

lamaPLC project: Digitales Potentiometer Board Moduls

A digital potentiometer (or “digipot”), such as the **Renesas X9C** series, is a semiconductor device that replicates the function of a mechanical potentiometer—varying resistance—but replaces the manual knob with digital control signals.

Renesas X9C series

The X9C102, X9C103, X9C104, and X9C503 are digitally controlled (XDCCP) potentiometers. The device consists of a resistor array, wiper switches, a control section, and nonvolatile memory. The wiper position is controlled by a three-wire interface.



The potentiometer is implemented using a resistor array composed of 99 resistive elements and a wiper-switching network. Between each element and at either end are tap points accessible to the wiper terminal. The position of the wiper element is controlled by the CS, U/D, and INC inputs. The wiper position can be stored in non-volatile memory and recalled upon subsequent power-up.

The device can be used as a three-terminal potentiometer or a two-terminal variable resistor in a wide variety of applications, from control to signal processing to parameter adjustment.

Model	Total Resistance (R_{total})	Step Size (approx.)	Temp.Coefficient	Max Terminal Voltage Differential (ΔV)
X9C102	1 K Ω	10.1 Ω	+600 ppm/ $^{\circ}$ C	4 V
X9C103	10 K Ω	101 Ω	+300 ppm/ $^{\circ}$ C	10 V
X9C104	100 K Ω	505 Ω	+300 ppm/ $^{\circ}$ C	10 V
X9C503	50 K Ω	1010 Ω	+300 ppm/ $^{\circ}$ C	10 V

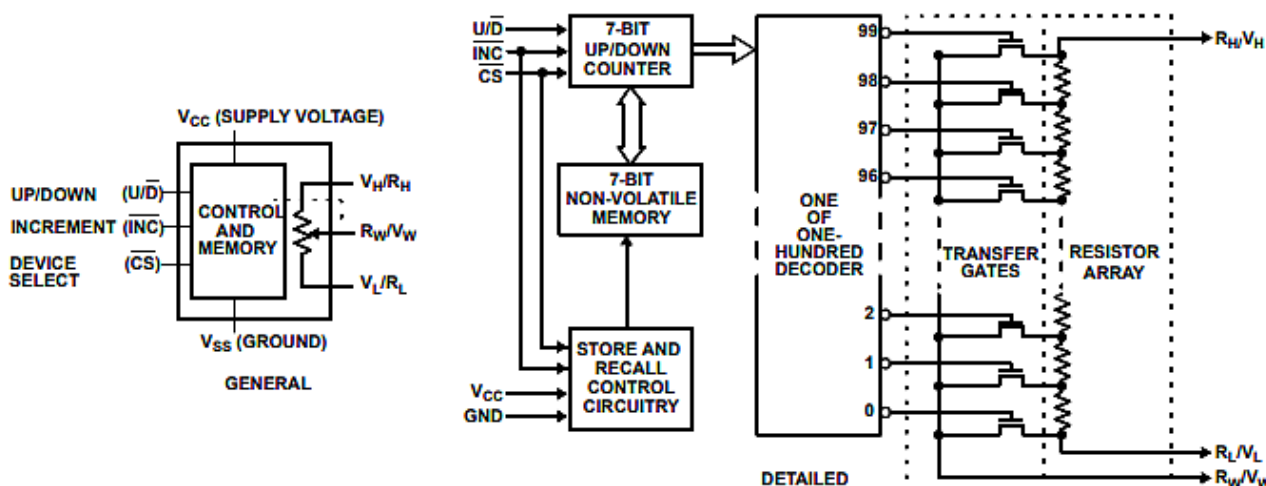
- **Resolution:** 100 Wiper Tap Points (0–99).
- **Interface:** 3-wire serial (CS, U/D, INC).
- **Memory:** Non-volatile EEPROM (retains position for 100 years).
- **Supply Voltage (Vcc):** 5V
- **Resistance Tolerance:** $\pm 20\%$ end-to-end.
- **Typical Wiper Resistance:** 40 Ω at 1 mA



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2026/02/14 23:38



Full datasheet: <https://www.renesas.com/en/document/dst/x9c102-x9c103-x9c104-x9c503-datasheet>

Pinout for the Renesas X9C series module board

The Renesas X9C series module board, commonly known as the X9C103S module, organizes the chip's pins into two separate header rows, making it more convenient to connect with breadboards and microcontrollers such as Arduino. Usually, it includes a 5-pin control header on one side and a 3-pin potentiometer header on the opposite side.

Header	Pin Label	Name	Function
Control	VCC	Power	Connects to +5V supply.
Control	GND	Ground	Circuit common ground.
Control	CS	Chip Select	Active LOW. Must be pulled low to enable control.
Control	INC	Increment	Negative-edge triggered. Pulses move the wiper.
Control	U/D	Up/Down	Direction: HIGH to increase, LOW to decrease.
Potentiometer	VH (or H)	High	High-end terminal of the pot (max +5V).
Potentiometer	VW (or W)	Wiper	The adjustable "middle" output pin.
Potentiometer	VL (or L)	Low	Low-end terminal of the pot (min -5V).

Quick Wiring Guide

- **For 0-5V Voltage Divider:** Connect VH to 5V, VL to GND, and read the output from VW.
- **Control Interface:** Connect CS, INC, and U/D to any three digital GPIO pins on your microcontroller.
- **Saving Settings:** To save the current resistance so it persists after power-off, you must pull CS HIGH while INC is already HIGH.

Arduino example code

To operate a Renesas X9C series digital potentiometer (such as the X9C103S) with an Arduino, you can either utilise a dedicated library like **DigiPotX9Cxxx** or manually control the pins. Here is a

straightforward example that gradually varies the resistance from minimum to maximum without requiring any external library.

Wiring Diagram

X9C Module Pin	Arduino Pin	Description
VCC	5V	Power Supply
GND	GND	Ground
CS	Pin 10	Chip Select (Active LOW)
INC	Pin 9	Increment (Pulse to move)
U/D	Pin 8	Up/Down (HIGH = Up, LOW = Down)
VH / VL	5V / GND	To use as a 0-5V voltage divider
VW	A0	Connect to Analogue Pin 0 to see results

```
// Pin Definitions
const int CS_PIN = 10;
const int INC_PIN = 9;
const int UD_PIN = 8;

void setup() {
  Serial.begin(9600);

  // Set control pins as outputs
  pinMode(CS_PIN, OUTPUT);
  pinMode(INC_PIN, OUTPUT);
  pinMode(UD_PIN, OUTPUT);

  // Initial state: deselect chip and set high idle
  digitalWrite(CS_PIN, HIGH);
  digitalWrite(INC_PIN, HIGH);

  Serial.println("Starting X9C Sweep...");
}

// Function to move the wiper 1 step
void moveWiper(bool up) {
  digitalWrite(UD_PIN, up ? HIGH : LOW); // Set direction
  digitalWrite(CS_PIN, LOW);           // Select chip
  delayMicroseconds(1);

  digitalWrite(INC_PIN, LOW);           // Falling edge moves wiper
  delayMicroseconds(1);
  digitalWrite(INC_PIN, HIGH);         // Return to high

  digitalWrite(CS_PIN, HIGH);          // Deselect to end movement
}

// Function to reset the wiper to 0 (by moving down 100 times)
void resetToZero() {
```

```

for (int i = 0; i < 100; i++) {
  moveWiper(false);
}
}

void loop() {
  resetToZero(); // Start from a known position (0)
  Serial.println("At 0% resistance");
  delay(2000);

  // Gradually increase resistance
  for (int i = 0; i < 100; i++) {
    moveWiper(true);
    int value = analogRead(A0); // Read voltage at wiper
    Serial.print("Step: "); Serial.print(i);
    Serial.print(" | Analog Value: "); Serial.println(value);
    delay(50);
  }

  Serial.println("At 100% resistance");
  delay(2000);
}

```

Key Logic Steps

- **Selection:** The chip is only active when CS is pulled LOW.
- **Direction:** The U/D pin indicates whether the resistance increases or decreases.
- **The “Pulse”:** The INC pin is negative-edge triggered. A transition from HIGH to LOW triggers the movement.
- **No Feedback:** These chips cannot tell the Arduino their current position. The *resetToZero()* function ensures you start at a known point by forcing the wiper down 100 times.

Sensor topics on lamaPLC

Page	Date	Tags
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• LamaPLC: AHT20 / BMP280 Modul	2026/04/23 21:52	bmp280, aht20, adafruit, temperature, humidity, pressure, sensor, arduino, code, i2c
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- [lamaPLC: CJMCU-811 CCS811 Gas Sensor \(VOCs TVOC CO2\)](#) 2026/04/23 21:52 [cjmcu-811](#), [ccs811](#), [gas](#), [sensor](#), [vocs](#), [tvoc](#), [eco2](#), [co2](#), [arduino](#), [air quality](#) [metal oxide](#), [mox](#), [i2c](#), [micropython](#), [rp2040-eth](#)
- [LamaPLC: CJMCU-8221 Analog Devices Precision instrumentation amplifier module](#) 2026/04/23 21:52 [cjmcu-8221](#), [ad8221ar](#), [analog devices](#), [amplifier](#), [sensor](#), [cjmcu](#)
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- [LamaPLC: DHT Temperature /Humidity sensors with 1-wire / I²C communication](#) 2026/04/23 21:52 [dht11](#), [dht20](#), [dht22](#), [temperature](#), [humidity](#), [pressure](#), [sensor](#), [1-wire](#), [arduino](#), [code](#)
- [LamaPLC: DPS Infineon Temperature/Pressure sensors with I2C communication](#) 2026/04/23 21:52 [dps310](#), [infineon](#), [temperature](#), [pressure](#), [sensor](#), [arduino](#), [i2c](#), [communication](#), [code](#)
- [lamaPLC: DS18B20 1-Wire Digital Thermometer](#) 2026/04/23 21:52 [ds18b20](#), [sensor](#), [1-wire](#), [communication](#), [arduino](#), [thermometer](#), [parasitic mode](#)
- [lamaPLC: Energy, power, current, and voltage](#) 2025/05/31 23:32 [i2c](#), [i c](#), [communication](#), [arduino](#), [energy](#), [power](#), [current](#), [sensor](#), [ina226](#)
- [LamaPLC: ENS ScioSense Multi-gas sensors with I²C communication](#) 2026/04/23 21:52 [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 17:29 [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: GM MEMS Gas-sensors](#) 2026/04/23 21:52 [gm-102b](#), [gm-302b](#), [gm-502b](#), [gm-702b](#), [mems](#), [gas-quality](#), [sensor](#), [arduino](#), [code](#), [nitrogen dioxide](#), [no2](#), [volatile organic compounds](#), [voc](#), [carbon monoxide](#), [co](#), [ethyl alcohol](#), [c2h5ch](#), [formaldehyde](#), [ch2o](#), [alcohol](#), [c2h5oh](#)
- [lamaPLC: GY-511 6DOF sensor module](#) 2026/04/23 21:52 [stmicroelectronics](#), [lsm303dlhc](#), [i2c](#), [lsm303](#), [sensor](#), [gy-511](#), [6dof](#), [pololu](#), [module](#), [arduino](#)
- [LamaPLC: HC-SR04 Ultrasonic Sensor Module](#) 2026/04/23 21:52 [hc-sr04](#), [ultrasonic](#), [sensor](#), [arduino](#), [code](#)
- [LamaPLC: HDC Texas Instruments Temperature/humidity sensors with I²C communication](#) 2026/04/23 21:52 [sht21](#), [htu21](#), [si7021](#), [gy-21](#), [gy-213v](#), [hdc1080](#), [gy-213v-hdc1080](#), [cjmcu](#), [cjmcu-1080](#), [texas instruments](#), [temperature](#), [humidity](#), [sensor](#), [i2c](#), [communication](#), [arduino](#), [code](#)

• LamaPLC: HTU TE Connectivity temperature/humidity sensors with I ² C communication	2026/04/23 21:52	htu, htu31d, htu21d, htu20d, sht20, htu20, sht21, htu21, si7021, gy-21, gy-213v, hdc1080, si702, gy-20, sht31, htu31, si7031, gy-31, te connectivity, temperature, humidity, i2c, communication, sensor, arduino, code
• LamaPLC: HX711 24-bit analog-to-digital converter (ADC)	2026/04/11 18:28	hx711, hx-711, analog-to-digital, adc, converter, load cell, wheatstone bridge, weight, sensor, communication, arduino, code
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• lamaPLC: INA226 - current/voltage/power monitor with I ² C communication	2026/04/23 21:52	i2c, i c, communication, arduino, energy, power, current, monitor, sensor, ina226, ina219, ina
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• LamaPLC: MAX30100/MAX30102 Heart Rate Click Sensor Module	2026/04/23 21:52	max30102, max30100, heart rate click, sensor, communication, i2c, arduino, code
• lamaPLC: Max31865 RTD to Digital Converter - PT100/PT1000 Platine	2026/04/23 21:52	max31865, rtd, pt 100, pt 1000, temperature, spi, platinum, arduino, code, sensor, adafruit
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• LamaPLC: MH-Z19 series of NDIR CO ₂ sensors	2026/04/23 21:52	mh-z19, mh-z19d, mh-z19c, mh-z19b, mh-z19e, ndir, co ₂ , sensor, winsen, uart, pwm, communication, non-dispersive infrared, infrared, ir, temperature, arduino, code, tasmota
• lamaPLC: MPU-6050 (HW-123, GY-521) 6-axis MotionTracking device	2026/04/23 21:52	mpu-6050, hw-123, gy-521, 6-axis motiontracking, dmp, temperature, sensor, mems, arduino code, arduino, accelerometer, gyroscope, tilt
• LamaPLC: MQ Winsen Gas-sensors	2026/04/23 21:52	mq, mq-2, mq-3, mq-4, mq-5, mq-6, mq-7, mq-8, mq-9, mq-131, mq-135, mq-137, winsen, gas-sensor, sensor, arduino, code, alcohol, c ₂ h ₅ oh, benzine gas, smoke, lpg, propane, c ₃ h ₈ , hydrogen, h ₂ , methane, ch ₄ , iso-butane, town gas, ammonia, nh ₃
• LamaPLC: PIR sensors	2026/04/23 21:52	hc-sr501, hc-sr505, am-312, ekmb ekmc, pir, motion, sensor, arduino, code

• LamaPLC: Pixart PAJ7620U2 Gesture recognition sensors/module with I²C communication	2026/04/23 21:52	paj7620u2 , gy-paj7620 , pixart , gesture recognition , i2c , communication , sensor , arduino , code
• lamaPLC: PT100 / PT1000	2025/09/23 18:59	pt100 , pt1000 , temperature , sensor , platine , rtd
• lamaPLC: PTA8C04 4-channel PT100 Modbus Modul	2026/02/14 18:42	pta8c04 , sensor , modbus , rtu , rs-485 , communication , platine , um72
• LamaPLC: RCWL - Microwave radar sensor	2026/04/23 21:52	rcwl-0516 , rcwl , microwave , radar , sensor , arduino , code
• lamaPLC: RD-xx - Ai-Thinker Radar Module with UART communication	2026/04/23 21:52	radar , s3km1110 , fmcw , rd-01 , rd-03 , rd-03d , ai-thinker , k-band , 24 ghz , sensor , distance , micro-movements
• lamaPLC: RP2040_ETH_Modul: Read BME 680/688 sensor data	2026/05/12 21:06	code , micropython , 2026 , rp2040 eth , bme680 , i2c , sensor , communication
• lamaPLC: RP2040_ETH_Modul: Read BME 680/688 sensor data and store in Modbus input registers	2026/05/12 18:58	code , micropython , 2026 , rp2040 eth , bme680 , i2c , sensor , communication
• LamaPLC: Sensors	2026/04/15 19:42	sensor
• LamaPLC: SGP Sensirion TVOC/VOC sensors with I²C communication	2026/04/15 19:41	sgp30 , sgp40 , sgp41 , sensirion , gas-sensor , i2c , communication , sensor , arduino , code , eco2 , voc , tvoc , indoor air quality , iaq , nox , hydrogen
• LamaPLC: SHT Sensirion Temperature/humidity sensor with I²C communication	2026/04/23 21:52	sht20 , sht21 , sht25 , sht30 , sht31 , sht35 , sht40 , gy21 , temperature , humidity , i2c , communication , sensor , arduino , code
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• LamaPLC: UICPAL Temp.humi.sensor	2023/06/25 00:43	simatic , s7 , modbus , communication , temperature , humidity , sensor
• LamaPLC: VL53Lnn STMicroelectronics time-of-flight (ToF) laser-ranging sensors with I²C communication	2026/04/23 21:52	vl53l0x , vl53l1x , vl53l0 1xv2 , gy-530 , time-of-flight , tof , laser-ranging , i2c , communication , sensor , arduino , code
• LamaPLC: VL6180X STMicroelectronics Time-of-Flight (ToF) sensor with I²C communication	2026/04/23 21:52	vl6180x , stmicroelectronics , time-of-flight , tof , i2c , communication , sensor , arduino , code
• LamaPLC: Waveshare TOF Laser Range Sensor with UART / I²C communication	2026/04/23 21:52	distance measurement , laser , range , sensor , tof , waveshare

- [lamaPLC: XGZP68xx: Silicon Pressure Sensors/Module](#) 2026/05/15 15:17 [communication, i2c, sensor, modul, pressure, cfsensor, xgzp68xx, xgzp6810d, xgzp6857d, xgzp6859d, xgzp6887d, xgzp6897d, xgzp6899a, piezoresistive, capacitive](#)
- [lamaPLC: YR-3180 - Weight sensor module with UART or Modbus communication](#) 2026/02/15 00:00 [communication, modbus, rtu, sensor, weight, yr-3180, hx710b, arduino, ttl, rs-485](#)
- [LM393: Dual differential comparator \(flame, light, sound sensors\)](#) 2026/05/12 22:18 [communication, analog, lm393, lm-393, flame, ir, sound, hall, sensor, ky-026, hw-484, ky-037, ky-038, fc-03, hc-89, ky-024, modul](#)
- [Magnetic angle sensors](#) 2026/04/23 21:52 [magnetic angle sensor, magnetic flux, sensor, spi, i2c, pwm, communication, modul, as5047p, as5600, mt6701, mt6816, mt6835, tle5012b, amr, gmr, tmr, anisotropic magnetoresistive](#)
- [NT18B07: 7 Kanal RS485 Temperatur Sensor with Modbus RTU](#) 2026/02/14 18:49 [nt18b07, sensor, modbus, rtu, rs-485, communication, platine](#)
- [PT100 / PT1000 sensors](#) 2026/04/23 21:52 [rtd, pt100, pt1000, sensor, temperature](#)
- [Radar Module RD-xx](#) 2026/04/23 21:52 [radar, s3km1110, fmcw, rd-03, k-band, 24 ghz, sensor, distance, micro-movements](#)

[sensor, module, arduino code, Renesas, X9C series, X9C102, X9C103, X9C104, X9C503, XDPC, digitally controlled potentiometer](#)

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