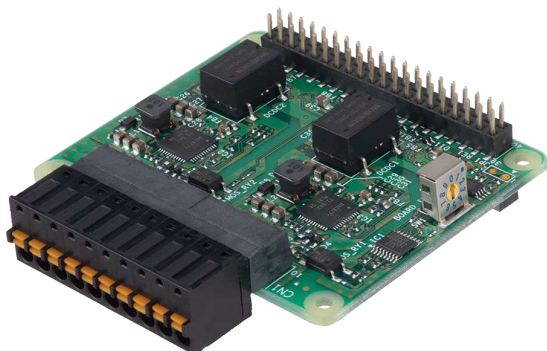


## Raspberry Pi Expansion Card Analog Output Board 16bit DAC Channel Isolation CPI-AO-1602LC



This product is an expansion card that adds an analog output interface to the Raspberry Pi. It has analog outputs with 16-bit resolution of inter-channel isolation.

Voltage output 2ch and current output 2ch are switchable with one card.

\* Specifications, color and design of the products are subject to change without notice.

\*The contents in this document are subject to change without notice.

\*Visit the CONTEC website to check the latest details in the document.

\*The information in the data sheets is as of October, 2021.

### Features

#### Analog outputs with inter-channel isolation

Analog voltage output and analog current output with inter-channel isolation are equipped.

Inter-channel isolation prevents interference between channels, therefore, the product can be used even when the ground levels of the device connected to each channel are different.

#### Supportable for various voltage output ranges and current output types

With the CPSN-AO-1602LC, the output ranges of  $\pm 10V$ ,  $\pm 5V$ , 0 to  $+10V$ , 0 to  $+5V$ , and 0 to  $+20mA$  can be switched by software command.

#### No external power is required for current outputs

The CPSN-AO-1602LC has the built-in power for current outputs, therefore, requires no external power supply.

#### Relay for controlling outputs

With the relay in the product, unstable output voltage/current, which often occurs when the CPU Unit is powered on, can be avoided.

Since outputs from all the channels are performed through the relay, damages or errors of the connected devices can be prevented.

#### Connectivity for up to 8 cards

Connect up to 8 expansion cards of the same series. Use the Board ID setting switch on the main body to identify connected expansion cards.

\* The Board ID setting switch cannot be set to 4 when using the CPI-RAS.

#### Adaptable to a wide range of temperature between -20 and +60°C

The product is capable of operating in the temperature between -20 and +60°C. It can be installed in the various environments.

#### No electrolytic capacitor

Without an electrolytic capacitor, which has a limited life, we are creating the product with a longer life.

#### Linux compatible driver software

Using the analog I/O driver API-AIO(LNX) makes it possible to create applications of Linux.

### Specifications

#### Function specification

Item		Description
Analog Output	Output type	Inter-channel isolation Voltage Current Outputs
	Output range	$\pm 10V$ , $\pm 5V$ , 0 - $+10V$ , 0 - $+5V$ , 0 - $+20mA$ (Set by software command)
	Maximum output current	$\pm 5mA$ (For voltage output)
	Load resistor	100 - 600 $\Omega$ (For current output)
	Voltage output impedance	10 $\Omega$ max.
	Output channel	2ch
	Resolution	16-bit
	Non-Linearity error *1	For voltage: $\pm 20LSB(25^{\circ}C, 1-99\%FS, \text{no load})$ For current: $\pm 20LSB(25^{\circ}C, 1-99\%FS, \text{with } 250\Omega)$
	Settling time *2	Voltage: 30 $\mu$ sec (no load) Current: 10 $\mu$ sec (with 250 $\Omega$ )
	Data buffer	-
Isolation		Bus / Inter-channel isolation
Voltage resistance		500VAC
Cable Length		For voltage: 1.5 meters approx. (vary depending on the wiring environment) For current: 50 meters approx. (vary depending on the wiring environment)
Bus specification		I2C bus (I2C1)
Max. module count for connection		Maximum of 8cards *3
Connector		2 pieces 3.81mm pitch 10-pin terminal
Applicable wire		AWG28 - 16
Electricity consumption		5VDC 400mA 3.3VDC 1mA
Physical dimensions (mm)		65.0(W) x 56.5(D) (No protrusions) Spacer height: 12.5mm
Weight		50g

\*1 The non-linearity error means an error of approximately 0.18% occurs over the maximum range at -20°C and 60°C ambient temperature.

\*2 Settling time is from when data is set in DAC IC until the change of the analog value stops.

\*3 The Board ID setting switch cannot be set to 4 when using the CPI-RAS.

### List of Option

Product Name	Model type	Description
RAS card	CPI-RAS	RAS/RTC function, 8 to 28 VDC input function expansion.
DIN RAIL ADAPTER	CPI-DIN01	

\* Information about the option products, see the Contec's website.

## Installation Environment Requirements

Item	Description
Operating Temperature	-20 ~ +60°C
Storage Temperature	-20 ~ +60°C
Humidity	10 ~ 90%RH (No condensation)
Floating dust particles	Not to be excessive
Corrosive gases	None
Line-noise resistance *1	Line noise / ±1kV (IEC61000-4-4 Level 3, EN61000-4-4 Level 3)
	Static electricity resistance / Indirect discharge / ±4kV (IEC61000-4-2 Level 2, EN61000-4-2 Level 2)
Vibration resistance	Sweep resistance / 10 ~ 57Hz/semi-amplitude vibration 0.15mm, 57 ~ 150Hz/2.0G 40minutes each in X, Y, and Z directions (JIS C60068-2-6-compliant, IEC60068-2-6-compliant)
Shock resistance	15G half-sine shock for 11ms in X, Y, and Z directions (JIS C 60068-2-27-compliant, IEC 60068-2-27-compliant)
Standard	VCCI Class A, FCC Class A, CE Marking (EMC Directive Class A, RoHS Directive)

\*1 When using the CPI-RAS.

## Packing List

Product [CPI-AO-1602LC] ...1  
 10-pin Connector ...1 (Attached to the product)  
 40-pin Pin-header...1  
 Plastic Spacer for CPU Card...1  
 Hexagonal Spacers...4 (Height 12.5mm)  
 Three-point Sems Screw...4  
 Nuts...4  
 Product Guide & Warranty Certificate...1  
 Serial Number Label ...1

## Support Software

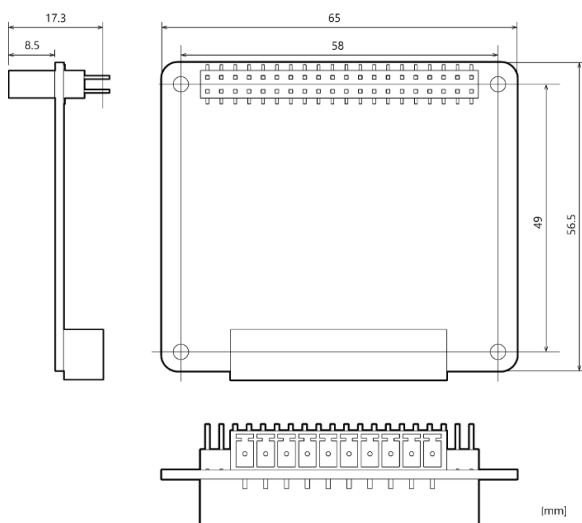
You can use CONTEC support software according to your purpose and development environment. For more details on the supported OS, applicable languages, or to download the latest version of software, visit the CONTEC Web site.

Name	Contents	How to get
Driver software API-AIO(LNX)	This is the Linux version driver software provided in API function formats. The software includes various sample programs such as gcc (C, C++) and Python programs.	Download from the CONTEC website

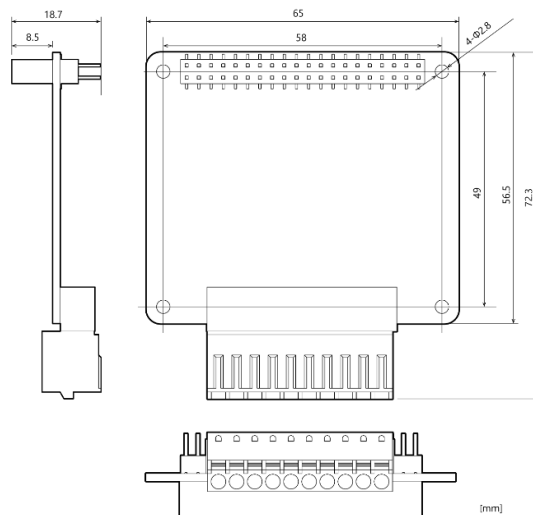
Download the files from the following URL. <https://www.contec.com/download/>

## Physical Dimensions

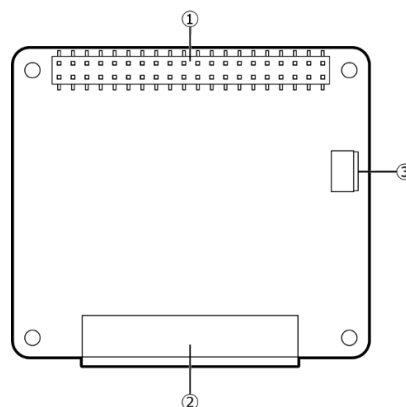
### Main body only



### With connector attached



## Component Name

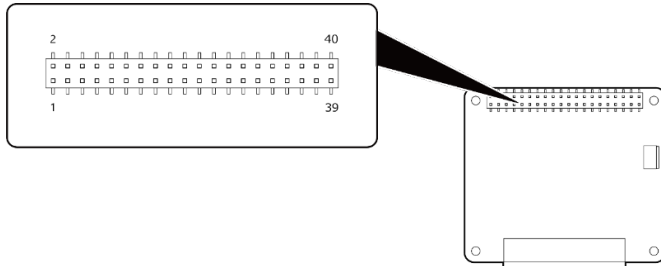


No.	Name	Function
1	GPIO 40 pin connector	This connector is used to connect to a Raspberry Pi or an expansion card.
2	Interface connector	This is a connector for analog output. Use the 10-pin connector included in the package.
3	Board ID setting switch	This setting switch is used to identify I2C communication expansion cards. The switch is used to change the I2C address.

## Connection to external devices

### GPIO 40 pin connector

This connector is used to connect to a Raspberry Pi or an expansion card.



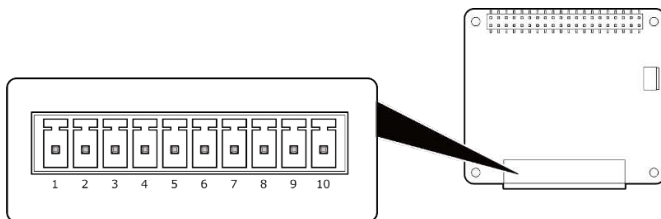
### Pin Assignment

Pin No.	Signal Name	Description	Pin No.	Signal Name	Description
1	3.3V Power	3.3V power supply	2	5V Power	5V power supply
3	GPIO 2(I2C1 SDA)	I2C1 SDA	4	5V Power	5V power supply
5	GPIO 3(I2C1 SCL)	I2C1 SCL	6	Ground	GND
7	GPIO 4(GPCLK0)	(Don't use)	8	GPIO 14(UART TX)	(Don't use)
9	Ground	GND	10	GPIO 15(UART RX)	(Don't use)
11	GPIO 17	(Don't use)	12	GPIO 18(PCM CLK)	(Don't use)
13	GPIO 27	(Don't use)	14	Ground	GND
15	GPIO 22	(Don't use)	16	GPIO 23	(Don't use)
17	3.3V Power	3.3V power supply	18	GPIO 24	(Don't use)
19	GPIO 10(SPI0 MOSI)	(Don't use)	20	Ground	GND
21	GPIO 9(SPI0 MISO)	(Don't use)	22	GPIO 25	(Don't use)
23	GPIO 11(SPI0 SCLK)	(Don't use)	24	GPIO 8(SPI0 CE0)	(Don't use)
25	Ground	GND	26	GPIO 7(SPI0 CE1)	(Don't use)
27	GPIO 0(EEPROM SDA)	I2C0 SDA	28	GPIO 1(EEPROM SCL)	I2C0 SCL
29	GPIO 5	(Don't use)	30	Ground	GND
31	GPIO 6	(Don't use)	32	GPIO 12(PWM0)	(Don't use)
33	GPIO 13(PWM1)	(Don't use)	34	Ground	GND
35	GPIO 19(PCM FS)	(Don't use)	36	GPIO 16	(Don't use)
37	GPIO 26	(Don't use)	38	GPIO 20(PCM DIN)	(Don't use)
39	Ground	GND	40	GPIO 21(PCM DOUT)	(Don't use)

### Interface connector

This connector is used for analog output. It uses the included 10-pin connector.

Connector type: DEGSN 15EDGKD-3.81-10P-13-00A(H)  
PHOENIX CONTACT FK-MCP 1.5/10-ST-3.81 (or equivalent)

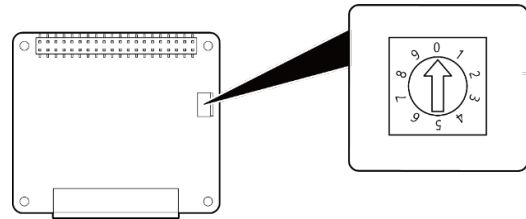


### Pin Assignment

Pin No.	Signal Name	Description
1	AGND1	Analog ground signals. The numbers correspond to channel numbers.
2	N.C.	No connection to this pin.
3	AGND1	Analog ground signals. The numbers correspond to channel numbers.
4	AO1	Analog output signals. The numbers correspond to channel numbers.
5	N.C.	No connection to this pin.
6	AGND0	Analog ground signals. The numbers correspond to channel numbers.
7	N.C.	No connection to this pin.
8	AGND0	Analog ground signals. The numbers correspond to channel numbers.
9	AO0	Analog output signals. The numbers correspond to channel numbers.
10	N.C.	No connection to this pin.

### Board ID setting switch

This setting switch is used to identify I2C communication expansion cards. The Board ID setting switch can be used to switch I2C addresses. The following table shows the switch settings and the corresponding I2C addresses.



### Switch settings and the corresponding I2C addresses

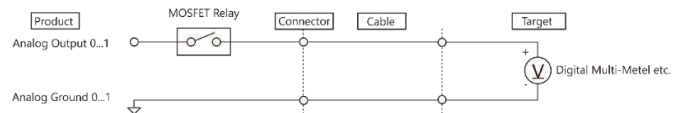
Setting the Board ID	Extended I/O (I2C1) I2C address	EEPROM(I2C0) I2C address
0	0x28 (Factory setting)	0x50 (Factory setting)
1	0x29	0x51
2	0x2A	0x52
3	0x2B	0x53
4 *	0x2C	0x54
5	0x2D	0x55
6	0x2E	0x56
7	0x2F	0x57
8	Do not use this setting.	
9		

\* The Board ID setting switch cannot be set to 4 when using the CPI-RAS because the I2C address (0x2C) with this setting will overlap with the I2C address of the CPI-RAS.

## Voltage Output

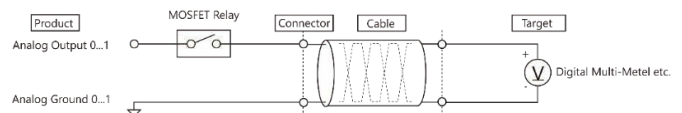
### [Connection using a flat cable]

The example below uses a flat cable to connect the product to an external device. For each analog output channel, connect the input of external device and ground on one-to-one basis.



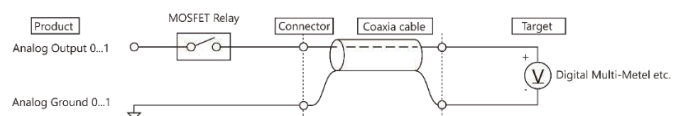
### [Connection using a twisted cable]

The example below uses a twisted cable to connect the product to an external device. Use this type of cable if the external device is located at a distance from the product. For each analog output channel, connect the input of the external device and ground on one-to-one basis.



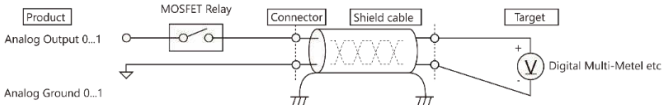
### [Connection using a coaxial cable]

The example below uses a coaxial cable to connect the product to an external device. Use this type of cable if the external device is located at a distance from the product. For each analog output channel, connect the core wires to the input of the external device and connect the shielding to ground.



### [Connection using a two-conductor twisted shield cable]

The example below uses a two-conductor twisted shield cable to connect the product to an external device. Use this type of cable if the external device is located at a distance from the product or if the connection requires higher noise immunity. For each analog output channel, connect the core wires to the input of the external device and to ground, connect the shielding to earth.



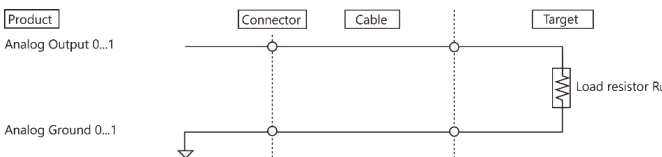
### CAUTION

- Do not short-circuit voltage output signals and analog ground, as it may cause failure on the product.
- Do not connect voltage output signals to any other analog output, either on the product or on an external device, as it may cause failure on the product.
- To avoid any malfunction or damages, the connector plug should not be attached or detached when the power for the product or the external device is on.
- In situations where the connecting cable is subject to the effects of noise, the accurate voltage outputs can fail. The connecting cable should be installed away from any source of noise.
- The maximum current capacity for a voltage output signal is  $\pm 5\text{mA}$ . To avoid any malfunction, do not connect an external device that generates a load exceeding this range.
- In situations where the connecting cable is excessively long, the accurate voltage outputs can fail. The connection cable should therefore be within 1.5 meters.

## Current Output

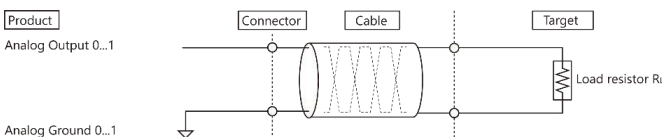
### [Connection using a flat cable]

The example below uses a flat cable to connect the product to an external device. For each analog output channel, connect the positive side and the negative side of the external device on one-to-one basis.



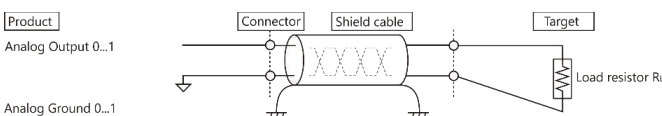
### [Connection using a twisted cable]

The example below uses a twisted cable to connect the product to an external device. Use this type of cable if the external device is located at a distance from the product. For each analog output channel, connect the positive side and the negative side of the external device on one-to-one basis.



### [Connection using a two-conductor twisted shield cable]

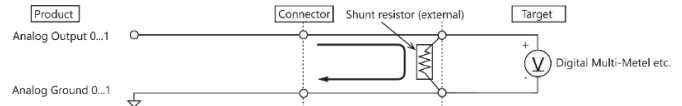
The example below uses a two-conductor twisted shield cable to connect the product to an external device. Use this type of cable if the external device is located at a distance from the product or if the connection requires higher noise immunity. For each analog output channel, connect the core wires to the external device and connect the shielding to ground.



## A connection example when current outputting with an external device.

### [Connection with an external device of voltage inputs]

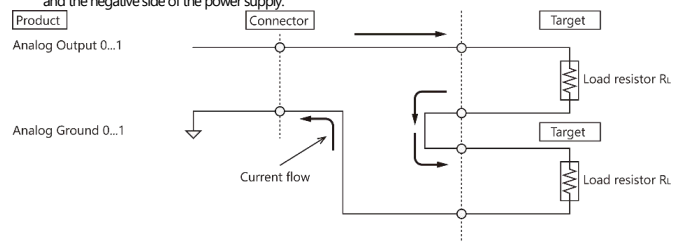
The current can be converted to voltage by connecting a shunt resistor to the external device for connecting with an external device of voltage inputs. 0-20mA can be converted to 0 - 5V when a 250 $\Omega$  shunt resistor is used.



### [Connection with more than one external device of current inputs]

When connecting with more than one external device of current inputs, the external devices can be connected in series. However, some external devices are unable to be connected for the following reasons.

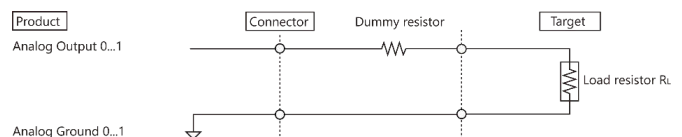
- The total input impedance of the input device exceeds the maximum load resistance (600 $\Omega$ ) of this product.
- There is no potential difference (common) between the negative side of the input pin on the external device and the negative side of the power supply.



### [Connection to an external device of current inputs with low input impedance]

This product is designed to operate with input impedance of between 100 $\Omega$  and 600 $\Omega$ . However, if the input impedance is low, the output accuracy might be affected by temperature, therefore it is recommended to use the product at 250 $\Omega$  or higher.

When connecting to the device with 50 $\Omega$  or 100 $\Omega$ , for instance, make a dummy resistor connection and make the total of input impedance to be 250 $\Omega$  to 600 $\Omega$ .



### CAUTION

- Do not connect current output signals to any other analog output, either on the product or on an external device, as it may cause failure on the product.
- In situations where the connecting cable is subject to the effects of noise, the accurate current output can fail. The connecting cable should be installed away from any source of noise.
- To avoid any malfunction or damages, the connector plug should not be attached or detached when the power for the product or the external device is on.

## Block Diagram

