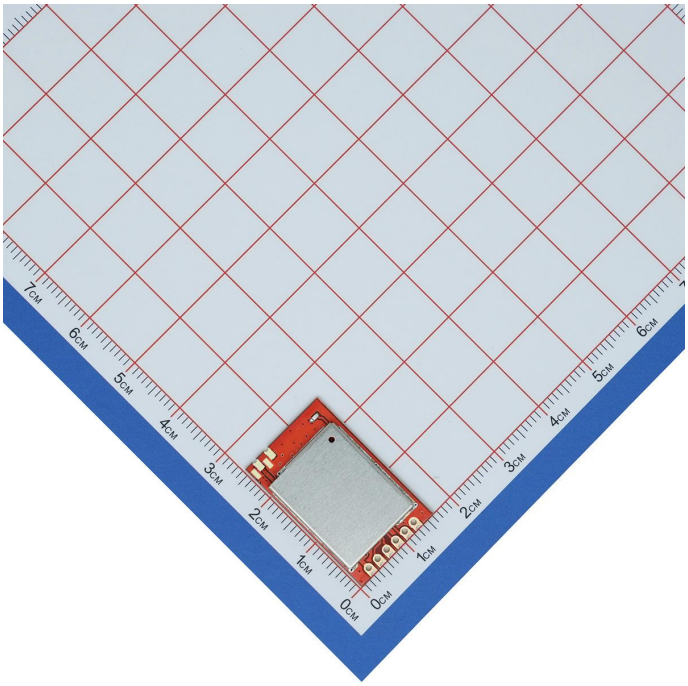
Ling-TR2H Wireless UART Module Datasheet



Item	Details
Product Model	Ling-TR2H
Document Version	V1.2
Release Date	2026-07-03
Brand	FNRF

Contents

1 Product Overview

The Ling-TR2H is a 433MHz FSK wireless transceiver module that connects to an MCU or serial device through its UART TTL interface. The module uses half-duplex communication and automatically performs RF Tx/Rx switching and protocol conversion. Power, UART baud rate, RF channel, Net ID, and other parameters can be configured through the UART.

The module is suitable for wireless remote control, data acquisition, smart-home, industrial-control, robotics, and smart-appliance applications. In an open, interference-free environment, its line-of-sight communication distance is approximately 600m. Actual range depends on the antenna, power supply, installation environment, enclosure design, RF channel, UART rate, and on-site interference; verify the complete product under its actual installation conditions.

2 Key Features

- 433MHz ISM band, FSK modulation, and half-duplex communication.
- Supports 40 RF channel configurations; default channel 20 corresponds to 433.92MHz.
- Supply range: 1.8-3.6V; typical: 3.3V.
- Maximum output power: 20dBm; transmit-power setting 0-30 is configurable.
- Typical receiver sensitivity: -119dBm@0.6kbps.
- Typical transmit current: 71.5mA@20dBm; typical receive current: 13.8mA.
- Typical sleep current: 5uA.
- Standard UART TTL interface; supports 600-115200bps; default: 9600bps.
- Compact SMD package suitable for embedded-device integration.

3 Typical Applications

Application Category	Description
Wireless Remote Control	Control products, discrete I/O control, and status feedback.
Data Acquisition	Low-rate wireless data transmission for sensors, instruments, and acquisition terminals.
Smart Home	Interconnection of doors/windows, lighting controls, small appliances, environmental sensors, and similar devices.
Robotics	Control and status links requiring moderate real-time performance and longer communication distance.

4 Technical Specifications

Parameter	Minimum	Typical	Maximum	Unit	Condition/Notes
Operating Voltage	1.8	3.3	3.6	V	Between VCC and GND.
Operating Frequency Band	423.92	433.92	443.92	MHz	Channels 0-40, 500kHz spacing; default channel: 20.
Number of RF Channels	0	20	40	ch	Default: 20, corresponding to 433.92MHz.
Modulation	-	FSK	-	-	433MHz wireless link.
Communication Mode	-	Half Duplex	-	-	Tx/Rx switching is performed automatically by the module.
Reference Range	-	600	-	m	Reference line-of-sight value in an open, interference-free environment; verify actual range in the complete product.
Receiver Sensitivity	-	-119	-	dBm	At 0.6kbps.
Transmit Power	-10	20	20	dBm	Settings 0-30 correspond to -10 to +20dBm.
Transmit Current	-	71.5	-	mA	At 20dBm transmit power.
Receive Current	-	13.8	-	mA	Typical value.
Sleep Current	-	5	-	uA	Sleep when CS is high or floating.
UART Baud Rate	600	9600	115200	bps	Settings 0-7 are configurable.
Antenna Interface	-	50	-	ohm	TT02 spring antenna recommended.
Package Type	-	SMD	-	-	Refer to the dimensional drawing and package documentation.

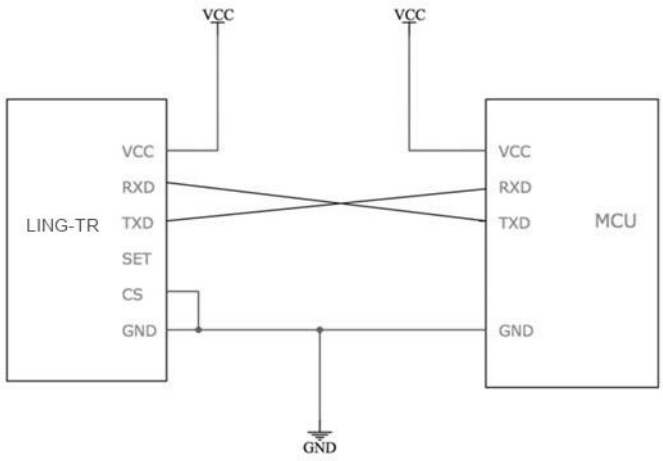
5 Pin Assignment

Bottom View

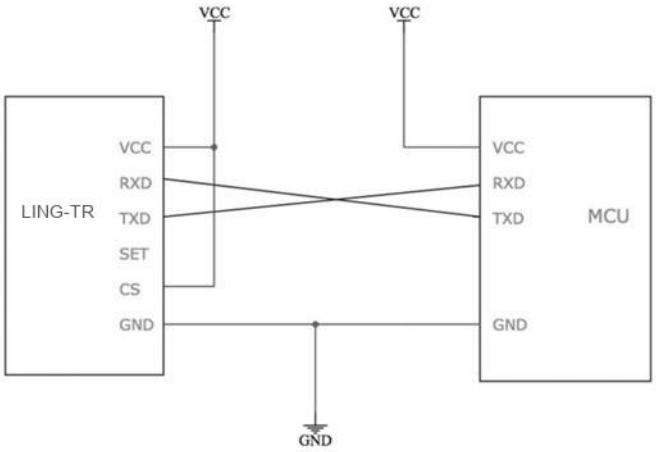
Pin	Type	Function	Description
VCC	Power	Positive Supply	1.8-3.6V; typical: 3.3V.
RXD	Input	Module Data Input	Connect to MCU TXD; UART TTL level.
TXD	Output	Module Data Output	Connect to MCU RXD; UART TTL level.
SET	Input	Configuration Enable	Low level enters configuration mode; floating or high level selects transparent transmission mode.
CS	Input	Active/Sleep Control	Active at low level; sleep at high level or when floating.
GND	Power	Supply Return	Common ground with the MCU or external serial device.
G	Power	Power Ground	Ground.
A	RF	Antenna Interface	50ohm antenna interface; TT02 spring antenna recommended.

6 Operating Modes

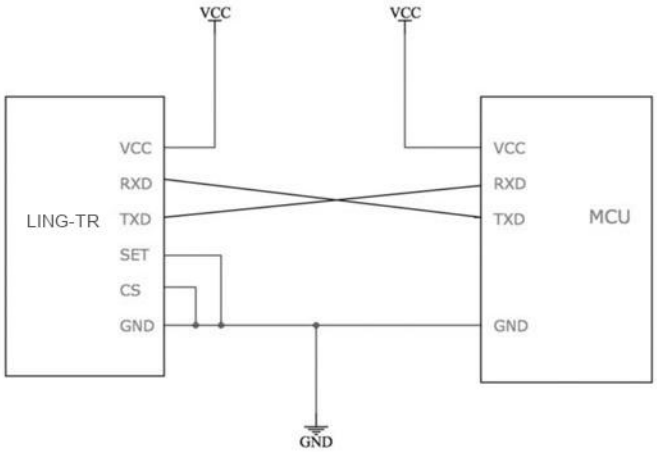
Mode	CS Pin	SET Pin	UART Status	Module Status
Transparent Transmission Mode	Low Level	High Level or Floating	Operates at the configured communication baud rate	UART wireless transparent transmission available.
Configuration Mode	Low Level	Low Level	Fixed at 9600bps, 8N1	Module parameters can be read and written; LED remains on.
Sleep Mode	High Level or Floating	Any	Communication Unavailable	Typical sleep current: 5uA; allow recovery time after wake-up.



Communication Mode



Sleep Mode



Configuration Mode

7 Quick Connection

Module Pin	Connection	Description
VCC	3.3V Supply	Supply range: 1.8-3.6V; direct connection to 5V is not recommended.
GND/G	MCU GND	Must share ground with the MCU or serial device.
RXD	MCU TXD	The host controller sends data to the module.
TXD	MCU RXD	The module outputs data to the host controller.
CS	MCU GPIO or GND	Active at low level; tie low if sleep is not used.
SET	MCU GPIO or Pull-up	High level/floating for transparent mode; pull low to configure parameters.
A	433MHz Antenna	Connect a 50ohm matched antenna and maintain antenna clearance.

8 Parameter Configuration

To enter configuration mode, both CS and SET must be low. In configuration mode, the UART is fixed at 9600bps, 8 data bits, no parity, and 1 stop bit. After configuration, leave SET floating or drive it high to return to transparent transmission mode; parameters take effect, are saved, and are retained after power-off.

Parameter-configuration commands use 18-byte HEX frames. The checksum is the low 8 bits of the sum of the first 17 bytes. Except for the 0x5A Set Parameters command, only the first two bytes of other commands are meaningful; remaining fields may contain any values, but the data length and checksum must be correct.

8.1 Parameter Configuration Frame Structure

Byte Position	Field	Attribute	Description
1	0xAA	Fixed	Frame-header byte 1.
2	Command	Fixed/Variable	0x56 Restart, 0x57 Restore Factory Settings, 0x58 Restore Response, 0x59 Query Version, 0x5A Set Parameters, 0x5B Set Response, 0x5C Query Parameters, 0x5D Query Response.
3-4	NC	Reserved	Reserved and unused; included in the checksum.
5-6	Net ID	Read/Write	Net ID; default: FFFF. Only modules with the same Net ID can exchange data.
7	NC	Reserved	Placeholder; included in the checksum.
8	RF Power	Read/Write	Transmit-power setting: 0-30 corresponds to -10 to +20dBm; default 30 is 20dBm.
9	NC	Reserved	Placeholder; included in the checksum.
10	Baud	Read/Write	0-7 corresponds to 600-115200bps; default 4 is 9600bps.
11	NC	Reserved	Placeholder; included in the checksum.
12	RF Channel	Read/Write	0-40 corresponds to 423.92-443.92MHz; default 20 is 433.92MHz.
13	NC	Reserved	Placeholder; included in the checksum.
14-15	NC	Reserved	Placeholder; included in the checksum.
16	Length	Fixed	Fixed at 0x12, i.e., 18 bytes.
17	NC	Reserved	Placeholder; included in the checksum.
18	CheckSum	Checksum	Low 8 bits of the sum of the first 17 bytes.

8.2 Command Examples

Purpose	HEX Command/Response	Description
Set Parameters	AA 5A 33 44 55 66 00 1E 00 04 00 14 00 00 00 12 00 7E	Net ID is 0x5566; power 0x1E is 20dBm; baud rate 0x04 is 9600bps; channel 0x14 is 433.92MHz.
Set Response	AA 5B 33 44 55 66 00 1E 00 04 00 14 00 00 00 12 00 7F	After receiving a valid Set Parameters command, the module responds with 0x5B.
Module Restart	AA 56 33 44 55 66 00 1E 00 04 00 14 00 00 00 12 00 7A	The module restarts after receiving this command.
Restore Factory Settings	AA 57 33 44 55 66 00 1E 00 04 00 14 00 00 00 12 00 7B	After receiving this command, the module restores factory parameters and returns the relevant 0x58 response.
Query Version	AA 59 33 44 55 66 00 1E 00 04 00 14 00 00 00 12 00 7D	The module returns a version string, for example, LingTR2H VER1.0 Sep 11 2020.
Query Parameters	AA 5C 33 44 55 66 00 1E 00 04 00 14 00 00 00 12 00 80	The module returns the 0x5D query response, whose format is the same as the 0x5A set response.

9 Parameter Tables

9.1 Transmit Power Table

Parameter Value	Hexadecimal	Transmit Power
0	0x00	-10dBm
1	0x01	-9dBm
2	0x02	-8dBm
3	0x03	-7dBm
4	0x04	-6dBm
5	0x05	-5dBm

Parameter Value	Hexadecimal	Transmit Power
6	0x06	-4dBm
7	0x07	-3dBm
8	0x08	-2dBm
9	0x09	-1dBm
10	0x0A	0dBm
11	0x0B	1dBm
12	0x0C	2dBm
13	0x0D	3dBm
14	0x0E	4dBm
15	0x0F	5dBm
16	0x10	6dBm
17	0x11	7dBm
18	0x12	8dBm
19	0x13	9dBm
20	0x14	10dBm
21	0x15	11dBm
22	0x16	12dBm
23	0x17	13dBm
24	0x18	14dBm
25	0x19	15dBm
26	0x1A	16dBm
27	0x1B	17dBm
28	0x1C	18dBm
29	0x1D	19dBm
30	0x1E	20dBm, default

9.2 UART Baud Rate Table

Parameter Value	Hexadecimal	UART Baud Rate
0	0x00	600bps
1	0x01	1200bps
2	0x02	2400bps
3	0x03	4800bps
4	0x04	9600bps, default
5	0x05	19200bps
6	0x06	38400bps
7	0x07	115200bps

9.3 RF Channel Table(Partial)

Decimal Channel	Hexadecimal	Frequency	Remarks
0	0x00	423.92MHz	Low-frequency end.
5	0x05	426.42MHz	Representative low-frequency channel.
10	0x0A	428.92MHz	Representative low-frequency channel.
15	0x0F	431.42MHz	Near and below the default channel.
20	0x14	433.92MHz	Default.
25	0x19	436.42MHz	Near and above the default channel.
30	0x1E	438.92MHz	Representative high-frequency channel.
35	0x23	441.42MHz	Representative high-frequency channel.
39	0x27	443.42MHz	Near the high-frequency end.
40	0x28	443.92MHz	High-frequency end.

10 Data Communication Behavior

The Ling-TR2H supports UART transparent transmission, but transparent transmission is not an application-layer reliable protocol. The module automatically packetizes data:

The module UART buffer is 100 bytes; continuously sending more than this amount to the module is not recommended. For longer application data, the host controller should send it in frame-based segments and use ACK, retransmission, and timeout mechanisms to control the transmission cadence.

The wireless link is half-duplex, and the module automatically performs Tx/Rx switching. System communication should use master-slave polling, request-response, or another mechanism that avoids simultaneous bidirectional transmission.

11 Timing Parameters

Item	Typical	Description
Power-On Initialization Time	0.6s	Wait for initialization to complete after power-on before communicating.
Sleep Wake-Up to Tx/Rx Ready	64ms	Data can be received and transmitted within 64ms after wake-up from sleep.
CS High to Sleep	4.3ms	A high level on CS enters sleep from normal mode.
SET Low to Enter Configuration	4.3ms	Pull SET low in normal mode to enter configuration mode.
SET High to Exit Configuration	64ms	After setting parameters, drive SET high to enter transparent transmission mode; parameters take effect.
9600bps Receive-Timeout Reference	6ms	Reference value used internally for UART timeout-based packetization.

12 MCU Reception and Example Guidance

At the receiving end, use a UART receive buffer with timeout-based frame delimiting. The TR2H module packetizes data automatically, but the application layer should still add a frame header, address, length, sequence number, and CRC to prevent incorrect operation caused by concatenated packets, split packets, or repeated control frames.

12.1 Receive-Timeout Example Framework

```
// Ling-TR2H UART receive example:
// RXD/TXD are module-side names; cross TXD/RXD when connecting to an MCU, and share GND.
// This example only demonstrates an application-layer UART timeout framing framework; production products should also add CRC, ACK, and retransmission.
#define TR2H_RX_TIMEOUT_MS  8     // At 9600bps, start verification with 6-10ms; finalize based on application frames and measurements.
#define TR2H_RX_BUF_SIZE    128   // TR2H UART buffer is about 100 bytes; use an application buffer slightly larger than the maximum application frame.
static uint8_t tr2h_rx_buf[TR2H_RX_BUF_SIZE];
static volatile uint16_t tr2h_rx_len = 0;
// UART receive interrupt: entered once for each received byte.
void TR2H_OnUartByte(uint8_t byte)
{
    // Prevent buffer overflow. If overflow occurs, discard the current frame and log an error to avoid parsing a partial frame.
    if (tr2h_rx_len < TR2H_RX_BUF_SIZE) {
        tr2h_rx_buf[tr2h_rx_len++] = byte;
    } else {
        tr2h_rx_len = 0;          // Simplified handling: clear on overflow and wait for the next frame.
        return;
    }
    // Restart the timeout timer whenever a new byte is received;
    // after an interval with no new bytes, pass the buffer to the protocol layer for parsing.
    TR2H_RestartRxTimeoutTimer(TR2H_RX_TIMEOUT_MS);
}
// Receive-timeout callback: triggered by the timer, indicating that the current UART data segment has ended.
void TR2H_OnRxTimeout(void)
{
```

```
    if (tr2h_rx_len == 0) {
        return;                 // No data; take no action.
    }
    // The protocol layer should check the frame header, length, device ID, sequence number, and CRC;
    // execute control actions only after validation to avoid incorrect operation from RF interference or partial frames.
    TR2H_ParseFrame(tr2h_rx_buf, tr2h_rx_len);
    // Processing of the current data segment is complete; clear the length to receive the next segment.
    tr2h_rx_len = 0;
}
```

12.2 Application-Layer Reliable Frame Recommendations

Field	Recommended Length	Purpose
Frame Header	2 bytes	Helps the receiver locate the start of a frame.
Address ID	2 bytes or project-defined	Used for grouping, pairing, or device identification.
Sequence Number	1 byte	Used for ACK, retransmission, and duplicate-frame suppression.
Length	1 byte	Defines the data-field length.
Data Field	0-N bytes	Application data; design single-frame length with the 49-byte wireless-packet limit in mind.
CRC/Checksum	1-2 bytes	CRC8/CRC16 is recommended for control products.

13 Power Supply Design Recommendations

- Typical module transmit current is 71.5mA@20dBm; the power supply must provide sufficient transient current capability.
- Keep the VCC trace short, wide, and close; avoid sharing a long, narrow power path with loads such as relays, motors, buzzers, or backlights.
- Place a 0.1uF decoupling capacitor close to the module VCC/GND and add suitable bulk capacitance as required by the complete-product power supply.
- For battery-powered systems, verify low-voltage operation, transmit-time voltage droop, sleep wake-up, and long-range communication success rate.
- When debugging range or packet-loss issues, use an oscilloscope near the module VCC/GND pins to observe transmit-time voltage droop, spikes, and ripple.
- Host-controller I/O levels must match the module supply. If the host controller uses 5V I/O, confirm level compatibility or add level translation.

14 EMC and Interference Immunity Recommendations

- Keep the module and antenna away from DC-DC inductors, relays, motors, compressors, buzzers, high-current harnesses, and high-voltage switching nodes.
- For inductive loads such as relays, motors, and coils, provide flyback paths, suppression, isolation, and ground-return paths according to complete-product EMC requirements.
- Keep digital lines such as UART, SET, and CS from running long distances parallel to noise sources. When needed, add series resistance or RC filtering and verify signal-edge quality.
- If communication fails when a load switches, test separately with no load, during load switching, with the enclosure assembled, and in the actual installation state.
- Range and stability tests should record the power supply, antenna, channel, Net ID, baud rate, enclosure, load switching, installation orientation, and success rate.

15 PCB Layout Recommendations

- When placing the module, prioritize clearance around the antenna interface and antenna area; avoid surrounding them with metal, batteries, shields, or large copper areas.
- Route the A antenna interface as a 50ohm RF path: keep it short and straight, and minimize vias, sharp bends, and branches.
- Evaluate copper pours, ground clearances, and mechanical parts under the module and near the antenna for the selected antenna type; do not copy an unverified layout directly.
- Keep the VCC/GND loop short and prevent high-current load return paths from passing through module ground.
- Keep UART, SET, and CS traces short and close to the host controller; do not route them through the antenna area or high-noise areas.

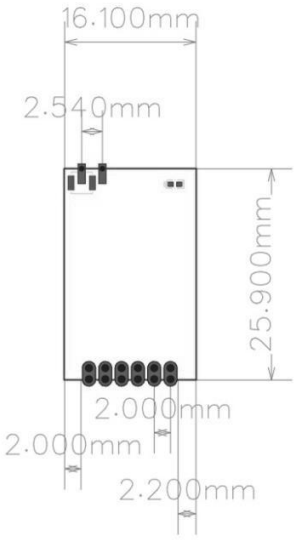
16 Antenna and Mechanical Recommendations

- The Ling-TR2H uses an external antenna interface; select a 50ohm antenna matched to the 433MHz band.
- The TT02 spring antenna is recommended; confirm the final antenna type and installation position through complete-product measurement.
- No antenna or an unmatched antenna seriously affects communication range and stability and must not be used for range evaluation.
- Antenna position and orientation, enclosure material, nearby metal, batteries, and harnesses all affect actual communication performance.
- For metal enclosures, control cabinets, basements, outdoor long-range applications, and similar scenarios, prioritize validation of external-antenna location and mechanical openings.

17 LED Indicator Description

Status	LED Behavior
Configuration Mode	LED remains on.
Valid Set Command Received	LED flashes once.
Transparent Transmission	Flashes while transmitting or receiving data.

18 Dimensions



19 Ordering and Technical Support

Technical documentation, configuration software, and test tools are available from the FNRF Wireless website:

WWW.FNRF-TECH.COM

Appendix A Quick Start

Data Transmission and Reception Test

After receiving the module, no parameter configuration is required. Once the circuit is connected correctly , UART communication can begin directly. Use the UART demo below to quickly begin data-transmission and reception testing.

UART DEMO (Test Board)

Appendix B Antennas

Antenna selection is critical. No antenna or an unsuitable antenna can seriously degrade performance or damage the module. The following antennas are commonly used:

Model	Image	Frequency	Dimensions
TT02		433MHz	27.5mm*5.0mm

Actual antenna performance also depends on the PCB, enclosure, and mechanical design. Purchase several antenna types for evaluation: