LC-1000R

2.4G Transparent low power consumption wireless UART Module

UM-LC-1000R-V20-EN

1 Features

- 2.4G wireless data transmission module
- Full duplex transparent serial port
- Configurable baud rate, range: 2400bps to 57600bps
- Add wireless communication without any RF knowledge requirement
- Frequency range: 2400-2483.5 MHz ISM
- 4 bytes RF TX/RX configurable address
- Maximum duplex RF air data rate reaches 38.4kbps
- Transmission distance more than 60 meters
- Connection type: Connector or SMD, suitable for DIY or mass production
- Suitable for high-speed data transmission with low power consumption
- Flexible mode configuration， support Normal, PSM and Direct mode
- Featured PSM (Power Saving Mode) Mode, can balance high-speed data transmission and low power consumption
- Configurable sleep time in PSM Mode: 20ms to 65000ms
- Operating voltage: DC 2.7V to 3.6V, rated voltage 3.3V
- Pin level Compatible both 3.3 V and 5 V TTL level
- Average working current (@DC 3.3V):
  - NML Mode: 26mA
  - PSM Mode: 1.6mA

2 Typical Application

- Wireless audio transmission
- Handheld device
- Wireless monitoring and control System
- Remote controlled toys

- Short distance wireless data transmission
- 1 to N wireless data acquisition

3 Pin Definitions

3.1 Product Structure Diagram

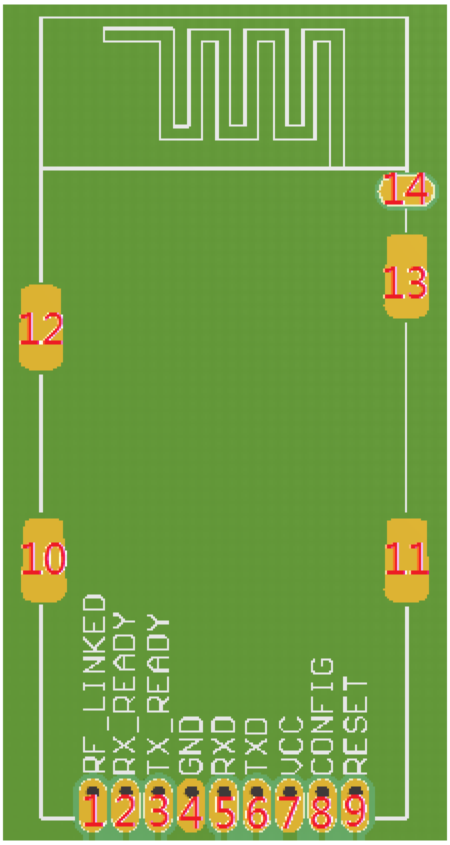

14
13
12
10
11
RF_LINKED
RX_READY
TX_READY
GND
RXD
TXD
VCC
CONFIG
RESET
1
2
3
4
5
6
7
8
9

Figure 2: PIN Configuration Sketch Map

P/N:LC-1000
INHAOS™
http://www.inhaos.com

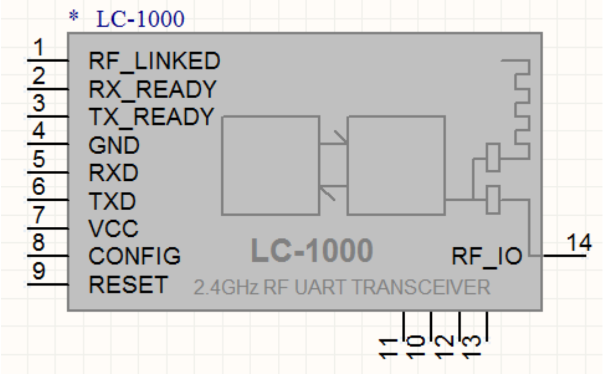

* LC-1000
1
2
3
4
5
6
7
8
9
RF_LINKED
RX_READY
TX_READY
GND
RXD
TXD
VCC
CONFIG
RESET
LC-1000
2.4GHz RF UART TRANSCEIVER
RF_IO
14
11
10
12
13

Figure 1 : LC-1000 Schematic Component symbol

LC-1000R supports two kinds of antenna connection mode: On-board antenna mode and an external antenna mode.

The on-board antenna is a Wiggle antenna which is specially validation tested, the rated gain is 1.5dBi. It can get a better communication performance directly using the on-board antenna when user doesn’t have special requirements.

A rated impedance of 50 ohm's external antenna can connect to LC-1000R’s RF_IO pin, when user needs an external antenna.

This two antenna connection mode can be configured by onboard SEL1 and SEL2. By default the on-board antenna mode is selected. If need external antenna mode, you can inform INHAOS to change the configuration after place an order.

3.2 Pin Description

Number	Name	Direction	Description
1	RF_LINKED	OUT	Indicating the RF connection status 0 Linked 1 Un-Linked Always 0, when in Direct mode
2	RX _READY	OUT	Indication valid data received 0 Data valid, and will send via TXD after 1ms 1 No data received
3	TX_READY	OUT	Indicate transmit finished, and new data packet can be wrote in 0 ready for data input 1 busy, data can't input
4，10，11，12， 13	GND	GND	All ground pins must be connect to the reference GND
5	RXD	IN	UART data input
6	TXD	OUT	UART data output
7	VCC	VDD	3.3V power supply
8	CONFIG	IN	Configuration Pin for configuring the LC-1000R 0 switch to configuration mode 1 switch out configuration mode Further, set the CONFIG to LOW and last at least 500ms, the LC-1000R will be power down; And LC-1000R will power up when

			CONFIG is set to HIGH again.
9	RESET	IN	Reset pin 0 LC-1000R into reset mode 1 LC-1000R into running mode
14	RF_IO	RF Signal IN/OUT	Pin for connect external antenna, selecting antenna mode through the SEL1 combined with SEL2. SEL1：NC SEL2：100pF ：external antenna SEL1：100pF SEL2：NC ：on-board antenna

4 Functional Description

4.1 System structure

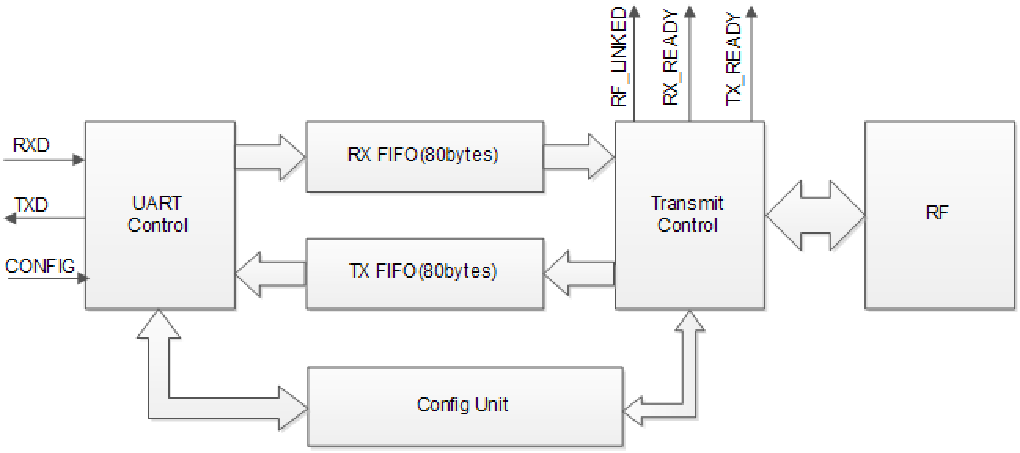

RF_LINKED
RX_READY
TX_READY
RXD
TXD
CONFIG
UART Control
RX FIFO(80bytes)
TX FIFO(80bytes)
Transmit Control
RF
Config Unit

Figure 3 System Structure

4.2 System State Diagram

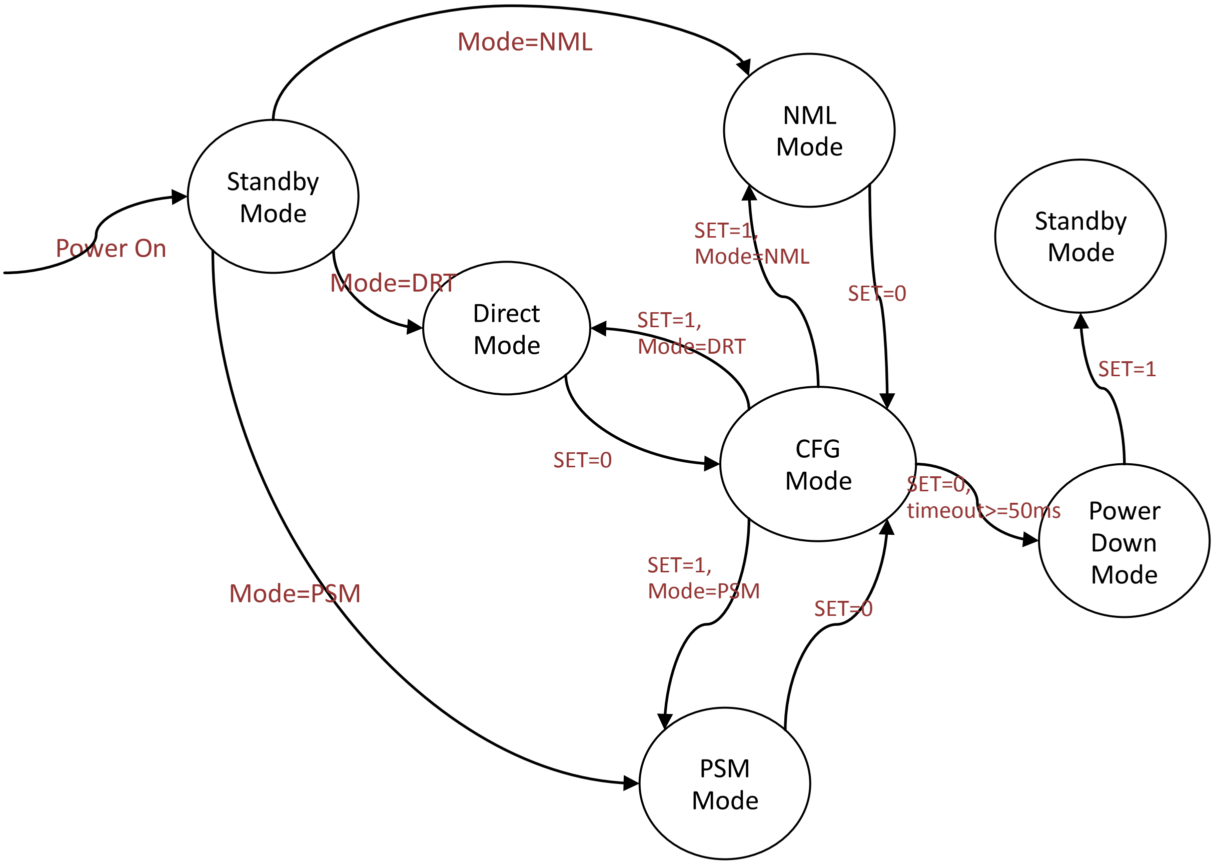

Mode=NML
NML Mode
Standby Mode
Power On
Mode=DRT
Direct Mode
SET=1, Mode=NML
SET=0
Standby Mode
SET=1, Mode=DRT
SET=1
SET=0
CFG Mode
SET=0, timeout>=50ms
Power Down Mode
Mode=PSM
SET=1, Mode=PSM
SET=0
PSM Mode

Figure 4 System State Diagram

4.3 Pin Indication

4.3.1 RF_LINKED Pin Indication

Once LC-1000R linked successfully, RF_LINKED pin will be pulled down at once. And RF_LINKED pin will be set to HIGH when link state is disconnected.

In NML mode , LC-1000R will stay in receive mode and periodically send handshake to other side for every 200mS , if handshake failed the RF_LINKED will be pull high , and the LC-1000R will keep periodically handshake and pull RF_LINKED low once handshake succeed.

In Direct Mode , the LC-1000R will stay in receive mode and do not try to handshake with each other , so the RF_LINKED pin is not available in direct mode , in this mode , the RF_LINKED pin will keep to low state.

In PSM Mode, the LC-1000R will stay in sleep mode and will periodically wake up to handshake with each other , if handshake failed over 3 times , the RF_LINKED will pull high to indicate RF link lost , same as the NML mode , the LC-1000R will periodically wake up and handshake , so once RF reconnect , the RF_LINKED will pull low again. Because the LC-1000R only update RF_LINKED state each time wake up , so the RF_LINKED is delay than the real RF connection state , the max delay is 3 times of Sleep time , for the example : the sleep time set to 0x0A , that mean the sleep time is (8mS * 10 = 80mS) , and the RF_LINKED will pull high if 3 times failed to handshake , so the RF_LINKED will delay max (80mS * 3 = 240mS).

4.3.2 RX_READY Pin Indication

When RX FIFO has valid data, the RX _READY pin will set to LOW immediately, and data will be sent through TXD after 1ms's delay time.

After all data received , RX_READY will become HIGH after 2ms's delay time. This feature can be used in low power consumption application , connect RX_READY to a INT pin of the microcontroller , and let microcontroller go to sleep mode , once data coming the RX_READY pin will pull low and wake the microcontroller up , after receive all the data the RX_READY will pull up and microcontroller can be enter sleep mode again .

The follow diagram shows the detail timing of RX_READY & TXD.

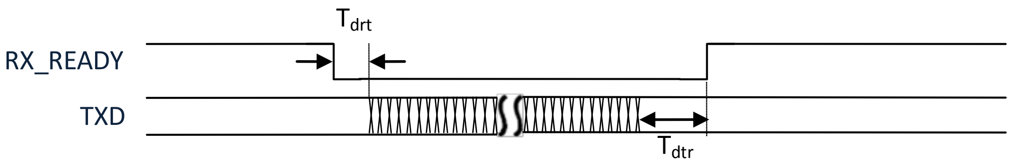


Figure 5 RX_READY & TXD

Symbol	Parameter	Min	Typ	Max	Unit
T_{drt}	RX_READY becomes LOW to TXD data valid	---	1	--	ms
T_{dtr}	Data FIFO empty to RX_READY becomes HIGH	---	2	--	ms

Table 1 RX_READY & TXD Timing Parameters

4.3.3 TX_READY Pin Indication

TX_READY pin indicates whether LC-1000R is busy for sending or not. Once new data coming from RXD, the TX_READY pin will be set to LOW at once and LC-1000R will buffer all this coming data in RX FIFO, then start for sending, till all the data in the RX FIFO be sent out, TX_READY pin reset to HIGH.

The follow diagram shows the detail timing of TX_READY & RXD.

User need to process TX_READY signal in below two case:

1, To ensure all data will transmit to other side , microcontroller need to read TX_READY pin before sending data , TX_READY is high means TX buffer is not blank , user need to wait till TX_READY become low , then send data to LC-1000R.

2, User want to pull low CONFIG pin to configuration the LC-1000R , to make sure all buffer data succeed send to other side , user need read TX_READY pin , user only can pull low CONFIG pin after TX_READY is low.

Notice , if RF link lost (RF_LINKED pull high) , the TX_READY will keep to high if TX buffer is not blank , in this case , user pull low the config pin , the TX buffer will be cleared and TX_READY can be become to low.

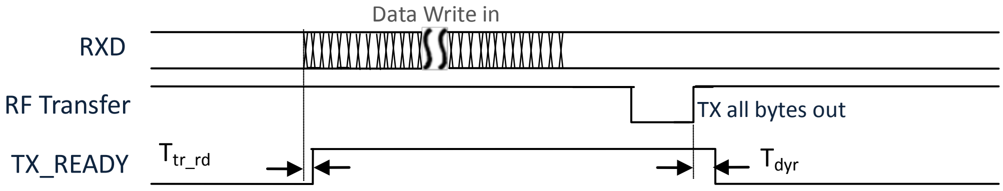


Figure 6 TX_READY & RXD

Symbol	Parameter	Min	Typ	Max	Unit
T_{tr_rd}	TX_READY become to HIGH after RXD data received	5	--	--	us
T_{dyr}	Transmit completed to TX_READY becomes LOW	--	--	50	us

Table 2 TX_READY & RXD Timing Parameters

4.4 Reset Baud rate

A baud rate resetting condition will be detected in the progress of initialization after LC-1000R powered on. The baud rate resetting condition is: CONFIG pin state is LOW and last at least 250ms. If this condition is established, then the baud rate of LC-1000R will reset to 9600bps.

User can reset the baud rate of LC-1000 whenever the baud rate state becomes fuzzy just following the steps:

1) Set RESET pin to LOW
2) Set CONFIG pin to LOW
3) Delay 100ms
4) Set RESET pin to HIGH
5) Delay at least 250ms
6) Set CONFIG pin to HIGH
7) Delay more than 50ms for LC-1000R internal preparation
8) LC-1000R's baud rate is 9600bps in the later

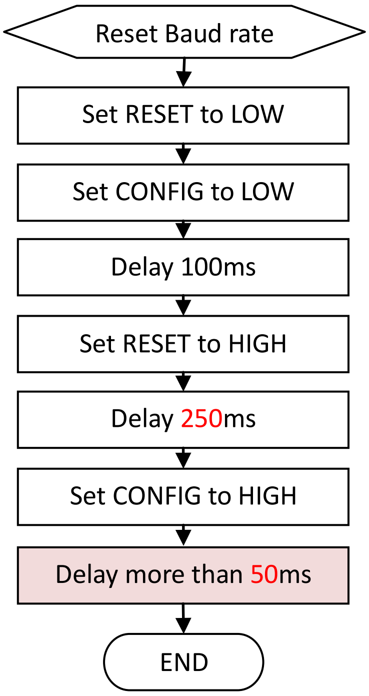

Reset Baud rate
Set RESET to LOW
Set CONFIG to LOW
Delay 100ms
Set RESET to HIGH
Delay 250ms
Set CONFIG to HIGH
Delay more than 50ms
END

Figure 7 Reset baud rate flow chat

4.5 Standby Mode

Standby mode is temporarily a translation mode. It does proper preparation for mode translation, such as clear all the RX FIFO, TX FIFO, get the RF frequency channel list, etc. After all this is done, LC-1000R switches to working mode via the setting parameter WORK_MODE.

WORK_MODE value	Working Mode
0	NML Mode
1	PSM Mode
2	Direct Mode

4.6 Power Down Mode

In the Power down Mode, the power consumption of LC-1000R's is lowest than other mode. After switched into Power down mode, the LC-1000R does following things to reduce the power consumption:

- Power down the RF chip
- Close all the timers
- Close UART
- MCU go into the deep sleep mode

So in the Power down mode, any data sending to LC-1000R via the RXD pin will be ignored.

Switch into the Power down mode:

Set the CONFIG pin to LOW and last at least 50ms, the LC-1000R will switch into the Power down mode.

Quit from the Power down mode:

Set the CONFIG pin to HIGH, the LC-1000R will wake-up at once and quit the Power down mode, and set the RESET pin to LOW, to reset the LC-1000R.

Please note, after quit from the Power down mode, the LC-1000R will switch into the Standby mode.

Both TX and RX buffer will be cleared after pull low the CONFIG pin , user must read TX_READY and RX_READY pin first if user do not want lost any data .

4.7 Direct Mode

Direct Mode is one of the most flexible working mode, it mainly used in applications of user-defined protocol, such as 1:N topology of networks.

4.7.1 Operation description of Direct Mode

In Direct Mode the LC-1000R stays in receiving state when no any data for sending. And once user write in sending data via RXD, the LC-1000R will buffer the input data in the RX FIFO firstly, then start sending progress. And the sending progress will continue until all the data in RX FIFO was sent out.

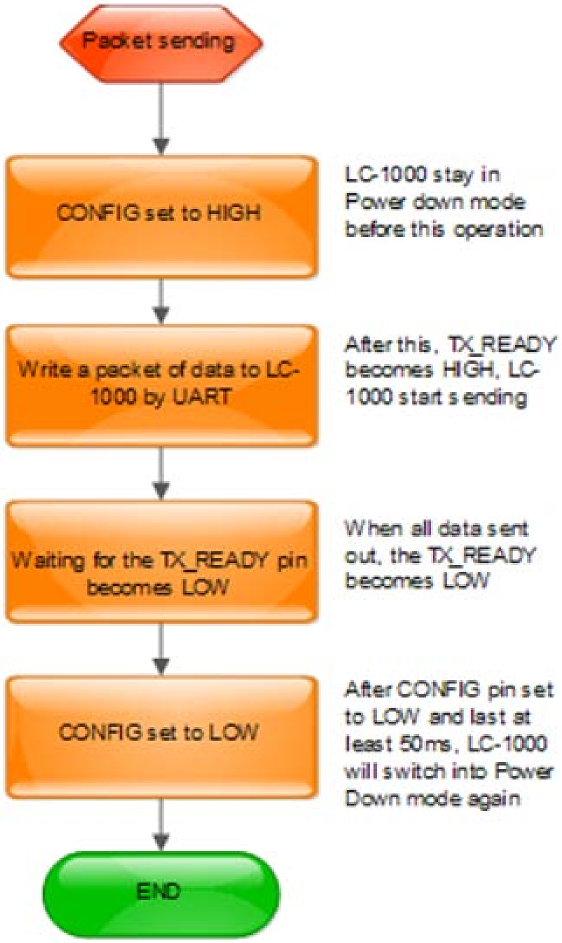
Please note, the input data length must less than the RX FIFO length (which is 80Bytes max), otherwise, data will be overfilled.

If any data received from remote device, the RX_READY pin will clear to LOW to indicate user of data received. After 1ms's delay immediately after RX_READY becomes LOW, RX data will sending out through the TXD pin. Then RX_READY set to HIGH again, after all the RX data sent out.

The TX_READY pin will set to HIGH automatically at once when received any input data, and after all data has sent out the TX_READY becomes LOW again.

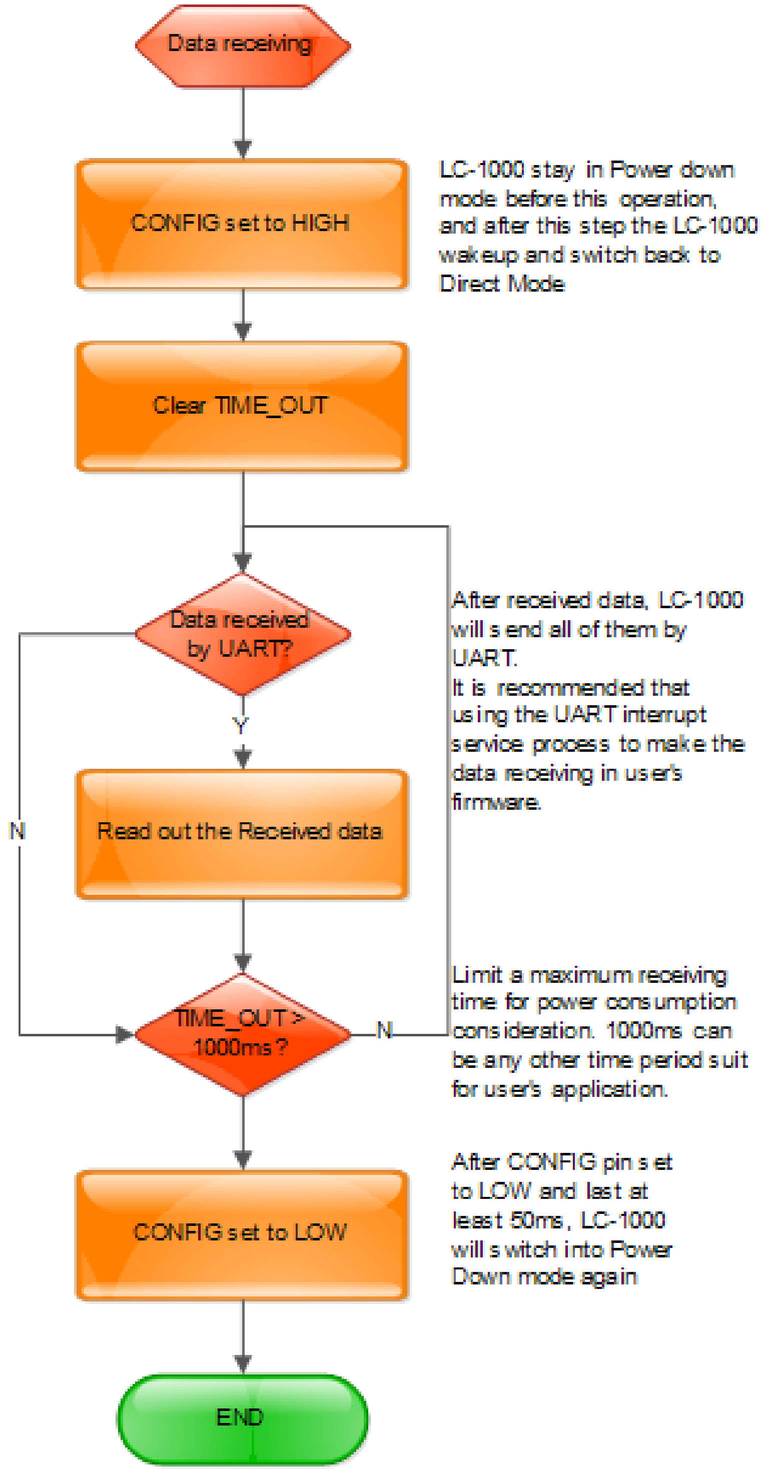
4.7.2 Packet sending progress in Direct Mode

It is recommended to use the following progress to make packet sending in LC-1000R's Direct Mode, which can minimize power consumption of the LC-1000R.


Packet sending
CONFIG set to HIGH
LC-1000 stay in Power down mode before this operation
Write a packet of data to LC-1000 by UART
After this, TX_READY becomes HIGH, LC-1000 start sending
Waiting for the TX_READY pin becomes LOW
When all data sent out, the TX_READY becomes LOW
CONFIG set to LOW
After CONFIG pin set to LOW and last at least 50ms, LC-1000 will switch into Power Down mode again
END

4.7.3 Data receiving progress in Direct Mode

It is recommended to use the following progress to make packet receiving in LC-1000R's Direct Mode, which can minimize power consumption of the LC-1000R.


Data receiving
CONFIG set to HIGH
Clear TIME_OUT
Data received by UART?
Y
N
Read out the Received data
TIME_OUT > 1000ms ?
N
CONFIG set to LOW
END

LC-1000 stay in Power down mode before this operation, and after this step the LC-1000 wakeup and switch back to Direct Mode

After received data, LC-1000 will send all of them by UART.
It is recommended that using the UART interrupt service process to make the data receiving in user's firmware.

Limit a maximum receiving time for power consumption consideration. 1000ms can be any other time period suit for user's application.

After CONFIG pin set to LOW and last at least 50ms, LC-1000 will switch into Power Down mode again

4.8 NML Mode

In NML mode, the LC-1000R keeps running with no power consumption consideration to improve the efficiency of data transmission.

NML Mode mainly used in applications of 1:1 topology of networks, such as one device with PSM mode and another device with NML mode, or one with NML and another also NML mode communicate.

4.8.1 Operation description of NML Mode

From the standpoint of wireless protocol, the NML mode the same with the Direct mode, but for one thing that NML mode will detect the connection state with the remote device of communication periodically. So please reference the 4.7.1 for operation description of the NML mode.

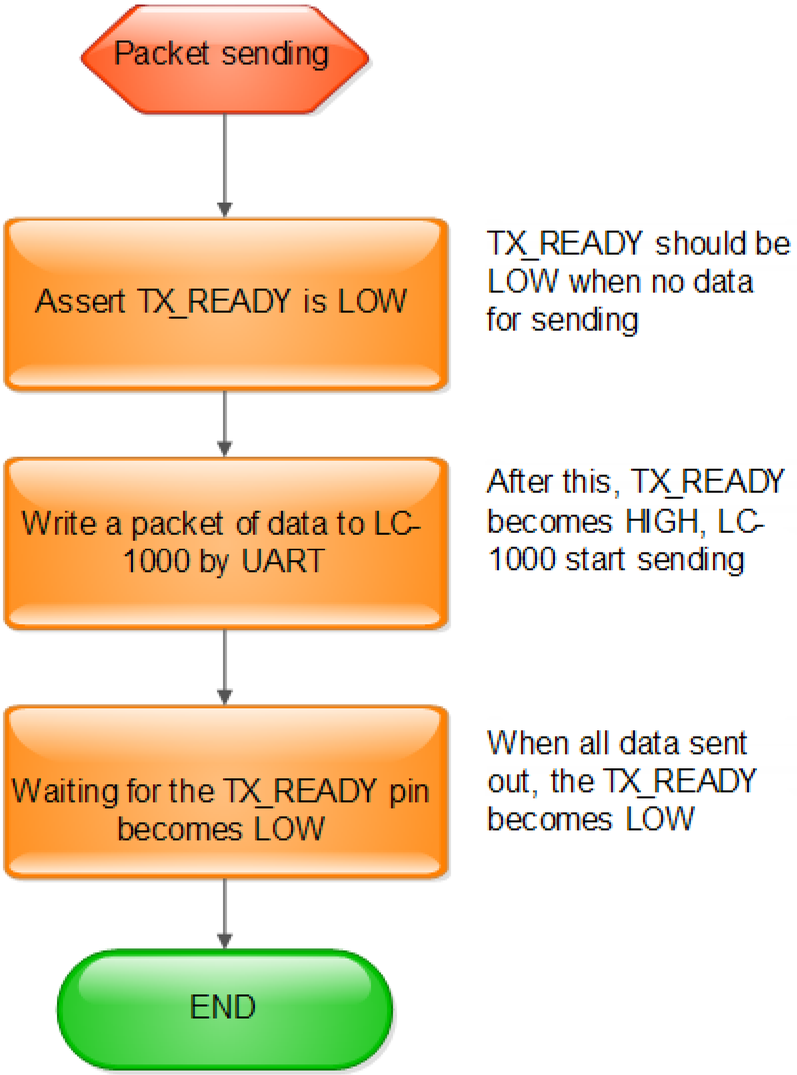
4.8.2 Connection detecting of the NML Mode

It will make a connection detecting periodically in NML mode, and the detecting period is 200ms. If the connection state keeps no changed, the RF_LINKED pin will keep LOW, but if the connection is disconnected, the RF_LINKED pin will set to HIGH. Even if in the disconnected state, the LC-1000R will continue make connection detect every 200ms. Once the remote device response normally, the LC-1000R connected again and the RF_LINKED pin will set to LOW.

For the detection period is 200ms in NML mode, so the time delay from the remote device disappear to local RF_LINKED pin become HIGH, is the three times as the detection period, typically 600ms to 800ms.

4.8.3 Packet sending progress in NML Mode

In the NML mode, user’s firmware can start data sending any time if the RF_LINKED pin is LOW by write to LC-1000R via UART interface. And the typically progress for packet sending as following chart:


Packet sending
Assert TX_READY is LOW
TX_READY should be LOW when no data for sending
Write a packet of data to LC-1000 by UART
After this, TX_READY becomes HIGH, LC-1000 start sending
Waiting for the TX_READY pin becomes LOW
When all data sent out, the TX_READY becomes LOW
END

4.8.4 Data receiving progress in Direct Mode

After any data received, LC-1000R will set the RX_READY pin to LOW, and after a shortly 1ms delay it sends all of them by UART to user’s firmware.

It is recommended that using the UART interrupt service process to make the data receiving in user's firmware.

4.8.5 Data receiving using RX_READY pin for wakeup in NML mode

In some cases, the main controller MCU may needs low power consumption performance as well as quickly response to the remote device. And the RX_READY pin can come in handy.

The following steps will guide you for using RX_READY pin for wakeup MCU and receiving data. For the detail timing of RX_READY and the TXD, please reference 4.3.2

Steps for go into sleep

- Configure the LC-1000R's work mode to NML/PSM mode
- Set MCU wakeup method is RX_READY pin(such as INT0, INT1, etc)
- Close MCU's UART
- Now set MCU go into sleep

Steps for wakeup and receiving and sleep again

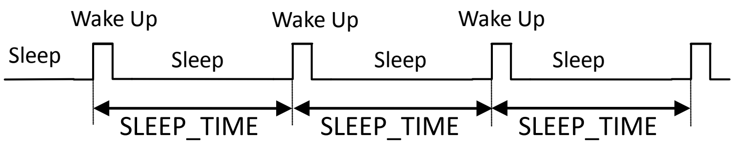
- Re-open MCU's UART
- Receiving data via UART,
- After timeout (for example: 10ms) when no data coming, Set MCU wakeup method is RX_READY pin(such as INT0, INT1, etc)
- Close MCU's UART
- Now set MCU go into sleep again

4.9 PSM Mode

PSM mode is designed for giving consideration to both data transmission and low power consumption.

4.9.1 Operation description of PSM Mode

In PSM mode, the LC-1000R will working with sleep and wakeup and sleep again periodically. The parameter SLEEP_TIME decides the period of sleep, and the WAKEUP_TIME decides the wake up period.



4.9.2 Connection detecting of the PSM Mode

The first thing LC-1000R will do after wakes up from sleep is to detect the connection state with remote device. If the remote device has no response, the LC-1000R will keep trying till the timeout of WAKEUP_TIME. The connection state changes to disconnect and RF_LINKED pin set to HIGH after 3 times of wakeup period. Once the remote device response normally, the LC-1000R connected and the RF_LINKED pin will set to LOW again.

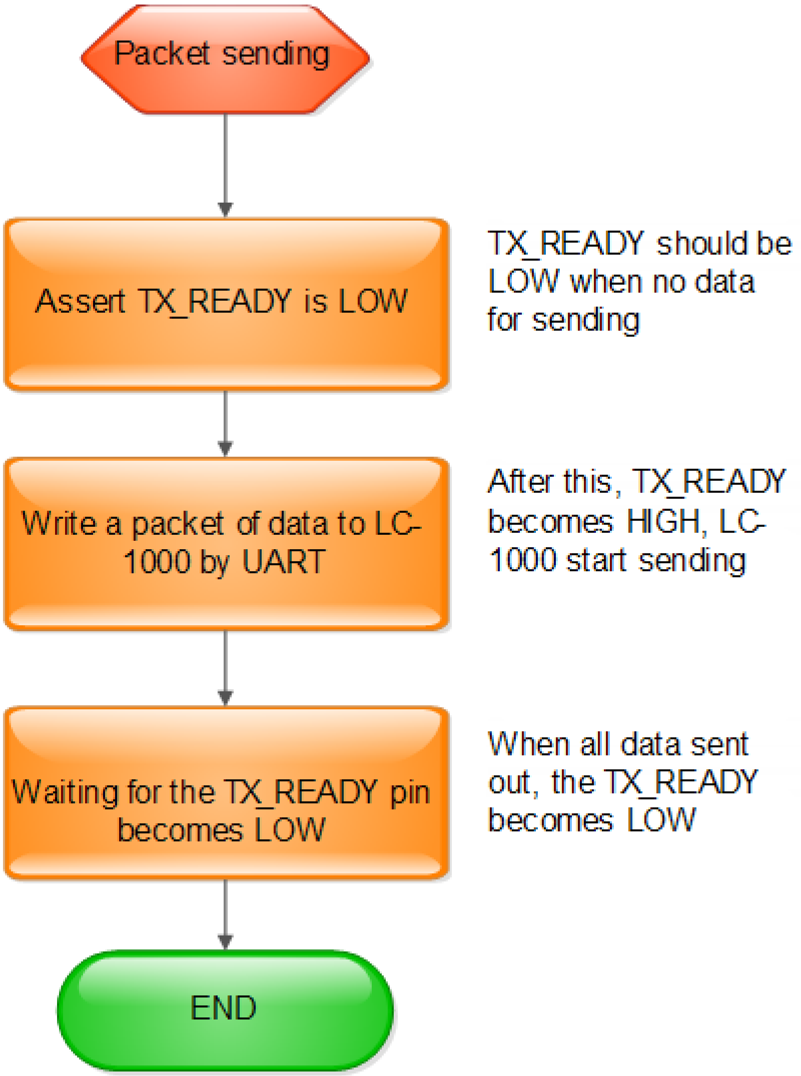
For the detect period is SLEEP_TIME + WAKEUP_TIME in PSM mode, so the time delay from the remote device disappear to local RF_LINKED pin become HIGH, is the three times as the detect period.

4.9.3 Packet sending progress in PSM Mode

The same with the NML mode, user's firmware can start data sending any time if the RF_LINKED pin is LOW by write to LC-1000R via UART interface. The UART interrupt will wake-up the LC-1000R at once, and buffer the received data to RX FIFO, and then LC-1000R will start sending progress.

Please note, the input data length must less than the RX FIFO length, otherwise, data will be overfilled.

The TX_READY pin will set to HIGH automatically at once when received any input data, and after all data has sent out the TX_READY becomes LOW again.


Packet sending
Assert TX_READY is LOW
TX_READY should be LOW when no data for sending
Write a packet of data to LC-1000 by UART
After this, TX_READY becomes HIGH, LC-1000 start sending
Waiting for the TX_READY pin becomes LOW
When all data sent out, the TX_READY becomes LOW
END

4.9.4 Data receiving progress in PSM Mode

After any data received, LC-1000R will set the RX_READY pin to LOW, and after a shortly 1ms delay it sends all of them by UART to user’s firmware.

Unlike the NML mode, the remote device’s sending data only can be received when LC-1000R in wake up state. So the delay time between remote device start sending a packet to local LC-1000R received, will affected by the setting parameter of SLEEP_TIME and WAKEUP_TIME, and also affected by the opportunity that remote start sending.

It is recommended that using the UART interrupt service process to make the data receiving in user's firmware.

4.9.5 Data receiving using RX_READY pin for wakeup in PSM mode

The same with NML mode, the RX_READY pin can be used as a wakeup pin for the main controller MCU which normally in sleep mode for reduce the power consumption of the system. Please reference 4.8.5 for detail.

4.10 CFG Mode

User application can read or write the configurations of LC-1000R when in CFG mode.

The CONFIG pin is used for CFG mode selection. The LC-1000R switches to CFG mode at once after CONFIG becomes LOW, and after the CONFIG pin set to HIGH again, the LC-1000R will quit from the CFG mode and switch to Standby mode.

Steps for configure the LC-1000R:

1) Set CONFIG pin to LOW
2) Write command packet to LC-1000R through UART
3) Waiting for the ACK packet of LC-1000R
4) …
5) Set CONFIG pin to HIGH, to exit the CFG mode.
6) Delay 5ms more

Notice that the CONFIG pin have two functions:

1, Sent Config command within 500mS after CONFIG pin pull low, the LC-1000R will entry config mode. Pull high CONFIG pin will back to working mode from config mode.

2, Pull low CONFIG pin and do not sent anything, the LC-1000R will entry power down mode after 500mS, pull high the CONFIG pin will wake up device from power down mode.

Figure 8 Flow chart of Configure LC-1000 shows a demo flow chart of configure the LC-1000R.

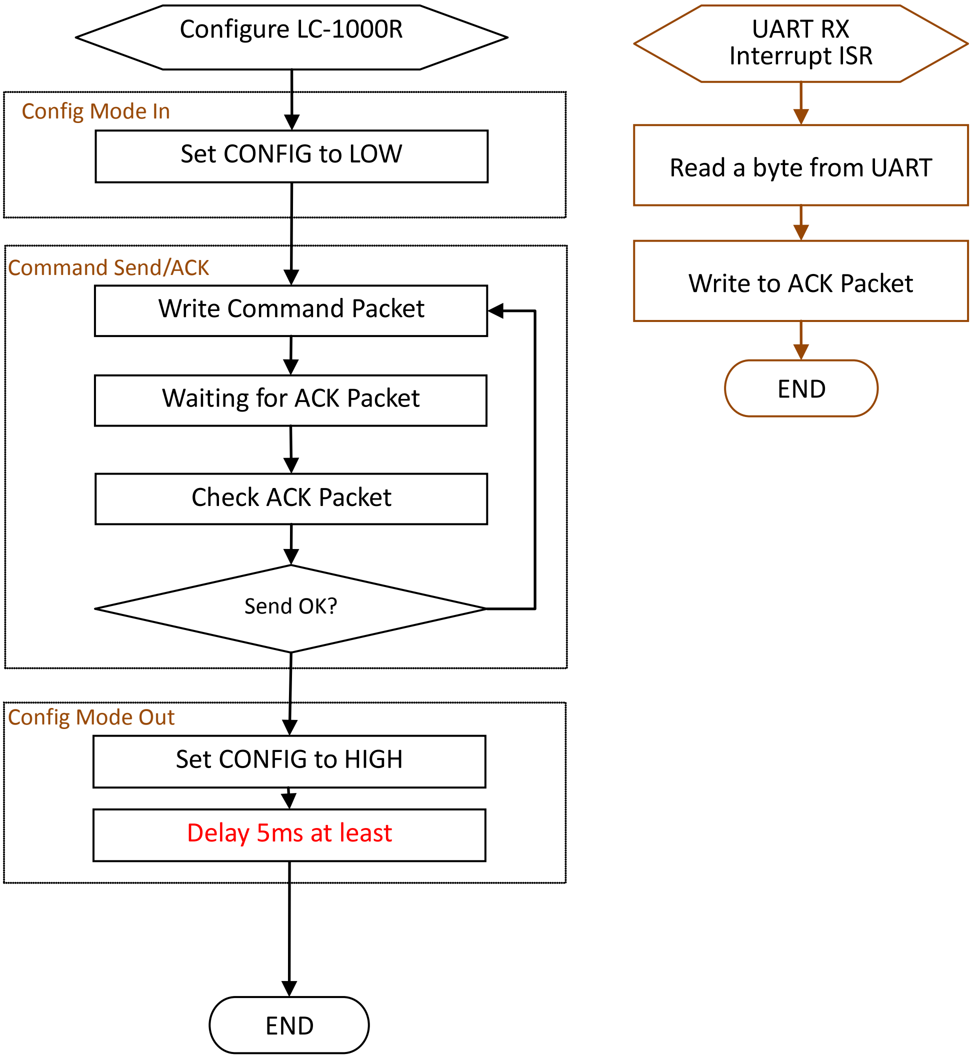

Configure LC-1000R
Config Mode In
Set CONFIG to LOW
Command Send/ACK
Write Command Packet
Waiting for ACK Packet
Check ACK Packet
Send OK?
Config Mode Out
Set CONFIG to HIGH
Delay 5ms at least
END
UART RX
Interrupt ISR
Read a byte from UART
Write to ACK Packet
END

Figure 8 Flow chart of Configure LC-1000R

The Figure 9 shows the detail timing for configure the LC-1000R.

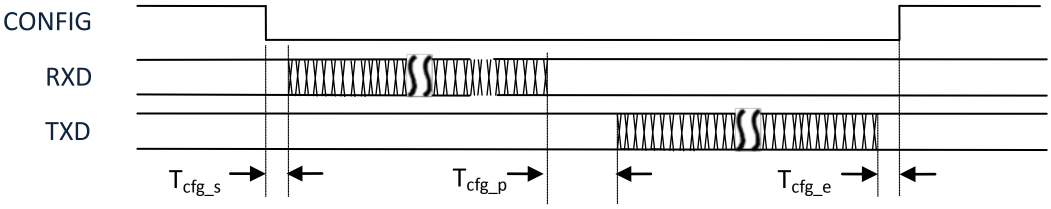

CONFIG
RXD
TXD
T_{cfg_s}
T_{cfg_p}
T_{cfg_e}

Figure 9 Configure Timing

Symbol	Parameter	Min	Typ	Max	Unit
T_{cfg_s}	Time delay after CONFIG set to LOW and before RXD signal valid	100	200	500	us
T_{cfg_p}	Time for LC-1000R process, when 'Save Flag' = 0	2	2.5	3	ms
	Time for LC-1000R process, when 'Save Flag' = 1	34	40	50	ms
T_{cfg_e}	Time delay after LC-1000R sent back ACK packet to set CONFIG to HIGH	100	200	500	us

Please note:

1. The waiting time of ACK packet after wrote configure packet to LC-1000R is determined by the 'Save Flag' section in the configure packet, as the as previous table shows. So it is suggested that set the timeout for receiving ACK packet to 50ms when configure the LC-1000R.
2. After set the CONFIG pin to HIGH for switch out CFG mode, please make sure more 5ms delay time is added, especially when using 'Set UART rate' command to change LC-1000R's baudrate.

5 Hardware Connection Mode

There are two application modes for LC-1000R according to usage occasions: Simple 3 lines Mode ("S3M" for short) and Hardware flow control Mode ("HFCM" for short).

5.1 Simple 3 lines Mode ("S3M")

The hardware connection is the simplest connection for LC-1000R application. Only 3 line need in this mode: TXD/RXD/GND. Figure 10 Hardware connection of S3M sketch shows the connection of this mode. But the baud rate of LC-1000R in this mode must less than 19200 bps, otherwise the correctness of data transmission cannot be guaranteed.

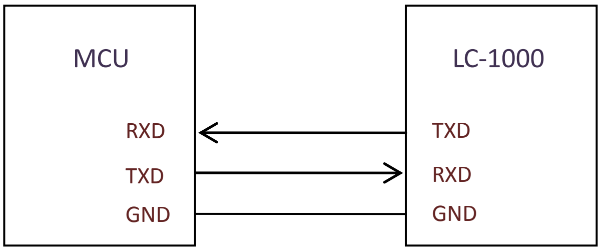

MCU
RXD
TXD
GND
LC-1000
TXD
RXD
GND

Figure 10 Hardware connection of S3M sketch

For data transferring, MCU must prepare for reading from the UART's RXD anytime if data is received by LC-1000R from remote device of communication. This reading operation usually handled by MCU's hardware UART RX interrupt service function. Then MCU can write data to LC-1000R through UART's TXD pin anytime regardless of any pin state. Figure 11 Data transfer flow chart in S3M shows a demo flow chart for S3M data transmit of LC-1000R.

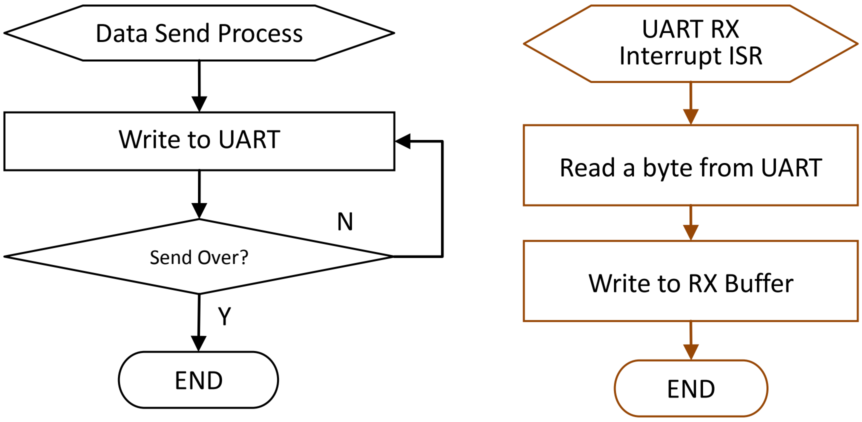

Data Send Process
Write to UART
Send Over?
N
Y
END
UART RX
Interrupt ISR
Read a byte from UART
Write to RX Buffer
END

Figure 11 Data transfer flow chart in S3M

The feature of S3M is: Easy to use, Low data rate and transmission error permitted.

Figure 12 Typical application example of S3M based on PC shows a typical application example for S3M of LC-1000R. In this application PC A and B can transmit data each other.

For example, A transmits data to B, its data flow as follows:

a) APP(A) write a packet to UC-3000(A) by COMx in PC

b) UC-3000(A) sends data to LC-1000R(A) through UART

c) LC-1000R(A) transmit it to LC-1000R(B) by RF

d) LC-1000R(B) sends data to UC-3000(B) through UART

e) APP(B) will read a packet from COMx in PC

In this application, the PC-A and PC-B ‘s baud rate can be set to difference (For the example PC-A can be set to 9600bps and PC-B can be set to 19200 bps), the communication speed is limit by the lower baud rate.

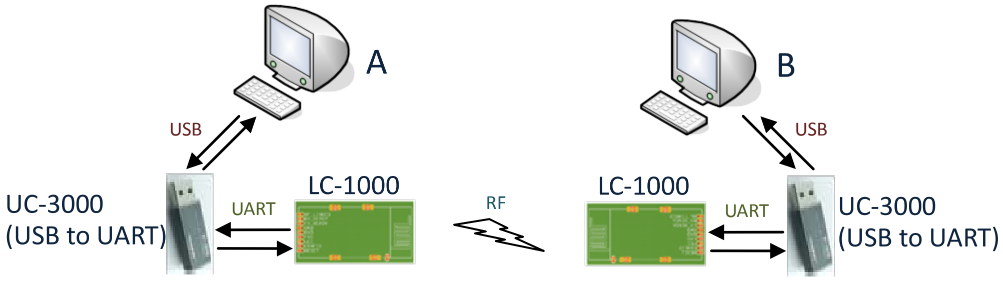


Figure 12 Typical application example of S3M based on PC

5.2 Hardware flow control Mode("HFCM")

Unlike S3M, the hardware connection is much more complicated in the HFCM. All pins of LC-1000R are needed for this mode.

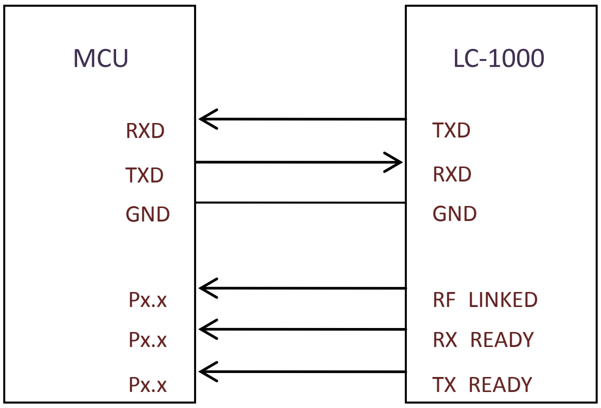


Figure 13 Hardware connect of HFCM sketch

The baud rate range is 2400bps to 57600bps. What's more the correctness of data transmission can be guaranteed in HFCM.

For data receiving in HFCM, MCU must prepare for reading from the UART's RXD within 1ms after RX_READY becomes LOW, otherwise the received data will be lost. This reading operation usually handled by MCU's hardware UART RX interrupt service function.

Before writing a packet to LC-1000R, MCU must assert following conditions:

1) The CONFIG pin is set to HIGH
2) the state of TX_READY pin is HIGH
3) The packet length must less than LC-1000R's RX FIFO size.

Figure 14 Data transfer flow chart in HFCM shows a demo flow chart of data transferring process in HFCM.

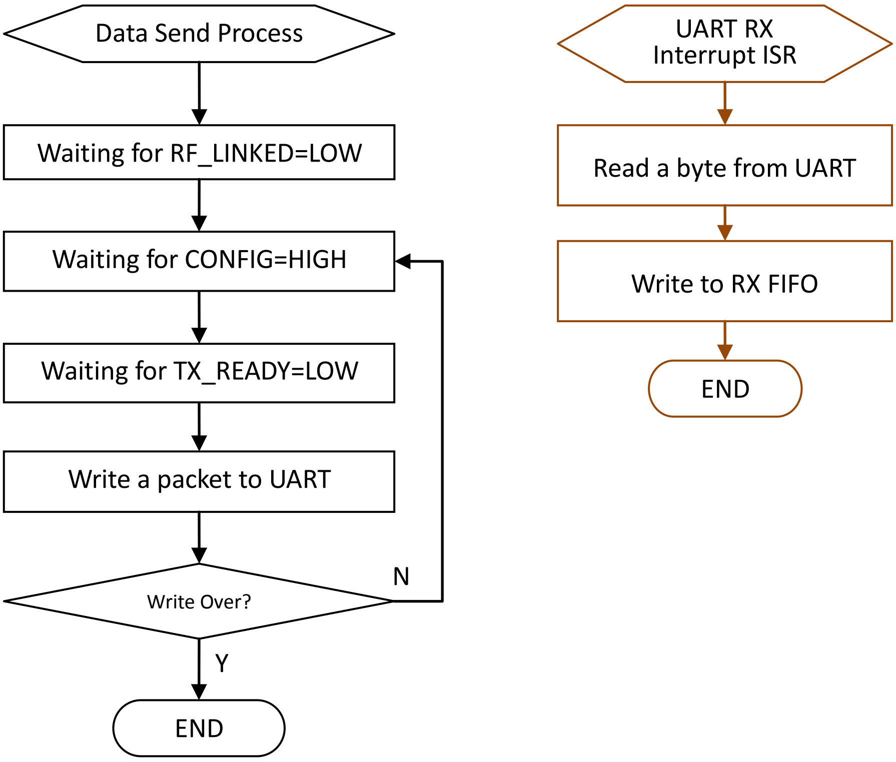

Data Send Process
Waiting for RF_LINKED=LOW
Waiting for CONFIG=HIGH
Waiting for TX_READY=LOW
Write a packet to UART
Write Over?
N
Y
END
UART RX Interrupt ISR
Read a byte from UART
Write to RX FIFO
END

Figure 14 Data transfer flow chart in HFCM

The feature of HFCM is: High speed data rate, High reliability, but more complex of Control, and Suitable for bulk data transfer.

Figure 15 Typical application example of HFCM shows a typical application example of HFCM. In this application MCU A and B can transmit data each other.

For example, A transmits data to B, its data flow as follows:

a) MCU(A) write a packet to LC-1000R(A) through UART

b) LC-1000R(A) transmit it to LC-1000R(B) by RF

c) MCU(B) will read a packet from LC-1000R(B)

Also the A and B can be set difference baud and the communication speed is limit by the lower baudrate.

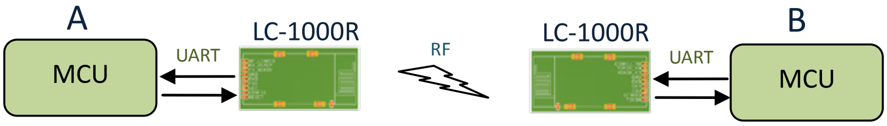

A
MCU
UART
LC-1000R
RF
LC-1000R
UART
B
MCU

Figure 15 Typical application example of HFCM

6 Configuration Command

6.1 LC-1000R's Configurable system parameters

LC-1000R's configurable system parameters can be wrote or read by sending the configuration commands to it.

There are serial configurable system parameters as follows:

LOCAL_ADDR ---- Local address

The default LOCAL_ADDR is the UID of LC-1000R (the UID is Unique for each devices).

TX_ADDR ---- Link address of remote device of communication

BAUD_RATE ---- baud rate configure value

This is not the direct UART's baud rate value, but the setting value for UART's baud rate, this value can be calculated by the formula as below:

BAUD_RATE = (1500000/ baud_rate) – 1

(The baud_rate is the real baud rate of LC-1000R's UART, it's value range is 2400bps~57600bps, And the corresponding BAUD_RATE range is 0x0270~0x0019).

SLEEP_TIME ---- sleep period in PSM mode

Please note: the unit of SLEEP_TIME is 8ms instead of 1ms, and the maximum value of SLEEP_TIME is 8191. That means the maximum sleep time is 8191 * 8 = 65528(ms).

WORK_MODE ---- work mode

When WORK_MODE = 0, system work mode is NML mode

When WORK_MODE=1, system work mode is PSM mode

When WORK_MODE = 2, system work mode is Direct mode

RF_POWER_LEVEL ---- RF power level

The RF_POWER_LEVEL's value range is 0~15 (0 is the highest power level).

WAKEUP_TIME ---- wake-up period in PSM mode

Please note: the unit of WAKEUP_TIME is 8ms instead of 1ms.

The maximum value is 255. That means the maximum sleep time is 255 * 8 = 2040(ms);

And the minimum value of WAKEUP_TIME is 3, which means the minimum sleep time can be set is 3 * 8 = 24(ms).

The default value of these system parameters is as follows:

LOCAL_ADDR ---- UID
TX_ADDR ---- Not Sure
BAUD_RATE ---- 0x9B, (baud rate is 9600bps)
SLEEP_TIME ---- 128, (=1024ms)
WORK_MODE ---- 0x00, (NML mode)
RF_POWER_LEVEL ---- 0x00, (the highest power level)
WAKEUP_TIME ---- 8, (=64ms)

6.2 Configure TX_ADDR and LOCAL_ADDR for two devices

For connection successfully, user mush ensure the parameters TX_ADDR and LOCAL_ADDR in LC-1000R meets the conditions as Figure 16 shows.

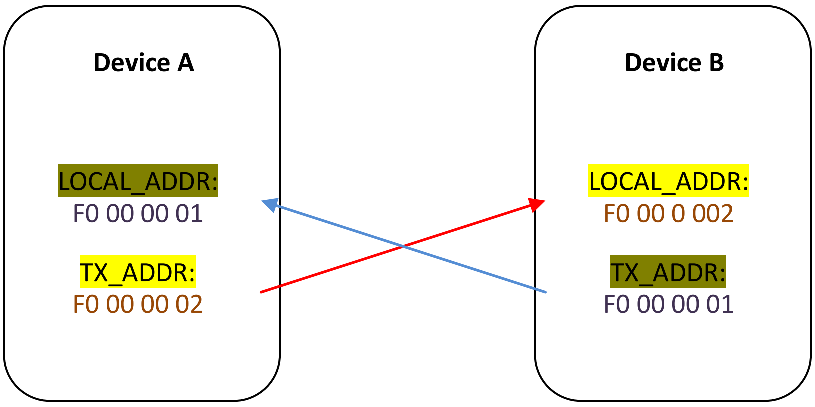


Figure 16 Example for TX_ADDR and LOCAL_ADDR configuration

6.3 Configuration command packet format

Name	Checksum	Save	CMD/MSG	Length	Parameter	END
Bytes	1	1	1	1	7	2
Values	0X00~0Xff	0/1	Command List	0X00~0X07	0X00~0XFF	0X0D, 0X0A

Figure 17 Configuration command packet format

- Checksum

Can be calculated by the formula:

Checksum = NOT (Checksum+Save+CMD+Length+Parameter+END)

Please set Checksum byte to 0, before make this calculation.

- Save

Save flag

=1, indicates this parameter value need to be saved to EEPROM

=0, indicates this parameter value no need to save

- Command/MSG

Command of this packets, please reference to “Configuration command list”

- Length

The valid data length of parameter

Note the Length field must be set to the correct length of parameter field’s length in both the read and write command packet.

- Parameter
- END

End symbol, it takes a fixed value = 0x0D0A

6.4 Configuration command list

Function	Dir	Configuration packet	Description
Set RF carrier out (CMD=0xEF)	TX	0xXX,Save,0XEF,0x02,Chn,Power,0x00, 0x00,0x00,0x00,0x00,0x00,0x0D,0x0A	**Chn** RF channel，0~83； **Power** RF Power level: 0x00~0x0F (0x00–highest power 0x0F–lowest power)
	RX	None	
Set local address (CMD=0XF0)	TX	0xXX,Save,0xF0,0x04,Addr0(LSB),Addr1, Addr2,Addr3,0x00,0x00,0x00,0x0D,0x0A	**Addr** Local address: 0x000001~0xfffffe
	RX	0xXX,Save,0xF0,0x04,Addr0(LSB),Addr1, Addr2,Addr3,0x00,0x00,0x00,0x0D,0x0A	
Set Link address	TX	0xXX,Save,0xF1,0x04,Addr0(LSB),Addr1,	**Addr**

(CMD=0XF1)		Addr2,Addr3,0x00,0x00,0x00,0x0D,0x0A	Link address: 0x000001~0xfffffe
	RX	0xXX,Save,0xF1,0x04,Addr0(LSB),Addr1, Addr2,Addr3,0x00,0x00,0x00,0x0D,0x0A	
Set UART rate (CMD=0XF2)	TX	0xXX,Save,0xF2,0x02,Rate0(LSB),Rate1, 0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	**Rate** UART rate value Rate = (1500000/ baudrate) – 1, baudrate is the actual value of UART baud rate. Its value range: 2400bps~57600bps, And the value range of Rate is: 0x0270 ~ 0x19
	RX	0xXX,Save,0xF2,0x02,Rate0(LSB),Rate1, 0x00,0x00,0x00,0x00,0x00,0x0D,0x0A	
Set sleep time (CMD=0XF3)	TX	0xXX,Save,0xF3,0x02,Time0(LSB),Time1, 0x00,0x00,0x00,0x00,0x00,0x0D,0x0A	**Time** Sleep time: 0x0000~1FFF Unit: 8ms
	RX	0xXX,Save,0xF3,0x02,Time0(LSB),Time1, 0x00,0x00,0x00,0x00,0x00,0x0D,0x0A	
Set work mode (CMD=0XF4)	TX	0xXX,Save,0xF4,0x01,Mode,0x00,0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	**Mode** Work mode: 0x00 --NML Mode 0x01 --PSM Mode
	RX	0xXX,Save,0xF4,0x01,Mode,0x00,0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	
Set RF power level (CMD=0XF5)	TX	0xXX,Save,0XF5,0x01,Power,0x00,0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	**Power** RF power level: 0x00~0x0F 0x00-highest power 0x0F-lowest power
	RX	0xXX,Save,0XF5,0x01,Power,0x00,0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	
Set wakeup time (CMD=0XF6)	TX	0xXX,Save,0xF6,0x01,Time,0x00, 0x00,0x00,0x00,0x00,0x00,0x0D,0x0A	**Time** Wakeup time: 0x03~0xff Unit: 8ms
	RX	0xXX,Save,0xF6,0x01,Time,0x00, 0x00,0x00,0x00,0x00,0x00,0x0D,0x0A	
Read local address (CMD=0XD0)	TX	0xXX,Save,0XD0,0x04,0x00,0x00,0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	**Addr** Local address
	RX	0xXX,Save,0xD0,0x04,Addr0(LSB),Addr1, Addr2,Addr3,0x00,0x00,0x00,0x0D,0x0A	
Read link address (CMD=0XD1)	TX	0xXX,Save,0XD1,0x04,0x00,0x00,0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	**Addr** Link address
	RX	0xXX,Save,0xD1,0x04,Addr0(LSB),Addr1, Addr2,Addr3,0x00,0x00,0x00,0x0D,0x0A	
Read UART rate (CMD=0XD2)	TX	0xXX,Save,0XD2,0x02,0x00,0x00,0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	**Rate** UART Rate
	RX	0xXX,Save,0xD2,0x02,Rate0(LSB),Rate1, 0x00,0x00,0x00,0x00,0x00,0x0D,0x0A	
Read sleep time (CMD=0XD3)	TX	0xXX,Save,0XD3,0x02,0x00,0x00,0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	**Time** Sleep time
	RX	0xXX,Save,0xD3,0x02,Time0(LSB),Time1, 0x00,0x00,0x00,0x00,0x00,0x0D,0x0A	

Read work mode (CMD=0XD4)	TX	0xXX,Save,0XD4,0x01,0x00,0x00,0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	**Mode** Work mode
	RX	0xXX,Save,0xD4,0x01,Mode,0x00,0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	
Read RF power level (CMD=0XD5)	TX	0xXX,Save,0XD5,0x01,0x00,0x00,0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	**Power** RF power level
	RX	0xXX,Save,0xD5,0x01,Power,0x00,0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	
Read wakeup time (CMD=0XD6)	TX	0xXX,Save,0XD6,0x01,0x00,0x00,0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	**Time** wakeup time
	RX	0xXX,Save,0xD6,0x01,Time,0x00, 0x00,0x00,0x00,0x00,0x00,0x0D,0x0A	
Read device type name (CMD=0XCE)	TX	0xXX,Save,0XCE,0x07,0x00,0x00,0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	**IDN** Device type, fixed value “LC1000R”
	RX	0xXX,Save,0xCE,0x07,IDN0(LSB),IDN1, IDN2,IDN3,IDN4,IDN5,IDN6,0x0D,0x0A	
Read FW version (CMD=0XCF)	TX	0xXX,Save,0XCF,0x02,0x00,0x00,0x00, 0x00,0x00,0x00,0x00,0x0D,0x0A	**Ver** Version Ver0--major; Ver1--minor
	RX	0xXX,Save,0xCF,0x02,Ver0(LSB),Ver1, 0x00,0x00,0x00,0x00,0x00,0x0D,0x0A	

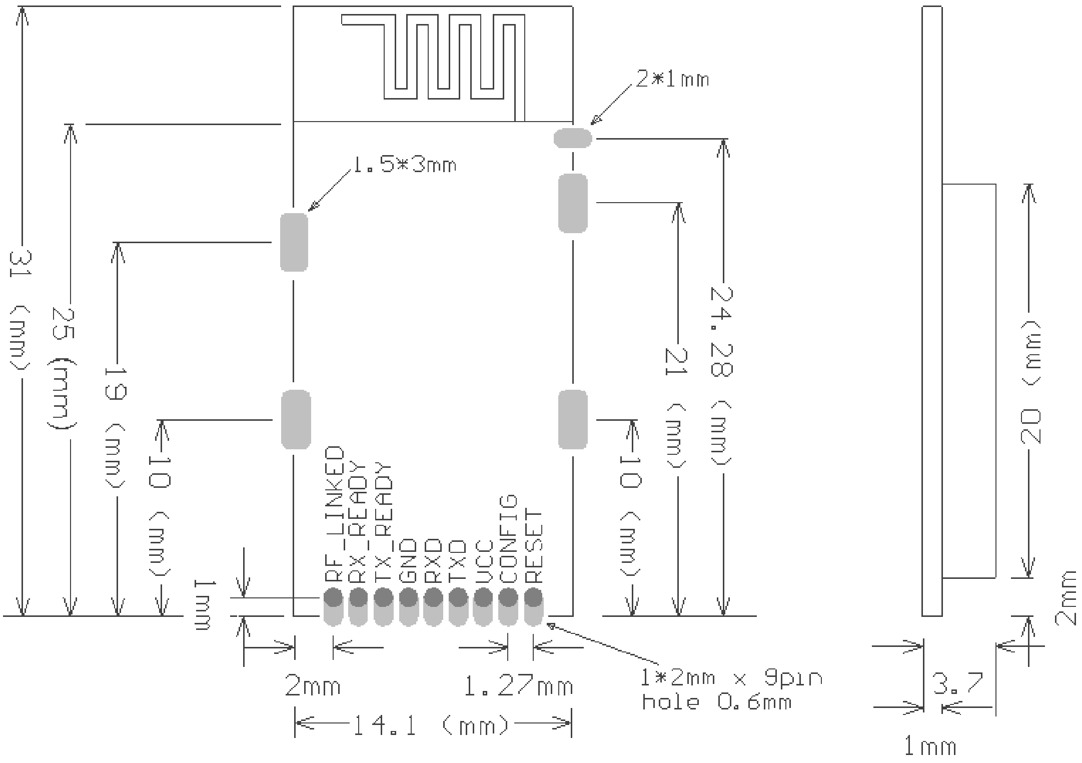
6.5 Error MSG list for configuration packet

LC-1000R will send back an ACK packet which MSG field is the same value with the received packet’s CMD field, when the received configuration packet was processed correctly. Otherwise the MSG field’s value is as follows:

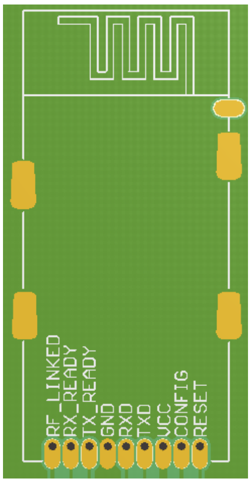
1) Parameter has error, MSG = 0XE1
2) Checksum error, MSG = 0XE2
3) Command error, MSG = 0XE3

7 Dimensional Drawings

7.1 Machine Dimensions (Unit: mm)


2*1mm
1.5*3mm
31 (mm)
25 (mm)
19 (mm)
10 (mm)
1mm
RF_LINKED
RX_READY
TX_READY
GND
RXD
TXD
VCC
CONFIG
RESET
10 (mm)
21 (mm)
24.28 (mm)
20 (mm)
2mm
2mm
1.27mm
14.1 (mm)
1*2mm x 9pin
hole 0.6mm
3.7
1mm

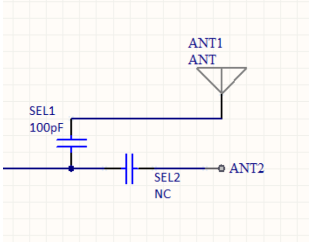
7.2 PCB design reference

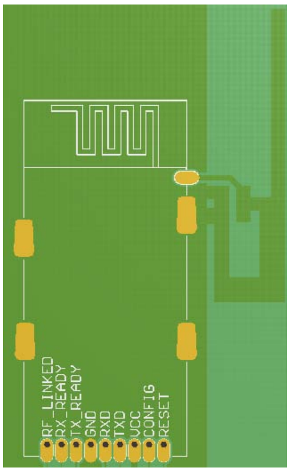

RF_LINKED
RX_READY
TX_READY
GND
RXD
TXD
VCC
CONFIG
RESET

PCB designed sample 1： Using on-board Wiggle antenna

When using on-board Wiggle antenna, the SEL1 must placed with a 100pF 0402 NP0 ceramic capacitor. Meanwhile the PCB of the antenna part cannot place any Component or circuit, especially the large areas of GND paving.

(Note：the designator of the on-board antenna in the right schematic diagram is ANT1)

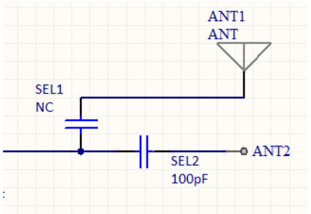

ANT1
ANT
SEL1
100pF
SEL2
NC
ANT2



PCB designed sample 2：Using an External antenna

It is allowed to using the extennal antenna for LC-1000, and in this mode, the SEL2 must placed with a a 100pF 0402 NPO ceramic capacitor, and the PCB of the on-board antenna must place with a large areas of GND paving.

(Note：the designator of the on-board antenna in the right schematic diagram is ANT2)



8 Characteristic parameter

8.1 Electric parameter

Name	Parameter	Min	Typ	Max	Unit
	Operation Condition				
VDD	Supply Voltage	3.0	3.3	3.6	V
VSS	Supply GND	0	0	0	V
TEMP	Temperature	-40	+25	+86	℃
	Digital Signal Level				
V_{Low}	Signal Low level	0.3	0.3	0.8	V
V_{Hi}	Signal High Level	2.0	VDD-0.3	VDD-0.3	V
	Current consumption				
I_{nml}	Average Current of NML Mode, when idle (VDD=3.0V,TEMP=25℃)	30	31	33	mA
	Average Current of NML Mode, when continue transfer data (VDD=3.0V,TEMP=25℃)	24.9	25	26	mA

I_{psm}	Wakeup Current in PSM Mode (VDD=3.0V,TEMP=25℃)	30	31	33	mA
	Sleep Current of PSM Mode (VDD=3.0V,TEMP=25℃)	1.50	1.55	1.60	mA
I_{drt}	Average Current in Direct Mode (VDD=3.0V,TEMP=25℃)	30	31	33	mA
I_{cfg}	Average Current in CFG Mode (VDD=3.0V,TEMP=25℃)	30	31	33	mA
I_{pdn}	Average Current in Power down Mode (VDD=3.0V,TEMP=25℃)	1.50	1.55	1.60	mA

8.2 Other Timing parameter

Symbol	Parameter	Min	Typ	Max	Unit
$T_{poweron}$	Power on delay time for system initialize (CONFIG = 1)	--	35	--	ms
	Power on delay time for system initialize (CONFIG = 0)	--	245	--	ms

9 Revision History

Version	Date	Author	Description
V10	2013-10-28	Tony Tan	First released
V20	2014-03-25	Tony Tan	Fixed Reset Baud rate timing; Fixed CFG mode timing.

Declare

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