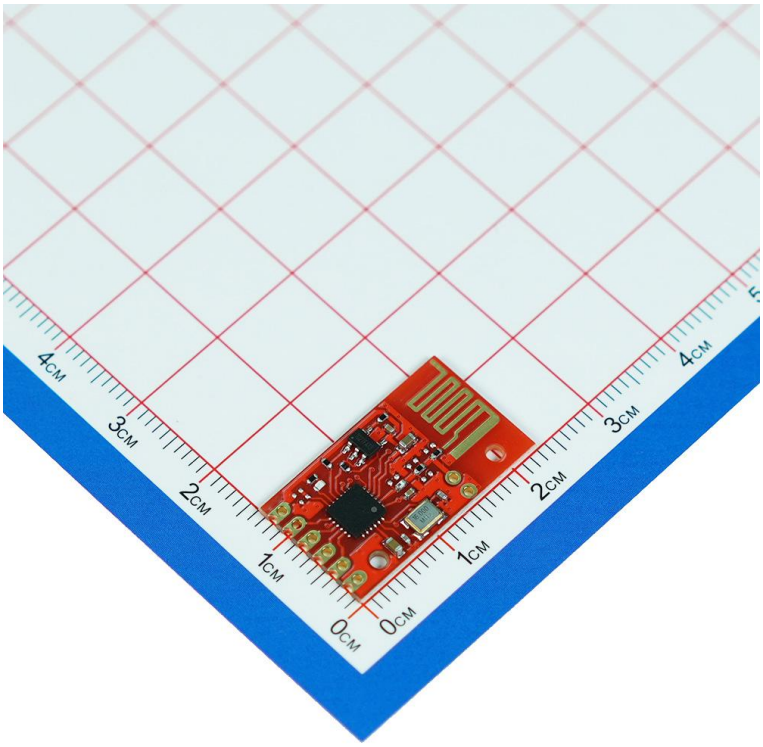
Ling-TR2 Wireless UART Module Datasheet



Item	Details
Product Model	Ling-TR2
Document Version	V3.7
Release Date	2026-07-15
Brand	FNRF

Contents

1 Product Overview

Ling-TR2 is a 2.4 GHz wireless transceiver module supporting transparent UART TTL transmission, with integrated RF transceiving and data-communication processing. Users can configure RF channel, transmit power, UART baud rate, Net ID, and other parameters through UART commands or the configuration tool.

The module converts MCU UART data, control data, and status data into a 2.4 GHz wireless link for applications such as remote control, data acquisition, smart homes, industrial control, robotics, and smart appliances.

3 Key Features

- 2.4GHz GFSK wireless transceiving, 2.45 GHz by default (configurable)
- Supports 128 RF channels.
- Transparent UART TTL transmission for convenient connection to MCUs or serial devices.
- Supports configuration of RF transmit power, UART baud rate, RF channel, and Net ID.
- Supply voltage: 2.2-3.6 V; typical: 3.3 V.
- Typical receiver sensitivity: -95 dBm.
- Supports CS sleep control; typical sleep current: 9.5 uA.
- SMD package suitable for embedded-product integration.

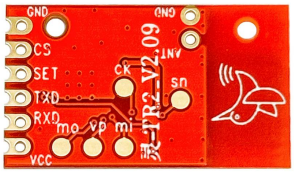
4 Typical Applications

- Remote-Control Equipment
- Data-Acquisition Terminals
- Smart-Home Devices
- Industrial Control
- Robot Control
- Smart Appliances
- Low-Rate Status-Data Feedback

5 Technical Specifications

Parameter	Minimum	Typical	Maximum	Unit	Condition/Notes
Operating Voltage	2.2	3.3	3.6	V	Between VCC and GND.
Operating Frequency Band	2.4	2.45	2.5	GHz	2.4 GHz ISM band.
Number of RF Channels	-	100	-	units	-
Modulation	-	GFSK	-	-	-
Maximum Output Power	-	12	-	dBm	RF Power parameter 0.
Receiver Sensitivity	-	-95	-	dBm	Typical value.
Transmit Current	-	40	-	mA	At 12 dBm transmit power.
Transmit Current	-	25	-	mA	At 0 dBm transmit power.
Receive Current	-	27	-	mA	Receive state.
Sleep Current	-	9.5	-	uA	CS sleep state.
UART Baud Rate	600	9600	38400	bps	Default 9600 bps; configurable.
RF Air Data Rate	-	1	-	Mbps	RF air data rate.
Reference Range	-	100	-	m	Open line of sight; actual range depends on antenna, power supply, structure, and on-site interference.
Interface Level	-	TTL	-	-	UART TTL level.
Package Type	-	SMD	-	-	Surface-mount package.

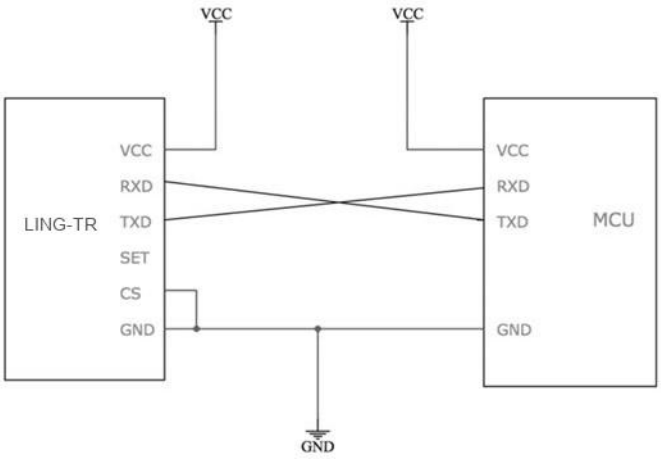
6 Pin Assignment



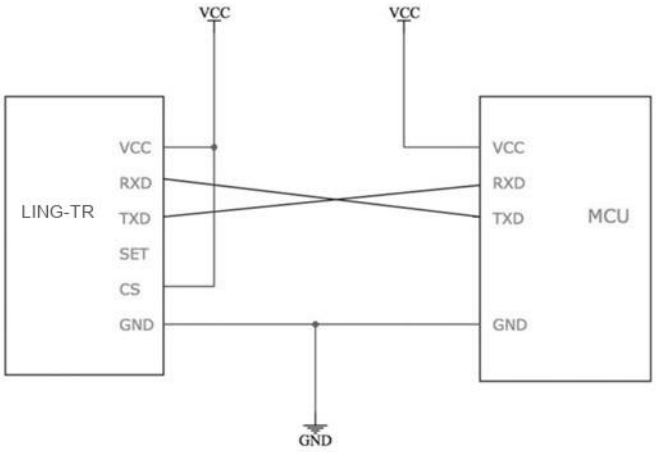
Bottom View

Pin	Type	Function	Description
VCC	Power	Positive Supply	2.2–3.6 V; typical: 3.3 V.
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 communication mode.
CS	Input	Active/Sleep Control	Active at low level; sleep at high level or when floating.
GND	Power	Power Ground	Common ground with the MCU or external serial device.
ANT	RF	External Antenna Interface	Connect a 2.4 GHz matched antenna; when using an external antenna, follow the module pad design.

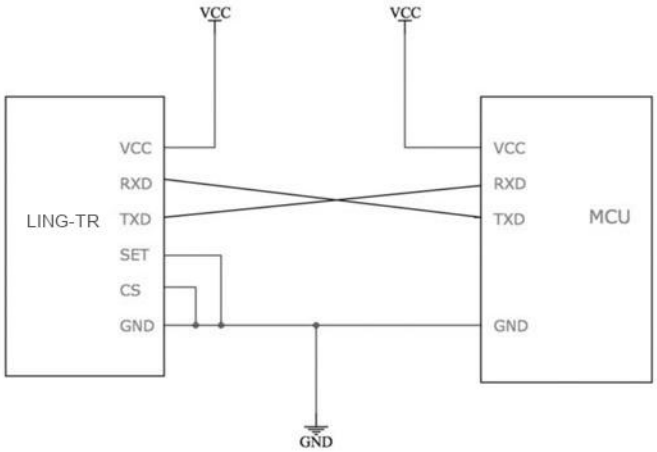
7 Operation and Operating Modes



Communication Mode



Sleep Mode



Configuration Mode

Mode	CS Pin	SET Pin	UART Status	Module Status
Communication Mode	Low Level	High Level or Floating	Transparent Transmission	Can transmit and receive wireless data.
Configuration Mode	Low Level	Low Level	Parameter Configuration	Used to configure or query module parameters.
Sleep Mode	High Level or Floating	-	No Communication	Low-power sleep.

8 Configuration Commands

8.1 Parameter Configuration Frame

Byte Position	Field	Attribute	Description
1	0xAA	Fixed	Command byte.
2	0x5A	Fixed	Set-Parameters command byte.
3-4	Self ID	2Byte	Module ID; setting it does not affect the actual module ID.
5-6	Net ID	2Byte	Net ID; both communication endpoints must match.
7	NC	1Byte	Reserved; must be 0x00.
8	RF Power	1Byte	Transmit-power parameter, range 0-14.
9	NC	1Byte	Reserved; must be 0x00.
10	Baud	1Byte	UART baud-rate parameter, range 0-6.
11	NC	1Byte	Reserved; must be 0x00.
12	RF Channel	1Byte	RF channel parameter, range 0-127.
13	NC	1Byte	Reserved; must be 0x00.
14-15	NC	2Byte	Reserved.
16	Length	1Byte	Fixed at 0x12.
17	NC	1Byte	Reserved; must be 0x00.
18	CheckSum	1Byte	Low 8 bits of the sum of the first 17 bytes.

8.2 Configuration Examples

Field	Example Value	Description
Host Sends	AA 5A 00 00 00 00 00 00 00 04 00 0A 00 00 00 12 00 24	Sets Net ID to 0000, transmit power to 12 dBm, UART baud rate to 9600 bps, and RF channel to 10.
Module Returns	AA 5B 05 21 00 00 00 00 00 04 00 0A 00 00 00 12 00 4B	The returned data includes the module ID.
Query Parameters	AA 5C 00 00 00 00 00 00 00 00 00 00 00 00 00 12 00 18	Queries current parameters.
Query Version	AA 5D 00 00 00 00 00 00 00 00 00 00 00 00 00 00 07	Queries the software version.
Factory Settings	AA 5A 00 00 00 00 00 00 00 04 00 64 00 00 00 12 00 7E	Factory example parameters.

To enter configuration mode, keep SET and CS low. The configuration UART format is 8 data bits, no parity, 1 stop bit, and 9600 bps.

9 Parameter Tables

9.1 Transmit Power Table

Parameter Value	Hexadecimal	Corresponding Transmit Power
0	0x00	12dBm
1	0x01	10dBm
2	0x02	9dBm
3	0x03	8dBm
4	0x04	6dBm
5	0x05	3dBm
6	0x06	0dBm
7	0x07	-2dBm
8	0x08	-5dBm
9	0x09	-10dBm
10	0x0A	-15dBm
11	0x0B	-20dBm
12	0x0C	-25dBm
13	0x0D	-30dBm
14	0x0E	-35dBm

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
5	0x05	19200bps
6	0x06	38400bps

9.3 Representative RF Channel Values

Parameter Value	Hexadecimal	Corresponding Frequency	Description
0	0x00	2400MHz	Multiples of 16 cannot be used.
1	0x01	2401MHz	Representative channel.
10	0x0A	2410MHz	Representative channel.
20	0x14	2420MHz	Representative channel.
32	0x20	2432MHz	Multiples of 16 cannot be used.
48	0x30	2448MHz	Multiples of 16 cannot be used.
50	0x32	2450MHz	Factory default value.
64	0x40	2464MHz	Multiples of 16 cannot be used.
80	0x50	2480MHz	Multiples of 16 cannot be used.
96	0x60	2496MHz	Multiples of 16 cannot be used.
100	0x64	2500MHz	Representative channel.

Avoid 0 and multiples of 16 when configuring channels; for parallel groups, use different Net IDs and RF channels.

10 Data Communication Behavior

- The module uses half-duplex communication and cannot transmit and receive simultaneously.
- After RXD receives UART data, the module starts wireless packet transmission.
- When the receiver outputs UART data, byte intervals may be uneven; use timeout-based packetization at the MCU receiver.
- UART baud rate and RF air data rate are different parameters; the typical RF air data rate is 1 Mbps.
- Both communication endpoints must use matching Net ID, RF channel, UART baud rate, and other parameters.

11 Timing Parameters

Item	Typical	Description
Power-On Initialization Time	80ms	Normal communication is available after initialization completes.
Sleep Wake-Up Time	190us	Typical recovery time after CS switches from sleep to active.
Sleep-to-Tx/Rx Allowance Time	2ms	Reserve this time in application firmware.
Tx/Rx Switching Time	320us	Theoretical time for switching between transmit and receive directions.
Receive-Timeout Packetization Time	10ms	At the MCU receiving end, 10 ms with no new byte can be treated as the end of one packet.

12 MCU Reception and Routine Recommendations

Use a ring buffer and receive-timeout mechanism for UART reception. Because the module receiver may output uneven byte intervals, do not rely solely on an MCU UART idle interrupt to determine the end of a complete packet.

```
#include <stdint.h>
#include <stddef.h>
#define TR2_RX_TIMEOUT_MS 10u
#define TR2_RX_BUFFER_SIZE 128u
static uint8_t tr2_rx_buffer[TR2_RX_BUFFER_SIZE];
static size_t tr2_rx_len = 0;
```

```
/*
 * TR2_OnUartByte()
 * Called from the MCU UART receive interrupt or DMA receive callback.
 * Each received byte is written to the receive buffer and restarts the receive-timeout timer.
 */
void TR2_OnUartByte(uint8_t byte)
{
    if (tr2_rx_len < TR2_RX_BUFFER_SIZE) {
        tr2_rx_buffer[tr2_rx_len++] = byte;
    } else {
        /*
         * Discard this packet when the buffer is full to prevent array overflow.
         * Production projects can add an error counter or resynchronization mechanism here.
         */
        tr2_rx_len = 0;
    }
    /*
     * Treat UART reception as complete only after no new byte arrives for TR2_RX_TIMEOUT_MS.
     * This timing accommodates uneven byte intervals at the module receiver.
     */
    TR2_RestartRxTimeoutTimer(TR2_RX_TIMEOUT_MS);
}
/*
 * TR2_OnRxTimeout()
 * Called by the receive-timeout timer callback.
 * Entry to this function indicates that no new UART byte has arrived for a period; pass data to the upper-layer protocol.
 */
void TR2_OnRxTimeout(void)
{
    if (tr2_rx_len == 0) {
        return;
    }
    /*
     * tr2_rx_buffer[0..tr2_rx_len-1] is the received packet.
     * If the application layer uses a header, length, CRC, or command, parse it in TR2_ProcessFrame().
     */
    TR2_ProcessFrame(tr2_rx_buffer, tr2_rx_len);
```

```
    /*
     * Clear the length after processing and wait for the next packet.
     */
    tr2_rx_len = 0;
}
```

13 Power-Supply Design Recommendations

- VCC supply range is 2.2–3.6 V; typical: 3.0 V.
- At 12 dBm transmit power, typical transmit current is 40 mA; allow transient-current margin in the power-supply design.
- Place a decoupling capacitor close to the module between VCC and GND to reduce transmit-time voltage droop.
- The module is not suitable for direct supply from coin cells with insufficient output capability.
- The MCU, serial tool, and module must share ground to avoid inconsistent UART voltage references.

14 EMC and Interference-Immunity Recommendations

- The module operates in the 2.4 GHz band; complete-product structure, antenna position, power noise, and on-site co-channel interference affect communication performance.
- Keep the module away from DC-DC inductors, high-current traces, relays, motors, and high-speed digital interfaces.
- Communication endpoints can be grouped by Net ID and RF channel to reduce mutual interference when multiple device groups operate in parallel.
- Before mass production, verify communication range in the actual enclosure, with the actual power supply, and in the target installation orientation.

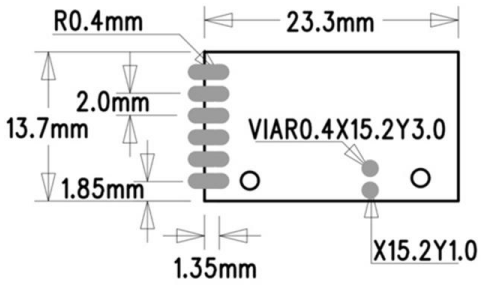
15 PCB Layout Recommendations

- Keep VCC and GND traces short and wide, and maintain a continuous ground reference near the module.
- Keep RXD, TXD, SET, and CS traces away from high-frequency switching nodes and high-current loops.
- Route ANT as a 2.4 GHz RF path; avoid sharp angles, long stubs, and unnecessary vias.
- Maintain antenna clearance near the external antenna interface and reduce obstruction by metal parts, batteries, and shields.
- If the enclosure or structure is close to the antenna, verify range and directionality in the final structure.

16 Antenna and Mechanical Recommendations

- ANT is an external antenna interface; connect a 2.4 GHz matched antenna.
- When using an external antenna, handle components at the PCB antenna connection according to module pad and structural requirements.
- Keep the antenna area away from metal enclosures, large copper areas, batteries, shields, and hand-obstruction areas.
- No antenna or an unmatched antenna can seriously affect communication range or even damage the product.
- For long-range or complex-structure projects, perform complete-product range testing in the target enclosure and installation orientation.

17 Dimensions



18 Ordering and Technical Support

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

www.fnrf-tech.com

Appendix 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)