

lamaPLC: MPU-6050 (HW-123, GY-521) 6-axis MotionTracking device

The MPU-6050 (HW-123, GY-521) is a popular 6-axis motion-tracking sensor that combines a 3-axis gyroscope and a 3-axis accelerometer on a single chip. It is a MEMS device created to measure acceleration, rotational velocity, and orientation.



Key Technical Specifications

- **Sensor Type:** 6-axis Inertial Measurement Unit (IMU) with an integrated temperature sensor.
- **Resolution:** 16-bit analog-to-digital converters (ADCs) for all six channels, providing high-precision raw data.
- **Programmable Ranges:**
 - **Gyroscope:** ± 250 , ± 500 , ± 1000 , and ± 2000 °/sec.
 - **Accelerometer:** $\pm 2g$, $\pm 4g$, $\pm 8g$, and $\pm 16g$.
- **Communication:** Primary interface is I²C (up to 400 kHz).
- **Operating Voltage:** 2.375V to 3.46V for the raw chip; common breakout modules like the GY-521 include a 3.3V regulator for 5V compatibility.
- **I²C Addresses:** 0x68 (default) or 0x69 (selectable via the AD0 pin).

Notable Features

- **Digital Motion Processor (DMP):** An on-chip co-processor that offloads complex sensor fusion calculations (like converting raw data into quaternions or Euler angles) from the main microcontroller.
- **FIFO Buffer:** A 1024-byte buffer that allows the system processor to read data in bursts, reducing power consumption by letting the host stay in sleep mode longer.
- **Auxiliary I²C Bus:** Allows the MPU-6050 to act as a master to external sensors, such as a 3rd-party magnetometer, to provide full 9-axis “MotionFusion” output.

Pinout Table (HW-123, GY-521)

Pin Name	Description	Note
VCC	Power Supply	Typically 3V to 5V (due to onboard regulator).
GND	Ground	Common ground for the system.
SCL	I ² C Serial Clock	Connect to MCU clock line (e.g., A5 on Uno).
SDA	I ² C Serial Data	Connect to MCU data line (e.g., A4 on Uno).
XDA	Aux Serial Data	For connecting external I ² C sensors (optional).
XCL	Aux Serial Clock	For connecting external I ² C sensors (optional).
AD0	Address Select	Low (default) = 0x68; High = 0x69.
INT	Interrupt Output	Signals the MCU when new data is available.

Pin Functions & Wiring Tips

- **I²C Communication:** The module acts as a slave. SCL and SDA pins are essential for all basic

operations.

- **Multi-Sensor Setup:** Use the AD0 pin to change the I²C address if you need to use two MPU-6050s on the same bus.
- **External Master:** The XDA and XCL pins allow the MPU-6050 to act as a master to a secondary sensor, such as a magnetometer, to create a 9-axis fusion system.
- **Interrupts:** The INT pin can be programmed to trigger on specific events, such as “Data Ready” or “Motion Detected,” allowing the MCU to perform other tasks until needed.

Arduino example code

To connect the MPU-6050 to an Arduino, the simplest method is to use the **Adafruit MPU6050** library, which handles I²C communication and converts raw data to standard units (*mls*² for acceleration and *rad/s* for rotation).

This code initializes the sensor and prints real-time movement data to the Serial Monitor at 115200 baud.

```
#include <Adafruit_MPU6050.h>
#include <Adafruit_Sensor.h>
#include <Wire.h>

Adafruit_MPU6050 mpu;

void setup(void) {
  Serial.begin(115200);
  if (!mpu.begin()) {
    while (1) { delay(10); } // Loop if sensor not found
  }
  // Optional: Set ranges
  mpu.setAccelerometerRange(MPU6050_RANGE_8_G);
  mpu.setFilterBandwidth(MPU6050_BAND_21_HZ);
}

void loop() {
  sensors_event_t a, g, temp;
  mpu.getEvent(&a, &g, &temp);

  // Print accel and gyro data to Serial Monitor
  Serial.print(a.acceleration.x); Serial.print(", ");
  Serial.print(g.gyro.x); Serial.println();
  delay(500);
}
```

Tips for Better Results

- **Calibration:** For precise motion tracking, calculate offsets (the average reading when the sensor is perfectly still) and subtract them from your raw data.
- **Filtering:** If your readings are “noisy,” a Complementary Filter can help combine accelerometer and gyroscope data to produce a smoother orientation (tilt) estimate.

I2C topics on lamaPLC

Page	Date	Tags
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• lamaPLC Communication: I²C	2025/09/23 19:25	i2c , i c , smbus , philips , bus , communication , arduino
• LamaPLC: AHT10 Modul	2026/03/21 19:20	communication , i2c , temperature , humidity , sensor , aht , aht 10 , modul
• LamaPLC: AHT20 / BMP280 Modul	2026/02/15 20:33	bmp280 , aht20 , adafruit , temperature , humidity , pressure , sensor , arduino , code , i2c
• LamaPLC: APDS - Avago ALS and proximity detection sensors with I²C communication	2026/02/14 22:24	avago , apds-9900 , apds-9930 , apds-9960 , als , proximity , detection , gesture recognition , gesture , i2c , communication , sensor , arduino , code
• LamaPLC: BMP/BME Bosch Temperature/Humidity/Pressure sensors with I²C communication	2026/02/15 20:40	bme280 , bme680 , bmp180 , bmp280 , hw-611 , hw611 , bosch , temperature , humidity , pressure , sensor , arduino , i2c , communication , cjmcu
• LamaPLC: CJMCU-219/INA-219 breakout board/IC with I²C communication	2026/02/14 23:37	cjmcu-219 , ina-219 , ina219 , breakout board , i2c , communication , sensor , voltage , current , arduino , code , cjmcu
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• LamaPLC: D6T Omron Non-Contact Thermal Sensors with I²C communication	2026/02/14 18:19	d6t , d6t-32l , d6t-44l , d6t-8l , d6t-1a , omron , non-contact , thermal , sensor , i2c , arduino , code
• LamaPLC: DPS Infineon Temperature/Pressure sensors with I²C communication	2026/02/14 18:11	dps310 , infineon , temperature , pressure , sensor , arduino , i2c , communication , code
• lamaPLC: Energy, power, current, and voltage	2025/05/31 21:32	i2c , i c , communication , arduino , energy , power , current , sensor , ina226
• LamaPLC: ENS ScioSense Multi-gas sensors with I²C communication	2026/02/14 19:29	ens160 , sciosense , gas-quality , i2c , communication , sensor , arduino , code , eco2 , tvoc , aqi , indoor air quality , iaq , co2 , voc
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• LamaPLC: Gas sensors	2023/07/01 15:29	gas, sensor, i2c, onewire, communication, mq-3, mq-4, mq-5, mq-6, mq-7, mq-8, mq-9, mq-135, gm-102b, gm-302b, gm-502b, gm-702b, alcohol, ch4, natural gas, smoke, lng, co, co2, lpg, h2, iso-butane, nox, nh3, benzene, town gas, formaldehyde, propane, humidity, temperature, voc, grv gas sens v2
• lamaPLC: GY-511 6DOF sensor module	2026/03/22 00:26	stmicroelectronics, lsm303dlhc, i2c, lsm303, sensor, gy-511, 6dof, pololu, module, arduino
• LamaPLC: GY-9250 MPU-9250/6500 9-axis Attitude Sensor Board	2026/02/14 22:45	ak8963, gy-9250, mpu-9250, 9-axis, motion detection, magnetometer, communication, i c, i2c, spi
• LamaPLC: HDC Texas Instruments Temperature/humidity sensors with I²C communication	2026/02/14 22:09	sht21, htu21, si7021, gy-21, gy-213v, hdc1080, gy-213v-hdc1080, cjmcu, cjmcu-1080, texas instruments, temperature, humidity, sensor, i2c, communication, arduino, code
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• lamaPLC: INA226 - current/voltage/power monitor with I²C communication	2026/02/14 23:58	i2c, i c, communication, arduino, energy, power, current, monitor, sensor, ina226, ina219, ina
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• LamaPLC: SC16IS750 / SC16IS752: One or two serial (UART) ports from microcontroller via I²C or SPI communication	2026/02/14 22:53	cjmcu-750, cjmcu-752, cjmcu, nxp, sc16is750, sc16is752, uart, serial, i2c, spi, modul, converter, arduino, code
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- LamaPLC: SHT Sensirion Temperature/humidity sensor with I²C communication 2026/02/15 20:29 sht20, sht21, sht25, sht30, sht31, sht35, sht40, gy21, temperature, humidity, i2c, communication, sensor, arduino, code
 - lamaPLC: Signal level converters 2026/02/14 22:47 pca9306, i2c, voltage, level, converter
 - lamaPLC: TCA9548A (HW617); Low-Voltage 8-Channel I²C Switch Module 2026/02/14 22:51 tca9548a, hw617, i2c, switch, communication, expansion board, arduino
 - lamaPLC: TM1637 7-segment display 2026/02/14 17:26 i2c, 7-segment display, display, tm1637, arduino
 - LamaPLC: TOFnnnC STMicroelectronics Time-of-Flight (ToF) sensors with I²C communication 2026/02/14 22:22 tof050c, vl6180, tof200c, vl53l0x, tof400c, vl53l1x, stmicroelectronics, time-of-flight, tof, i2c, communication, sensor, arduino, code
 - LamaPLC: VL53Lnn STMicroelectronics time-of-flight (ToF) laser-ranging sensors with I²C communication 2026/02/14 22:21 vl53l0x, vl53l1x, vl53l0 1xv2, gy-530, time-of-flight, tof, laser-ranging, i2c, communication, sensor, arduino, code
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 - SSH1106/SSD1306 OLED Display with I²C communication 2026/02/14 17:27 i2c, oled, display, ssd1306, sh1106, ssh1106, arduino, cmos
- MPU-6050, HW-123, GY-521, 6-axis MotionTracking, DMP, temperature, sensor, MEMS, arduino code, Arduino, accelerometer, gyroscope, tilt

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