

Embedded low power radio modem
SLR-434M
Smart RF modem



Operation Guide
Version 1.1 (Sep. 2018)

Circuit Design, Inc.

7557-1 Hotaka, Azumino, Nagano, Japan
Tel: 0263-82-1024
Fax: 0263-82-1016

e-mail: info@circuitdesign.jp
<http://www.circuitdesign.jp>

Contents

| | |
|--|----|
| 1. OVERVIEW | 3 |
| 2. FEATURES AND APPLICATIONS | 3 |
| 3. SPECIFICATIONS | 4 |
| 4. PART NAMES AND FUNCTIONS | 5 |
| 5. CONNECTION EXAMPLES FOR DIO TERMINALS | 8 |
| 6. APPEARANCE | 9 |
| 7. COMMUNICATION FREQUENCY TABLE | 10 |
| 8. UART PORT COMMUNICATION SETTINGS | 11 |
| 9. SERIAL COMMUNICATION COMMANDS | 12 |

1. Overview

The SLR-434M smart RF modem is a compact, easy to use, wireless modular RF modem for embedding in other equipment.

In addition to conventional FSK mode communication, it also comes with a LoRa mode for ultra long distance communication and low bit rate. With its superior receive sensitivity using LoRa modulation, it achieves both specific low power output, with a line of sight communication range of more than 10 kilometers.

Connection to an external microcomputer or a PC via a UART and our proprietary command system fostered in the industry make it possible for you to easily transmit/receive data.

Also you can control up to 8 contacts.

2. Features and applications

Features

- RED compliant (Plan)
- Ultra long distance communication using the LoRa mode
- Enhanced resistant to city noise and longer range compared with our earlier products
- Select between FSK mode and LoRa mode
- UART interface
- Control of 8 contacts
- Low power consumption enables battery powered operation
- Compact size

Applications

- Data transfer inside buildings, air conditioning control
- Debris avalanche monitoring for debris barriers
- Water level monitoring for river dams, opening and closing of water gates
- Paddy field temperature and water level monitoring
- Monitoring and control of greenhouse temperature and humidity
- Transmission of sensor data from underground or inside manholes
- Measurement and observation of the state of tunnels and bridges
- Monitoring the state of electric fences
- Monitoring the state of animal traps
- Other IoT applications

3. Specifications

*All values are when the antenna connector is the 50 Ω terminal.

*Unless otherwise indicated, specified values are at a temperature of 25 °C ± 5 °C.

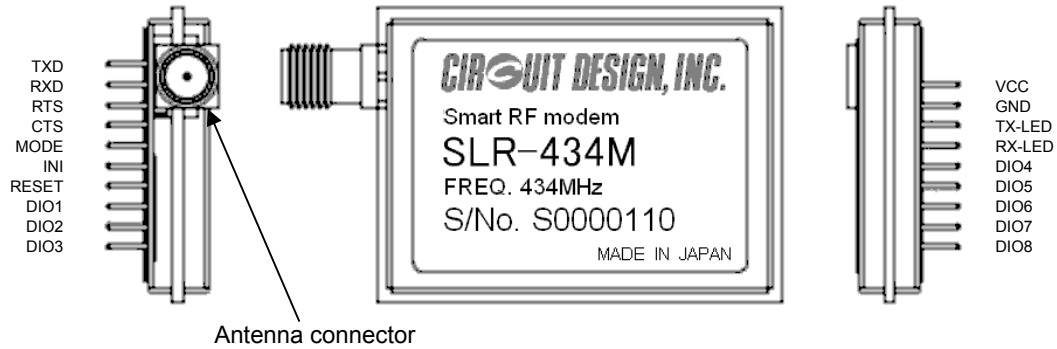
| Item | Specification |
|-------------------------------------|--|
| Applicable standard | EN 300 220 |
| Frequency channels | 433.075 MHz to 434.7750 MHz (12.5 KHz step, 137 channels) |
| Frequency deviation | ± 2 ppm or less |
| Antenna power | 10 mW or less |
| Communication method | Half-duplex or one-way |
| Radio wave format | F1D |
| Modulation* ¹ | LoRa or Binary FSK |
| Radio communication speed | 15 to 245 bps (Real speed using LoRa, depends on the spreading factor) 4800 bps (FSK) |
| Receiver spurious radiation | -54 dBm or less |
| Receive sensitivity* ² | -133 dBm (LoRa 128 chip), -115 dBm or less (FSK), PER 1% with the user data of 45 bytes or less |
| Carrier sensing threshold | -96 dBm (LoRa) |
| Operating temperature range | -30 to +70°C |
| Storage temperature range | -30 to +80°C |
| Recommended operating voltage range | 3.5 to 5.0 V |
| Warranted operating voltage range | 3.3 to 5.5 V |
| Operating current | Tx: 29 mA (Typ) Rx: 17 mA (Typ) (Supply power = 5 V) |
| Antenna provided | 1/4λ whip antenna (L=170 mm, gain 2.14 dBi or less) |
| Antenna connector | SMA |
| Interface | UART port |
| External dimensions | 40 × 29 × 6.2 mm (±0.4) (Not including the antenna and projections) |
| Weight | 13 g |
| Soldering conditions | Hand soldering Soldering iron temp.: 350°C within 3 seconds |

Note:

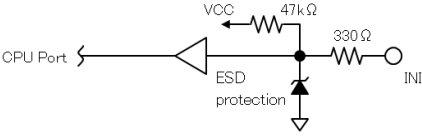
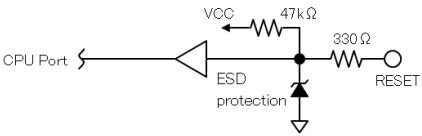
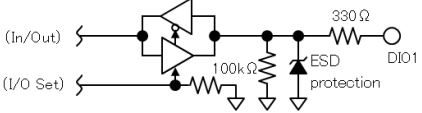
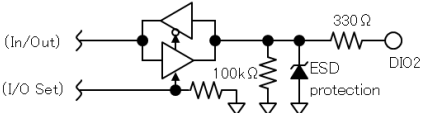
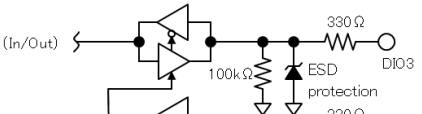
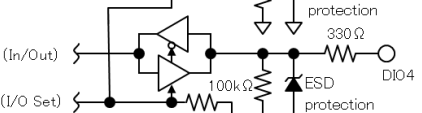
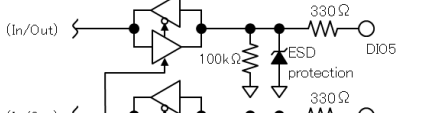
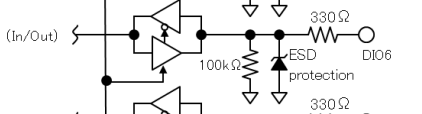
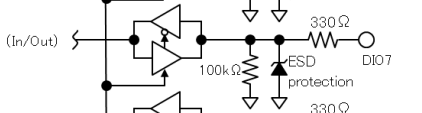
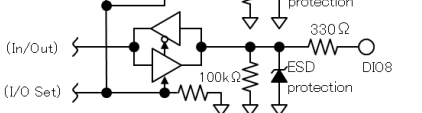
*1: When using the LoRa mode and moving around, the impact of the Doppler effect may make communication impossible.

*2: Receive sensitivity performance is affected by the power supply and surrounding noise levels (floor noise level). The approximate minimum level at which reception is possible is noise level +10 dB for FSK and -10 dB for LoRa. (Example: When the floor noise level is -110 dBm, reception is possible with FSK to about -100 dBm and with LoRa to about -120 dBm). You can check the floor noise level with the @RA command and the evaluation application (air monitor).

4. Part Names and Functions



| Names and functions | I/O | Content | | Internal equivalent circuit |
|---------------------|-----|---|---------------------------------------|-----------------------------|
| TXD | O | A UART serial communication terminal. It sets the device and transmits and receives data. | Serial data Transmitter | |
| RXD | I | (Communication conditions: 19.2 kbps, Bits =8, Parity = none, Stop = 1) | Serial data Receiver | |
| RTS | O | The UART control terminal. When RTS = "Hi", do not input data. | Hardware flow control output terminal | |
| CTS | I | The UART control terminal. When CTS = "Hi", data is not output. (Set it to "Lo".) | Hardware flow control input terminal | |
| MODE | I | (Reserved) Nothing should be connected to this terminal. | | |

| | | | |
|---|------------|---|--|
| <p>INI</p> | <p>I</p> | <p>With the power on, setting this terminal to "Lo" for 3 s or more resets and restarts the unit, and if the wireless communication mode is binary mode, it enters the command mode. For details about the wireless communication mode, refer to the operation guide "SLR-434 Serial Communication".</p> <p>Normally, when set to the wireless communication mode, the settings are saved automatically and are used as the initial values next time the power is switched on. However, after setting the binary mode, it is not possible to receive commands, therefore it is necessary to perform this task to return to the command mode. When this task is performed, "LORA CMD MODE" or "FSK CMD MODE" is output from the TXD terminal after the device restarts.</p> <p>After reset and restart, the device is initialized to the setting value saved by adding 'W' to commands such as chip number, frequency channel.</p> |  |
| <p>RESET</p> | <p>I</p> | <p>The CPU reset terminal (Lo active). After reset and restart, the device is initialized to the setting value saved by adding 'W' to commands such as chip number, frequency channel.</p> |  |
| <p>DIO1</p> | <p>I/O</p> | <p>Digital I/O pin 1. Input/output settings can be made with commands.</p> |  |
| <p>DIO2</p> | <p>I/O</p> | <p>Digital I/O pin 2. Input/output settings can be made with commands.</p> |  |
| <p>DIO3</p> | <p>I/O</p> | <p>Digital I/O pin 3.</p> |  |
| <p>DIO4</p> | <p>I/O</p> | <p>Digital I/O pin 4.</p> |  |
| <p>DIO5</p> | <p>I/O</p> | <p>Digital I/O pin 5.</p> |  |
| <p>DIO6</p> | <p>I/O</p> | <p>Digital I/O pin 6.</p> |  |
| <p>DIO7</p> | <p>I/O</p> | <p>Digital I/O pin 7.</p> |  |
| <p>DIO8</p> | <p>I/O</p> | <p>Digital I/O pin 8.</p> |  |
| <p>Input/output settings can be made with commands. DIO3 and DIO4 cannot be set individually.</p> | | <p>Input/output settings can be made with commands. DIO5 to DIO8 cannot be set individually.</p> | |

| | | | |
|-------------------|-----|--|--|
| RX-LED | O | The reception monitor LED connection terminal (Lo Active). When a radio wave communication signal is received, this terminal changes to "Lo" for about 0.1 s. | |
| TX-LED | O | The transmission monitor LED connection terminal (Lo Active). When a radio wave communication signal is sent, this terminal changes to "Lo". | |
| GND | | The ground terminal. | |
| VCC | | The power supply terminal. Connect to a stabilized DC+3.3 V to +5.5 V power supply. | |
| Antenna Connector | I/O | The connection pin for the antenna. | |

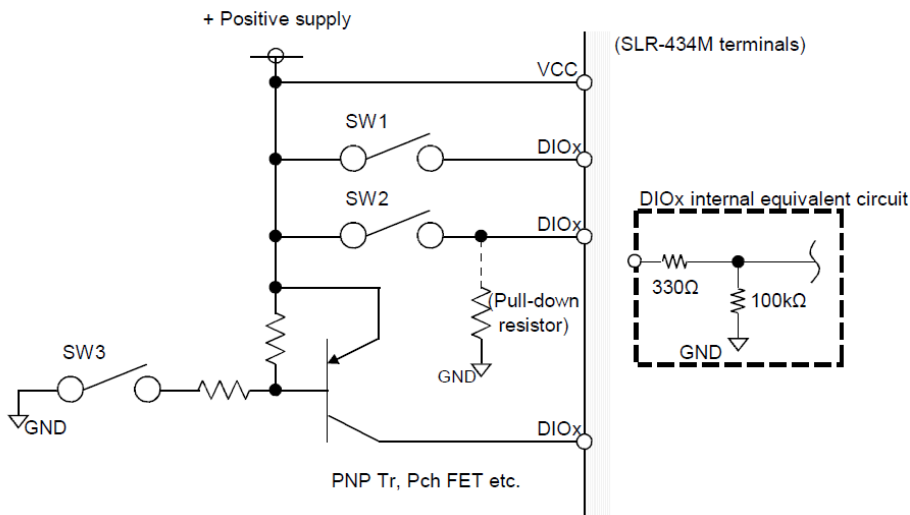
※ The voltage range of the output terminal is 0 to Vcc [V].
Use the input terminal within the range Hi = 2.0 to Vcc [V], Lo = 0 to 0.6 [V]

5. Connection examples for DIO terminals

<When using the DIO terminals as input ports and connecting switches>

The DIO terminals are internally pulled-down and can be operated by connecting switches between the DIO terminals and the VCC terminal as shown below (SW1 & SW2). The SW3 in the circuit below shows an example of connecting a switch to the GND side with the signal level inverted via a transistor.

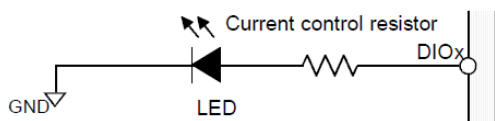
Using long wiring between the DIO terminal and the switch may cause malfunction due to noise. In that case, take measures such as externally pulling down with a resistor of a few to tens of kΩ.



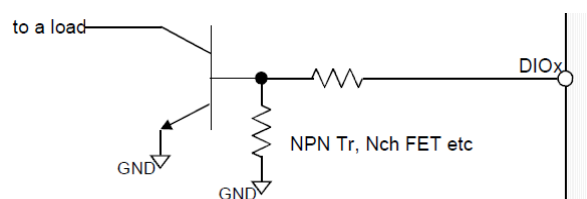
<When using the DIO terminals as output ports and connecting loads>

The output current at the DIO terminal should be 5 mA or less. Pay attention to the voltage drop due to the 330 Ω resistor inside the SLR-434M (see the equivalent circuit above.)

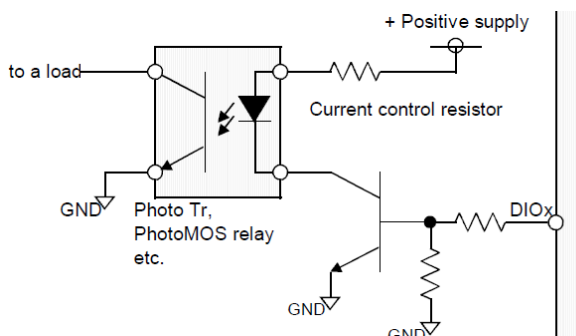
A load of a few mA, such as LED, can be directly driven as below.



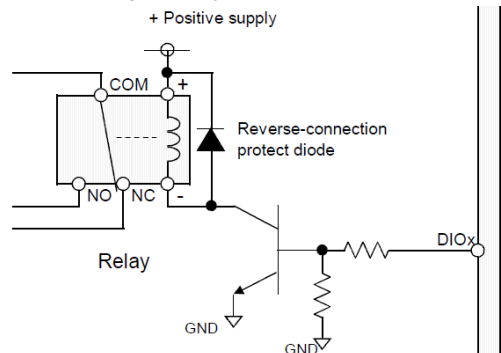
Connecting a transistor or FET



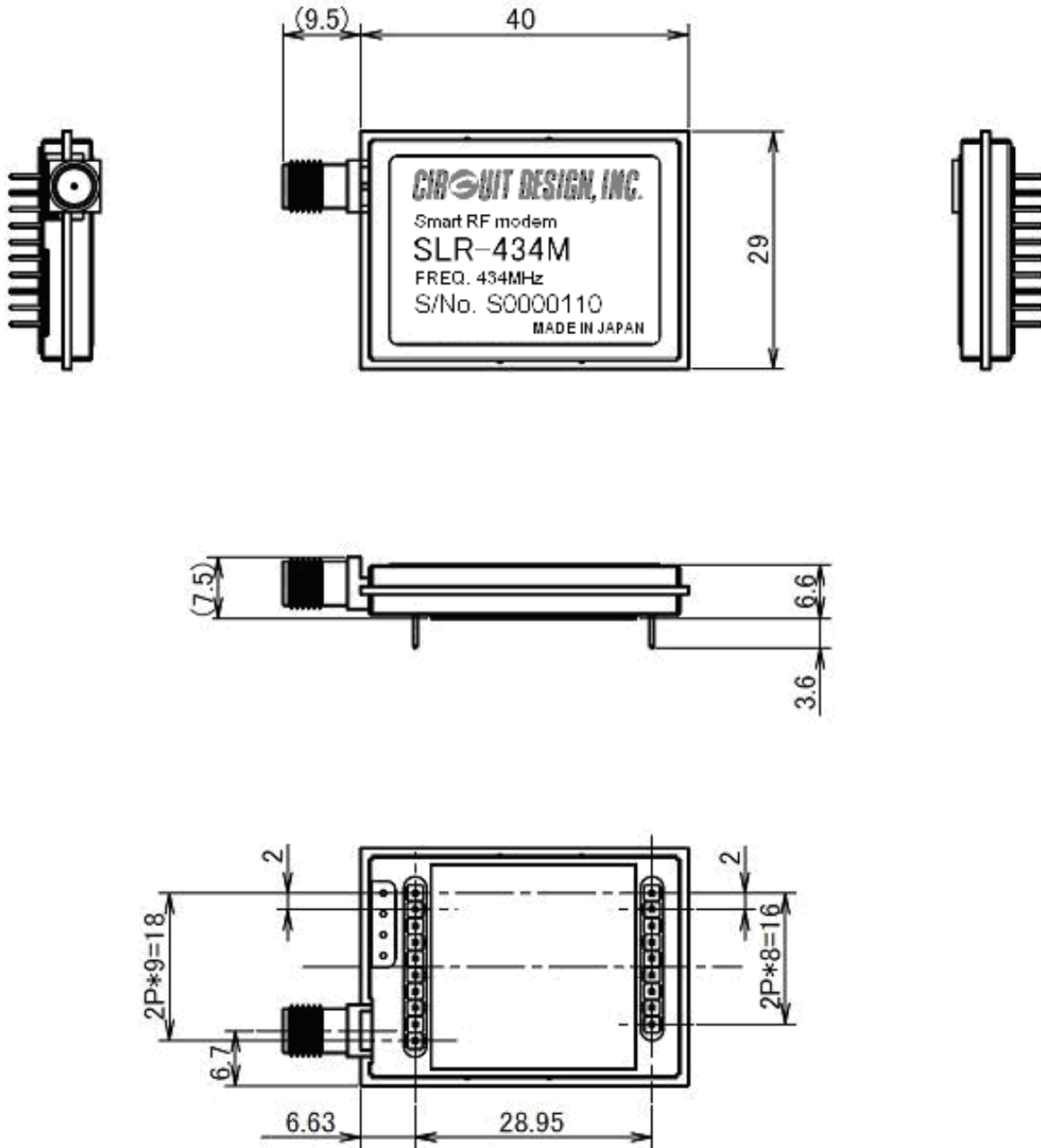
Connecting a Photo Tr or PhotoMOS relay



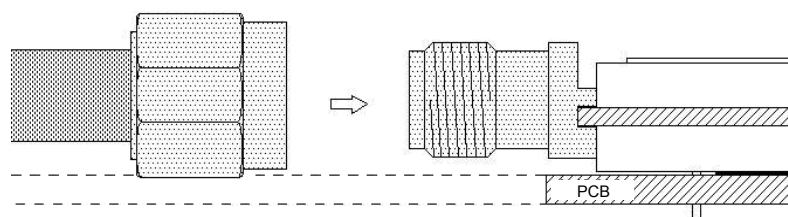
Connecting a relay



6. Appearance



Note: When designing circuit boards, take care to ensure space for the SMA connector dimensions and screw fixture for connecting the antenna. (If the underside of the connector is also the surface of the substrate, provide a notch or the like)



7. Communication frequency table

The frequencies used for radio communication are the 137 channels in the 434 MHz band shown in the table below.

| Channel | | Frequency (MHz) | Channel | | Frequency (MHz) | Channel | | Frequency (MHz) |
|---------|-----|--------------------|---------|-----|--------------------|-----------|-----------|--------------------|
| NO. | HEX | | NO. | HEX | | NO. | HEX | |
| 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 (MHz) | Channel | | Frequency (MHz) | Channel | | Frequency (MHz) |
|---------|-----|--------------------|---------|-----|--------------------|---------|-----|--------------------|
| NO. | HEX | | NO. | HEX | | NO. | HEX | |
| 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://circuitdesign-jp.check-xserver.jp/wp-pre/technical/technicaltool/channel-planning/>

8. UART port communication settings

The serial communication conditions for the UART port of this product are as follows.

| | | |
|---------------------|--|--------------------------------------|
| Communication speed | 19,200 bps | Fixed value Cannot be changed. |
| Data | 8-bit | |
| Parity | None | |
| Stop | 1-bit | |
| Flow control | Hardware: RTS/CTS pin (Software flow: Xon/Xoff is not used) | |

(The RTS output terminal is normally Lo. When the CTS input terminal is “Hi”, UART data is not output)

Note: The UART serial communication terminals (TXD/RXD/RTS/CTS) cannot be connected directly to a PC or other Com port because the signal level and logic is different.

9. Serial communication commands

The table below shows examples of the basic commands and responses.
See the operation guide "SLR-434M Serial Communication" for details and other command values.

| Item | Commands | Value (hex) | Options | Response example | Content (with a response example) |
|--|-------------------|-------------|---------|---|---|
| Radio communication mode setting | @MO | 00 | | *WR=PS *MO=00 FSK BIN MODE | Sets the communication mode to FSK binary mode. The value set is automatically saved and the device restarts. |
| | | 01 | | *WR=PS *MO=01 FSK CMD MODE | Sets the communication mode to FSK command mode. A character string that indicates the mode of the response example is output after restarting. |
| | | 02 | | *WR=PS *MO=02 LORA BIN MODE | Sets the communication mode to LoRa binary mode. In the binary mode, it is not possible to receive any commands, therefore it is necessary to set the INI terminal to Low for more than 3 seconds to return to the command mode. |
| | | 03 | | *WR=PS *MO=03 LORA CMD MODE | Sets the communication mode to LoRa command mode. |
| LoRa Number of chips setting | @SF | 00 | /W | *SF00 *WR=PS *SF00 | Sets the number of chips with LoRa to 128 chips. |
| Channel setting | @CH | 4A | /W | *CH1B *WR=PS *CH1B | Sets the communication frequency to 434.000 MHz (See '7.Communication frequency table'.) |
| ID setting (Equipment, Target station, Group ID) | @EI @DI @GI | 0A | /W | (With Equipment ID) *EI=0A *WR=PS *EI=0A | Sets the Equipment ID (local station) to "0A" (Sets the ID for identifying each radio station and the other party in communication.) |
| Transmit data | @DT | 05abcde | | *DT=05 | Sends the 5-byte data "abcde". |
| Receive data | | | | *DR=05abcde | Indicates that the 5-byte data "abcde" was received. |
| RSSI acquisition for the last data received. | @RS | | | *RS=-100dBm | Acquires the RSSI level (strength of the radio waves of the received signal) for the last data received. |
| Current RSSI acquisition | @RA | | | *RA=-120dBm | Acquires the current RSSI level (radio wave strength) of the channel set. |
| Contact function IO setting | @PS | 0F | /W | *PS =0F *WR=PS *PS=0F | Sets contacts DIO1 to DIO4 as input ports and DIO5 to DIO8 as output ports. |
| Contact state check and setting | @PO | 10 | /W | *PO=10 *WR=PS *PO=10 | Sets contact DIO5 to Hi. Acquires the status if it is the input port. |
| Target station contact state check and setting | @PT | | | *PT=10 *PR=040280 | Acquires the contact information of the target station. (" * PR = ..." shows the response from the target station.) |
| | | 20 | | *PT=20 *PR=040220 | Sets the contact status of the target station. (" * PR = ..." shows the response from the target station.) |
| Contact communication mode setting | @PM | 01 | /W | *PM=01 *WR=PS *PM=01 | If the status of the contacts set to input changes, the contact information is transmitted automatically (once). If the target station receives this signal, the status of the corresponding contact output changes. |

After command + value + data (optional), add the line feed code 'CR' 'LF'.
If you omit value + data, you can check the content of the current settings.
If the optional '/W' is added, the setting value is saved, and it becomes the initial value next time the power is switched on.

Important notice

- Customers are advised to consult with Circuit Design sales representatives before ordering. Circuit Design believes the provided information is accurate and reliable. However, Circuit Design reserves the right to make changes to this product without notice.
- Circuit Design products are neither designed nor intended for use in life support applications where malfunction can reasonably be expected to result in significant personal injury to the user. Any use of Circuit Design products in such safety-critical applications is understood to be fully at the risk of the customer and the customer must fully indemnify Circuit Design, Inc for any damages resulting from any improper use.
- As the radio module communicates using electronic radio waves, there are cases where transmission will be temporarily cut off due to the surrounding environment and method of usage. The manufacturer is exempt from all responsibility relating to resulting harm to personnel or equipment and other secondary damage.
- The manufacturer is exempt from all responsibility relating to secondary damage resulting from the operation, performance and reliability of equipment connected to the radio module.

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Cautions

- Do not use the equipment within the vicinity of devices that may malfunction as a result of electronic radio waves from the radio module.
- Communication performance will be affected by the surrounding environment, so communication tests should be carried out before actual use.
- Ensure that the power supply for the radio module is within the specified rating. Short circuits and reverse connections may result in overheating and damage and must be avoided at all costs.
- Ensure that the power supply has been switched off before attempting any wiring work.
- The case is connected to the GND terminal of the internal circuit, so do not make contact between the '+' side of the power supply terminal and the case.
- When batteries are used as the power source, avoid short circuits, recharging, dismantling, and pressure. Failure to observe this caution may result in the outbreak of fire, overheating and damage to the equipment. Remove the batteries when the equipment is not to be used for a long period of time. Failure to observe this caution may result in battery leaks and damage to the equipment.
- Do not use this equipment in vehicles with the windows closed, in locations where it is subject to direct sunlight, or in locations with extremely high humidity.
- The radio module is neither waterproof nor splash proof. Ensure that it is not splashed with soot or water. Do not use the equipment if water or other foreign matter has entered the case.
- Do not drop the radio module or otherwise subject it to strong shocks.
- Do not subject the equipment to condensation (including moving it from cold locations to locations with a significant increase in temperature.)
- Do not use the equipment in locations where it is likely to be affected by acid, alkalis, organic agents or corrosive gas.
- Do not bend or break the antenna. Metallic objects placed in the vicinity of the antenna will have a great effect on communication performance. As far as possible, ensure that the equipment is placed well away from metallic objects.
- The GND for the radio module will also affect communication performance. If possible, ensure that the case GND and the circuit GND are connected to a large GND pattern.

Warnings

- Do not take apart or modify the equipment.
- Do not remove the product label (the label attached to the upper surface of the module.) Using a module from which the label has been removed is prohibited.

Revision History

| Version | Date | Description | Remark |
|---------|-----------|-------------------------------------|--------|
| 0.91 | Feb. 2017 | Provisional Edition | |
| 1.0 | Jan. 2018 | | |
| 1.1 | Sep. 2018 | URL link address changed. (Page 11) | |

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