and responses

Basic format of data transmission commands

Prefix + command name + transmission data byte count + transmission data + [CR] + [LF]

Prefix: '@'=40h, a code that indicates the start of the command string.
Command name: 'D' 'T', a code of 2 ASCII characters.
Transmission data byte count: Specify the byte count of user data in hex ('0' '0' to 'F' 'F').
Transmission data: Byte strings of user data. You can set all binary data from 00h to FFh Hex.

Example: Sending the character string "ABCDEF"

[@] + [D] + [T] + [0] + [6] + [A] + [B] + [C] + [D] + [E] + [F] + [CR] + [LF]

Example: Sending the binary data 00h, 01h, 02h, 03h, 04h

[@] + [D] + [T] + [0] + [5] + [00h] + [01h] + [02h] + [03h] + [04h] + [CR] + [LF]

Example: Sending 255-byte data

[@] + [D] + [T] + [F] + [F] + ‥‥‥‥‥‥‥‥‥‥‥‥‥‥‥‥‥‥‥‥‥‥‥‥ + [CR] + [LF]

Basic format of responses to data transmission commands

Prefix + response name + [=] + transmission data byte count + [CR] + [LF]

Prefix: '*' = 2Ah, a code that indicates the start of the response string.
Response name: 'D' 'T', a code of 2 ASCII characters.
Data byte count: The same value as the data byte count set with transmit data command is set.

Example: Data transmission command

[@] + [D] + [T] + [0] + [6] + [A] + [B] + [C] + [D] + [E] + [F] + [CR] + [LF]

Data transmission response

[*] + [D] + [T] + [=] + [0] + [6] + [CR] + [LF]

Note:
In wireless communication, the longer data length you use, the higher communication error probability there will be. Try to minimize the data length.
It is recommended to use a data length of 45 bytes or less in the FSK command mode.
(In the FSK command mode, if the size of transmission data exceeds 45 bytes, the data is sent in several packets.)

5. Error responses to data transmission commands

5.1 Basic format of error responses

Prefix + error string + [=] + error code + [CR] + [LF]

Prefix: '*' = 2Ah, a code that indicates the start of the error response string.
Error string: 'E' 'R', a code of 2 ASCII characters.
Error code: A code of 2 ASCII characters representing an error code corresponding to each command.

Example: [*] + [E] + [R] + [=] + [0] + [3] + [CR] + [LF]

The details of the error codes are shown in the table below.

Error code	Content
"03"	Output if the format of the data transmission command is wrong.
"01"	Output when the error code is not "03".

6. Information responses (LoRa command mode only)

When the LoRa command mode is set, an information response is output if the device cannot emit radio waves due to carrier sensing or correlation sensing and when data transmission completes. In other communication modes such as FSK command mode, FSK binary mode, LoRa binary mode, the information response is not output.

6.1 Basic format of information responses

Prefix + information string + [=] + response code + [CR] + [LF]

Prefix: '*' = 2Ah, a code that indicates the start of the information response string.
Information string: 'I' 'R', a code of 2 ASCII characters.
Response code: A code of 2 ASCII characters representing each response.

Example: [*] + [I] + [R] + [=] + [0] + [3] + [CR] + [LF]

6.2 Response to carrier sensing (only with LoRa command mode)

The SLR-434M performs carrier sensing automatically internally.
When transmitting data, if the channel selected is being used by other equipment, the device does not emit radio waves.
When carrier sensing determines that transmission is not possible, the character string "*IR=01" is output after the data transmission response.
If data cannot be transmitted, it is not retransmitted.

Example: Data transmission command

[@] + [D] + [T] + [0] + [6] + [A] + [B] + [C] + [D] + [E] + [F] + [CR] + [LF]

Data transmission response

[*] + [D] + [T] + [=] + [0] + [6] + [CR] + [LF]

When data could not be transmitted

[*] + [I] + [R] + [=] + [0] + [1] + [CR] + [LF]

If RSSI output during carrier sensing is enabled with '@CI01', the RSSI value is output following the above response.
(The RSSI value is also output when transmission is performed with the '@PT' command or '@PMxx' command.)

Example) When the RSSI value is -110 dBm
[R] + [S] + [S] + [I] + [=] + [-] + [1] + [1] + [0] + [d] + [B] + [m] + [CR] + [LF]

6.3 Response to correlation sensing (only with LoRa command mode)

With LoRa modulation, communication is possible at levels lower than city noise, so it is not possible to check for the presence of other LoRa modulation radio waves before emitting with the carrier sensing in 6.2 alone.
Therefore, the SLR-434M uses a proprietary method called correlation sensing to check for the presence of other LoRa modulation radio waves before emitting waves.
When correlation sensing determines that transmission is not possible due to the presence of other LoRa modulation radio waves, the character string “*IR=02” is output after the data transmission response.
If data cannot be transmitted, it is not retransmitted.

Example: Data transmission command

[@] + [D] + [T] + [0] + [6] + [A] + [B] + [C] + [D] + [E] + [F] + [CR] + [LF]

Data transmission response

[*] + [D] + [T] + [=] + [0] + [6] + [CR] + [LF]

When data could not be transmitted

[*] + [I] + [R] + [=] + [0] + [2] + [CR] + [LF]

6.4 Data transmission complete response (only with LoRa command mode)

When the LoRa command mode is set, the following response is output after all the data set with @DT is sent.
(This response is also output when contact signal is transmitted with the PT command.)

[*] + [I] + [R] + [=] + [0] + [3] + [CR] + [LF]

*To send data continuously, set the transmission data as follows.

FSK command mode: Wait for the data transmission response
LoRa command mode: Wait for the data transmission complete response

7. Receive data from the target station

If the SLR-434M receives data from the target station, it outputs the received data with the following format.

7.1 Basic format of received data

Prefix + response name + [=] + received data byte count + received data + [CR] + [LF]

Prefix: '*' = 2Ah, a code that indicates the start of the response string.

Response name: 'D' 'R', a code of 2 ASCII characters.

Received data byte count: '0' '0' to 'F' 'F' (A hexadecimal ASCII code showing values from 0 to 255)

Received data: Received data

Example: Data transmission command on the transmitter side

[@] + [D] + [T] + [0] + [6] + [A] + [B] + [C] + [D] + [E] + [F] + [CR] + [LF]

Received data on the receiver side

[*] + [D] + [R] + [=] + [0] + [6] + [A] + [B] + [C] + [D] + [E] + [F] + [CR] + [LF]

8. Contact function

The SLR-434M enables you to transmit and receive contact data wirelessly using the DIO terminals and proprietary commands
This chapter explains the contact function and the commands used for contact data communication. For the DIO terminals, refer to the operation guide *"SLR-434M"*.

For safety operation of the contact function, it is recommended to set a user ID ('@UI') and a Unique ID ('@PI').
(The PI command was added to the FW version 1.081 and later.)

8.1 Basic format of control commands and control responses

• Control command basic format

Prefix + command name + value + [CR] + [LF]

Prefix: '@'=40h, a code that indicates the start of the command string.
Command name: A code of 2 ASCII characters.
Value: A code of 2 ASCII characters corresponding to each command.

• Control response basic format

Prefix + command name + [=] + value + [CR] + [LF]

Prefix: '*' = 2Ah, a code that indicates the start of the response string.
Command name: A code of 2 ASCII characters for the received command.
Value: A code of 2 ASCII characters corresponding to each command.

/W option

Values set with the following commands can also be saved.

@PS command
@PO command
@PM command
@PF command

If the value set for each command is saved, the set value becomes the initial value next time the power is switched on.
To save the value, add "/W" to the basic command format above.

Prefix + command name + value + [/] + [W] + [CR] + [LF]

If you save the values set with the commands, the following response is output before the response basic format above.

[*] + [W] + [R] + [=] + [P] + [S] + [CR] + [LF]

If you save the value set, wait for the response "*WR=PS" before switching the power off.

Acquiring the currently set values

If you did not add a value in the command basic format, the currently set value is output in accordance with the response basic format.

8.2 “@PI” Set Unique ID for contact communication

Setting the Unique ID for contact communication ensures safety operation of the contact function.
All radio stations in a system need to be set with the same Unique ID.
Since the serial number individually allocated to the SLR-434M unit is read out and used as the Unique ID, the user cannot use the Unique IDs allocated to the units other than the units they own. This prevents malfunctions due to interference with other users.

Identification by setting '@ EI', '@ DI', '@ GI', '@ UI', that is explained in the previous sections, is also available in contact data communication. However, since the IDs other than User ID can be set to any value, there is a possibility that radio stations set with the same ID accidentally communicate each other.
Identification by the Unique ID can be freely set and used by the user.

The serial number of the SLR-434M consists of 1 alphabetical letter and 7-digit numbers. The serial number described below means the 7-digit numbers.

8.2.1 Check Unique ID currently set

Control command: @PI
Example 1) Control response: * PI=000000 (000000 means the Unique ID is set to 'Not using'.)
Example 2) Control response: * PI=12D687 (When the Unique ID is set, the ID is returned.
12D687 (Hex) = 1234567)

* When the Unique ID is used, 3-byte data is added to the data format, resulting in a longer transmission time.

8.2.2 Set to 'Not using Unique ID' (factory setting)

Control command: @PIC
Control response: *WR=PS (This response means the setting is saved.)
*PI=000000 (Cleared to 000000)

8.2.3 Set Unique ID to the local station

Set the Unique ID to the local station with its own serial number.

Example) When the SLR-434M of the local station has "S/No. A1234567" on its label.

Control command: @PIS
Control response: *WR=PS (This response means the setting is saved.)
*PI=12D687 (12D687 (Hex) = 1234567)

8.2.4 Receive Unique ID and set it as its own Unique ID

Sets the local station into a ready state to receive the Unique ID sent from other equipment. .

Control command: @PIR
Control response: *PI=Ready (Ready to receive the Unique ID)

(Receive response example)

*PR=100212D687

100212D687 means as follows:
10: Function code for Unique ID setting
02: Equipment ID of the equipment which sent the Unique I D
12D687: Received Unique ID

*WR=PS (This response means the setting is saved.)
*PI=12D687 (Unique ID set to the local station)

*The ready state is cancelled when the function code for Unique ID setting is received and also when other '@PI' commands ('@PI', '@PIC', '@PIS', '@PIT') are executed. .

8.2.5 Transmit Unique ID

Transmit the Unique ID of the local station to the target station that is in a ready state to receive the Unique ID.

Control command: @PIT
Control response: *PI=12D687 (The transmitted ID is returned)

* Set the target station to the Unique ID waiting mode (ready state) before executing this command.
It is possible to set a Unique ID to multiple target stations simultaneously.

* If this command is executed when 'Not using Unique ID' is set (PI=000000), the target stations are also set to 'Not using Unique ID'.

8.2.6 Unique ID setting examples

When performing contact communication between multiple devices, use the serial number of one of the devices as the Unique ID.
The examples below show the steps to set the Unique ID of the Device 1 to other devices, provided that all the devices are set to the same GI (Group ID) and UI (User ID).

Example 1: Set the Unique ID of the Device 1 to other devices

Step	Commands and responses used with each device			
	Device 1 EI=01 S/No: A0001001	Device 2 EI=02 S/No.A0001002	Device 3 EI=03 S/No.A001003	Description
1		@PIR *Ready	@PIR *Ready	Set Device 2 and Device 3 to the Unique ID waiting mode (ready state).
2	@DI00 *DI=00			Set the DI of the Device 1 to "00" to communicate with the Device 2 and Device 3 simultaneously (multi-address calling) .
3	@PIS *WR=PS *PI=0003E9			Set Unique ID to the Device 1 with its own serial number (1001 = 3E9 in hex)
4	@PIT *PI=0003E9			Device 1 transmits its Unique ID (0003E9). Device 2 and Device 3 receive and save the ID.
		*PR=10010003E9 *WR=PS *PI=0003E9	*PR=10010003E9 *WR=PS *PI=0003E9	

Example 2: Device 3 sets the Unique ID set in the example 1 to Device 4.

Step	Commands and responses used with each device		
	Device 3 EI=03 S/No:A0001003	Device 4 EI=04 S/No:A0001004	Description
5		@PIR *Ready	Set Device 4 to the Unique ID waiting mode (ready state).
6	@DI04 *DI=04		Set the DI of the Device 3 to "04" to communicate with the Device 4.
7	@PIT *PI=0003E9	*PR=10030003E9 *WR=PS *PI=0003E9	Device 3 transmits the currently set Unique ID (0003E9). Device 4 receives and saves the ID.

8.3 “@PS” Set input/output port

Set whether to use each DIO terminal with the input port or output port.
The default setting at shipment is ‘F’ ‘F’ (All DIO terminals are input ports).
Input the 2-character ASCII code after ‘@PS’ to set the input/output status of each DIO terminal.

Value	DIO terminal								Local station or Target station
	8	7	6	5	4	3	2	1	
‘F’ ‘F’	Input				Input		Input	Input	Local
‘0’ ‘0’	Output				Output		Output	Output	Target
‘F’ ‘E’	Input				Input		Input	Output	Local
‘0’ ‘1’	Output				Output		Output	Input	Target
‘F’ ‘D’	Input				Input		Output	Input	Local
‘0’ ‘2’	Output				Output		Input	Output	Target
‘F’ ‘C’	Input				Input		Output	Output	Local
‘0’ ‘3’	Output				Output		Input	Input	Target
‘F’ ‘3’	Input				Output		Input	Input	Local
‘0’ ‘C’	Output				Input		Output	Output	Target
‘F’ ‘2’	Input				Output		Input	Output	Local
‘0’ ‘D’	Output				Input		Output	Input	Target
‘F’ ‘1’	Input				Output		Output	Input	Local
‘0’ ‘E’	Output				Input		Input	Output	Target
‘F’ ‘0’	Input				Output		Output	Output	Local
‘0’ ‘F’	Output				Input		Input	Input	Target

Each bit of the value means input or output (1= Input, 0=Output).
'DIO 8 to DIO 5' and 'DIO 4 and DIO 3' cannot be set individually.

Example: Change to FCh (Set DIO8 to DIO3 for input and DIO2 to DIO1 for output)

Control command: @PSFC
Control response: *PS=FC

*Set the input/output ports of each DIO terminal for the other party in communication as a pair, in accordance with the setting values of the input/output ports of each DIO terminal. (The status of the terminal of the local station set in the input port is sent to the terminal of the target station set in the output port.)

Example: Local station: @PSFC (Set DIO8 to DIO3 for input and DIO2 to DIO1 for output)
Target station: @PS03 (Set DIO8 to DIO3 for output and DIO2 to DIO1 for input)

Note:
The output status of the output ports set with the '@PS' command are the status registered with the '@PO##/W' command or the status set with '@PO##' command.
Even after the output status is changed with the '@PT##' command or '@PM##' command issued from the target station, the status is set back to the status set with '@PO##/W' or '@PM##' when changing the port setting by executing the '@PS' command.

8.4 "@PO" Set and acquire the local station port status

8.4.1 Set the status of the local station port

Set the status of the port (High or Low) for each DIO terminal of the local station already set in the output port. The status of all ports are set to Low by default.

The setting for the DIO terminal set for the input port can be either High or Low. However, when changed to the output port, the set status is enabled (see Note of 8.4.2).

Input the 2-character ASCII code (Hex) after '@PO'. The values from bit 7 to bit 0 corresponds to the status of DIO 8 to DIO1.

Example: Set DIO8 to DIO3 to the output port and DIO2 to DIO1 to the input port with @PS03, and set the status of each output port as follows

I/O setting	DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
	Output port						Input port	
Output status setting (Input status)*	Low	High	High	Low	Low	High	(Low)	(Low)

* Input status is shown in brackets

Control command: @PO64 (The same if @PO65, @PO66, or @PO67 are set.)
Control response: *PO=64

8.4.2 Acquire the status of the local station port

Acquire the status of the port (High or Low) of each DIO terminal of the local station already set in the input port.
The current output status (High or Low) is acquired for each DIO terminal already set in the output port.
When inputting '@PO', the status of each port is returned in hexadecimal notation as the control response.

Example: When @DIO8 to DIO3 are set to input port and DIO2 to DIO1 are set to output port with @PSFC, and each port is the following status:

I/O setting	DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
	Input port						Output port	
Output status setting (Input status)	(Low)	(High)	(High)	(Low)	(Low)	(High)	High	Low

* Input status is shown in brackets

Control command: @PO
Control response: *PO=66

Note: The following example shows how the setting already set with @PO is enabled when the port setting is changed from input to output with @PS:

Example: After setting High to the input ports DIO4 to DIO1 with @PO, change the port setting of the DIO4 to DIO1 to output port with @PS.

Step	Command	Response	DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
1	@PSFF	*PS=FF	Input port							
2	@PO0F	*PO=00	(Low)	(Low)	(Low)	(Low)	(Low)	(Low)	(Low)	(Low)
3	@PSF0	*PS=F0	Input port				Output port			
4	@PO	*PO=0F	(Low)	(Low)	(Low)	(Low)	High	High	High	High

* Input status is shown in brackets

8.5 “@PT” Set and acquire the target station port status

8.5.1 Acquire the status of the target station port

Acquire the status of the port (High or Low) of each DIO terminal of the target station already set in the input port.
The current output status is acquired for the DIO terminal already set in the output port.

NOTE

With the control response, the status of the DIO terminals of the local station are output.
The status of the DIO terminals of the target station can be acquired with the '*PR' response (See "*8.8 Contact function responses"*).

Example: When local station DIO terminals @DIO8 to DIO3 are set to input port and DIO2 to DIO1 are set to output port with @PSFC, and the port of each DIO terminal is the following status:

I/O setting	DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
	Input port						Output port	
Output status setting (Input status)*	(Low)	(High)	(High)	(Low)	(Low)	(High)	High	Low

* Input status is shown in brackets

Control command: @PT
Control response:*PT=66 (Status of the local station)
Response from target station: *PR=040200 (When the target station ID is 02 and the port status is 00.)

8.5.2 Set the status of the target station port

Set the status of the port for each DIO terminal of the target station already set in the output port.
The setting for the DIO terminal set for the input port can be either High or Low.

Input the 2-character ASCII code (Hex) after ‘@PT’ to set the port status.
The /W option cannot be used.

Example: When target station DIO terminals @DIO8 to DIO3 are set to output port and DIO2 to DIO1 are set to input port with @PS03, and the port status of each DIO terminal of the target station is set as follows:

Target station I/O setting	DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
	Output port						Input port	
Output status setting of the target station (Input status)*	Low	High	High	Low	Low	High	(Low)	(Low)

* Input status is shown in brackets

Control command: @PT64 (The same if @PT65, @PT66, or @PT67 are set.)
Control response: *PT=64
Response from target station: *PR=040264 (When the target station ID is 02 and the port status is 64.)

* If '@PT##' is executed while the specified times transmission mode when changing input ports is set ('@PM01' to '@PM05'), transmission to the target station is performed the specified number of times, however, in this case, any response is not returned from the target station.

8.6 “@PM” Set contact function communication mode

You can set the following 3 types of communication mode for the contact function.

- Specified times transmission mode when changing input ports (LoRa/FSK command mode)
- One-way continuous transmission mode (FSK command mode only)
- Two-way continuous communication mode (FSK command mode only)

The default setting at shipment is ‘0’‘0’.
For data communication with the @DT command, use the default setting.

8.6.1 Specified times transmission mode when changing input ports (LoRa/FSK command mode)

A mode for transmitting the input port status of the local station to a target station the specified number of times when changing any of the DIO terminals (High → Low or Low → High) already set in the input port.

For example, first set DIO1 of the local station to input port and DIO1 of the target station to output port.

When the status of the DIO1 of the local station changes, the information on the change is transmitted to the target station and when the target station receives it, the output of the DIO1 of the target station changes.

(As for the output ports of the local station, the output status is transmitted to the target station.)

Input the 2-character ASCII code after ‘@PM’ to set the number of times to transmit (maximum 5 times).

By setting also the target station in this mode, the input port status of both stations can be sent to each other. For example, set DIO terminals DIO8 to DIO5 of the local station to input port, DIO4 to DIO1 to output port, DIO terminals DIO8 to DIO5 of the target station to output port, and DIO4 to DIO1 to input port. However, there is a possibility that communication is not established when both station transmit at the same time or one transmits while the other is transmitting.

Values: ‘0’ ‘1’: Transmit once
‘0’ ‘2’: Transmit twice
‘0’ ‘3’: Transmit 3 times
‘0’ ‘4’: Transmit 4 times
‘0’ ‘5’: Transmit 5 times

Example: Change to 03 (Transmit 3 times)

Control command: @PM03
Control response: *PM=03

8.6.2 One-way continuous transmission mode (FSK command mode only)

A mode for continuously transmitting the input port status of the local station already set in the input port to a target station.

It can be used for applications where all the DIO terminals of the local station are set to input ports and all the DIO terminals of the target station are set to output ports, to change the status of the corresponding DIO terminal of the target station when the status of the DIO terminals of the local station are transmitted continuously.
The transmission interval is about 50 ms, and if a situation where the contact status sent by the local station cannot be received by the target station continues for 1 s, the status of the DIO terminal of the target station already set in the output port changes to the factory default Low or the status set with @PO.

To enable this mode, set the local station to '@PM10'.

Be sure to set the target station to "PM00".

Example: Control command: @PM10
Control response: *PM=10

8.6.3 Two-way continuous communication mode (FSK command mode only)

A mode for two-way continuous transmission of the input port status of the local station to the target station, and the input port status of the target station to the local station.

For example, first set DIO terminals DIO8 to DIO5 of the local station to input port, DIO4 to DIO1 to output port, DIO terminals DIO8 to DIO5 of the target station to output port, and DIO4 to DIO1 to input port. It can be used for applications with two-way continuous communication to send the status of the input port of the DIO terminal of the local station to the output port of the target station, and the status of the input port of the target station to the output port of the local station.

The transmission interval is about 110 ms (the interval from transmission of the contact status of the local station to the target station to reception of the contact status from the target station), and if a situation where the contact status from the target station cannot be received continues for 1 s, the status of the DIO terminal of the local station already set in the output port changes to the factory default Low or the status set with @PO.

To enable this mode, set the local station to '@PM20'.

Be sure to set the target station to "PM00".

Example: Control command: @PM20
Control response: *PM=20

8.7 "@PF" Set output port holding time

When contact information is sent in the specified times transmission mode or with the '@PT##' command, the target station can set an output holding time to keep the received contact status.

This setting is not available when port status is set with '@PO##' and when the communication mode is set to the one-way continuous transmission mode or the two-way continuous transmission mode.

The setting range is from 0.1 seconds (0001) to 6553.5 seconds (FFFF).

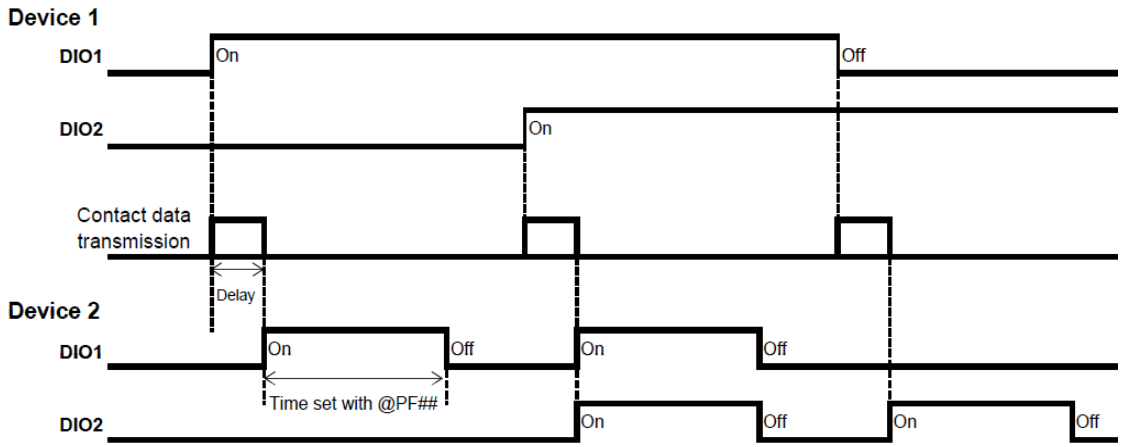
The factory setting is 0000 (no time restriction).

Input the 4-character ASCII code (Hex) after '@PF' to set the output holding time.

Example) Device 1 inputs contact signal and Device 2 outputs it with the output holding time of 30 seconds.

Device 1	Device 2
'@PM01' (Transmit once when changing input ports)	'@PM00' (Contact communication mode OFF) '@PF012C' (30 seconds= 012C in hex)

Note:
When the status of any of the input ports changes, the status information of other ports is also transmitted, resulting that the status of the ports that did not change is also output as shown below.



8.8 Contact function responses

When communicating using the contact function, a response in the following format is output to the UART (only when the CTS terminal is set to Low) when any contact information is received.

8.8.1 "PR" response

The response contents are represented by function codes.

Response basic format

Prefix + response name + [=] + function code + Target station ID + contact data + [CR] + [LF]

Prefix: '*' = 2Ah, a code that indicates the start of the response string.
Response name: The 2 characters "PR".
Function code: Represented by a 2-character ASCII code. See the table below.
Target station ID: Represented by a 2-character ASCII code. See "*2.6 "@DI" Set Target station ID*."
Contact data: Represented by a 2-character ASCII code.

Function code	Content	Response output at:	
		Local station	Target station
“01”	A response output at the target station when the local station sends contact information with @PT and the target station receives it. (See *"8.5.1 Acquire the status of the target station port”*)		○
“02”	A response output at the target station when the local station sends contact information to set with @PT and the target station receives it. (See *“8.5.2 Set the status of the target station port”*)		○
“03”	A response output at the target station when the local station which is set to the specified times transmission mode sends contact information and the target station receives it. (See *“8.6.1 Specified times transmission mode when changing input ports"*)		○
“04”	A response output at the local station when it acquires the target station port status or sets the target station port status with @PT and receives an acknowledgement from the target station. (See *“8.5.1 Acquire the status of the target station port”* and *“8.5.2 Set the status of the target station port”*)	○	
“05”	A response output at the target station when the local station which is set to the one-way continuous transmission mode sends contact information and the target station receives it. (See *“8.6.2 One-way continuous transmission mode”*)		○
“06”	A response output at the target station when the local station which is set to the two-way continuous communication mode sends contact information and the target station receives it. (See *“8.6.3 Two-way continuous communication mode”*)		○
“07”	A response output at the local station when it is set to the two-way continuous communication mode and receives an contact information from the target station. (See *“8.6.3 Two-way continuous communication mode”*)	○	
“08”	A response output at the target station when the local station which is set to the specified times transmission mode sends contact information to set with @PT and the target station receives it. (See *“8.5.2 Set the status of the target station port”*)		○
“10”	A response output at the target station when the local station sends its own Unique ID with @PIT and the target station receives it. (See *" 8.2.4 Receive the Unique ID of the target station and set it to the local station”*)		○

8.8.2 'PD' response

When transmitting in the Specified times transmission mode, a response in the following format is output to the UART of the local station.

Response basic format

Prefix + response name + [=] + contact data + [CR] + [LF]

Prefix: '*' = 2Ah, a code that indicates the start of the response string.
Response name: The 2 characters "PD".
Contact data: The status of the input/output ports of the local station is represented by a 2-character ASCII code.

8.8.3 Combination of the 'PR' and 'PD' responses

The table below shows the combination example of PR and PD responses, when communicating between two SLR-434M devices using the @PT command and the contact function communication modes.

In the following example, Device 1 is set to any of the communication modes with the @PM command and Device 2 is set to 'PM00' (Contact function communication OFF).

<table>
<tr><th colspan="3">Device 1
(Local station Eqipment ID="xx", Target station ID="yy")</th><th colspan="2">Device 2
(Local station Eqipment ID="yy",
Target station ID="xx")</th></tr>
<tr><th>Communication mode setting</th><th>Behavior</th><th>Response output example</th><th>Communication mode setting</th><th>Response output example</th></tr>
<tr><td rowspan="2">@PM00</td><td>'@PT' command transmission
(acquire the status of target station port)</td><td rowspan="2">*PR=04yy$$</td><td rowspan="5">@PM00</td><td>*PR=01xx&&</td></tr>
<tr><td>'@PT##' command transmission
(set the status of target station port)</td><td>*PR=02xx##</td></tr>
<tr><td rowspan="2">@PM01
:
@PM05</td><td>Transmission when changing input ports</td><td rowspan="2">*PD=&&</td><td>*PR=03xx&&
(outputs the specified number of times)</td></tr>
<tr><td>'@PT##' command transmission</td><td>*PR=08xx##
(outputs the specified number of times)</td></tr>
<tr><td>@PM10</td><td>One-way continuous transmission</td><td></td><td>*PR=05xx&&</td></tr>
<tr><td>@PM20</td><td>Two-way continuous transmission</td><td>*PR=07yy$$</td><td>*PR=06xx&&</td></tr>
</table>

"&&" is the status of the input/output ports of Device 1 and "$$" is the status of the input/output ports of Device 2.

9. Command list

Frequency channel setting (Factory setting: "4A" 434.000 MHz)

Item	Command format	Response format	Setting value / Error description
Setting command	@CH##	*CH=##	"00" to "88"
Setting command (save the value)	@CH##/W	*WR=PS *CH=##	
Acquire the setting value	@CH	*CH=##	
Error response		*ER=01	Command error
		*ER=02	Setting value error
		*ER=03	Command format error

Radio communication mode setting (Factory setting: "03" LoRa command mode)

Item	Command format	Response format	Setting value / Error description
Setting command	@MO##	*MO=##	"00":FSK binary mode "01":FSK command mode "02":LoRa binary mode "03":LoRa command mode "04":Air monitor mode
Setting command (save the value)	@MO##/W	*WR=PS *MO=##	
Acquire the setting value	@MO	*MO=##	
Error response		*ER=01	Command error
		*ER=02	Setting value error
		*ER=03	Command format error

Number of chips setting with LoRa modulation (Factory setting: "00" 128 chips)

Item	Command format	Response format	Setting value / Error description
Setting command	@SF##	*SF=##	"00": 128 chips, "03":1024 chips "01": 256 chips, "04":2048 chips "02": 512 chips, 05":4096 chips
Setting command (save the value)	@SF##/W	*WR=PS *SF=##	
Acquire the setting value	@SF	*SF=##	
Error response		*ER=01	Command error
		*ER=02	Setting value error
		*ER=03	Command format error

Equipment ID setting (Factory setting: "01" Equipment ID=1)

Item	Command format	Response format	Setting value / Error description
Setting command	@EI##	*EI=##	"00" to "FF"
Setting command (save the value)	@EI##/W	*WR=PS *EI=##	
Acquire the setting value	@EI	*EI=##	
Error response		*ER=01	Command error
		*ER=03	Command format error

Target station ID setting (Factory setting: "01" Target station ID=1)

Item	Command format	Response format	Setting value / Error description
Setting command	@DI##	*DI=##	"00" to "FF"
Setting command (save the value)	@DI##/W	*WR=PS *DI=##	
Acquire the setting value	@DI	*DI=##	
Error response		*ER=01	Command error
		*ER=03	Command format error

Group ID setting (Factory setting: "00" Group ID=0)

Item	Command format	Response format	Setting value / Error description
Setting command	@GI##	*GI=##	"00" to "FF"
Setting command (save the value)	@GI##/W	*WR=PS *GI=##	
Acquire the setting value	@GI	*GI=##	
Error response		*ER=01	Command error
		*ER=03	Command format error

User ID setting (Factory setting: "0000" User ID=0000)

Item	Command format	Response format	Setting value / Error description
Setting command (save the value)	@UI####,XXXX	*WR=PS *UI=####	"0000" to "FFFF" XXXX is a password.
Acquire the setting value	@UI	*UI=####	
Error response		*ER=01	Command error
		*ER=03	Command format error
		*ER=04	Password error

Acquisition of RSSI for the last data received

Item	Command format	Response format	Setting value / Error description
Acquire the setting value	@RS	*RS=###dBm	

Acquisition of current RSSI

Item	Command format	Response format	Setting value / Error description
Acquire the setting value	@RA	*RA=###dBm	
Error response		*ER=05	Device is not in reception mode.

RSSI output ON/OFF during carrier sensing (Factory setting: "00" RSSI output OFF)

Item	Command format	Response format	Setting value / Error description
Setting command	@CR##	*CR=##	"00":RSSI output OFF "FF":RSSI output ON
Setting command (save the value)	@CI##/W	*WR=PS *CI=##	
Acquire the setting value	@CR	*CR=##	
Error response		*ER=01	Command error
		*ER=02	Setting value error
		*ER=03	Command format error

Acquisition of firmware version

Item	Command format	Response format	Setting value / Error description
Acquire the setting value	@FV	*FV=#.###,SLR-434M	
	@VR	*VR=SLR-434M_V#R###	

Acquisition of serial number

Item	Command format	Response format	Setting value / Error description
Acquire the setting value	@SN	*SN=$########	

Input / Output port setting (Factory setting: "FF" All DIO terminals are input.)

Item	Command format	Response format	Setting value / Error description
Setting command	@PS##	*PS=##	"00","01","02","03","0C","0D", "0E","0F","F0","F1","F2","F3", "FC","FD","FE","FF"
Setting command (save the value)	@PS##/W	*WR=PS *PS=##	
Acquire the setting value	@PS	*PS=##	
Error response		*ER=01	Command error
		*ER=03	Command format error

Acquisition/setting of local station port status (Factory setting: "00")

Item	Command format	Response format	Setting value / Error description
Setting command	@PO##	*PO=##	"00" to "FF"
Setting command (save the value)	@PO##/W	*WR=PS *PO=##	
Acquire the setting value	@PO	*PO=##	
Error response		*ER=01	Command error
		*ER=03	Command format error

Acquisition/setting of target station port status

Item	Command format	Response format	Setting value / Error description
Setting command	@PT##	*PT##	"00" to "FF"
Acquire the setting value	@PT	*PT##	Port status of the local station: "00" to "FF" (Target port status can be acquired with *PR)
Error response		*ER=01	Command error
		*ER=03	Command format error

Contact function communication mode setting (Factory setting:"00" Auto transmission OFF)

Item	Command format	Response format	Setting value / Error description
Setting command	@PM##	*PM=##	Auto transmission OFF: "00" Specified times transmission: "01" to "05" One-way continuous transmission: "10" Two-way continuous transmission: "20"
Setting command (save the value)	@PM##/W	*WR=PS *PM=##	
Acquire the setting value	@PM	*PM=##	
Error response		*ER=01	Command error
		*ER=03	Command format error

Output port holding time setting (Factory setting: "0000" No time restriction)

Item	Command format	Response format	Setting value / Error description
Setting command	@PF####	*PM=####	"0000" to "FFFF" (1 count = approx. 0.1 s)
Setting command (save the value)	@PF####/W	*WR=PS *PM=####	
Acquire the setting value	@PF	*PM=####	
Error response		*ER=01	Command error
		*ER=03	Command format error

Unique ID setting for contact function (Factory setting: "0000" Not using Unique ID)

Item	Command format	Response format	Setting value / Error description
Setting cancel	@PIC	*WR=PS *PI=000000	"000000" : Not using Unique ID
Setting command	@PIS	*WR=PS *PI=######	"000001" to "98967F" (S/No. *0000001 to 9999999)
Set to Ready mode	@PIR	*PI=Ready	
Transmit the setting value	@PIT	*PI=######	
Check the setting value	@PI	*PI=######	
Error response		*ER=01	Command error
		*ER=03	Command format error

10. Channel plan

Channel		Frequency	Channel		Frequency	Channel		Frequency
NO.	HEX	(MHz)	NO.	HEX	(MHz)	NO.	HEX	(MHz)
0	00	433.0750	34	22	433.5000	68	44	433.9250
1	01	433.0875	35	23	433.5125	69	45	433.9375
2	02	433.1000	36	24	433.5250	70	46	433.9500
3	03	433.1125	37	25	433.5375	71	47	433.9625
4	04	433.1250	38	26	433.5500	72	48	433.9750
5	05	433.1375	39	27	433.5625	73	49	433.9875
6	06	433.1500	40	28	433.5750	**74**	**4A**	**434.0000**
7	07	433.1625	41	29	433.5875	75	4B	434.0125
8	08	433.1750	42	2A	433.6000	76	4C	434.0250
9	09	433.1875	43	2B	433.6125	77	4D	434.0375
10	0A	433.2000	44	2C	433.6250	78	4E	434.0500
11	0B	433.2125	45	2D	433.6375	79	4F	434.0625
12	0C	433.2250	46	2E	433.6500	80	50	434.0750
13	0D	433.2375	47	2F	433.6625	81	51	434.0875
14	0E	433.2500	48	30	433.6750	82	52	434.1000
15	0F	433.2625	49	31	433.6875	83	53	434.1125
16	10	433.2750	50	32	433.7000	84	54	434.1250
17	11	433.2875	51	33	433.7125	85	55	434.1375
18	12	433.3000	52	34	433.7250	86	56	434.1500
19	13	433.3125	53	35	433.7375	87	57	434.1625
20	14	433.3250	54	36	433.7500	88	58	434.1750
21	15	433.3375	55	37	433.7625	89	59	434.1875
22	16	433.3500	56	38	433.7750	90	5A	434.2000
23	17	433.3625	57	39	433.7875	91	5B	434.2125
24	18	433.3750	58	3A	433.8000	92	5C	434.2250
25	19	433.3875	59	3B	433.8125	93	5D	434.2375
26	1A	433.4000	60	3C	433.8250	94	5E	434.2500
27	1B	433.4125	61	3D	433.8375	95	5F	434.2625
28	1C	433.4250	62	3E	433.8500	96	60	434.2750
29	1D	433.4375	63	3F	433.8625	97	61	434.2875
30	1E	433.4500	64	40	433.8750	98	62	434.3000
31	1F	433.4625	65	41	433.8875	99	63	434.3125
32	20	433.4750	66	42	433.9000	100	64	434.3250
33	21	433.4875	67	43	433.9125	101	65	434.3375

Channel		Frequency	Channel		Frequency	Channel		Frequency
NO.	HEX	(MHz)	NO.	HEX	(MHz)	NO.	HEX	(MHz)
102	66	434.3500	114	72	434.5000	126	7E	434.6500
103	67	434.3625	115	73	434.5125	127	7F	434.6625
104	68	434.3750	116	74	434.5250	128	80	434.6750
105	69	434.3875	117	75	434.5375	129	81	434.6875
106	6A	434.4000	118	76	434.5500	130	82	434.7000
107	6B	434.4125	119	77	434.5625	131	83	434.7125
108	6C	434.4250	120	78	434.5750	132	84	434.7250
109	6D	434.4375	121	79	434.5875	133	85	434.7375
110	6E	434.4500	122	7A	434.6000	134	86	434.7500
111	6F	434.4625	123	7B	434.6125	135	87	434.7625
112	70	434.4750	124	7C	434.6250	136	88	434.7750
113	71	434.4875	125	7D	434.6375			

*The channel is set to No. 74 (434.000 MHz) for shipment.
*If you intend to use several SLR-434M units in the same area, use a channel plan that takes into account radio interference due to third-order intermodulation.

Circuit Design provides a computational tool on our website for creating channel plans that avoid interference due to third-order intermodulation.

Calculation tool: http://www.cdt21.com/resources/siryo6.asp

11. Data transmission time in the FSK/LoRa mode

11.1 Data transmission time in the FSK mode

FSK command mode Tsend：

≒ Roundup {(number of data bytes+7)/52,0}*(34*8/4.8+0.9)+(number of data bytes+7)*8/4.8 [ms]

FSK binary mode Tsend：

≒ Roundup {number of data bytes/52,0}*(34*8/4.8+0.9)+number of data bytes*8/4.8 [ms]

The transmission time in the binary mode is shorter by 7 bytes than in the command mode. In the binary mode, transmission of data exceeding 255 bytes is possible, however we do not provide support for the transmission time of data exceeding 255 bytes.

11.2 Data transmission time in the LoRa mode

LoRa command mode Tsend：

When the number of data bytes is 1 to 235
Nsym = Roundup {(8*(number of data bytes+15)-4*SF+44)/(4*(SF-2)),0}*5
Tsend = (20.25+Nsym)*Tsym [ms]

When the number of data bytes is 236 to 255
Nsym = Roundup{(8*(number of data bytes+8-235)-4*SF+44)/(4*(SF-2)),0}*5
Tsend = Tplmax+(20.25 + Nsym)*Tsym [ms]

LoRa binary mode Tsend：

When the number of data bytes is 1 to 242
Nsym = Roundup{(8*(number of data bytes+8)-4*SF+44)/(4*(SF-2)),0}*5
Tsend = (20.25+Nsym)*Tsym [ms]

When the number of data bytes is 243 to 255
Nsym = Roundup {(8*(number of data bytes+1-235)-4*SF+44)/(4*(SF-2)),0}*5
Tsend = Tplmax+(20.25+Nsym)*Tsym [ms]

The transmission time in the binary mode is shorter by 7 bytes than in the command mode. In the binary mode, transmission of data exceeding 255 bytes is possible, however we do not provide support for the transmission time of data exceeding 255 bytes.

Number of chips	Spreading factor SF	Tsym (ms)	Tplmax (ms)	Transmission delay (ms)
128	7	16.384	8606	22 to 1222
256	8	32.768	14426	22 to 1522
512	9	65.536	24920	22 to 3022
1024	10	131.072	43942	22 to 5222
2048	11	262.144	78709	22 to 9372
4096	12	524.288	141689	22 to 22022

Important note:

The SLR-434M uses the packet communication function of the internal RF IC. The payload length of one packet is up to 60 bytes in the FSK mode and up to 250 bytes in the LoRa mode.

When transmitting data in the command mode, since 15 bytes are added to the user data as Equipment ID, control commands and so on, the number of user data per packet is up to 45 bytes in the DSK mode and up to 235 bytes in the LoRa mode.

For example, in the FSK mode, the user data of up to 45 bytes is sent in one packet, and the data of 46 to 90 bytes is sent in two packets. A 'Hi' pulse is output to the TXLED between packets.

11.3 Data transmission time

Binary mode	Command mode	FSK	LoRa					
			128 chip	256 chip	512 chip	1024 chip	2048 chip	4096 chip
Data [byte]		Transmission time Tsend [ms]						
1		59.2	741	1319	2310	4620	7930	15860
2		60.9	741	1319	2638	4620	9241	15860
3		62.6	823	1483	2638	4620	9241	18481
4		64.2	823	1483	2638	5276	9241	18481
5		65.9	823	1483	2638	5276	9241	18481
6		67.6	905	1647	2966	5276	10551	18481
7		69.2	905	1647	2966	5276	10551	18481
8	1	70.9	987	1647	2966	5931	10551	21103
9	2	72.6	987	1810	3293	5931	10551	21103
10	3	74.2	987	1810	3293	5931	10551	21103
11	4	75.9	1069	1810	3293	5931	11862	21103
12	5	77.6	1069	1974	3293	6586	11862	21103
13	6	79.2	1151	1974	3621	6586	11862	23724
14	7	80.9	1151	1974	3621	6586	11862	23724
15	8	82.6	1151	2138	3621	6586	13173	23724
16	9	84.2	1233	2138	3949	7242	13173	23724
17	10	85.9	1233	2138	3949	7242	13173	23724
18	11	87.6	1315	2302	3949	7242	13173	26345
19	12	89.2	1315	2302	3949	7242	13173	26345
20	13	90.9	1315	2302	4276	7897	14483	26345
21	14	92.6	1397	2466	4276	7897	14483	26345
22	15	94.2	1397	2466	4276	7897	14483	26345
23	16	95.9	1479	2466	4604	7897	14483	28967
24	17	97.6	1479	2630	4604	8552	15794	28967
25	18	99.2	1479	2630	4604	8552	15794	28967
26	19	101	1561	2630	4604	8552	15794	28967
27	20	103	1561	2793	4932	8552	15794	28967
28	21	104	1642	2793	4932	9208	15794	31588
29	22	106	1642	2793	4932	9208	17105	31588
30	23	108	1642	2957	5259	9208	17105	31588
31	24	109	1724	2957	5259	9208	17105	31588
32	25	111	1724	2957	5259	9863	17105	31588
33	26	113	1806	3121	5259	9863	18416	34210
34	27	114	1806	3121	5587	9863	18416	34210
35	28	116	1806	3121	5587	9863	18416	34210
36	29	118	1888	3285	5587	10519	18416	34210
37	30	119	1888	3285	5915	10519	18416	34210
38	31	121	1970	3285	5915	10519	19726	36831
39	32	123	1970	3449	5915	10519	19726	36831
40	33	124	1970	3449	5915	11174	19726	36831
41	34	126	2052	3449	6242	11174	19726	36831
42	35	128	2052	3613	6242	11174	21037	36831
43	36	129	2134	3613	6242	11174	21037	39453
44	37	131	2134	3613	6570	11829	21037	39453
45	38	133	2134	3777	6570	11829	21037	39453
46	39	134	2216	3777	6570	11829	21037	39453
47	40	136	2216	3777	6570	11829	22348	39453
48	41	138	2298	3940	6898	12485	22348	42074
49	42	139	2298	3940	6898	12485	22348	42074
50	43	141	2298	3940	6898	12485	22348	42074
51	44	143	2380	4104	7225	12485	23658	42074
52	45	144	2380	4104	7225	13140	23658	42074
53	46	203	2462	4104	7225	13140	23658	44696
54	47	205	2462	4268	7225	13140	23658	44696
55	48	207	2462	4268	7553	13140	23658	44696
56	49	208	2544	4268	7553	13795	24969	44696
57	50	210	2544	4432	7553	13795	24969	44696
58	51	212	2626	4432	7881	13795	24969	47317
59	52	213	2626	4432	7881	13795	24969	47317
60	53	215	2626	4596	7881	14451	26280	47317
61	54	217	2707	4596	7881	14451	26280	47317
62	55	218	2707	4596	8208	14451	26280	47317
63	56	220	2789	4760	8208	14451	26280	49938
64	57	222	2789	4760	8208	15106	26280	49938
65	58	223	2789	4760	8536	15106	27591	49938
66	59	225	2871	4923	8536	15106	27591	49938
67	60	227	2871	4923	8536	15106	27591	49938
68	61	228	2953	4923	8536	15761	27591	52560
69	62	230	2953	5087	8864	15761	28901	52560

Binary mode	Command mode	FSK	LoRa					
			128 chip	256 chip	512 chip	1024 chip	2048 chip	4096 chip
Data [byte]		Transmission time Tsend [ms]						
70	63	232	2953	5087	8864	15761	28901	52560
71	64	233	3035	5087	8864	15761	28901	52560
72	65	235	3035	5251	9191	16417	28901	52560
73	66	237	3117	5251	9191	16417	28901	55181
74	67	238	3117	5251	9191	16417	30212	55181
75	68	240	3117	5415	9191	16417	30212	55181
76	69	242	3199	5415	9519	17072	30212	55181
77	70	243	3199	5415	9519	17072	30212	55181
78	71	245	3281	5579	9519	17072	31523	57803
79	72	247	3281	5579	9847	17072	31523	57803
80	73	248	3281	5579	9847	17727	31523	57803
81	74	250	3363	5743	9847	17727	31523	57803
82	75	252	3363	5743	9847	17727	31523	57803
83	76	253	3445	5743	10174	17727	32834	60424
84	77	255	3445	5906	10174	18383	32834	60424
85	78	257	3445	5906	10174	18383	32834	60424
86	79	258	3527	5906	10502	18383	32834	60424
87	80	260	3527	6070	10502	18383	34144	60424
88	81	262	3609	6070	10502	19038	34144	63046
89	82	263	3609	6070	10502	19038	34144	63046
90	83	265	3609	6234	10830	19038	34144	63046
91	84	267	3690	6234	10830	19038	34144	63046
92	85	268	3690	6234	10830	19694	35455	63046
93	86	270	3772	6398	11158	19694	35455	65667
94	87	272	3772	6398	11158	19694	35455	65667
95	88	273	3772	6398	11158	19694	35455	65667
96	89	275	3854	6562	11158	20349	36766	65667
97	90	277	3854	6562	11485	20349	36766	65667
98	91	278	3936	6562	11485	20349	36766	68289
99	92	280	3936	6726	11485	20349	36766	68289
100	93	282	3936	6726	11813	21004	36766	68289
101	94	283	4018	6726	11813	21004	38076	68289
102	95	285	4018	6889	11813	21004	38076	68289
103	96	287	4100	6889	11813	21004	38076	70910
104	97	288	4100	6889	12141	21660	38076	70910
105	98	348	4100	7053	12141	21660	39387	70910
106	99	349	4182	7053	12141	21660	39387	70910
107	100	351	4182	7053	12468	21660	39387	70910
108	101	353	4264	7217	12468	22315	39387	73531
109	102	354	4264	7217	12468	22315	39387	73531
110	103	356	4264	7217	12468	22315	40698	73531
111	104	358	4346	7381	12796	22315	40698	73531
112	105	359	4346	7381	12796	22970	40698	73531
113	106	361	4428	7381	12796	22970	40698	76153
114	107	363	4428	7545	13124	22970	42009	76153
115	108	364	4428	7545	13124	22970	42009	76153
116	109	366	4510	7545	13124	23626	42009	76153
117	110	368	4510	7709	13124	23626	42009	76153
118	111	369	4592	7709	13451	23626	42009	78774
119	112	371	4592	7709	13451	23626	43319	78774
120	113	373	4592	7873	13451	24281	43319	78774
121	114	374	4674	7873	13779	24281	43319	78774
122	115	376	4674	7873	13779	24281	43319	78774
123	116	378	4755	8036	13779	24281	44630	81396
124	117	379	4755	8036	13779	24936	44630	81396
125	118	381	4755	8036	14107	24936	44630	81396
126	119	383	4837	8200	14107	24936	44630	81396
127	120	384	4837	8200	14107	24936	44630	81396
128	121	386	4919	8200	14434	25592	45941	84017
129	122	388	4919	8364	14434	25592	45941	84017
130	123	389	4919	8364	14434	25592	45941	84017
131	124	391	5001	8364	14434	25592	45941	84017
132	125	393	5001	8528	14762	26247	47251	84017
133	126	394	5083	8528	14762	26247	47251	86639
134	127	396	5083	8528	14762	26247	47251	86639
135	128	398	5083	8692	15090	26247	47251	86639
136	129	399	5165	8692	15090	26903	47251	86639
137	130	401	5165	8692	15090	26903	48562	86639
138	131	403	5247	8856	15090	26903	48562	89260

Binary mode	Command mode	FSK	LoRa					
			128 chip	256 chip	512 chip	1024 chip	2048 chip	4096 chip
Data [byte]		Transmission time Tsend [ms]						
139	132	404	5247	8856	15417	26903	48562	89260
140	133	406	5247	8856	15417	27558	48562	89260
141	134	408	5329	9019	15417	27558	49873	89260
142	135	409	5329	9019	15745	27558	49873	89260
143	136	411	5411	9019	15745	27558	49873	91881
144	137	413	5411	9183	15745	28213	49873	91881
145	138	414	5411	9183	15745	28213	49873	91881
146	139	416	5493	9183	16073	28213	51184	91881
147	140	418	5493	9347	16073	28213	51184	91881
148	141	419	5575	9347	16073	28869	51184	94503
149	142	421	5575	9347	16400	28869	51184	94503
150	143	423	5575	9511	16400	28869	52494	94503
151	144	424	5657	9511	16400	28869	52494	94503
152	145	426	5657	9511	16400	29524	52494	94503
153	146	428	5738	9675	16728	29524	52494	97124
154	147	429	5738	9675	16728	29524	52494	97124
155	148	431	5738	9675	16728	29524	53805	97124
156	149	433	5820	9839	17056	30179	53805	97124
157	150	492	5820	9839	17056	30179	53805	97124
158	151	494	5902	9839	17056	30179	53805	99746
159	152	495	5902	10002	17056	30179	55116	99746
160	153	497	5902	10002	17383	30835	55116	99746
161	154	499	5984	10002	17383	30835	55116	99746
162	155	500	5984	10166	17383	30835	55116	99746
163	156	502	6066	10166	17711	30835	55116	102367
164	157	504	6066	10166	17711	31490	56426	102367
165	158	505	6066	10330	17711	31490	56426	102367
166	159	507	6148	10330	17711	31490	56426	102367
167	160	509	6148	10330	18039	31490	56426	102367
168	161	510	6230	10494	18039	32145	57737	104989
169	162	512	6230	10494	18039	32145	57737	104989
170	163	514	6230	10494	18366	32145	57737	104989
171	164	515	6312	10658	18366	32145	57737	104989
172	165	517	6312	10658	18366	32801	57737	104989
173	166	519	6394	10658	18366	32801	59048	107610
174	167	520	6394	10822	18694	32801	59048	107610
175	168	522	6394	10822	18694	32801	59048	107610
176	169	524	6476	10822	18694	33456	59048	107610
177	170	525	6476	10985	19022	33456	60359	107610
178	171	527	6558	10985	19022	33456	60359	110232
179	172	529	6558	10985	19022	33456	60359	110232
180	173	530	6558	11149	19022	34111	60359	110232
181	174	532	6640	11149	19350	34111	60359	110232
182	175	534	6640	11149	19350	34111	61669	110232
183	176	535	6722	11313	19350	34111	61669	112853
184	177	537	6722	11313	19677	34767	61669	112853
185	178	539	6722	11313	19677	34767	61669	112853
186	179	540	6803	11477	19677	34767	62980	112853
187	180	542	6803	11477	19677	34767	62980	112853
188	181	544	6885	11477	20005	35422	62980	115474
189	182	545	6885	11641	20005	35422	62980	115474
190	183	547	6885	11641	20005	35422	62980	115474
191	184	549	6967	11641	20333	35422	64291	115474
192	185	550	6967	11805	20333	36078	64291	115474
193	186	552	7049	11805	20333	36078	64291	118096
194	187	554	7049	11805	20333	36078	64291	118096
195	188	555	7049	11969	20660	36078	65602	118096
196	189	557	7131	11969	20660	36733	65602	118096
197	190	559	7131	11969	20660	36733	65602	118096
198	191	560	7213	12132	20988	36733	65602	120717
199	192	562	7213	12132	20988	36733	65602	120717
200	193	564	7213	12132	20988	37388	66912	120717
201	194	565	7295	12296	20988	37388	66912	120717

Binary mode	Command mode	FSK	LoRa					
			128 chip	256 chip	512 chip	1024 chip	2048 chip	4096 chip
Data [byte]		Transmission time Tsend [ms]						
202	195	567	7295	12296	21316	37388	66912	120717
203	196	569	7377	12296	21316	37388	66912	123339
204	197	570	7377	12460	21316	38044	68223	123339
205	198	572	7377	12460	21643	38044	68223	123339
206	199	574	7459	12460	21643	38044	68223	123339
207	200	575	7459	12624	21643	38044	68223	123339
208	201	577	7541	12624	21643	38699	68223	125960
209	202	636	7541	12624	21971	38699	69534	125960
210	203	638	7541	12788	21971	38699	69534	125960
211	204	640	7623	12788	21971	38699	69534	125960
212	205	641	7623	12788	22299	39354	69534	125960
213	206	643	7705	12952	22299	39354	70844	128582
214	207	645	7705	12952	22299	39354	70844	128582
215	208	646	7705	12952	22299	39354	70844	128582
216	209	648	7786	13115	22626	40010	70844	128582
217	210	650	7786	13115	22626	40010	70844	128582
218	211	651	7868	13115	22626	40010	72155	131203
219	212	653	7868	13279	22954	40010	72155	131203
220	213	655	7868	13279	22954	40665	72155	131203
221	214	656	7950	13279	22954	40665	72155	131203
222	215	658	7950	13443	22954	40665	73466	131203
223	216	660	8032	13443	23282	40665	73466	133825
224	217	661	8032	13443	23282	41320	73466	133825
225	218	663	8032	13607	23282	41320	73466	133825
226	219	665	8114	13607	23609	41320	73466	133825
227	220	666	8114	13607	23609	41320	74777	133825
228	221	668	8196	13771	23609	41976	74777	136446
229	222	670	8196	13771	23609	41976	74777	136446
230	223	671	8196	13771	23937	41976	74777	136446
231	224	673	8278	13935	23937	41976	76087	136446
232	225	675	8278	13935	23937	42631	76087	136446
233	226	676	8360	13935	24265	42631	76087	139067
234	227	678	8360	14098	24265	42631	76087	139067
235	228	680	8360	14098	24265	42631	76087	139067
236	229	681	8442	14098	24265	43287	77398	139067
237	230	683	8442	14262	24592	43287	77398	139067
238	231	685	8524	14262	24592	43287	77398	141689
239	232	686	8524	14262	24592	43287	77398	141689
240	233	688	8524	14426	24920	43942	78709	141689
241	234	690	8606	14426	24920	43942	78709	141689
242	235	691	8606	14426	24920	43942	78709	141689
243	236	693	9347	15745	27230	48562	86639	157549
244	237	695	9347	15745	27558	48562	87950	157549
245	238	696	9429	15909	27558	48562	87950	160170
246	239	698	9429	15909	27558	49218	87950	160170
247	240	700	9429	15909	27558	49218	87950	160170
248	241	701	9511	16073	27886	49218	89260	160170
249	242	703	9511	16073	27886	49218	89260	160170
250	243	705	9593	16073	27886	49873	89260	162792
251	244	706	9593	16236	28213	49873	89260	162792
252	245	708	9593	16236	28213	49873	89260	162792
253	246	710	9675	16236	28213	49873	90571	162792
254	247	711	9675	16400	28213	50528	90571	162792
255	248	713	9757	16400	28541	50528	90571	165413
256	249	715	9757	16400	28541	50528	90571	165413
257	250	716	9757	16564	28541	50528	91882	165413
258	251	718	9839	16564	28869	51184	91882	165413
259	252	720	9839	16564	28869	51184	91882	165413
260	253	721	9921	16728	28869	51184	91882	168034
261	254	780	9921	16728	28869	51184	91882	168034
262	255	782	9921	16728	29196	51839	93192	168034

Note: Although the data input buffer of the UART has sufficient area of 256 bytes or more, if you input long data in the binary mode without using the RTS control signal, buffer over occurs and data may be discarded. It is recommended that the data length of one transmission is e 256 bytes or less.

Revision History

Version	Date	Description	Remark
0.91	Feb. 2017	Provisional Edition	
1.0	Feb. 2018		
1.1	Sep. 2018	Chapter 11 added	