

WMRNET-III
***Wireless water meter
reading network
technical Instruction
manual VER2.2***

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I .Overview

WMRNET-III wireless meter reading network is a wireless self- networking ecially developed for water meter collection. The system adopts reliable mesh topology. The maximum number of networks is 8 and can accommodate up to 1024 nodes. The logical address of the module takes the ID of the 4-bytes. The WMRNET-III network is a peer-to-peer network. Each module is the same. It has a routing function. There is no separate router. The installation is very simple. It is truly plug-and-play, and the networking process is completed automatically. There is no need to manually set parameters on site.

The WMRNET-III network automatically optimizes network routing and automatically discovers and deletes nodes. For faulty nodes, WMRNET-III has automatic identification and can automatically repair routes to make the network in optimal communication state due to the use of mesh (Mesh) topology, it performs great in terms of networking reliability and meter reading success rate.

The WMRNET-III wireless network module is embedded in the high-performance RF chip of SEMTECH in the United States. The software data link coding innovatively adopts efficient cyclic interleaving error correction coding, which can be corrected to the maximum 24bits continuous burst error, its coding gain is up to nearly 3dBm, and it is greatly improved against burst interference and sensitivity. The communication distance between the modules reaches 400-600m. The WMRNET-III wireless network has strong and distant penetrating ability. The outdoor network covers a radius of more than 3Km area.

II. Characteristics

- Fully self- networking, automatically optimizing routing, automatically discovering and deleting nodes
- Robust mesh (MESH) structure for stable performance and high reliability
- Level 8 routing with up to 1024 nodes
- Plug and play, the networking process is completed automatically, no need to manually set parameters on site
- Fast network construction, fast meter reading, high success rate of one meter reading
- Free ISM wireless metering frequency, multi-frequency point can be set

- Node module uses US SETMECH ultra low power high performance RF chip
- Encoding uses efficient cyclic interleaving error detection coding
- Strong penetration, long distance, outdoor network coverage radius over 3Km
- Supports various protocols with a uniform 4-byte ID Supporting various regulations
- Superior price/performance ratio

III. Network description

The WMRNET-III wireless network consists of a concentrator and several nodes, as shown in Figure 1. The address of the node adopts a uniform 4-byte ID, and the WMRNET-III wireless network also has a 2-byte network ID. The network ID of the concentrator and the node must be the same in the same network. Otherwise, even in the same area, the node of the same frequency It is also not possible to join different network ID networks. The WMRNET-III wireless network mode is a master-slave read mode, and all read node commands are issued by the concentrator for the user. The node can only passively upload data after receiving the command and cannot actively send data. The user's operation of reading data is all completed by the concentrator. In the network protocol, the user is shielded from the networking and maintenance network. User's operation of reading data is completed by centrator, which shields users from networking and maintenance work in network protocol. Users can query the nodes and their status in the network at any time, and read the data of water meter through nodes by concentrator, while it's not necessary for them to care about and interfere with the operation of the network. All the maintenance work of the network is done in the background software.

The WMRNET-III wireless network communication command is simple, with only one communication command, and supports up to 180 bytes of transmission and reception. The WMRNET-III wireless network supports the network silent mode. After the network set as seilient mode through the concentrator, the entire network can be silent within 30 SEC. The concentrator and all nodes of the same network will not transmit data on it's own, and the user can cancel silent state at any time. With the functional network quiescing feature, users can activate the network in a time divison manner, which allows multiple networks to be read at one frequency.

The WMRNET-III wireless network networking mode is a top-down automatic networking mode. The WMRNET-III wireless network adopts a robust mesh topology, which uses the strength of the receiving and transmitting field to determine the quality of the link, thereby determining the conditions of networking. Each node of the network can

have multiple paths, and one node supports multiple parent nodes. Any node can be used as a parent node, and the WMRNET-III wireless network can automatically select a reasonable routing path. when a new node is in network coverage, the WMRNET-III wireless network automatically recognizes the node ID and joins the network at a certain time if a WMRNET-III wireless network in active status . When the network is silent, the route and node status of the network are frozen, but the user can still use the concentrator to read the data of the water meter through the node.

The user must set the concentrator and module nodes before using WMRNET-III. The parameters set by the concentrator include the working frequency, network ID, and serial port rate. For the module node, you need to set the working frequency, network ID, and node ID.

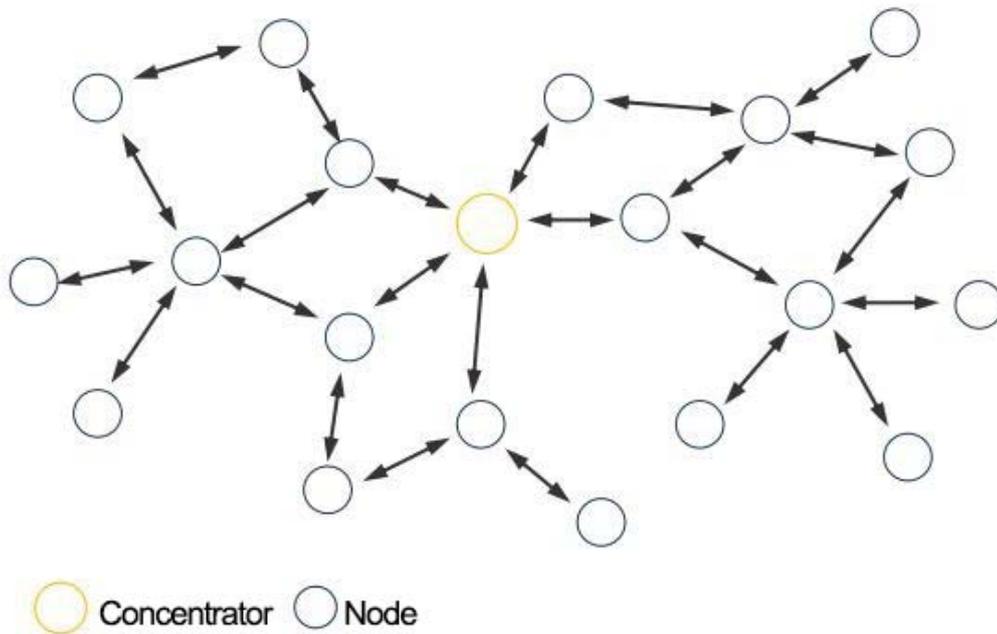


Figure 1 WMRNET-III Wireless network diagram

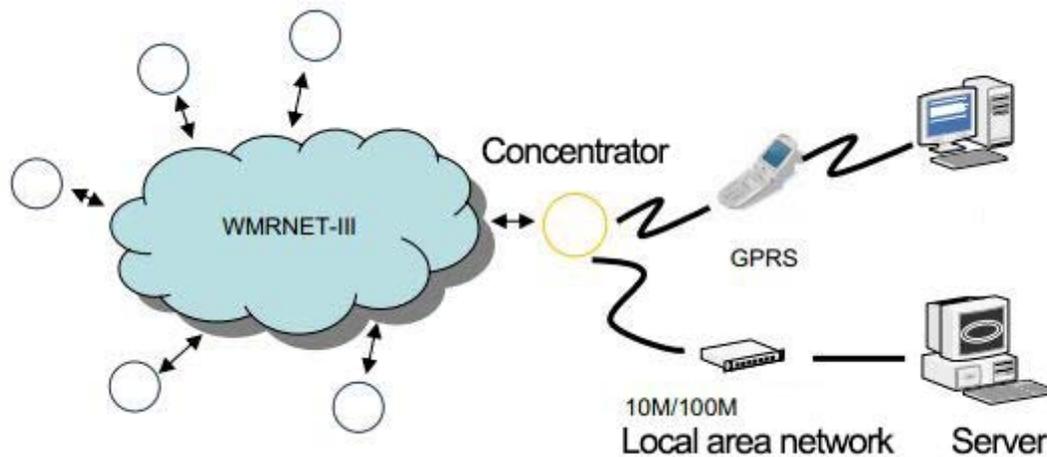


Figure 2 *WMRNET-III Wireless network application diagram*

The same frequency is configured in two different geographical areas like the GSM network. For example, AM or FM broadcast stations of the same frequency are used in different cities. There may be many co-channel WMRNET-III networks in a system, and the entire spectrum allocation is divided into K frequency reuse modes, that is, the number of WMRNET-III networks in the unit wireless zone group, as shown in Figure 3, where K=4, 7, 12, etc. The minimum distance allowed to be reused at the same frequency depends on many factors, such as the number of co-channel networks in the vicinity of the network, the geographic terrain category, the range K of each network node increases, and the frequency reuse distance D also increases. The increased frequency reuse distance will reduce the possibility of co-channel interference. By the same principle, using the WMRNET-III network muting function, it is also possible to implement time division multiplexing with one frequency, so that several WMRNET-III networks can be read over the entire area with one frequency. The frequency reuse distance D is determined by:

$D = \sqrt{3K} R$ where K is the frequency reuse pattern shown in Figure 3. then:

$D=3.4R$ $K=4$

$D=4.6R$ $K=7$

$D=6.0R$ $K=12$

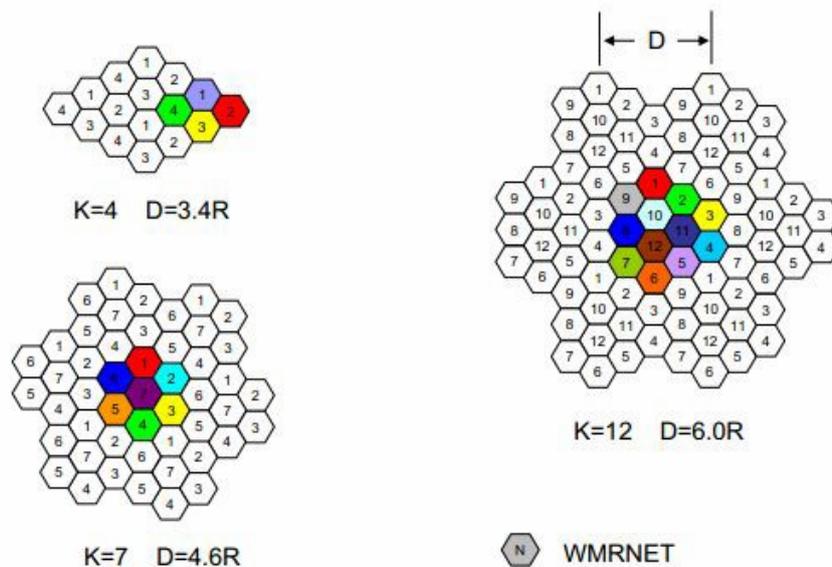


Figure 3. WMRNET-III Wireless network frequency reuse mode

IV. Concentrator (APC930M)

1 Overview:

The APC930M uses ARM7 Single Chip Micryoco and high-performance RF chips from SETMECH. The system operates at 36MHz and supports complex operations. The code is high-efficiency cyclic interleaving error correction coding, with power-down detection and protection function, small size, convenient for customer application, and the specific size and interface definition of the concentrator are shown in Figure 3.

2. Introduction to the instructions:

The APC930M and the host computer use UART interface, a total of 12 communication commands, see Table 1, the specific command use method "WMRNET-III wireless meter reading network to the host computer communication protocol."

WMRNET-III wireless meter reading network to the host computer communication protocol.		
No	Command	Explanation
1	DELNET	Delete network

2	CMD	Communication between host computer and wireless module node
3	TST	host computer tests wireless module
4	RDNODE	Read the ID of the wireless module node in the network
5	FREQ	Read-write frequency parameters
6	NETID	Read and write network ID
7	MTNET	Maintaining the Network
8	BATCH	Maintain network and read meter
9	STOPMT	Stop maintaining the network
10	STATUS	Maintenance status query
11	RATE	Write serial port rate
12	MRATE	Write module serial port rate

Table 1 WMRNET wireless meter reading network for host computer communication commands

3. Size and interface definition:

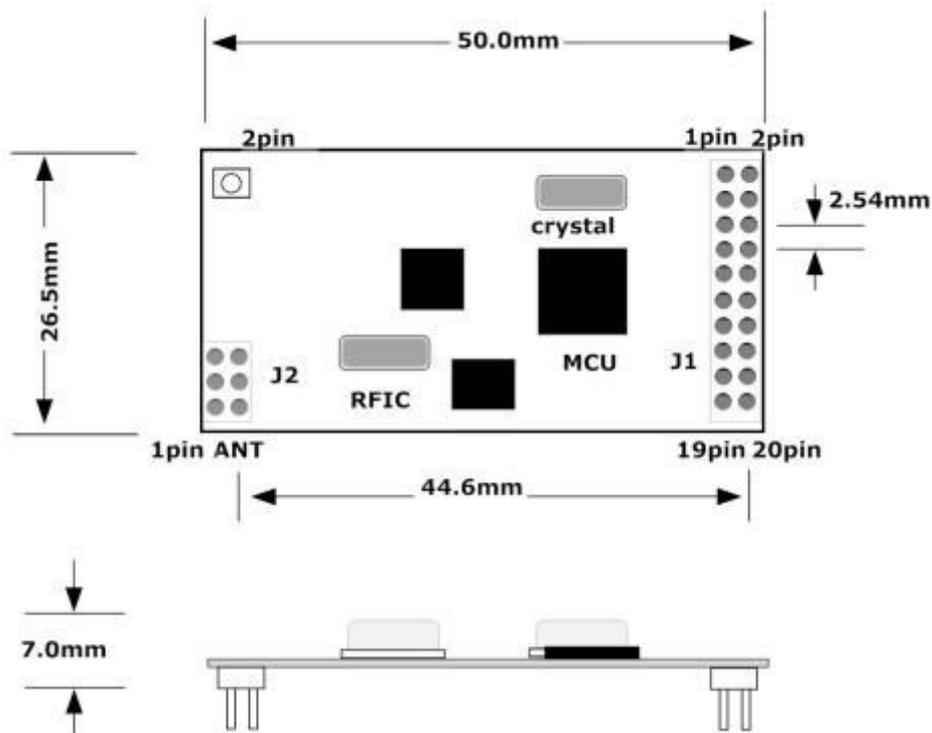


Figure 4 Concentrator size and interface definition

APC930M The interface has two interfaces and one antenna. The specific functions are shown in Table 2:

APC930M PIN definition			
Interface	PIN number	Function	Remark
J1	6	+3.3V digital power output	Must hang in the air
	1, 5, 15, 17, 19	GND	ground connection
	2, 3, 4, 7, 8, 9, 10,11,12,13	NC	Must hang in the air
	14	RESET	RESET, effective in low - level voltage
	20	+5V(VCC)	Power input
	18	RXD	UART input
	16	TXD	UART output
J2	1, 2, 3, 4, 5, 6	GND	ground connection

Table 2 APC930M PIN definition

4. APC930M technical specification :

APC930M technical specification	
Network Type	Network structure (MESH)
Networking speed	200 nodes, typical 20 minutes
Maximum support node	1024
Maximum route	8 layers
working frequency	406-411MHz, 430-437MHz, 490-510MHz
Modulation Method	FSK
Frequency interval	≥300KHz
Transmit power	50mw
Receiving sensitivity	-114dBm@5Kbps (typical)
interface	UART/9600-115200bps/no proof test
Interface voltage level	3.3V (supports 5V input)
Working humidity	10%~90% (no condensation)
Operating temperature	-20°C - 70°C
Power	4.5 – 6.0V (50mV ripple)
Operating currency	≤100mA

Table 3 APC930M technical indicators

V. Wireless module node (APC240F)

1. Overview and description of RF operating mode:

The APC240F wireless module node is a highly integrated half-duplex micropower module. It uses ultra-low-power MCU and high-performance RF chip from SEMTECH of the United States. The APC240F wireless module node uses efficient cyclic interleaving error correction coding, which can correct 24bits continuously.

Burst error, its coding gain is up to near

3dBm, anti-burst interference and sensitivity are greatly improved.

The APC240F wireless module adopts 1 second to open the method for normal standby. The specific principle is as follows: The typical wireless transceiver code is as shown below.

PREAMBLE	SYNCWORD	DATA + FEC +CRC
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The preamble is a "1010" alternating code, which is used to synchronize the destination receiver clock with the transmitter.

The length of the preamble is generally 32 bits. The preamble also has the function of waking up the receiver. At this time, the transmitter must send a long preamble to wake up the receiver in the power saving mode to the normal working state. If the receiver is set to wake up once in 1 second, the receiver wakes up the search preamble (tw) every 1 second, and the duration is generally 16 bits. The transmitter first transmits a preamble of more than 1 second and then transmits a synchronization code, etc., which means that the receiver can successfully detect and wake up the reception under normal conditions as long as the preamble is found in the channel during the wake-up period. The diagram is shown in Figure 5.

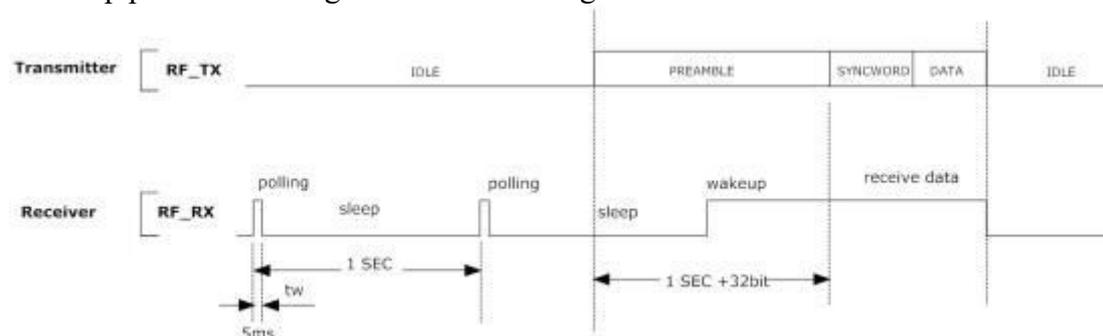


Figure 5 APC240F transceiver timing diagram

2. Using Power Consumption Calculations:

Because the APC240F is power-saving by periodically waking up the reception, the power consumption is related to the wake-up period and the time (tw) of the wake-up search for each preamble, and the static power consumption of the sleep. The APC240F wake-up period is 1 second, and the average time (tw) of the search preamble is 5 ms. The transmission and reception rate is 5Kbps.

The battery life in the power saving mode can be calculated by the following formula:

$$\text{Service life} = \frac{\text{battery capacity mAH}}{(\text{Search for preamble time/wake cycle}) * \text{Receive current} + \text{sleep current}}$$

For example, the battery is a 3.6V/3.6AH ER18505 lithium ion battery, and the APC240F receives current.

2.8mA, sleep current 1.5uA. RF transmission rate 5Kbps, wake-up period 1SEC, then battery life is:

$$= \frac{3600\text{mAH}}{(5\text{ms}/1000\text{ms}) * 2.8\text{mA} + 0.0015\text{mA}} \approx 232258\text{H} \approx (26.5 \text{ years})$$

Considering the self-discharge of the battery, the difference in capacity under different currents, the power consumption such as temperature and several times a month, the 3.6V/3.6AH ER18505 lithium-ion battery has a service life of more than 10 years under normal conditions.

3. APC240F Wireless module node size diagram shown in Figure 6:

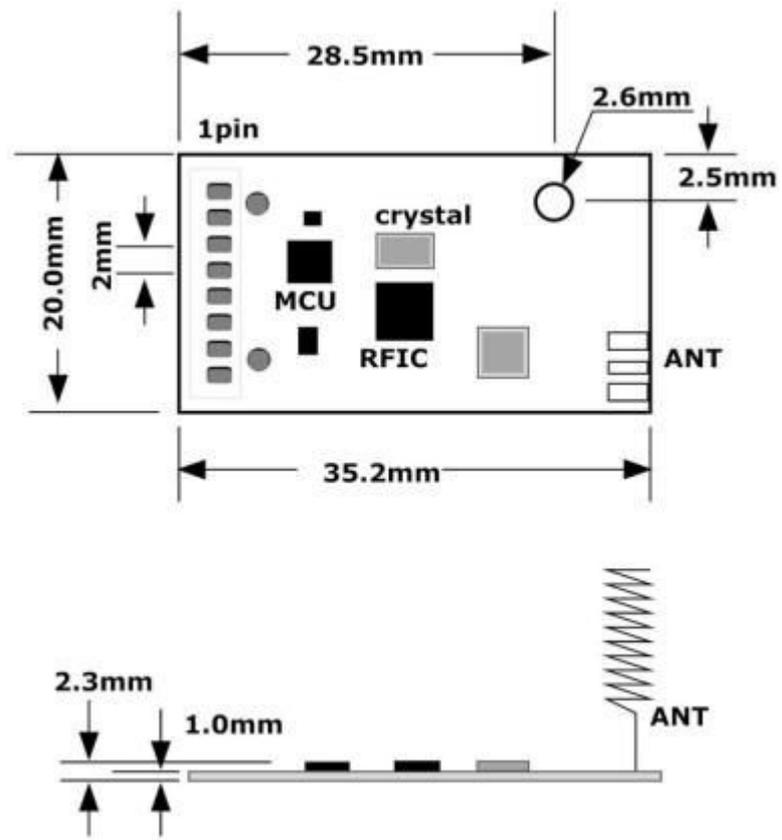


Figure 6 Product size

4. APC240F Pin definition description:

The APC240F module has a total of 8 pins, which are defined as follows:

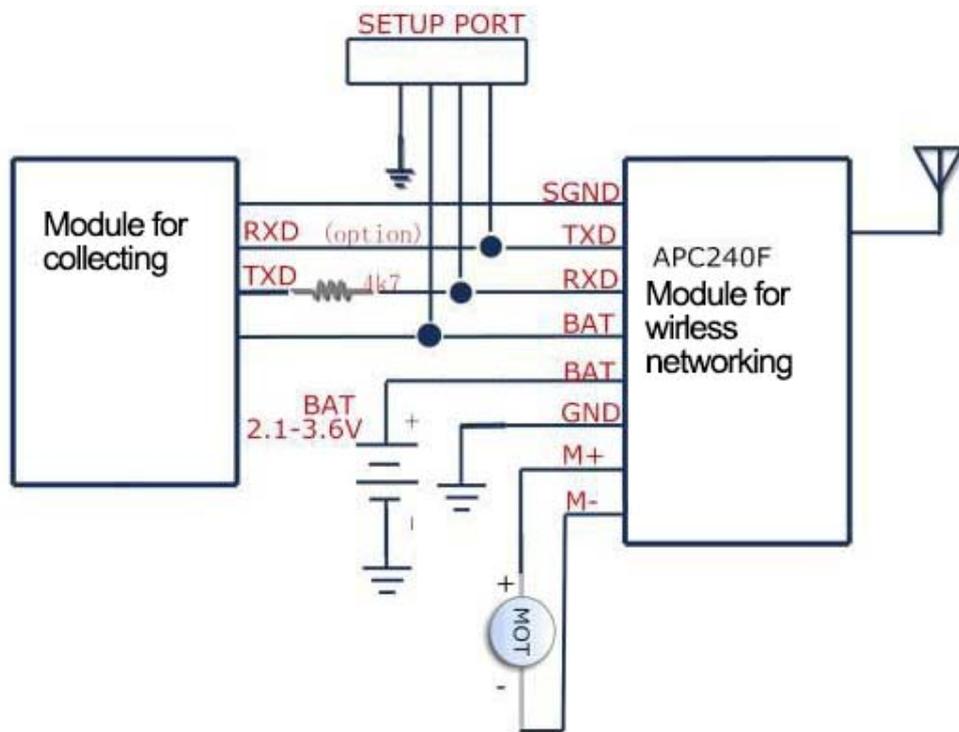
APC240F Pin definition		
PIN	Definition	Explanation
1	SGND	SENDER GND. Methods for different types of meters are different, see Figure 8, Figure 9
2	TXD	UART output ,TTL voltage level
3	RXD	UART input ,TTL voltage level
4	BATT	Battery positive, 2.1-3.6V
5	BATT	Battery positive, 2.1-3.6V (connected to the 4 feet)
6	GND	Ground 0V
7	M+	Motor positive wiring
8	M-	Motor negative wiring

Table 4 APC240F pin definition

5. Introduction to different types of water meter hardware connections:

1>The data is collected by the MCU or the photoelectric module at the end of the table: the connection between the module and the meters,see figure 8

The 4,5-pin BATT is connected inside the module. The first pin SGND is normally high. When it receives the command from the concentrator, it goes low. After 0.5 seconds, it goes high again. At the same time, the first pin SGND has 20mA. The driving ability, the customer can use this feature to connect the BATT of the positive pole of the photoelectric module of the water and gas meter to the first pin SGND. After receiving the reading command, the first pin SGND goes low and the photoelectric module starts. Working, the data is sent to the APC240F through the TXD of the optoelectronic module within 0.5 seconds, and the APC240F uploads the battery voltage value to the concentrator together with the last byte plus the current transmission. For details, please refer to the introduction of the relevant instructions in the <<WMRNET Wireless Water and Gas Meter Reading Network for Host Computer Communication Protocol>>.



Accumulated readings, the readings of the meters are directly counted by the APC240F module, and the data is collected by the node, so no serial communication is required.

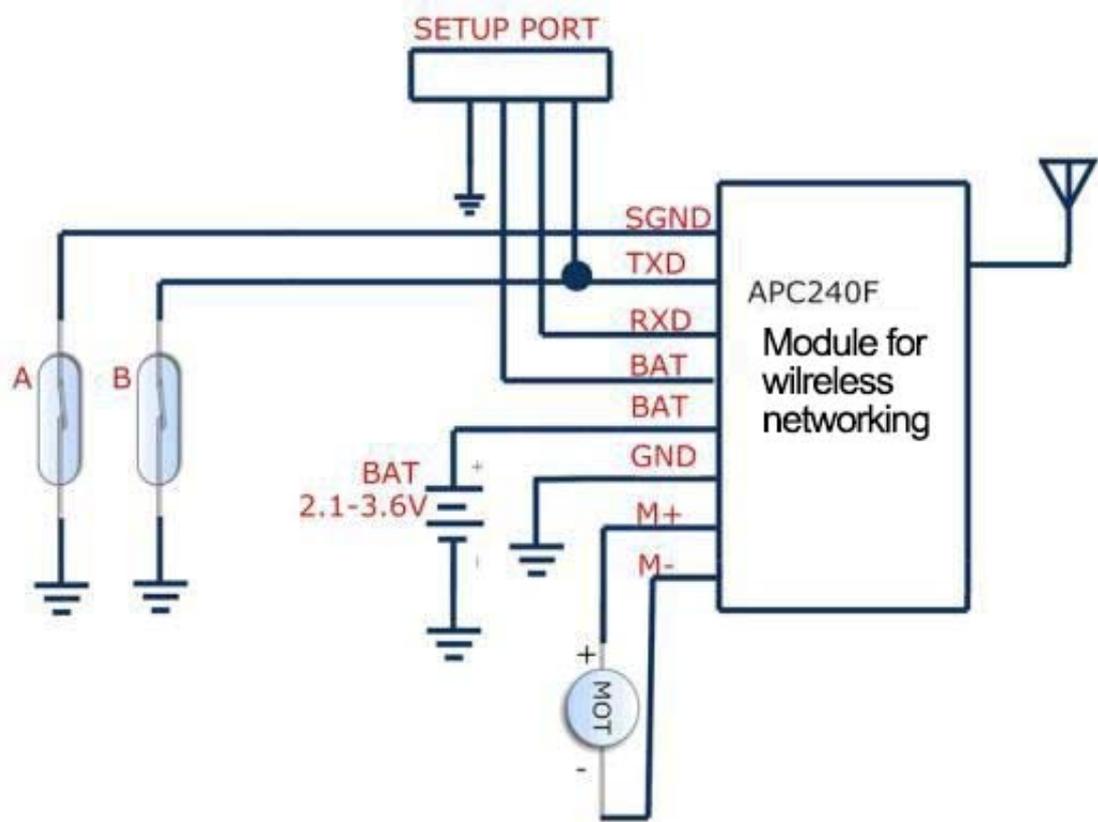


Figure 9 APC240F and double reed switch pulse meter connection circuit diagram

3> Pulse meter sampling Hall sensor data acquisition and APC240F connection wiring diagram shown in Figure 10.

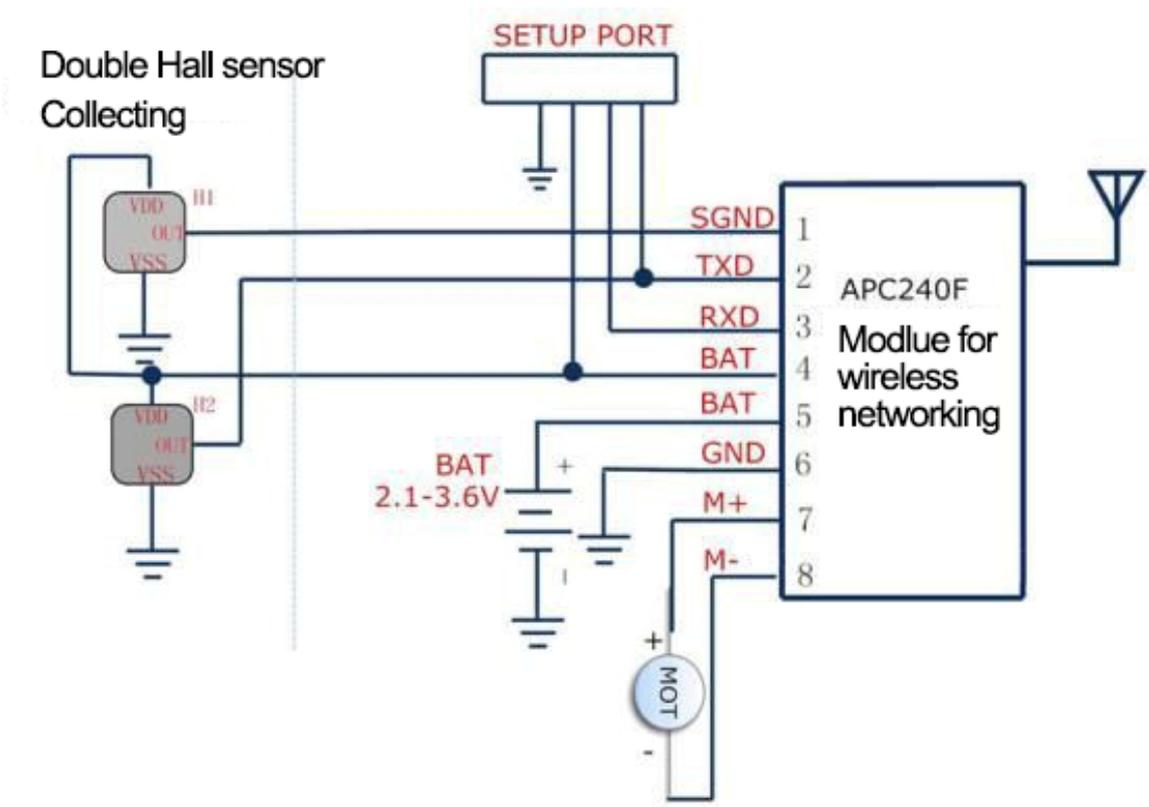


Figure 10 APC240F and Hall sampling pulse meter connection circuit diag