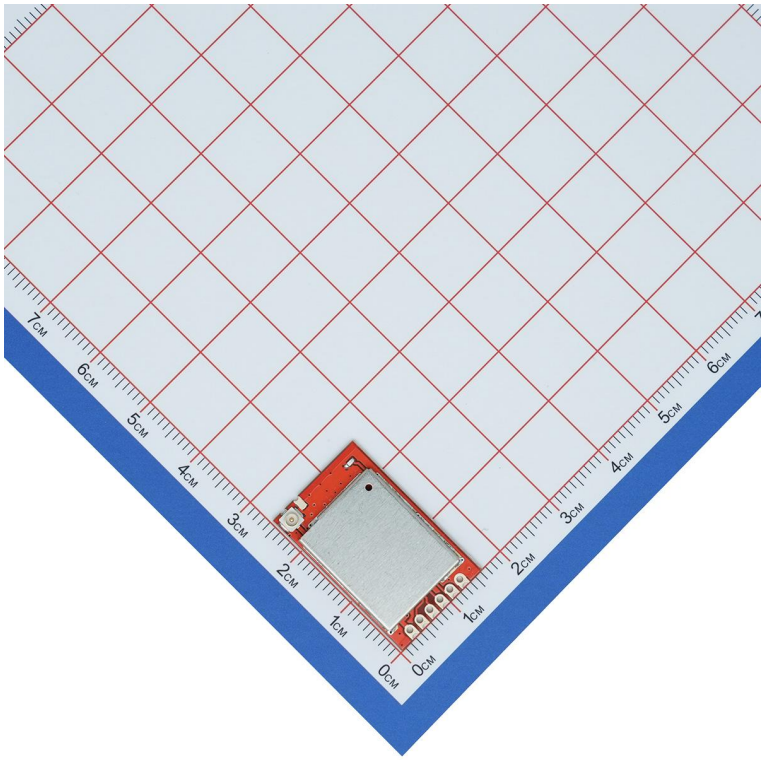
Ling-TR6 Wireless UART Module Datasheet



Item	Details
Product Model	Ling-TR6
Document Version	V1.8
Release Date	2026-07-02
Brand	FNRF

Contents

1 Product Overview

The Ling-TR6 is a spread-spectrum wireless UART module that connects to an MCU or serial device through its UART TTL interface. The module supports UART transparent transmission and allows configuration of transmit power, UART baud rate, RF channel, Net ID, bandwidth, spreading factor, coding rate, and other parameters.

The Ling-TR6 is suitable for low-rate data acquisition, long-range control, status feedback, industrial-equipment interconnection, and smart-device communication.

2 Key Features

- Spread-spectrum communication, long range, and interference immunity.
- Available in 433MHz, 490MHz, and 915MHz band versions; default: 433.92MHz.
- The 433MHz version supports channels 0-40, corresponding to 423.92-443.92MHz.
- Supply range: 2.0-3.6V; typical: 3.3V.
- Typical receiver sensitivity: -143dBm.
- Typical transmit current: 76mA@22dBm; typical receive current: 9mA.
- Typical sleep current: 6uA.
- UART TTL transparent transmission; 600-115200bps; default: 9600bps.
- Supports grouping by a combination of Net ID and RF channel, enabling multiple module groups to operate in the same area.

3 Typical Applications

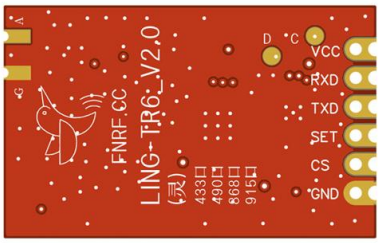
Application Category	Description
Data Acquisition	Low-rate wireless transmission of UART data for sensors, instruments, and acquisition terminals.
Remote Control and Discrete I/O Control	Point-to-point control, status feedback, and long-range discrete I/O control.
Smart Device Interconnection	Data interconnection among smart-home devices, smart appliances, and low-rate UART devices.
Robotics and Mobile Devices	Control links requiring moderate real-time performance and longer communication distance.

4 Technical Specifications

Parameter	Minimum	Typical	Maximum	Unit	Condition/Notes
Operating Voltage	2.0	3.3	3.6	V	Between VCC and GND.
Operating Frequency Band	423.92	433.92	443.92	MHz	433MHz version, channels 0-40.
Available Band	-	433	-	MHz	Optional: 490/915MHz.
Number of RF Channels	0	20	40	ch	Default channel: 20.
Communication Mode	-	Spread-Spectrum Communication	-	-	UART transparent transmission, half duplex.
UART Baud Rate	600	9600	115200	bps	Settings 0-8 are configurable.
Receiver Sensitivity	-	-143	-	dBm	Typical value.
Transmit Current	-	76	-	mA	At 22dBm transmit power.
Receive Current	-	9	-	mA	Typical value.
Sleep Current	-	6	-	uA	Wireless data cannot be received in sleep mode.
Transmit Power Parameter	0	22	-	-	-
Bandwidth	62.5	125	500	kHz	Available: 62.5/125/250/500kHz.
Spreading Factor	SF5	SF7	SF12	-	A larger value provides a lower data rate and longer range.
Coding Rate	4/5	4/5	4/8	-	Settings 0-3 correspond to 4/5, 4/6, 4/7, and 4/8.
Reference Range	-	4000	-	m	Reference line-of-sight value at 0.6kbps in an open, interference-free environment; verify actual range in the complete product.
Temperature Range	-30	25	+80	℃	Confirm complete-product operating temperature.
Antenna Interface	-	50	-	ohm	ANT is the external antenna interface. TF45 recommended.

Parameter	Minimum	Typical	Maximum	Unit	Condition/Notes
Module Width	-	16.10	-	mm	
Module Length	-	25.90	-	mm	
Main Pin-Header Pitch	-	2.00	-	mm	

5 Pin Assignment

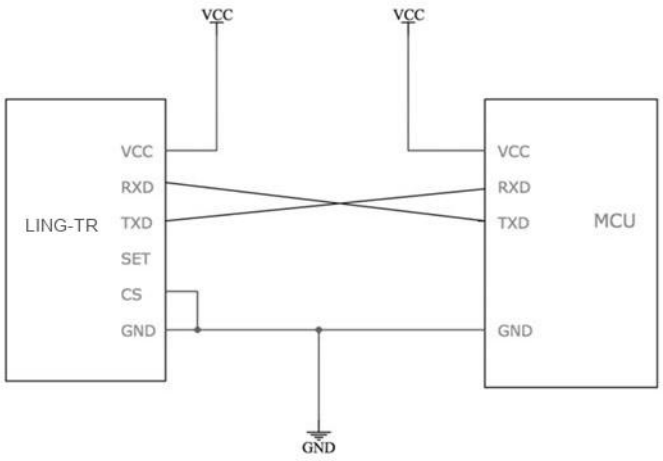


Bottom View

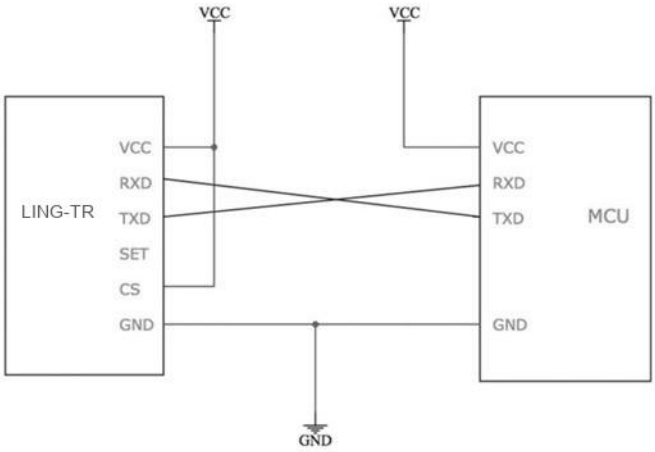
Pin	Type	Function	Description
VCC	Power	Positive Supply	2.0-3.6V; typical: 3.3V.
RXD	Input	Module Data Input	Connect to MCU TXD; UART TTL level.
TXD	Output	Module Data Output	Connect to MCU RXD; UART TTL level.
SET	Input	Configuration Enable	Low level enters configuration mode; floating or high level selects 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	50ohm antenna interface; TF45 recommended。

6 Operating Modes

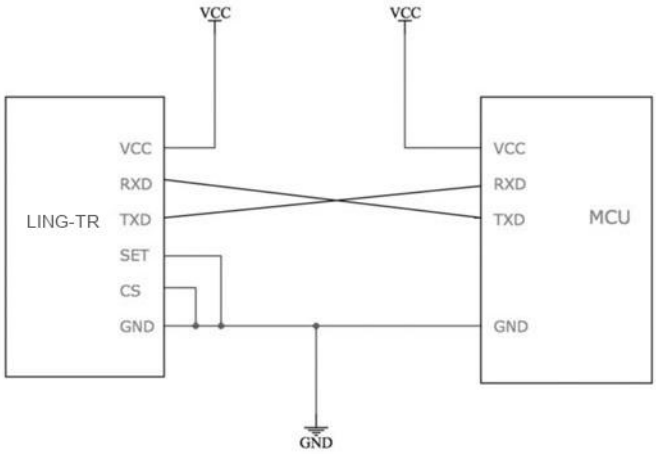
Mode	CS Pin	SET Pin	UART Status	Module Status
Comm. Mode	Low Level	High Level or Floating	Operates at the configured communication baud rate	Wireless UART transparent transmission available.
Sleep Mode	High Level or Floating	Any	Communication Unavailable	Quiescent current is approximately 6uA; wireless data cannot be received.
Config. Mode	Low Level	Low Level	Fixed at 9600bps, 8N1	Module parameters can be read and written; LED remains on.



Communication Mode



Sleep Mode



Configuration Mode

7 Quick Connection

Module Pin	Connection	Description
VCC	3.3V Supply	Supply range: 2.0-3.6V; verify first at 3.3V.
GND	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 Floating	Floating/high level for communication mode; pull low to configure parameters.
ANT	External Antenna	Connect an antenna matched to the target band and maintain antenna clearance.

8 Configuration Commands

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; this UART format is independent of the application baud rate configured in communication mode.

8.1 Parameter Configuration Frame Structure

AA 5A 00 00 00 00 00 00 01 04 0A 00 02 00 00 00 00 15

Byte Position	Field	Attribute	Description
1	0xAA	Fixed	Frame-header byte 1.
2	Command	Fixed/Variable	0x5A Set Parameters, 0x5B Set Response, 0x5C Query Parameters, 0x5D Query Response, 0x59 Query Version, 0x58 Restore Defaults.
3-4	Product ID	Read Only	Product ID; cannot be modified.
5-6	Net ID	Read/Write	Net ID; it must match at both ends for communication.
7	NC	Reserved	Placeholder; included in the checksum.
8	RF Power	Read/Write	Transmit power setting. Default: maximum.
9	Bandwidth	Read/Write	0-3 correspond to 62.5/125/250/500kHz. Default: 125kHz.
10	Baud	Read/Write	0-8 correspond to 600-115200bps; default 4 is 9600bps.
11	NC	Reserved	Placeholder; included in the checksum.
12	RF Channel	Read/Write	0-40 correspond to 423.92-443.92MHz; default 20 is 433.92MHz.
13	SF	Read/Write	0-7 correspond to SF5-SF12. Default: SF7.
14	Coding Rate	Read/Write	0-3 correspond to 4/5, 4/6, 4/7, and 4/8. Default: 4/5.
15-17	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 00 00 12 34 00 00 02 04 00 14 02 00 00 00 00 66	Sets Net ID, power, bandwidth, baud rate, channel, SF, coding rate, and other fields.
Set Response	AA 5B 4C 04 12 34 00 00 02 04 00 14 02 00 00 00 00 B7	The response frame header changes from AA 5A to AA 5B.
Query Parameters	AA 5C 00 00 12 34 00 00 02 04 00 14 04 00 00 00 00 6A	Queries the current parameters; the response frame header is AA 5D.
Query Version	AA 59 00 00 12 34 00 00 02 04 00 14 04 00 00 00 00 67	The module returns an ASCII-formatted version string.
Restore Defaults	AA 57 00 00 00 00 02 00 03 04 0A 00 02 00 00 00 00 16	Restores factory default parameters.

Default parameters: frequency 433.92MHz (the frequency may differ depending on the band version).

UART baud rate: 9600bps.

Net ID: 0000.

SF: 7.

Bandwidth: 125kHz.

9 Parameter Tables

9.1 Transmit Power Parameters

Parameter Item	Value	Description
Parameter Code Range	0-21 (0x00-0x16)	1 Byte; read/write.
Factory Setting	Maximum Power	0x00 = 22dBm.

Parameter Value	Hexadecimal	UART Baud Rate
0	0x00	22dBm (default)
1	0x01	21dBm
2	0x02	20dBm
3	0x03	19dBm
...	...	...
21	0x16	1dBm

9.2 UART Baud Rate Parameters

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	57600bps
8	0x08	115200bps

9.3 Bandwidth Parameters

Parameter Value	Hexadecimal	Bandwidth
0	0x00	62.5kHz
1	0x01	125kHz (default)
2	0x02	250kHz
3	0x03	500kHz

9.4 Spreading Factor

Parameter Value	Hexadecimal	Spreading Factor	Description

Parameter Value	Hexadecimal	Spreading Factor	Description
0	0x00	SF5	Higher data rate and relatively shorter range.
1	0x01	SF6	Balance between data rate and range.
2	0x02	SF7	Common default parameter range. (Default)
3	0x03	SF8	Lower data rate and relatively longer range.
4	0x04	SF9	Low data rate and relatively longer range.
5	0x05	SF10	Low data rate and relatively longer range.
6	0x06	SF11	Low data rate and relatively longer range.
7	0x07	SF12	Lowest data rate and longer range.

9.5 Coding Rate Parameters

Parameter Value	Coding Rate
0	4/5 (default; no change required)
1	4/6
2	4/7
3	4/8

9.6 RF Channel (Partial)

Decimal Parameter	Hexadecimal	Corresponding Frequency	Description
0	0x00	423.92MHz	Low-frequency end.
10	0x0A	428.92MHz	Representative channel.
20	0x14	433.92MHz	Factory-default channel.
30	0x1E	438.92MHz	Representative channel.
40	0x28	443.92MHz	High-frequency end.

10 Data Communication Behavior

The Ling-TR6 performs UART transparent transmission, but transparent transmission is not an application-layer reliable protocol. Depending on RF air data rate and wireless parameters, the

module may internally packetize and depacketize UART data, and byte intervals at the receiver may be uneven.

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.

A single wireless packet can carry up to 20 bytes of payload data. If more than 20 bytes are sent, the module splits the data into multiple wireless packets. The RF data rate may be lower than a continuous UART input stream, so continuous high-rate transmission from the host may cause buffer overflow or data congestion. Where the protocol allows, arranging continuous data in multiples of 20 bytes can reduce partially filled trailing packets and improve transmission efficiency.

Official documentation specifies a 500-byte rolling UART receive buffer. Buffer overflow may occur when UART input rate exceeds wireless transmit capability. For continuous data, set the transmission cadence according to RF parameters, application-frame length, and actual packet-loss rate.

11 Timing Parameters

Item	Typical	Description
Power-On Initialization Time	160ms	Wait for initialization to complete after power-on before communicating.
CS High or Floating to Enter Sleep	5.1ms	Wireless data cannot be received in sleep mode.
CS Low to Exit Sleep	6ms	After wake-up, allow 10-30ms before sending application data.
SET Low to Enter Configuration	10ms	The UART is fixed at 9600bps, 8N1 after entering configuration mode.
SET Exit Configuration	54ms	Returns to communication mode after exit.

11.1 Rate Relationship Reference

Bandwidth kHz	SF Factor	Startup Time	1-Byte Time	Total Time for n-Byte Packet	Remarks

Bandwidth kHz	SF Factor	Startup Time	1-Byte Time	Total Time for n-Byte Packet	Remarks
500	5	1.7ms	0.4ms	1.7 + n x 0.4ms	Fastest rate.
125	7	25ms	2ms	25 + n x 2ms	Default parameter values.
125	9	82.9ms	20ms	82.9 + n x 20ms	Low-rate, long-range scenario.
62.5	12	1327ms	300ms	1327 + n x 300ms	Slowest rate; not recommended as a routine configuration.

12 MCU Reception and Example Guidance

At the receiving end, do not rely solely on the UART idle interrupt to determine the end of a packet. A more robust approach is to receive bytes in a ring buffer and start a short timeout after the last byte arrives; after 1-10ms with no new byte, pass the current buffer to the protocol layer as one application-data segment.

12.1 Receive-Timeout Example Framework

```
// Called once for each received UART byte, typically in a UART interrupt or receive callback.
void TR6_OnUartByte(uint8_t byte)
{
    // In an actual project, first check whether rx_len exceeds the maximum rx_buffer length to avoid buffer overflow.
    rx_buffer[rx_len++] = byte;

    // Restart the receive-timeout timer after a new byte is received.
    // Consider the current UART data segment complete after about 10ms with no new byte.
    // Adjust this time according to baud rate, data length, MCU timer accuracy, and the actual communication scenario.
    TR6_RestartRxTimeoutTimer(10);
}

// Receive-timeout callback: pass the current buffered data segment to the upper layer for parsing.
void TR6_OnRxTimeout(void)
{
    if (rx_len == 0) {
        return;
    }
```

```
    // Note: timeout-based segmentation does not necessarily equal a complete application frame.
    // TR6_ProcessFrame() must still check the frame header, length, command, address, checksum, and CRC.
    // For applications requiring greater reliability, add a sequence number, ACK/retransmission, and duplicate-frame filtering.
    TR6_ProcessFrame(rx_buffer, rx_len);

    // Clear the receive length to prepare for the next data segment.
    // If the UART receive interrupt and timeout callback may access rx_len concurrently, use critical-section protection.
    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 pairing, grouping, or identifying permitted transmitters.
Sequence Number	1 byte or project-defined	Used for ACK, retransmission, and duplicate-frame suppression.
Length	1 byte or project-defined	Defines the data-field length.
Data Field	0-N bytes	Application data.
CRC/Checksum	1-2 bytes	CRC8/CRC16 is recommended for control products.

13 Power Supply Design Recommendations

- Module transmit-time current can reach tens of mA; 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 according to the complete-product power supply.
- 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.
- 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.
- 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 UART, SET, and CS digital lines from running long distances parallel to noise sources. When needed, add series resistance or RC filtering and verify signal-edge quality.
- Range and stability tests should record power supply, antenna, RF channel, Net ID, 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 ANT 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

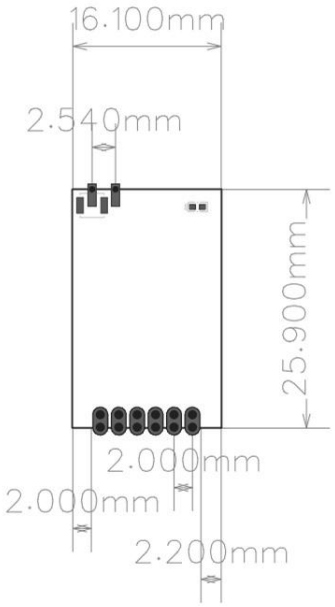
- The Ling-TR6 uses an external antenna interface; select a 50ohm antenna matched to the target band.
- No antenna or an unmatched antenna seriously affects communication range and stability.

- Antenna position and orientation, enclosure material, nearby metal, batteries, and harnesses all affect actual communication performance.
- The 433MHz version commonly uses 433MHz antennas such as TF45 and TT02; use complete-product measurement as the final basis.
- For metal enclosures, control cabinets, basements, outdoor long-range applications, and similar scenarios, prioritize an external antenna and validate its installation position.

17 LED Indicator Description

Status	LED Behavior
Configuration Mode	LED remains on.
Communication/Sleep State	Refer to the actual module version and test state.

18 Dimensions



19 Ordering and Technical Support

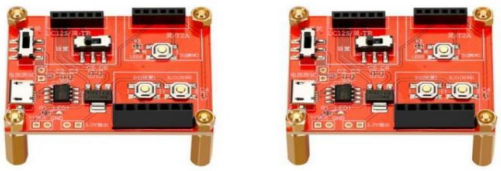
Technical documentation, configuration software, and test tools are available from the FNRF Wireless website:

WWW.FNRF-TECH.COM

Appendix A Quick Start

Data Transmission and Reception Test

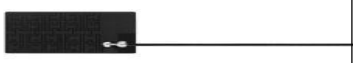
After receiving the module, no parameter configuration is required. Once the circuit is connected correctly , UART communication can begin directly. Use the UART demo below to quickly begin data-transmission and reception testing.



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
TF45		433MHz	45mm*17mm
TT02		433MHz	27.5mm*5.0mm

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