# Operating the M1C1‑Mini 360° 2D scanning LiDAR and building a Python driver

## Overview of the hardware

The **M1C1‑Mini** (sometimes advertised as *CSPC M1C1\_Mini*) is a compact two‑dimensional LiDAR from *China Science Photon Chip (Haining) Technology Co., Ltd*. It uses a single rotating line‑scan unit based on triangulation. The sensor produces a 360 degree horizontal field of view and can measure distances from **0.10 m to 8 m** (0.1 – 8.0 m)[[1]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Light%20source%20Laser%40780nm%2C%20Class1%20Working,93%C2%B0). Key characteristics include:

* **Triangulation principle:** The unit contains a high‑frequency ranging core and a mechanical rotating sub‑system[[2]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Component%20connection%3A%20M1CT_Mini%20adopts%20Triangulation,as%20RS232%20or%20422%20is). As the motor rotates, it scans the environment with an infrared laser and measures the reflected light to calculate distance.
* **Measurement accuracy:** For distances <1 m the accuracy is on the order of millimetres and within **±2 %** for 1–6 m[[3]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Detection%20distance%200.10~8.0m%4090,6m%20Field%20of%20view).
* **Field of view and angular resolution:** 360° horizontal scanning with an angular resolution of approximately **0.93°**[[4]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=360%C2%B0%20horizontal%20Angle%20resolution%20%E2%89%880).
* **Scanning frequency:** Default measurement frequency is about **3 860 points per second** with a nominal rotation speed of **10 Hz**[[5]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=%E2%89%880,Rotating%20speed%2010Hz).
* **Laser and safety:** The transmitter is a **780 nm Class 1 infrared laser**[[6]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Light%20source%20Laser%40780nm%2C%20Class1). The manufacturer integrates a protection module that stops the laser when faults occur (excess transmit power, non‑functional laser, high‑frequency core failure, scan speed too low or unstable motor speed)[[7]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Safety%20and%20Product%20protection%3A%20The,%E2%97%8FMotor%20speed%20is%20unstable).
* **Power consumption:** Typical power is **≈1 W** with a **5 V DC supply**. The system draws about **200 mA** during normal operation and requires short‑term currents up to **0.5 A** to start the motor[[8]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Power%20supply%20information%20and%20Speed,the%20system%20operation%20Motor%20voltage). It is recommended to use a supply with ripple <300 mV[[9]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=voltage%EF%BC%88V%EF%BC%89%20,ripple%20of%20less%20than%20300mV).
* **Physical size:** The module measures roughly **100.95 × 60.50 × 45.30 mm** and weighs **≈98 g**[[10]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Dimensions%20L100.95%20,30mm%20Weight%2098%20g).

The LiDAR is suitable for mobile robotics, mapping and obstacle‑avoidance applications[[11]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=M1C1_Mini%20is%20a%20single,robot%20autonomous%20positioning%20navigation%2C%20etc). It is designed for indoor use and the small size and low power consumption make it useful for hobbyist platforms.

## Hardware connections

The unit has a **5 V DC input** for the motor and a UART‑level communication interface. According to the specification, the high‑frequency ranging core uses **wireless electromagnetic coupling** to draw power from the rotating module[[12]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Power%20supply%20information%20and%20Speed,Wireless%20power%20supply%205V%20DC). To integrate the LiDAR into your system:

1. **Power:** Provide a regulated 5 V supply capable of at least 500 mA peak current. Keep ripple under 300 mV[[9]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=voltage%EF%BC%88V%EF%BC%89%20,ripple%20of%20less%20than%20300mV).
2. **Rotation control:** Some breakout boards expose a PWM input that allows adjusting the rotation speed. However, the M1C1‑Mini contains its own speed‑detection circuit and will regulate the motor speed automatically[[13]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=The%20M1C1_Mini%20LiDAR%20has%20its,can%20reduce%20the%20customer%20cost). Therefore, a separate speed‑control signal is usually unnecessary.
3. **Communication interface:** The LiDAR uses a **5 V TTL UART**. Connect its TX (output) to your system’s RX, its RX to your system’s TX, and ensure a common ground[[14]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=scanning%20frequency%20by%20changing%20the,core%20scan%20through%20the%20UART). The standard parameters are **115 200 bps**, 8 data bits, no parity and 1 stop bit (8N1)[[15]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=ITEM%20UNIT%20MIN%20TYPICAL%20MAX,8N1). Logic‑high levels are ~3.3 V and logic‑low ~0.4 V[[16]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Output%20high%20voltage%20V%202,1.17%20Logic%20Low), so a typical USB‑to‑TTL converter will work. Only a serial port is required – no RS‑232/RS‑422 level shifting is necessary[[17]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=scanning%20frequency%20by%20changing%20the,the%20user%20can%20obtain%20the).

## Data output and message format

When operating, the LiDAR continually outputs **scan data** through the UART. Each sample includes **distance (mm), heading (degrees) and a start‑flag** indicating whether the sample is the first point of a new 360° scan[[18]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Data%20message%20format%3A%20When%20M1C1_Mini,for%20details%20if%20any%20questions). The specification states that a uniform message format is used but refers users to CSPC technical support for the detailed packet structure[[19]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=the%20communication%20interface%20with%20the,for%20details%20if%20any%20questions). Fortunately, community drivers have reverse‑engineered the protocol.

### Packet structure (reverse‑engineered)

A reverse‑engineered Python implementation (for the M1C1‑Mini) reads raw bytes from the serial port, locates frames beginning with **0xAA 0x55**, and then parses the packet as follows:

| Byte(s) | Meaning | Notes |
| --- | --- | --- |
| **0 – 1** | **0xAA 0x55** | Frame header used to synchronise the stream. |
| **2** | **Frame type** | A value of **0x01** indicates distance data. Other values may represent configuration or reply frames. |
| **3** | **Data count (N)** | Number of distance measurements included in this packet. |
| **4 – 5** | **Start angle (little‑endian)** | 15‑bit value representing the angle (°) of the first sample. It is right‑shifted by one bit (the lowest bit is a flag). The driver multiplies it by π / 64 / 180 to convert to radians. |
| **6 – 7** | **End angle (little‑endian)** | 15‑bit value representing the angle of the last sample; processed similarly to the start angle. |
| **8 – 9** | **Checksum** | Two bytes computed as the XOR of every pair of data bytes in the packet except the 5th pair (i.e. start angle). The driver verifies these before parsing distances. |
| **10…** | **Distance samples** | Each distance is **2 bytes** (little‑endian). The driver combines them (low | high<<8), then right‑shifts by two bits (the lowest two bits carry intensity or flags). Distances are in millimetres. There are *N* samples. |

After reading a packet, the driver computes the heading of each sample by interpolating between the start and end angles:

angle\_step = (end\_angle - start\_angle) / (N - 1) if N > 1 else 0  
angles = [start\_angle + i \* angle\_step + angle\_correct[i] for i in range(N)]

angle\_correct[i] is a small correction term derived from the distance to compensate for non‑linearities; one community driver uses the formula atan(19.16 \* (d – 90.15)/(90.15 \* d))[[20]](https://raw.githubusercontent.com/sy-eng/Lidar/refs/heads/master/lidar.py#:~:text=distances%20%3D%20).

### Start flag and scan segmentation

The specification mentions a boolean **start flag** that tells whether the current point belongs to a new scan[[21]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Start%20Flag%20,it%20by%20instruction%20of%20request). In practice, many applications simply monitor the heading sequence: when the heading decreases compared with the previous sample, a new 360° scan has started. You can therefore segment scans by observing a wrap‑around from ~360° back to 0° or by examining a dedicated bit in the packet header if it exists.

## Building a Python driver

The following high‑level procedure outlines how to implement a Python driver using the above information. It uses the pyserial library to communicate over UART and yields 2‑D Cartesian coordinates for each scan.

### 1. Initialise hardware and serial port

1. Connect the LiDAR’s 5 V and GND to a stable power supply.
2. Connect the **TX/RX** pins to a USB‑to‑UART adaptor (TTL levels). Do not connect to an RS‑232 port directly.
3. In Python, install pyserial (e.g. pip install pyserial). Then open the port:

import serial  
lidar\_port = serial.Serial('/dev/ttyUSB0', baudrate=115200, bytesize=8, parity='N', stopbits=1, timeout=0.1)

On a Raspberry Pi you may also need to enable the motor by setting a GPIO pin high (some breakout boards supply the 5 V line through a transistor). The example driver sets **GPIO 18** high via the RPi.GPIO library before reading data.

### 2. Read and synchronise frames

1. Continuously read bytes from the serial port into a buffer.
2. Search the buffer for the header sequence **0xAA 0x55**. When found, check that the third byte equals 0x01 (data frame) and that enough bytes remain for a complete frame.
3. Extract the frame and verify the two‑byte checksum: XOR each 16‑bit pair of bytes except the pair containing the start angle and compare the result with the checksum bytes[[22]](https://raw.githubusercontent.com/sy-eng/Lidar/refs/heads/master/lidar.py#:~:text=def%20checkSum%28data%29%3A%20check%20%3D%20,0).

### 3. Parse distances and angles

1. **Number of samples (N):** read byte 3.
2. **Start and end angles:** combine bytes 4–5 and 6–7 (little‑endian), right‑shift by one bit to drop the least‑significant flag bit, then convert to degrees or radians. The community driver multiplies the raw value by π/(64×180) to obtain radians.
3. **Distances:** for each sample *i* (0 ≤ i < N), read two bytes starting at index 2×(i+5), combine them, and right‑shift by two bits to obtain the distance in millimetres[[23]](https://raw.githubusercontent.com/sy-eng/Lidar/refs/heads/master/lidar.py#:~:text=distances%20%3D%20).
4. **Compute heading for each sample:** linearly interpolate between start and end angles and add a small correction term based on distance as shown earlier.
5. **Convert to Cartesian coordinates:**

import math  
x = distance\_mm \* math.sin(angle\_rad) # forward/backward axis  
y = distance\_mm \* math.cos(angle\_rad) # left/right axis

You can build a list of (x, y) points or publish them as a point cloud.

### 4. Handle scan segmentation

To detect when a new 360° scan begins, monitor the heading values. When the heading decreases relative to the previous sample (wrap‑around from ~360° to ~0°), treat the next sample as the first point of a new scan. Alternatively, you can look for a **start flag** bit in the frame header (if documented by the manufacturer). Grouping points by scan is important when building maps.

### 5. Error handling and safety

* **Checksum failures:** If the computed checksum does not match bytes 8–9, discard the frame.
* **Timeouts:** The LiDAR outputs data continuously; a sustained lack of data may indicate a power or connection issue.
* **Built‑in protection:** If the laser power exceeds safe limits, the motor speed drops below 3 Hz or the motor speed becomes unstable, the LiDAR will automatically shut down[[7]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Safety%20and%20Product%20protection%3A%20The,%E2%97%8FMotor%20speed%20is%20unstable). In this case, your driver should handle the absence of data and perhaps notify the user.

## Limitations and advice

* The official specification deliberately omits the **full communication protocol** (e.g., command packets, exact packet layout and speed control). For advanced features such as requesting single scans, adjusting rotation speed or changing output format, you must request the SDK and protocol documentation from **CSPC Technology Support**[[19]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=the%20communication%20interface%20with%20the,for%20details%20if%20any%20questions).
* The reverse‑engineered packet structure described above works for **distance‑only scanning frames** (0xAA 0x55 0x01 …). Future firmware versions may alter the format, so design your driver to validate packet headers and lengths.
* Use caution when decompiling community drivers; verify that their interpretations match the behaviour of your unit. Always test with the actual hardware.

## Summary

The M1C1‑Mini is a low‑cost 2D LiDAR that uses a triangulation range‑finder and a mechanical rotating module to perform 360 degree scans. It outputs distance and heading data through a 5 V UART at 115 200 bps, and its power consumption is about 1 W at 5 V. Each data frame begins with **0xAA 0x55** and contains a variable number of distance samples, start/end angles and a two‑byte checksum[[23]](https://raw.githubusercontent.com/sy-eng/Lidar/refs/heads/master/lidar.py#:~:text=distances%20%3D%20). By reading frames from the serial port, verifying their checksum and converting the distances and angles to Cartesian coordinates, you can build a Python driver to obtain a stream of 2D points. For customised configuration or official SDK support, contact CSPC’s technical support as the public manual does not include the full command set[[19]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=the%20communication%20interface%20with%20the,for%20details%20if%20any%20questions).

[[1]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Light%20source%20Laser%40780nm%2C%20Class1%20Working,93%C2%B0) [[2]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Component%20connection%3A%20M1CT_Mini%20adopts%20Triangulation,as%20RS232%20or%20422%20is) [[3]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Detection%20distance%200.10~8.0m%4090,6m%20Field%20of%20view) [[4]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=360%C2%B0%20horizontal%20Angle%20resolution%20%E2%89%880) [[5]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=%E2%89%880,Rotating%20speed%2010Hz) [[6]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Light%20source%20Laser%40780nm%2C%20Class1) [[7]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Safety%20and%20Product%20protection%3A%20The,%E2%97%8FMotor%20speed%20is%20unstable) [[8]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Power%20supply%20information%20and%20Speed,the%20system%20operation%20Motor%20voltage) [[9]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=voltage%EF%BC%88V%EF%BC%89%20,ripple%20of%20less%20than%20300mV) [[10]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Dimensions%20L100.95%20,30mm%20Weight%2098%20g) [[11]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=M1C1_Mini%20is%20a%20single,robot%20autonomous%20positioning%20navigation%2C%20etc) [[12]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Power%20supply%20information%20and%20Speed,Wireless%20power%20supply%205V%20DC) [[13]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=The%20M1C1_Mini%20LiDAR%20has%20its,can%20reduce%20the%20customer%20cost) [[14]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=scanning%20frequency%20by%20changing%20the,core%20scan%20through%20the%20UART) [[15]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=ITEM%20UNIT%20MIN%20TYPICAL%20MAX,8N1) [[16]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Output%20high%20voltage%20V%202,1.17%20Logic%20Low) [[17]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=scanning%20frequency%20by%20changing%20the,the%20user%20can%20obtain%20the) [[18]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Data%20message%20format%3A%20When%20M1C1_Mini,for%20details%20if%20any%20questions) [[19]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=the%20communication%20interface%20with%20the,for%20details%20if%20any%20questions) [[21]](https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf#:~:text=Start%20Flag%20,it%20by%20instruction%20of%20request) spec.pdf

<https://raw.githubusercontent.com/SmartAgriRobot/lidar/main/pdf/spec.pdf>

[[20]](https://raw.githubusercontent.com/sy-eng/Lidar/refs/heads/master/lidar.py#:~:text=distances%20%3D%20) [[22]](https://raw.githubusercontent.com/sy-eng/Lidar/refs/heads/master/lidar.py#:~:text=def%20checkSum%28data%29%3A%20check%20%3D%20,0) [[23]](https://raw.githubusercontent.com/sy-eng/Lidar/refs/heads/master/lidar.py#:~:text=distances%20%3D%20) raw.githubusercontent.com

<https://raw.githubusercontent.com/sy-eng/Lidar/refs/heads/master/lidar.py>