HM-6601 Transparent Transmission Module User Guide

1. module features

HM-6601 transparent transmission module is a serial module for wireless data transmission and reception based on LoRa modulation. It has the advantages of optional output power (maximum output power 22dBm), optional RF parameters BW, SF, and CR, high sensitivity, long transmission distance, and low current when low power consumption.

The user interface is simple and the application is easy to operate. The user's MCU only needs to connect with the module through the serial port. When sending a data packet, it sends data to the module through the serial port. The module transmits the user's data packet through the radio frequency in LoRa modulation mode. After receiving the data packet, the receiving end decodes it and spits it out directly from the serial port The data packet is sent to the MCU at the receiving end.

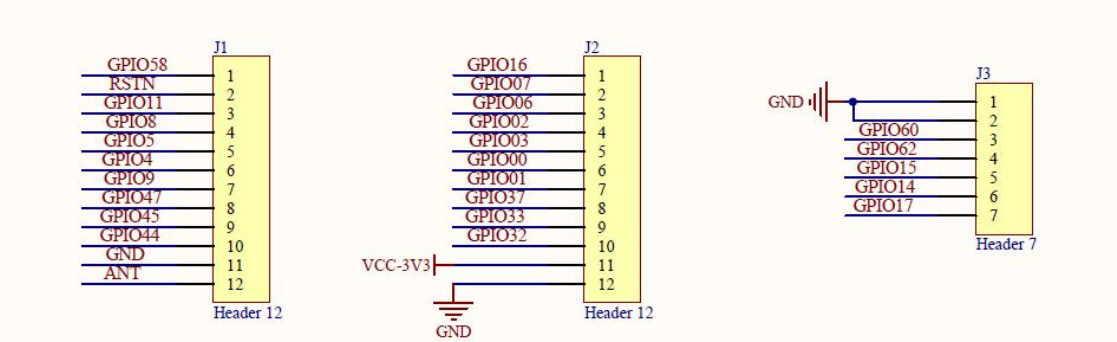
The user can make the module enter the AT command configuration state through special command timing. The module can work in: 1. Data sending and receiving state; 2. AT command configuration state. See Chapter 2 for the timing of entering the AT command state from the data sending and receiving state.

There are two working modes in the state of data sending and receiving: 1.Continuous working mode, 2 Intermittent working mode. In the continuous working mode the radio frequency of the transceiver module does not sleep. If the serial port receives the data packet, it will start to send the data packet to the air network,and enter the continuous receiving state by default after the transmission is completed. If there is a data packet coming from the air network, the data packet will be received and decoded, and the serial port will output the parsed data.

The provided AT command set can be used to set various parameters of the module.Such as: transmit and receive frequency, transmit and receive (BW), transmit and receive spreading factor (SF), transmit and receive code rate (CR) transmit power, serial port baud rate, etc. (Refer to the third section for the specific application of the instruction format).

2. user interface

2.1 overall user interface



➢The minimum interface of the module to the user is TXD and RXD. The functions of the two I/O ports are as follows:

Pin	IO characters
TXD（GPIO17）	output
RXD（GPIO16）	input

➢Optional interface of the module to the user:

Pin	IO characters
GPIO11（PULL UP）	input
GPIO14（PULL UP）	input

2.2 module working status

- OTA

  Special note: Using OTA upgrade, the hardware needs to add GPIO port control GPIO11 to make the module enter OTA mode, and the GPIO11 needs to be lowered to make the module enter OTA mode before power supply.

- Data ending and receiving status

- Continuous working mode

  In the continuous working mode, the radio frequency of the module does not sleep. If the serial port receives the data packet, it will start

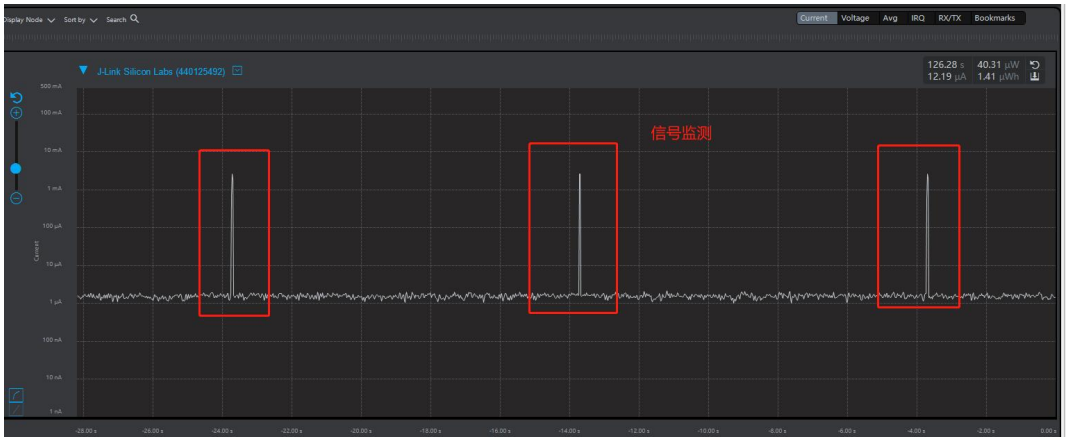
to send the data packet to the air network, and enter the continuous receiving state by default after the transmission is completed. If there is a data packet coming from the air network, the data packet will be received and decoded, and the serial port will output the parsed data.

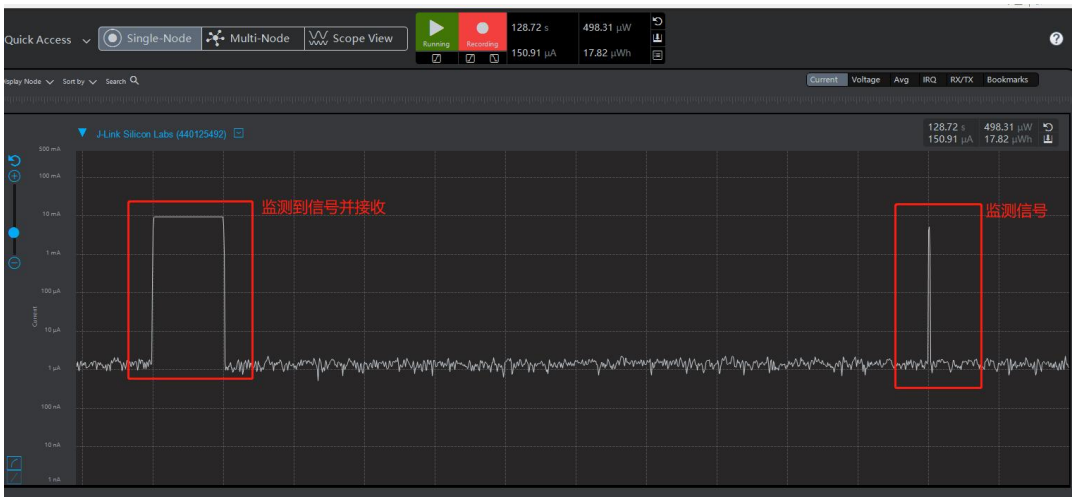
be noticed：under continuous work mode，the preamble time，the sleep time，the receive work time don't work.

- ## Intermittent work mode

Intermittent working mode mainly means that the module sets SleepTime, wakes up from the hibernation state regularly, uses a very short Time slot (8 Symbol Time) to detect whether there is a signal in the empty network, if not, it immediately sleeps, if there is, it collects the data packet within the specified WorkTime. After receiving the packet, continue to sleep.

The average standby power consumption in indirect mode is about 12uA.(Sleep Time=10000).





be noted: The receiver needs to be aware that the WorkTime time needs to be greater than the entire air time of the transmitter's launch. This way the receiver will not lose packets due to receiving timeout.

be noted: since the parameter preamble time is only valid in the intermittent working mode, the transmitter corresponding to the intermittent receiver must also be configured in the intermittent working mode. In addition, it must be ensured that the parameter SleepTime or WorkTime of the transmitter is 0. In this way, if the transmitter is not in a dormant state when the receiver replies, the response packet sent by the receiver can be correctly received.

Special note:

① In intermittent working mode, the hardware needs to add GPIO port control GPIO14 (internal pull-up) to interrupt the wake up and then perform the serial port operation (enter the AT command operation).
② When GPIO14 maintains low power level, the operation condition is basically the same as that of continuous operation mode.
③ When GPIO14 maintains high power level, it enters intermittent working mode.

■ AT command configuration status

When in the state of AT command, relevant parameters can be set through AT command.

■ switch of working status

The module needs the following two steps to switch from the data sending and receiving mode to the AT command mode:

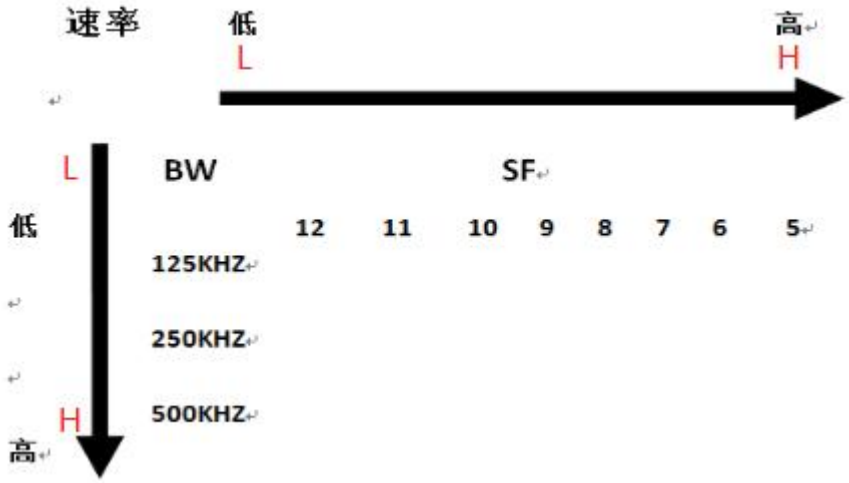
- Send "**$$$aaa**" to the serial port tool.
- The AT configuration mode is displayed. The string "**+AT MODE**" is returned.

The module needs the following two steps to switch from the AT command mode to the data sending and receiving mode:

- Send "**AT+CEXITAT**" to the serial port tool.
- After receiving it, the module enters the AT configuration mode. And reply with the string "**ExitAt**".

2.3 RF parameter setting

■ The setting of bandwidth BW, spreading factor SF, and coding rate CR needs to be set according to certain rules.
The relationship between parameters BW, SF and speed is shown in the figure below.



In addition, the coding rate is used for packaging the internal data packets of LORA, which are 4/5, 4/6 4/7 4/8 respectively. The larger the encoding rate value, the smaller the payload. The relative effective data rate is lower.

■ the setting principles of BW, SF, and CR are mainly as follows:

➢Configure low rates if high sensitivity is required.
➢To configure a low rate, you need to reduce BW and increase SF.
➢To configure a high rate, increase BW and decrease SF.
➢For combinations of the same rate level, a small BW is recommended.

For example, BW (250 KHZ) SF(11) combination and BW (500 KHZ) SF(12) combination are recommended to use BW (250 KHZ) SF(11) combination.

The coding rate CR does not have a direct impact on the rate, the high coding rate increases other loads, and the effective data rate is relatively low.

the more commonly used is 4/5, the others are not commonly used the setting of the parameter needs to conform to the value range of the parameter. If it exceeds the range, it is considered illegal and the setting is unsuccessful.

■ the value range of each parameter is as follows

- TxFreq
  41000~47000 47000~51000 83800~89800 90000~96000 unit:10KHZ
- RxFreq
  41000~47000 47000~51000 83800~89800 90000~96000 unit:10KHZ
- TxSF
  5~12
- RxSF
  5~12
- TxBw
  7、8、 9（125KHZ、250KHZ、500KHZ）
- RxBw
  7、8、 9（125KHZ、250KHZ、500KHZ）
- TxCR
  1、2、3、4（4/5、4/6、4/7、4/8）
- RxCR
  1、2、3、4（4/5、4/6、4/7、4/8）
- WorkMode
  1（intermittent work mode）、2（continuous work mode）
- PreambleTime
  0~16000 uint:1ms
- SleepTime
  0~15000 uint:1ms
- WorkTime
  0~20000 uint:1ms

■ preamble time and preamble time symbol shows as below :

$$ToA = \frac{2^{SF}}{BW} * N_{symbol}$$

ToA:preamble time.
Nsymbol symbol.
It can be seen from the above that the lead time is the product of a single symbol time and the number of symbols. The period of a single symbol depends on the rate, and the period of a single symbol is different for different rates, and the period of a single symbol may not be an integer. Therefore, the leading time is only an approximate time and may not be very accurate. When the product of the number of symbols and the symbol period is less than the predetermined leading time, the processing method is to add several symbols.

➢The period of a single symbol at different rates is as follows:

SF / BW	12	11	10	9	8	7	6	5
125KHZ	32.768ms	16.384ms	8.192ms	4.096ms	2.048ms	1.024ms	0.512ms	0.256ms
250KHZ	16.384ms	8.192 ms	4.096ms	2.048ms	1.024ms	0.512ms	0.256ms	0.128ms
500KHZ	8.192 ms	4.096ms	2.048ms	1.024ms	0.512ms	0.256ms	0.128ms	0.064ms

■ Calculation of data packet air transmission time
the same formula can be used for the air time of the data packet. It's just that the calculation of the symbolic number is relatively complicated.

$$ToA = \frac{2^{SF}}{BW} * N_{symbol}$$

The formula for calculating the sign number is as follows:

For SF5 and SF6:

$$N_{symbol} = N_{symbol_{preamble}} + 6.25 + 8 + ceil\left(\frac{\max\left(8 * N_{byte_{payload}} + N_{bit_{CRC}} - 4 * SF + N_{symbol_{header}}, 0\right)}{4 * SF}\right) * (CR + 4)$$

For all other SF:

$$N_{symbol} = N_{symbol\_preamble} + 4.25 + 8 + ceil\left(\frac{\max(8*N_{byte\_payload}+N_{bit\_CRC}-4*SF+8+N_{symbol\_header},0)}{4*SF}\right) * (CR + 4)$$

3. AT command sets

3.1 AT command format

the AT command adopts the command line based on ASCII code, and the command format is as follows:
the request message format is:AT+<CMD>[OP][para-1,para-2,……para-n]<\r>

table 1 AT request message format

domain	explanation .
AT+	command message prefix .
CMD	command string .
OP	command operating,contents can be followings: ✓ “=”: parameter set. ✓ “？”:search current parameter value. ✓ “”:execute command. ✓ “=？”:search set command parameter .
para-1,para-2,……para-n	the set parameter value, or specifies the parameter to be queried .
\r	terminator symbol,ASCII code is 0x0D .

respond message format:<\r\n>[+CMD:][para-1,para-2,…para-n]<\r\n>or:<\r\n><STATUS><\r\n> or both above.

table 2 AT response message format

domain	explanation
\n	line break, ASCII code is 0x0A .
+CMD	corresponding command string.
para-1,para-2,……para-n	corresponding parameter string.
STATUS	command execution status,contents are as follow: ✓ “OK”:executed successfully. ✓ “ERROR”:fail execution. ✓ “+CME ERROR:<err>”:fail execution and return to the appropriate error code.

Notice:

- <>:content must include.
- []:option contents.
- \r:returen terminator symbol, ASCII code is 0x0D.
- \n:line break, ASCII code is 0x0A.

For example:search the software version number, send the Command: AT+CGMR?\r\n

respond message:
\r\n+CGMR=v1.0\r\n
\r\nOK\r\n
In the following text, \r\n will be hidden for readability

- Serial parameter configuration: baud rate 115200, data bit 8, stop bit 1, parity bit 0.
- The current command supports echoing, but does not support backspace (BackSpace) for the time being, and does not support turning back historical commands for the time being.

3.2 AT command instructions

3.2.1 read version ID +CGMR

command type	command format	response
search command	AT+CGMR?	+CGMR:<revision> OK
parameter instruction	<revision>:version ID	
Return value instruction		
sample	AT+CGMR?\r\n +CGMR=v1.0 OK	
notice		

3.2.2 set the serial port baud rate +CGBR

command type	command format	response
search command	AT+CGBR?	+CGBR=<baud> OK
set command	AT+CGBR=<baud>	OK
parameter instruction	<baud>:the default value of the baud rate is 1, and the value range is 1~6 1 - 115200 2 - 57600 3 - 38400 4 - 19200	
Return value instruction		

	5 - 9600 6 - 4800
sample	AT+CGBR=6 OK
notice	After changing the baud rate, it needs to be saved AT+CSAVE\r\n, and it will take effect next power-on!

3.2.3 set tx power rate +CTXP

command type	command format	response
test command	AT+CTXP=?	+CTXP: “value” OK
search command	AT+CTXP?	+CTXP:<value> OK
execute command	AT+CTXP=<value>	OK or +CME ERROR:<err>
parameter instruction	<value>:tx power rate,default value is 22, 1 ~ 22dBm <err>:error code.	
Return value instruction		
sample	AT+CTXP=22\r\n OK	
notice	needs to be setup before sending data.	

3.2.4 set module RF work +CWMODE

command type	command format	response
test command	AT+CWMODE=?	+CWMODE: “value” OK
search command	AT+CWMODE?	+CWMODE:<value> OK
execute command	AT+CWMODE=<value>	OK or +CME ERROR:<err>
parameter instruction	<value>:work mode value range 1~2 1 - intermittent work 2 - continuous work <err>:error code.	
return value instruction		

sample	AT+CWMODE =1\r\n OK
notice	

3.2.5 set module preamble time +CPRMTIM

command type	command format	response
test command	AT+CPRMTIM=?	+CPRMTIM: “value” OK
search command	AT+CPRMTIM?	+CPRMTIM:<value> OK
execute command	AT+CPRMTIM=<value>	OK or +CME ERROR:<err>
parameter instruction return value instruction	<value>:intermittent work mode tx preamble time, value range:0~16000ms <err>: error code。	
sample	AT+CPRMTIM=1000\r\n OK	
notice	works only under intermittent work mode	

3.2.6 set module sleep time +CSLPTIM

command type	command format	response
test command	AT+CSLPTIM=?	+CSLPTIM: “value” OK
search command	AT+CSLPTIM?	+CSLPTIM:<value> OK
execute command	AT+CSLPTIM=<value>	OK or +CME ERROR:<err>
parameter instruction return value instruction	<value>:intermittent work mode sleep value range: 0~15000ms <err>: error code。	
sample	AT+CPRMTIM =1000\r\n OK	
notice	works only under intermittent work mode	

3.2.7 set module max rx time +CRXTIM

command type	command format	response
test command	AT+CRXTIM=?	+CRXTIM: “value” OK
search command	AT+CRXTIM?	+CRXTIM:<value> OK
execute command	AT+CRXTIM=<value>	OK or +CME ERROR:<err>
parameter instruction return value instruction	<value>:intermittent work mode max rx value range: 0~20000ms <err>: error code。	
sample	AT+CRXTIM=1000 \r\n OK	
notice	works only under intermittent work mode	

3.2.8 set module tx frequency +CTXF

command type	command format	response
test command	AT+CTXF=?	+CTXF: “value” OK
search command	AT+CTXF?	+CTXF:<value> OK
execute command	AT+CTXF =<value>	OK or +CME ERROR:<err>
parameter instruction return value instruction	<value>:default tx frequency 43300, value range: 41000 ~ 47000 unit:10KHZ 。 <err>: error code。	
sample	AT+CTXF=43300\r\n OK	
notice		

3.2.9 set module rx frequency +CRXF

command type	command format	response
test command	AT+CRXF=?	+CRXF: “value” OK

search command	AT+CRXF?	+CRXF:<value> OK
execute command	AT+CRXF=<value>	OK or +CME ERROR:<err>
parameter instruction return value instruction	<value>:default rx frequency 43300, value range: 41000 ~ 47000 unit:10KHZ 。 <err>: error code。	
sample	AT+CRXF=43300\r\n OK	
notice		

3.2.10 set module tx BW +CTBW

command type	command format	response
test command	AT+CTBW=?	+CTBW: “value” OK
search command	AT+CTBW?	+CTBW:<value> OK
execute command	AT+CTBW=<value>	OK or +CME ERROR:<err>
parameter instruction return value instruction	<value>:default tx BW value is 9,value range: 7 - 125KHZ 8 - 250KHZ 9 - 500KHZ <err>: error code。	
sample	AT+CTBW=7\r\n OK	
notice		

3.2.11 set module rx BW +CRBW

command type	command format	response
test command	AT+CRBW=?	+CRBW: “value” OK
search command	AT+CRBW?	+CRBW:<value> OK

execute command	AT+CRBW=<value>	OK or +CME ERROR:<err>
parameter instruction return value instruction	<value>:default rx BW value is 9,value range: 7 --- 125KHZ 8 --- 250KHZ 9 --- 500KHZ <err>: error code。	
sample	AT+CRBW=7\r\n OK	
notice		

3.2.12 set module tx SF +CTSF

command type	command format	response
test command	AT+CTSF=?	+CTSF: “value” OK
search command	AT+CTSF?	+CTSF:<value> OK
execute command	AT+CTSF=<value>	OK or +CME ERROR:<err>
parameter instruction return value instruction	<value>:default tx SF value is 9, value range: 5~12 <err>:error code。	
sample	AT+CTSF=8\r\n OK	
notice		

3.2.13 set module rx SF +CRSF

command type	command format	response
test command	AT+CRSF=?	+CRSF: “value” OK
search command	AT+CRSF?	+CRSF:<value> OK
execute command	AT+CRSF=<value>	OK or +CME ERROR:<err>
parameter instruction return value instruction	<value>:default rx SF value is 9, value range: 5~12 <err>:error code。	

sample	AT+CRSF=8\r\n OK
notice	

3.2.14 set module tx CR +CTCR

command type	command format	response
test command	AT+CTCR=?	+CTCR: “value” OK
search command	AT+CTCR?	+CTCR:<value> OK
execute command	AT+CTCR=<value>	OK or +CME ERROR:<err>
parameter instruction	<value>:default tx CR value is 2, value range: 1~4 <err>:error code。	
return value instruction		
sample	AT+CTCR=2\r\n OK	
notice		

3.2.15 set module rx CR +CRCR

command type	command format	response
test command	AT+CRCR=?	+CRCR: “value” OK
search command	AT+CRCR?	+CRCR:<value> OK
execute command	AT+CRCR=<value>	OK or +CME ERROR:<err>
parameter instruction	<value>:default rx CR value is 2, value range: 1~4 <err>:error code。	
return value instruction		
sample	AT+CRCR=2\r\n OK	
notice		

3.2.16 save parameter settings +CSAVE

command type	command format	response

test command	AT+CSAVE=?	+CSAVE OK
execute command	AT+CSAVE	OK or +CME ERROR:<err>
parameter instruction	this command saves configuration parameters to EERPOM/FLASH. <err>:error code	
return value instruction		
sample	AT+CSAVE\r\n OK	
notice		

3.2.17 exit AT command mode +CEXITAT

command type	command format	response
test command	AT+CEXITAT=?	+CEXITAT OK
execute command	AT+CEXITAT	ExitAt or +CME ERROR:<err>
parameter instruction	Exit the AT command mode after executing this command. <err>:error code	
return value instruction		
sample	AT+CEXITAT\r\n ExitAt	
notice		