

# HC-SR04 (2020 Version) Ultrasonic Ranging Module – User Manual

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## Overview

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The **HC-SR04 (2020 version)** is a fully backward-compatible ultrasonic ranging module with the same dimensions as the legacy HC-SR04. The upgraded version integrates **UART and I<sup>2</sup>C interfaces** in addition to the original GPIO trigger/echo mode. By configuring external resistors, the module can operate in **GPIO, UART, or I<sup>2</sup>C modes**.

Key enhancements include:

- Minimum blind zone of **2 cm**
- Typical maximum detection distance of **4.5 m**
- Ultra-low operating current of **2.2 mA**
- Upgraded demodulation chip **RCWL-9206**, with built-in MCU supporting UART and I<sup>2</sup>C
- Simplified external circuitry and wider supply voltage (3–5.5 V)

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## Features

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- Professional ultrasonic demodulation and ranging IC **RCWL-9206**
- Supports **GPIO, UART, I<sup>2</sup>C** interfaces
- Wide supply range: **3.0 – 5.5 V**
- Low power consumption: **2.2 mA typical**
- Minimum blind zone: **2 cm**
- Backward hardware/software compatibility with legacy **HC-SR04**
- Measurement range: **2 cm – 450 cm** (on flat wall target)
- Simplified peripheral design
- Operating temperature: **-10 °C to +70 °C** (depending on transducer housing)

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## Electrical & Performance Parameters

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| Parameter                            | Condition            | Min | Typ                        | Max | Unit |
|--------------------------------------|----------------------|-----|----------------------------|-----|------|
| Supply Voltage (Vcc)                 | —                    | 3.0 | —                          | 5.5 | V    |
| Operating Current                    | —                    | 2.2 | —                          | 3.0 | mA   |
| Max Detection Range                  | Flat wall target     | 350 | 450                        | 600 | cm   |
| Operating Frequency                  | —                    | —   | 40                         | —   | kHz  |
| Blind Zone                           | Random within zone   | 2   | —                          | 4   | cm   |
| Accuracy                             | Constant temperature | —   | ±2                         | —   | %    |
| Resolution                           | Theoretical          | —   | 1                          | —   | mm   |
| Detection Angle                      | Max beam spread      | ±15 | ±20                        | —   | °    |
| Measurement Cycle Time               | —                    | —   | 200                        | —   | ms   |
| Interfaces                           | —                    | —   | GPIO/UART/I <sup>2</sup> C | —   |      |
| Operating Temp (Plastic transducer)  | —                    | -10 | —                          | 60  | °C   |
| Operating Temp (Aluminum transducer) | —                    | -10 | —                          | 70  | °C   |

## Pin Definition

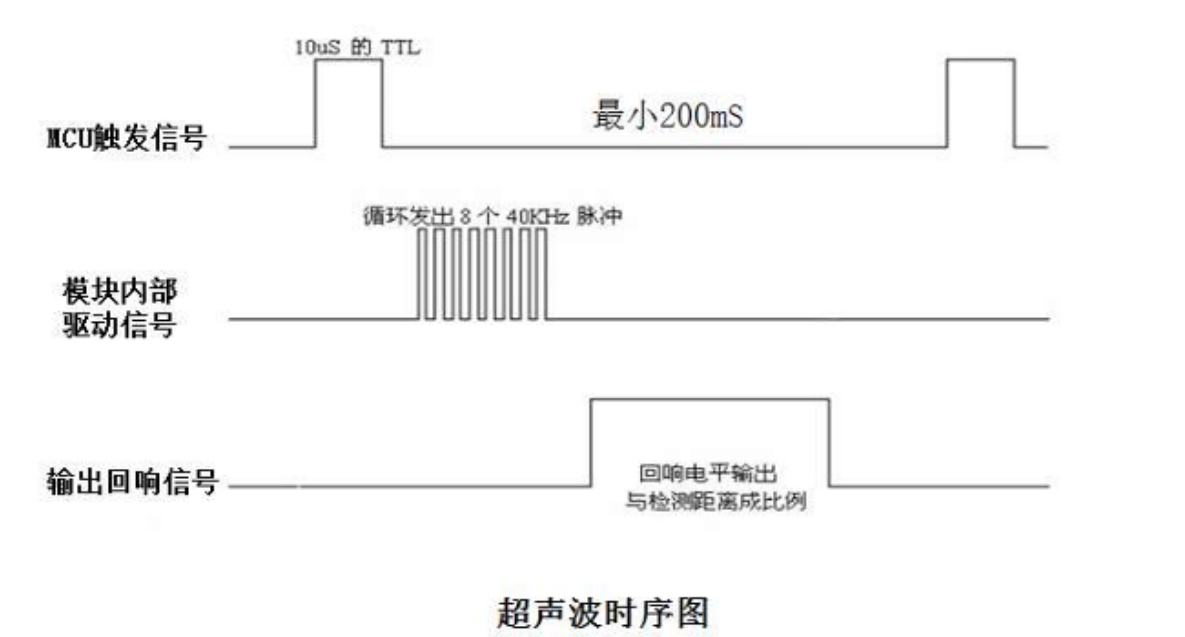
| Pin | Name        | GPIO Mode   | UART Mode | I <sup>2</sup> C Mode | Description                                |
|-----|-------------|-------------|-----------|-----------------------|--|
| 1   | Vcc         | —           | —         | —                     | Power Supply (3–5.5 V)                     |
| 2   | Trig/Rx/SCL | Trig Input  | Rx        | SCL                   | Trigger / UART Rx / I <sup>2</sup> C Clock |
| 3   | Echo/Tx/SDA | Echo Output | Tx        | SDA                   | Echo / UART Tx / I <sup>2</sup> C Data     |
| 4   | GND         | —           | —         | —                     | Ground Reference                           |

## Mode Selection

| Mode             | R4 Setting | R5 Setting | Default |
|------------------|------------|------------|---------|
| GPIO             | NC         | NC         | ✓       |
| UART             | NC         | 10 kΩ      | —       |
| I <sup>2</sup> C | 10 kΩ      | NC         | —       |

# Operation

## 1. GPIO Mode (Legacy HC-SR04 Compatible)



- MCU outputs a **>10  $\mu$ s HIGH pulse** on Trig.
- Module responds with a **HIGH pulse** on Echo, proportional to the measured distance.
- Distance calculation:  
$$d = \frac{T \times C}{2}$$
Where  $T$  = Echo pulse width,  $C$  = Speed of sound.
- Speed of sound temperature formula:  
$$C = 331.45 + 0.61 \times t \quad [\text{m/s}]$$
Example values:
  - At 0 °C: 330.45 m/s
  - At 20 °C: 342.62 m/s
  - At 40 °C: 354.85 m/s

Note: Temperature compensation is required for accurate measurement.

## 2. UART Mode

- Baud rate: **9600, N, 8, 1**
- Command/Response:

| Command | Response               | Description  |
|---------|------------------------|--|
| 0xA0    | BYTE_H, BYTE_M, BYTE_L | Distance (mm) = ((BYTE_H << 16) + (BYTE_M << 8) + BYTE_L) / 1000 |
| 0xF1    | String                 | Company & firmware version info                                  |

**UART Mode Operation:**

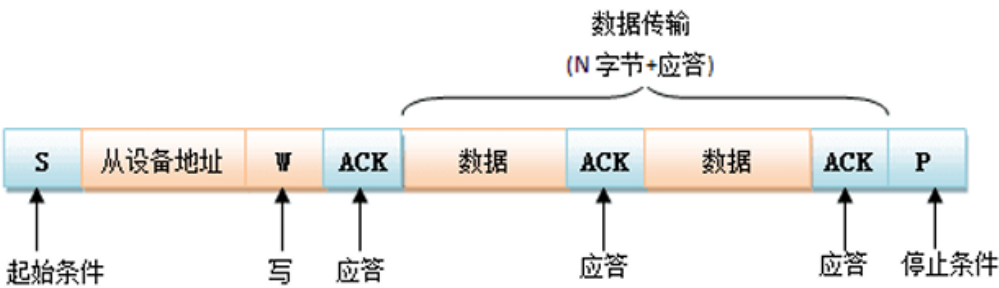
Connect the module via a serial port. When the external MCU or PC sends command `0xA0`, the module performs a ranging operation and then returns three bytes of distance data: **BYTE\_H**, **BYTE\_M**, **BYTE\_L**.

The distance calculation formula (unit: mm) is as follows:

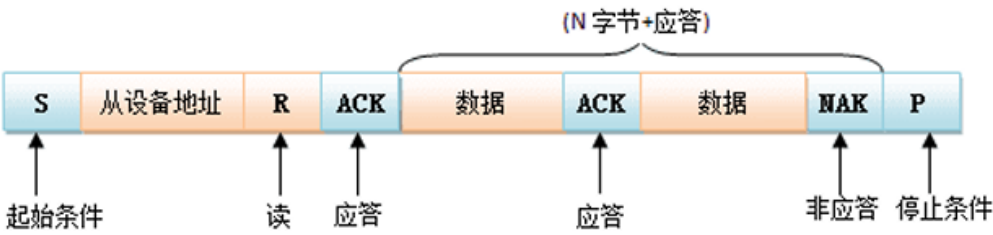
$$\text{Distance} = \frac{(\text{BYTE\_H} \ll 16) + (\text{BYTE\_M} \ll 8) + \text{BYTE\_L}}{100}$$

### 3. I<sup>2</sup>C Mode

- Address: **0x57** (7-bit)
- Write Command:



- Read Command:



| Operation | I <sup>2</sup> C Address       | Command / Return Value       | Description   |
|-----------|--------------------------------|------------------------------|---|
| Write     | <b>0xAE</b><br>(write address) | <code>0x01</code>            | Start ranging command. The module begins a measurement cycle (max measurement time ≈ 200 ms). |
| Read      | <b>0xAF</b><br>(read address)  | BYTE_H,<br>BYTE_M,<br>BYTE_L | Returns 3 bytes of ranging data, with the most significant byte first.                        |

**Distance Calculation Formula (unit: mm):**

$$\text{Distance} = \frac{(\text{BYTE\_H} \ll 16) + (\text{BYTE\_M} \ll 8) + \text{BYTE\_L}}{1000}$$

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## Application Notes

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1. Avoid hot-plugging; always connect **GND first** if power is applied.
2. For irregular surfaces or long distances, perform **multiple measurements and average**.
3. Minimum interval between two measurements: **200 ms**.