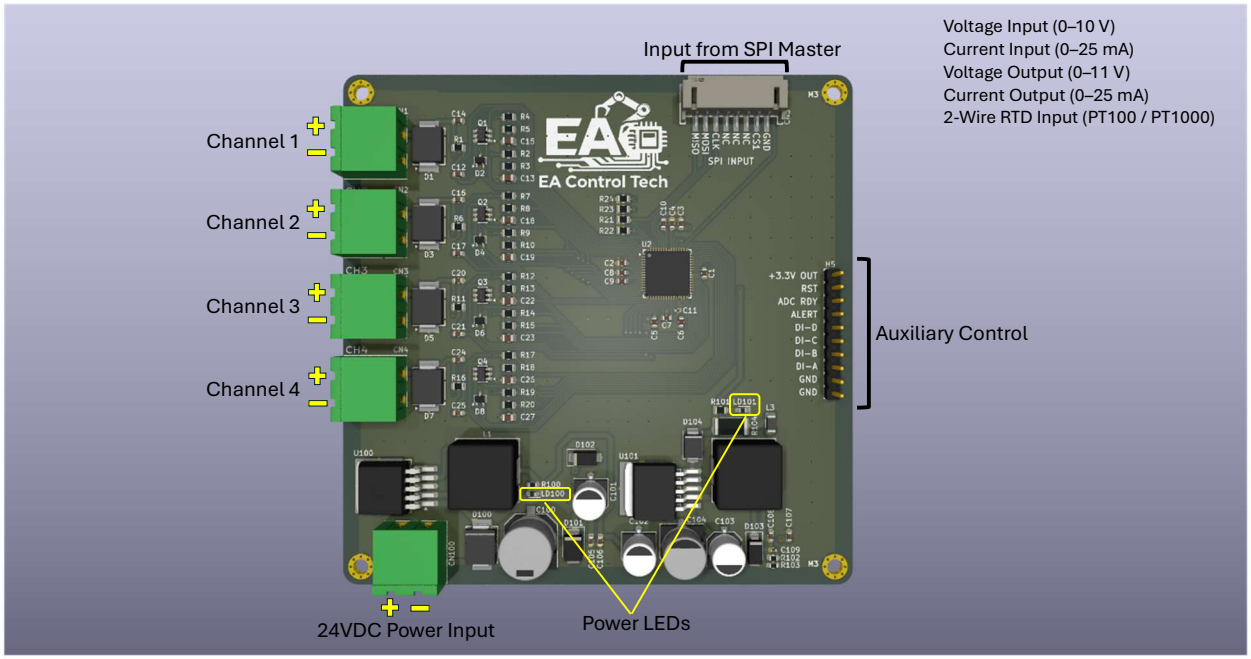
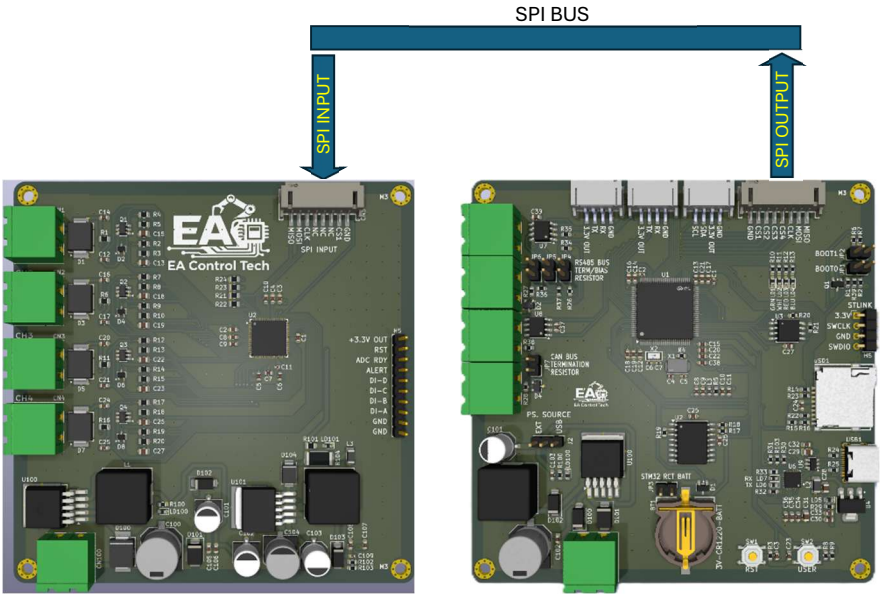
EA Control Tech
4 Channels Analog I/O Board – AD74412R

Model: EA-AIO-74412R-4CH
Hardware Revision: V1.0





EA-AIO-74412R-4CH

EA-CORE-407

Table of Contents

Product Overview 5

Key Features 5

Electrical Characteristics (Preliminary – HW Rev 1.0) 5

Power Input 5

Analog Channel Capabilities (Per Channel) 6

Mechanical Specifications 6

Board Layout Overview 6

Analog Channel Section (Left Side) 6

Central Processing Section 6

Power Supply Section (Bottom) 7

Power Supply Architecture 7

Overview 7

Input Protection Stage 7

3.3 V Digital Supply 7

Analog Supply (VDDA) 7

Analog Channel Architecture 8

General Architecture 8

Channel Configuration 8

Ground Reference 8

Channel Protection 9

SPI Communication Interface 9

Interface Overview 9

Electrical Interface 9

SPI Signals 10

Multi-Board Expansion 10

Auxiliary Control & Status Signals 10

Overview 10

Exposed Signals 10

Signal Description 11

Electrical Characteristics 11

Connector Pinout 11

Power Input Connector 11

Analog Channel Terminals 12

SPI Input Connector 12
Auxiliary Control Header (H5) 12
Installation & Wiring Guidelines 13
General Installation 13
Power Wiring 13
Voltage Input Wiring (0–10 V) 13
Current Input Wiring (0–25 mA) 13
Externally Powered Current Source (Passive Measurement) 13
Loop-Powered Sensor (Board-Sourced) 13
Voltage Output Wiring (0–11 V) 14
Current Output Wiring (0–25 mA) 14
RTD Wiring (2-Wire PT100 / PT1000) 14
Grounding Considerations 14
Operating Limits and Safe Use 14
General Safety Notes 15
Document Control 15
PCB Layout and Mechanical Dimensions 16

Product Overview

The EA-AIO-74412R-4CH is a 4-channel configurable analog input/output board built around the Analog Devices AD74412R software-configurable I/O platform.

Each channel can be independently configured via software to operate as:

- Voltage Input (0–10 V)
- Current Input (0–25 mA)
- Voltage Output (0–11 V)
- Current Output (0–25 mA)
- 2-Wire RTD Input (PT100 / PT1000)

The board includes full signal conditioning, protection circuitry, and regulated power supplies to support industrial 24 VDC systems.

Designed for integration with embedded controllers via SPI, this board enables flexible mixed-signal interfacing in automation, control, and industrial monitoring applications.

Key Features

- 4 independently software-configurable analog channels
- Based on AD74412R configurable analog I/O platform
- 24 VDC industrial power input
- Integrated DC/DC regulation (3.3 V and analog supply rails)
- TVS surge protection on power input
- Reverse polarity protection
- SPI communication interface
- Address selection via hardware jumpers
- 100 mm × 100 mm PCB form factor
- Designed in USA

Electrical Characteristics (Preliminary – HW Rev 1.0)

Power Input

Parameter	Value
Nominal Supply	24 VDC
Supply Type	External DC
Protection	Reverse polarity diode, TVS suppression
On-board regulation	Buck regulators (3.3 V & analog rail)

Analog Channel Capabilities (Per Channel)

Mode	Range
Voltage Input	0 – 10 V
Current Input	0 – 25 mA
Voltage Output	0 – 11 V
Current Output	0 – 25 mA
RTD Input	2-Wire PT100 / PT1000

Mechanical Specifications

Parameter	Value
PCB Dimensions	100 mm × 100 mm
Mounting	4 × M3 holes
Form Factor	Square industrial PCB

Board Layout Overview

The EA-AIO-74412R-4CH board is organized into four primary functional zones:

Analog Channel Section (Left Side)

- Four identical channel blocks
- Each channel includes:
  - Signal conditioning network
  - Protection components
  - Output driver stage
- Channel terminals are clearly labeled:
  - CH1+, CH1−
  - CH2+, CH2−
  - CH3+, CH3−
  - CH4+, CH4−

Each channel is electrically independent and software configurable.

Central Processing Section

- Main configurable analog I/O device (AD74412R)
- Associated decoupling and filtering network
- SPI routing to input/output headers

Power Supply Section (Bottom)

- 24 VDC input connector
- Reverse polarity protection diode
- TVS surge suppression device
- Buck regulator for:
  - 3.3 V digital rail
  - Analog supply rail (VDDA)
- Status indication LEDs

Power Supply Architecture

Overview

The EA-AIO-74412R-4CH board is powered from a single external 24 VDC supply.

On-board regulation generates two internal supply rails:

- 3.3 V Digital Rail
- VDDA Analog Supply Rail

The power architecture is designed for industrial 24 V systems with integrated protection and filtering.

Input Protection Stage

The 24 V input stage includes:

- Reverse polarity protection diode
- TVS surge suppression device
- Bulk and high-frequency filtering capacitors

This protects the board from transient overvoltage events and accidental polarity reversal.

3.3 V Digital Supply

A buck regulator generates a regulated 3.3 V rail used for:

- SPI interface logic
- Digital control circuitry
- Status indicators

This rail is available externally via the dedicated header pin.

Analog Supply (VDDA)

A second buck regulator generates the VDDA rail, which powers:

- The analog output drivers
- The internal excitation circuits
- Current output stages

The selected VDDA voltage ensures:

- Full 0–25 mA current output capability
- Full voltage output range (0–11 V)
- Proper RTD excitation support
- Operation within AD74412R recommended limits

Analog Channel Architecture

General Architecture

The EA-AIO-74412R-4CH implements a non-isolated, shared-ground architecture.

All four channels share a common system ground reference. The board is intended for use within a common-ground control system where the controller and field devices reference the same 0 V potential.

No galvanic isolation is implemented between:

- Channels
- SPI interface
- Power input
- Field I/O terminals

Channel Configuration

Each channel is independently software-configurable via SPI control of the AD74412R.

Per-channel supported modes:

- Voltage Input: 0 – 10 V
- Current Input: 0 – 25 mA
- Voltage Output: 0 – 11 V
- Current Output: 0 – 25 mA
- 2-Wire RTD Input: PT100 / PT1000

Mode selection is entirely firmware controlled.

Ground Reference

All channel negative terminals (CHx−) reference system ground internally.

This design simplifies integration in:

- PLC expansion systems
- Embedded controllers
- Panel-mounted control electronics

Common-ground automation architectures

For applications requiring channel-to-channel or system isolation, external isolation stages must be implemented.

Channel Protection

Each channel includes external conditioning components for:

- Input filtering
- Output stabilization
- Transient suppression

Channel electrical limits are governed by the AD74412R operating specifications.

SPI Communication Interface

Interface Overview

The EA-AIO-74412R-4CH communicates with a host controller via a standard 4-wire SPI interface.

The board includes:

- SPI Input header
- SPI Output header (for daisy-chain expansion)
- Hardware chip-select address jumpers

This architecture allows multiple boards to be connected in a shared SPI bus topology.

Electrical Interface

Parameter	Specification
Interface Type	4-Wire SPI
SPI Mode	Mode 1 (CPOL = 0, CPHA = 1)
Logic Level	3.3 V
Maximum SPI Clock	Per AD74412R device specification

SPI Signals

The SPI interface exposes the following signals:

- SCLK
- MOSI
- MISO
- CS (Chip Select)
- GND
- 3.3 V (reference supply)

The 3.3 V pin is provided for reference and light auxiliary usage only. It is not intended to power external systems.

Multi-Board Expansion

The board includes:

- Dedicated SPI Input connector
- Dedicated SPI Output connector

This allows multiple boards to share:

- SCLK
- MOSI
- MISO

Each board must have a unique Chip Select configuration.

Auxiliary Control & Status Signals

Overview

In addition to the primary SPI interface, the EA-AIO-74412R-4CH exposes dedicated control and status signals from the Analog Devices AD74412R device.

These signals are available through a separate auxiliary connector to allow advanced host control and interrupt-driven operation.

Exposed Signals

The following signals are externally accessible:

Signal	Direction	Description
RESET	Input	Hardware reset for AD74412R
ALERT	Output	Fault / diagnostic indication
ADC_READY	Output	ADC conversion ready indicator

Signal Description

RESET:

Allows the host controller to force a hardware reset of the AD74412R device.

This is useful during startup sequencing or fault recovery.

ALERT:

Indicates device-level faults or diagnostic events.

The host may monitor this line to detect:

- Fault conditions
- Overcurrent events
- Diagnostic flags
- Channel configuration issues

This signal enables interrupt-driven error handling instead of continuous polling.

ADC_READY:

Indicates that an ADC conversion cycle has completed and new data is available.

This allows:

- Deterministic sampling
- Reduced SPI polling overhead
- Synchronized data acquisition

Electrical Characteristics

These signals operate at:

- 3.3 V logic level
- Referenced to system ground

The host controller must use compatible 3.3 V digital inputs.

Connector Pinout

Power Input Connector

Pin	Label	Description
1	+24VDC	External 24 VDC supply input
2	GND	System ground

Analog Channel Terminals

Each channel provides differential terminals:

Terminal	Description
CHx+	Channel x positive terminal
CHx–	Channel x return (system ground referenced)

SPI Input Connector

Pin	Label	Description
1	MISO	Master In Slave Out
2	MOSI	Master Out Slave In
3	CLK	SPI Clock
4	CS4	Chip Select 4
5	CS3	Chip Select 3
6	CS2	Chip Select 2
7	CS1	Chip Select 1
8	GND	Ground reference

Auxiliary Control Header (H5)

Pin	Label	Description
1	+3.3V OUT	Regulated 3.3 V output reference
2	RST	AD74412R hardware reset
3	ADC_RDY	ADC conversion ready indicator
4	ALERT	Device fault/diagnostic output
5	DI-D	AD74412R Digital Input D
6	DI-C	AD74412R Digital Input C
7	DI-B	AD74412R Digital Input B
8	DI-A	AD74412R Digital Input A
9	GND	Ground
10	GND	Ground

Notes:

DI-A through DI-D are directly connected to the AD74412R digital input pins.

These inputs are intended for AD74412R-supported digital input functions and must be driven with 3.3 V logic referenced to board GND.

Installation & Wiring Guidelines

General Installation

- Ensure 24 VDC power is disconnected before wiring.
- Verify correct polarity on the power input terminals.
- Use appropriately rated wiring for voltage and current levels.
- All signals are referenced to system ground (non-isolated design).

Power Wiring

Connect external supply:

- +24VDC → +24VDC terminal
- 0V → GND terminal

Use a stable, regulated 24 VDC industrial power supply.

Voltage Input Wiring (0–10 V)

For voltage measurement:

- Signal positive → CHx+
- Signal return → CHx−

The input range must not exceed 10 V in voltage input mode.

Current Input Wiring (0–25 mA)

The board supports two wiring methods, depending on system configuration.

Externally Powered Current Source (Passive Measurement)

Used when the field device provides its own loop power.

Wiring:

- Current source positive → CHx+
- Current return → CHx−

The board measures loop current without sourcing excitation voltage.

Loop-Powered Sensor (Board-Sourced)

Used when powering a 2-wire transmitter from the channel.

Wiring:

- CHx+ → Transmitter +
- Transmitter − → CHx−

In this configuration, the channel provides loop drive and measures return current.

Maximum supported current range: 0–25 mA per channel.

Voltage Output Wiring (0–11 V)

- CHx+ → Load input
- CHx− → Load return

Ensure the load input impedance is compatible with the AD74412R voltage output specifications.

Current Output Wiring (0–25 mA)

For current sourcing applications:

- CHx+ → Load
- Load return → CHx−

Ensure total loop resistance does not exceed device compliance limits (determined by VDDA supply level).

RTD Wiring (2-Wire PT100 / PT1000)

- RTD lead 1 → CHx+
- RTD lead 2 → CHx−

Only 2-wire RTD configuration is supported in this hardware revision.

Accuracy and performance depend on lead resistance and calibration configuration.

Grounding Considerations

Because the board is non-isolated:

- All I/O share common ground.
- Avoid connecting to systems with different ground potentials.
- For high-noise environments, use proper shielded cables and single-point grounding.

Operating Limits and Safe Use

Because each channel is software-configurable, the allowable signal range depends on the active mode. Applying a signal outside the configured mode range may result in incorrect readings, unexpected behavior, or potential damage.

Mode-Dependent Signal Limits (Per Channel)

Voltage Input Mode

- Configured range: 0–10 VDC
- Do not apply more than: 10 VDC to CHx+ (referenced to CHx−)

Current Input Mode

- Configured range: 0–25 mA
- Do not exceed: 25 mA through the channel input path

Voltage Output Mode

- Configured range: 0–11 V
- Ensure the external load does not force the output beyond the configured range.

Current Output Mode

- Configured range: 0–25 mA
- Ensure the external loop/load does not demand more than 25 mA.

RTD Mode (2-Wire PT100/PT1000)

- Only connect RTD elements compatible with PT100 or PT1000 operation.
- Do not connect external voltages to the RTD terminals while in RTD mode.

General Safety Notes

- The board is **non-isolated**: all I/O share system ground.
- Always power down before changing wiring.
- Verify channel mode in software before applying field signals.

Document Control

Item	Description
Product	EA-AIO-74412R-4CH
Description	4-Channel Software-Configurable Analog I/O Module
Hardware Revision	V1.0
Document Revision	1.0
Manufacturer	EA Control Tech
Designed In	USA

PCB Layout and Mechanical Dimensions