Central-I Family

CiG1-AMP02-1A-01-00

Hardware User's Manual

Revision control table			
Version	Description	Date	
1.0	Initial (based on Hardware Manual of previous hardware versions)	May 15, 2017	Yiqing
1.1	Change the product picture	June 10, 2017	Yiqing
1.2	Correct some pin definition for IO port	June 14, 2017	Yiqing
1.3	Remove static brakes	Jan 2, 2018	Yiqing
1.4	Fix pictures	Oct 22, 2018	Jz
1.5	Fixed Analog return description in J7	Nov 06, 2018	Jz

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This manual describes hardware interfaces of the CIG1-AMP02-1A-01-00. [1]

Product description	Part numbers
Amplifier	CIG1-AMP02-1A-01-00

The –XX defines a product's hardware variant, as describes below.

Product structure

CIG1-AMP02-1A-01-XX

The following pictures show the overall structure CIG1-AMP02-1A-01-XX Amplifier, that the XX implies all variant types. All variants of this product type will use the same hardware that can be depicted in Figure 1.

Figure 1: CiG1-AMP02-1A-01-XX Board Overview

System Structure

Overview

The following section will discuss all the hardware functionality that is supported by this product.

Features

This new amplifier board combines the function of controller and driver.

- Precise control with integrated unit
- Support different types of motor with minor hardware
- Multifunction with smaller space and weight
- Low current rating with a much safer design

Number of axes

The CIG1-AMP02-1A-01-00 (amplifier board) supports driving of 1 motor. However, this motor can drive different kinds of motor

Supported motor types

The CIG1 amplifier can drive the following motor types:

- 1 DC-Brushless or Bipolar Stepper motor (each motor defined independently).
- 1 DC-Brush, Voice coil motors (each motor defined independently).
- Linear and rotary motors are both supported.

Note: This amplifier can provide a stable bus voltage from 12v to 48v which is an important factor for motor sizing.

Products' variants

The –XX at the end of the product's part number (see label on the product) defines the product's variant. This product belongs to a subset of families from the Central-I range. It is meant to act as a slave unit to the CIG1-MAS controller variants communicating via the Central-I protocol. Detailed information regarding the part numbering for Central-I products see [1]

Order Part Number	Hardware Part Number	Current full Scale
Ci-AMP02-0120	CiG1-AMP02-1A-01-36	20A
Ci-AMP02-0110	CiG1-AMP02-1A-01-37	10A
Ci-AMP02-0105	CiG1-AMP02-1A-01-38	5A

Power Connection

General

The following section will discuss the power connection of DC amplifier.
When use the CIG1-AMP02 to drive the motor, user should provide the module two parts of power which is described in the following part. Meanwhile, user should carefully follow the suggestion and detailed notes in the following sections to ensure the safety and correct use of the CIG1-AMP02.

Power Supplies and Connection

The power of the CIG1-AMP02 is combined by two parts of power:

- Logic 9V~36VDC power supply for both the logic signals and Isolated IO Power

  Recommended Logic Power Supply Type: Meanwell S-100-24 Power Supply

- Unit Power 12V~48VDC for motor driving.

  Recommended Logic Power Supply Type: Meanwell T-60C Power Supply

- It is always recommended to use a single “Ground Potential Point” for all supplies in the system.

The CIG1-AMP02 provides isolated IOs, differential IOs electrical interfaces. If these functions are required by the application, external power supply can be used.

Wire and Cable selection

This section will describe rules in detail for choosing the cables and wires used in the CIG1-AMP02 to ensure the high performance and low EMI of the whole system.

- Use twisted pair shielded wires for the control, feedback and communication
- The impedance of the wires must be as low as possible. The selection of the wires should on the basis of the current consumption. Usually, the size of the wires should be thicker than the real application current. Generally, a 24AWG wire is recommended to be used for the logic, analog control and feedback signals.
- Always use shielded cables for motor connection
- Keep motor cable as far as possible from the control, feedback and communication lines and cables
- Keep all wires and cables as short as possible
- Generally, under normal operating conditions, cables with shield should not carry any current. If not, this may damage the controller and even the whole system.

AMPLIFIER – CIG1-AMP02-1A-01-00

This document provides a detailed description of the interface of the amplifier.

Logic power connector

This chapter describes the amplifier's logic power connector.

Amplifier – J1 – Isolated IO Power

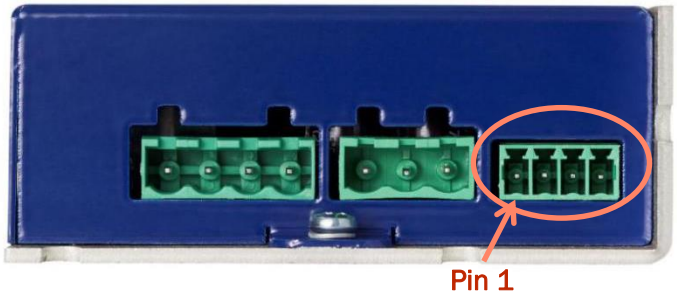

Figure 2 Isolated IO Power Port

Description: The graph above is about the isolated IO power port on the amplifier board.
Manufacturer: DEGSON (Phoenix compatible)
P/N (product side): 15EDGRC3.504P1400AH
Pitch: 3.5mm
Mating Type: MC 1,5/4-ST-3,5

Pin #	Name	Type	Description
1	Vin_24V_IO	PWR - IN	24V IO Power
2	Vin_24V_IO_RTN	PWR - IN	24V IO Power Return
3	Vin_9V~36	PWR - IN	9VDC-36VDC（Backup_Power#）
4	GND	PWR - IN	Logic power ground（Backup_Power_Ground）

Notes: Normally there is no need to connect the backup power. If the backup power is disconnected, then there is no power out in Pin1 and Pin 2 of J7 connector.

The purpose of backup power:
Normally the main power (J1-Pin 1/2) is enough, but when the system encounter main power fault (For example the main power was cut off unexpected) now the CiG1-AMP02 will stop work, means can't communication with PCsuite, so we will not know any status about the CiG1-AMP02.In such case, the backup power will play its role, with backup power on, we could read the CiG1-AMP02 status and feedback information.

Amplifier connectors

The chapter describes the connectors and interfaces of the amplifier board.

Amplifier – J2 – Unit power

J2 is used to supply power to the overall unit. The input voltage is directly connected to the amplifier power bridge to drive the motors, and in parallel it is used to generate internal logic power in order to power the amplifier.

Note – Optional schemes for isolated power supplies:
The amplifier is designed to support fully isolated power supplies, one for the power circuitry (ie. Amplifiers) to drive the motors and one for the digital logic. Such operation requires a dedicated hardware variant. Please consult the designer in case you would like to consider this scheme.

The amplifier includes a protection to avoid damage in case of inversed polarity at the input power.

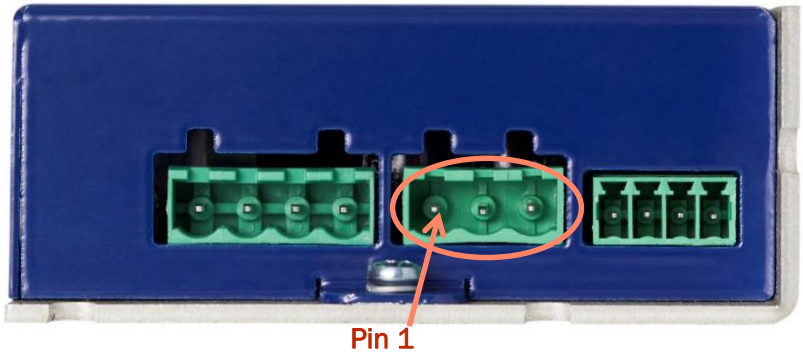

Figure 3 Unit Power Port

Description: The graph above is about the unit power port on the amplifier board.
Manufacturer: DEGSON (Phoenix compatible)
P/N (product side): 2EDGRC5.0803P14H
Pitch: 5.08mm
Mating Type: MSTB 2,5/ 3-ST-5,08

Pin #	Name	Type	Description
1	Main Power	PWR - IN	Motor power input: 12V to 48 V, up to 8A continuous
2	Power GND	PWR - IN	Power GND
3	GND-EARTH	PWR	Earth ground connection

Filter Capacitors are also connected with the main power to provide stable power supply for the I/O ports and encoder.

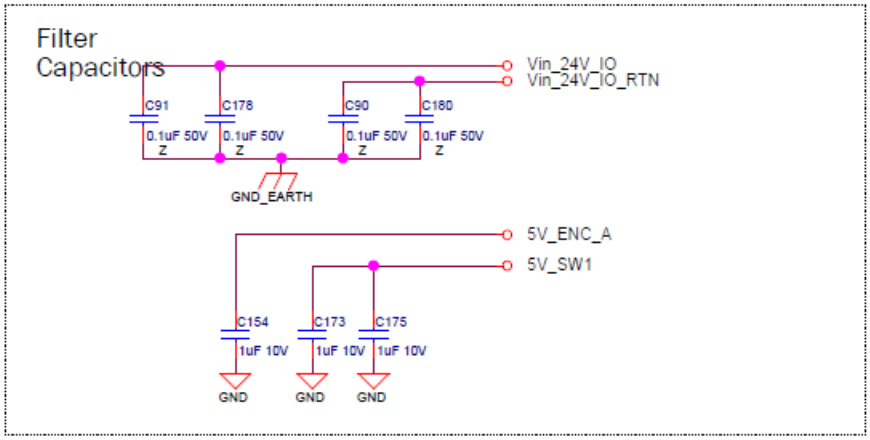

Figure 4 Filter Capacitor

Amplifier – J3 – Motor Phases

J3 is used to connect to the motors' phases. Connection depends on the motor type, as described below.

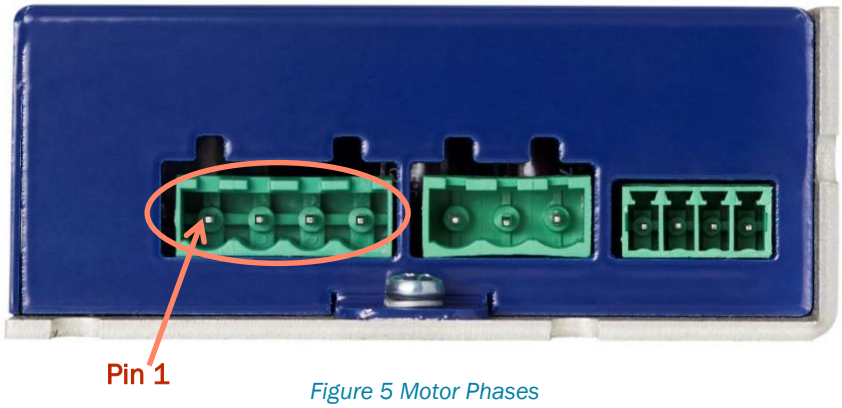

Figure 5 Motor Phases

Description: The graph above is about the motor phases port on the amplifier board.
Manufacturer: DEGSON (Phoenix compatible)
P/N (product side): 2EDGRC-5.08-04P-14-00AH
Pitch: 5.08mm
Mating Type: MSTB 2,4/5-ST-5,08

For one Brushless motor:

Pin #	Name	Type	Description
1	Motor A Phase A	PWR -OUT	
2	Motor A Phase B	PWR -OUT	
3	Motor A Phase C	PWR -OUT	
4	GND_EARTH	PWR -OUT	Earth ground connection

For one Brush (or voice coil) motor:

Pin #	Name	Type	Description
1	Motor A Phase 1+	PWR -OUT	
2	Motor A Phase 1-	PWR -OUT	
3	NA	PWR -OUT	Not connected
4	GND_EARTH	PWR -OUT	Earth-ground connection

For one stepper motor:

Pin #	Name	Type	Description
1	Motor A Phase 1 +	PWR -OUT	
2	Motor A Phase 2 +	PWR -OUT	
3	Motor A Phases 1- and 2 -	PWR -OUT	Two motor wires are connected to a single pin of the connector
4	GND_EARTH	PWR -OUT	Earth-ground connection

Note – Stepper voltage range:

Note that a bipolar stepper motor has two independent phases (total of 4 wires). With the CIG1-AMP02, you need to connect the (-) wire of both phases together, into the third pin of the connector (for motor A).

This connection implies a limitation of the voltage that will be applied to the stepper. For example, if the power supply to the unit is 24v, each phase of the stepper motor will be limited to 12v.

With suitable selection of the power supply this should impose no limitation on the stepper motor operation.

Amplifier – J4 – STO

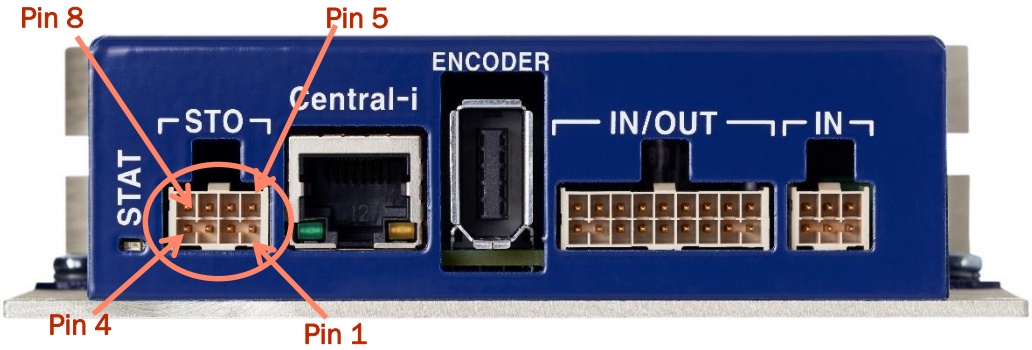

Figure 6 STO Port

Description: The graph above is about the STO port on the amplifier board.
Manufacturer: Samtec Inc
P/N (product side): IPL1-104-01-L-D-RA-K
Cable connector P/N: IPD1-04-D-K
Crimp P/N: CC79L-2630-01-L
Other options are possible; please, consult with the manufacturer.

Pin #	Name	Type	Description
1	5V or 24V	PWR - OUT	Power supply for STO circuits
2	STOFB-	OUT	Safe Torque Off 1 negative (emitter) output
3	STO2-	IN	Safe Torque Off 2 negative input
4	STO1-	IN	Safe Torque Off 1 negative input
5	GND	PWR -OUT	GND
6	STOFB+	OUT	Safe Torque Off 1 positive (collector) output
7	STO2+	IN	Safe Torque Off 2 positive input
8	STO1+	IN	Safe Torque Off 1 negative input

Notes – STO Implementation:

- STO1 and STO2 are completely independent. Each one of them disables the power to the motor in a different way.
- Both STO1 and STO2 disable the power to the motor by hardware circuitry, without any software intervention.
- The circuitry, logic and redundancy of the STO implementation were done according to safety standards. Yet, the design is to be tested and formally approved for the industry standard.

- The STO1 and STO2 are defined with a positive pin (+) and a negative pin (-). However (refer to the electrical interfaces described below) the opto coupler at the STO input (as for all other discrete, isolated inputs of the amplifier) is equipped with two input diodes, enabling operation at "positive" or "negative" input voltage. The input is actually activated by (enough) current at one of the input diodes, independently of the current direct. This enables NPN or PNP connection to the STO inputs (each one of them independently!).

- The STO protection logic is designed such that the STO inputs (both of them) must be powered in order to enable motor operation. Leaving an STO input disconnected will prevent motor operation. This logic is required in order to ensure that a disconnected safety cable will be considered by the control unit as an unsafe situation. When (enough) current is driven through an STO input, the state of this input is "safe". When no (not enough) current is driven through an STO input, the state of this input is "unsafe".

- The two STO inputs must be at "safe" state in order to enable motor operation.

- Both STO1 and STO2, although acting on the drive hardware directly, are also sensed by the controller software. The controller software is generating a feedback signal to the user (STO_FB) which is also an isolated signal. This feedback is generated by the software and is activated in case a least one of STO1 or STO2 signals unsafe situation.

Electrical interfaces – STO:

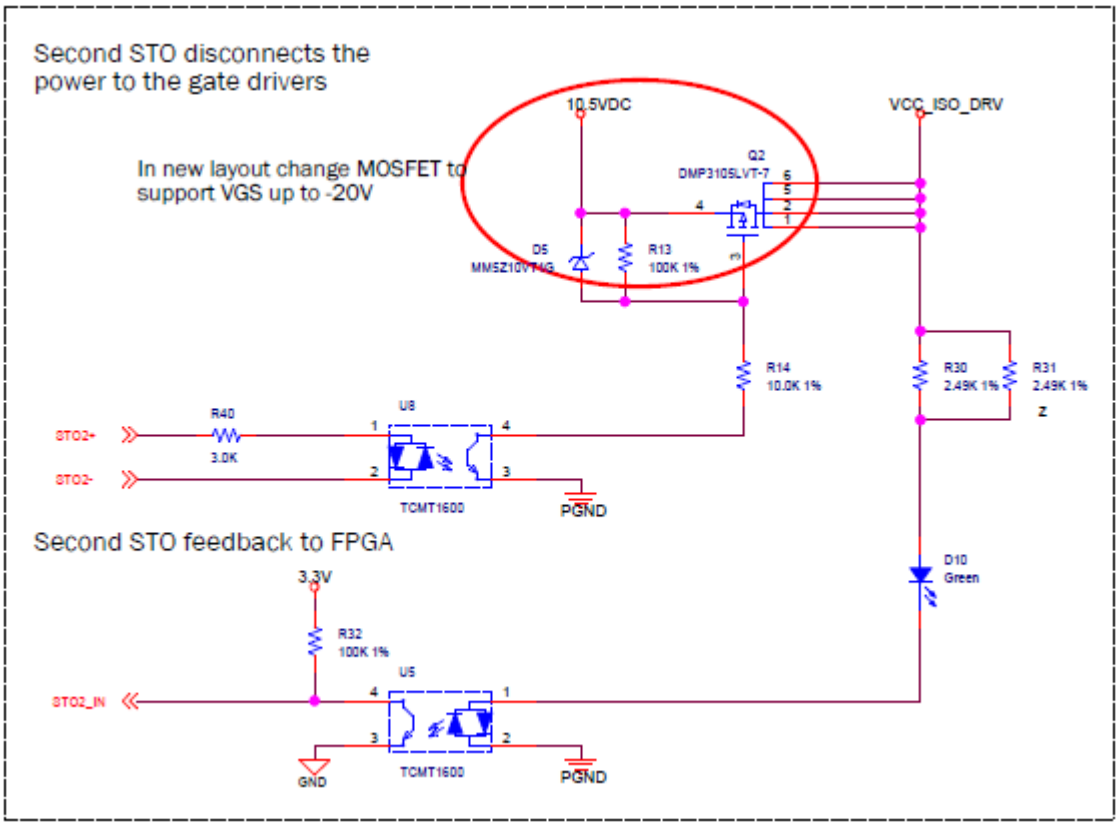

Figure 7 STO Circuit Diagram

- The electrical characteristics of the STO1 and STO2 inputs are identical to those of the discrete, isolated inputs of the controller. Refer to the chapter about J10 below.

Notes –The connection of bypassing STO:

- Connect the pin 1, pin7 and pin8 together and connect the pin 5, pin3 and pin4 together.

Pin #	UPPER	LOWER
	5	1
	6	2
	7	3
	8	4

Amplifier – J6 – Encoder

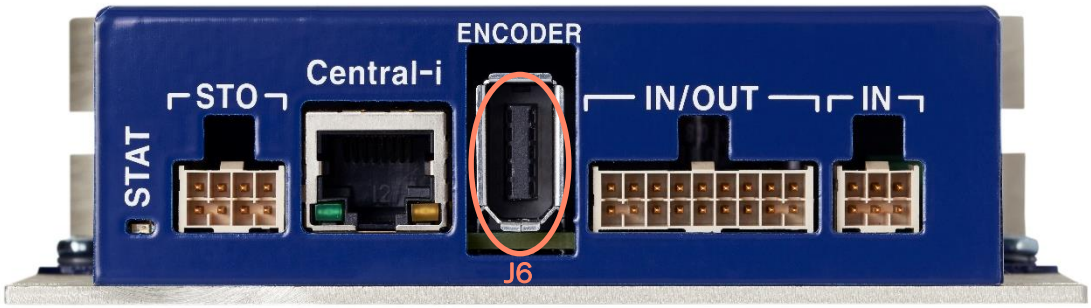

Figure 5 Encoder Port

Description: The graph above is about the encoder port on the amplifier board.
Manufacturer: SUNCHU.
P/N (product side): SC-MCR10S90A4G
Cable connector P/N: SC-10-4P
Other options are possible; please, consult with the manufacturer.

Pin #	Name	Type	Description
1	5V	PWR - OUT	5V for user usage (up to 0.5A, each connector)
2	GND	PWR -OUT	Reference for 5V and differential signals
3	Encoder_1P	Out	Differential output, not inverted
4	Encoder_1N	Out	Differential output, inverted
5	Encoder_2P	In	Differential input, not inverted
6	Encoder_2N	In	Differential input, inverted
7	Encoder_3P	In	Differential input, not inverted
8	Encoder_3N	In	Differential input, inverted
9	Encoder_4P	Bidirectional	Differential input/output, not inverted
10	Encoder_4N	Bidirectional	Differential input/output, inverted

Several encoder options are available. For each type of encoder, the inputs and outputs are selected according to the table below:

Differential line	Incremental	Sin/Cos	SSI	BiSS	Nikon	Tamagawa	Panasonic
Encoder_1				OUT			
Encoder_2	**IN- A**	IN-SIN					
Encoder_3	**IN- B**	IN-COS	IN	IN			IN
Encoder_4	**IN- Z**	IN-Z	OUT	OUT	INOUT	INOUT	OUT

Notes – Supported encoder types and connection of incremental encoder:

Currently only incremental encoder type is supported. SIN/COS analog encoders (and SSI, BiSS, Nikon, Tamagawa, and Panasonic encoders) will soon be supported as well, to be followed also with absolute encoders support.

Note (see table above) that the A. B and Z channels of the encoder are connected to Encoder_2, Encoder_3 and Encoder_4 pins of the connector, respectively.

Note – Incremental encoder interface details:

The internal design of the A, B and Z signals interfaces supports, by default, differential inputs. However, with a dedicated assembly, it can support, without any external component, also single ended encoders. Please consult the designer in case your application uses single ended encoders or any other special, non-differential interface.

The default differential encoder's interface includes a built-in 120 ohms terminator (per each channel) and also the required hardware circuits to detect disconnected encoder cable (and in such case, the controller will disable the motor). The detection is done on the A and B channels only (and not on the index, Z, channel)

Note: 5v supply limitation:

Note that the 5v supply that is provided at pin 1 of each of the J8 and J9 connectors is internally limited to 0.5A per each connector (independent limitation at each connector). This is in order to protect the controller from short to GND.

Future firmware versions of the controller will be able to detect and report such fault and to disable the 5v supply until the fault is fixed. Currently, the current will be limited, but the detection of this limit and the shutting off of the 5v supply is not supported yet.

Physical Pin Layout – Encoder:

Pin #	Left Column	Right Columm
	1 *	2
	3	4
	5	6
	7	8
	9	10

- The maximum current for each connector is 0.5A.

Amplifier – J7 – I/O Port2

This section describes the details of IO Ports J7.

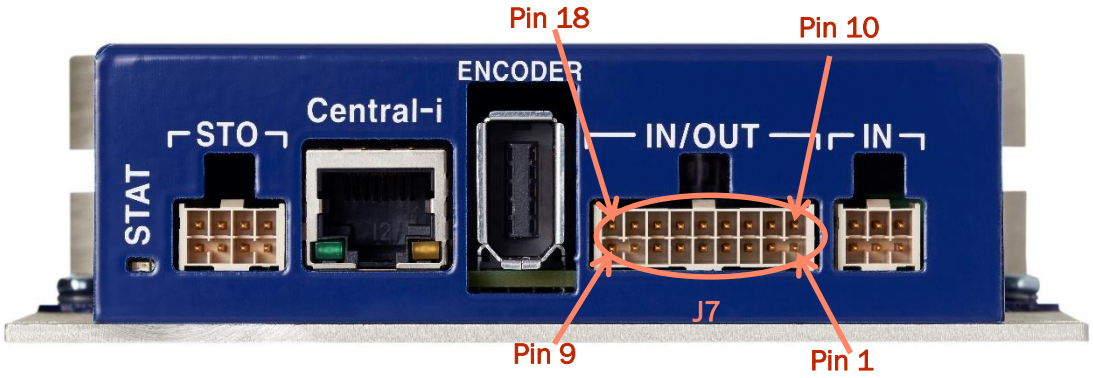

Figure 9 I/O Port 1

Description: The graphs above are about the two IO ports on the amplifier board.

Manufacturer:	Samtec Inc
P/N (product side):	IPL1-109-01-L-D-RA-K
Cable connector P/N:	IPD1-09-D-K
Crimp P/N:	CC79L-2630-01-L
	Other options are possible; please, consult with the manufacturer.

Pinout for J7 (I/O Port 2) is described below.

Pin #	Name	Type	Description
1	Vin_24V_IO_RTN	PWR - OUT	IO Power Return
2	Vin_24V_IO	PWR - OUT	24V IO Power
3	OC_Output_12_Common_Return	PWR - IN	Common power pin for discrete, isolated, outputs 1 to 2
4	OC_Output_12_Common_Power	PWR - IN	Common power return pin for discrete, isolated, outputs 1 to 2)
5	OC_Input7	IN	Discrete, isolated, input 7 (NPN or PNP, depending on connection of the common pin of this group)SW: DInPort (bit 6)
6	OC_Input5	IN	Discrete, isolated, input 5 (NPN or PNP, depending on connection of the common pin of this group)SW: DInPort (bit 4)
7	OC_Input_4567_Common	PWR	Common power pin for discrete, isolated, inputs 4 to 7
8	DIF_IO_P	IN	Differential IO, positive pin
9	Analog_Input 1	IN	Analog input 1, ±12v, 12 bit SW: AinPort (bit 0)
10	GND_EARTH	IN	Ground Earth Connection
11	GND	PWR-OUT	GND for 5V and differential signals
12	5V-SW1	PWR-OUT	5v supply for external I/O circuits. Limited to 0.5A
13	OC_Output2	Out	Discrete, isolated, output 2 (programmable sink or source)SW: DOutPort (bit1)
14	OC_Output1	Out	Discrete, isolated, output 1 (programmable sink or source) SW: DOutPort (bit 0)
15	OC_Input6	IN	Discrete, isolated, input 6 (NPN or PNP, depending on connection of the common pin of this group) SW: AinPort (bit 5)
16	OC_Input4	IN	Discrete, isolated, input 4 (NPN or PNP, depending on connection of the common pin of this group)SW: DInPort (bit 3)
17	DIF_IO_N	IN	Differential IO, negative pin
18	Analog_Input_Return_1	IN	Analog input 1 return (internally Not connected to GND)

Note – Analog outputs are not supported in some of the product variants:

Some variants of the product do not support the analog outputs. Please consult the designer for ordering the correct variant in case you need analog outputs for your application.

Analog outputs are required in case you need to interface external amplifier over a ±10v analog command, or in case you need analog output for any other general purpose.

Note: 5v supply limitation:

Note that the 5v supply that is provided on pin 12 in Port J7 and pin 8 in Port J12 is internally limited to 0.5A (both pins together). This is in order to protect the amplifier from short to GND.

Future firmware version of the amplifier will be able to detect and report this fault and to disable the 5v supply until the fault is fixed. Currently, the current will be limited, but the detection of this limit and the shutting off of the 5v supply is not supported yet.

Electrical interfaces – Discrete, Isolated, inputs:

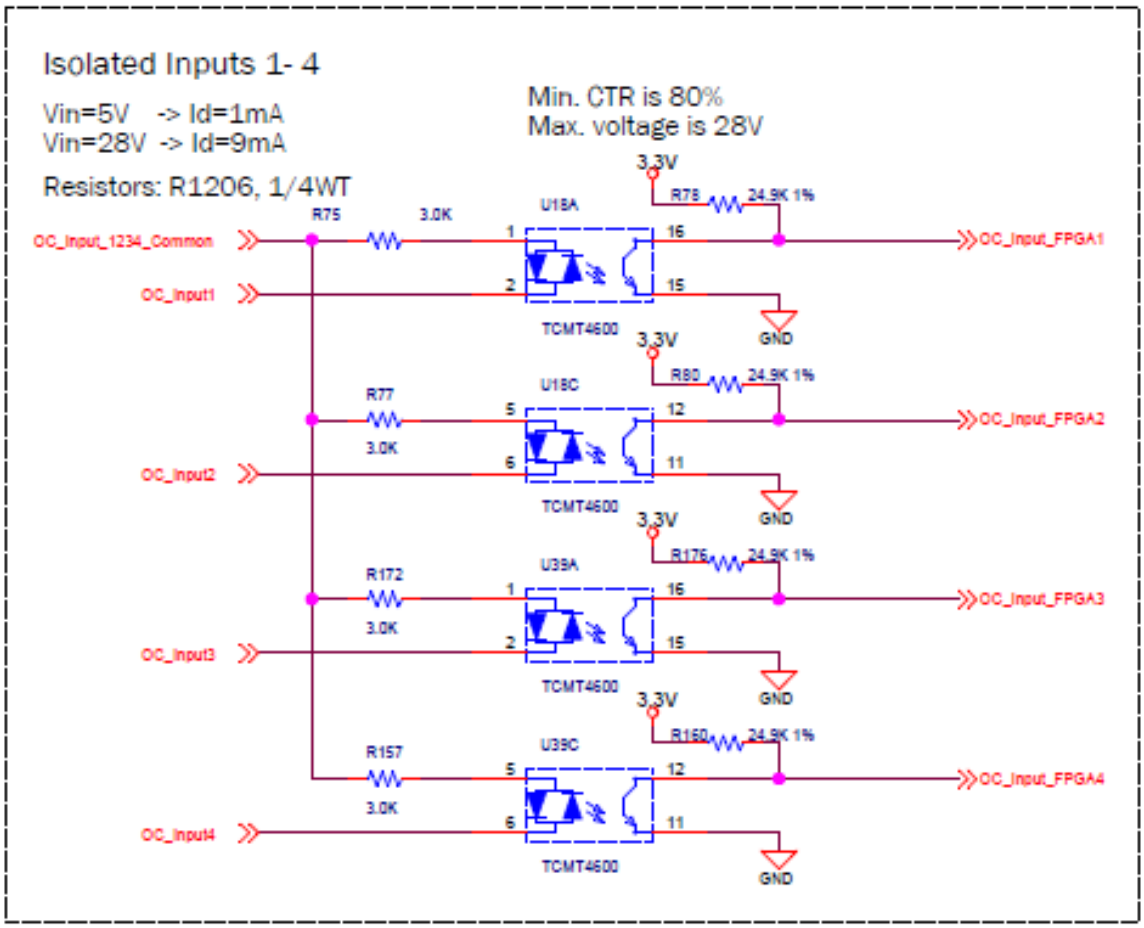

Figure 10 Digital Input

- The interface circuit is identical for inputs 4 to 7, which are organized as a single group.
- Similarly, in port J8, inputs 1-3 are organized as a group with an identical interface circuits. Each group is fully isolated and independent of the other groups.
- Each group can be connected as NPN or PNP interfaces, depending on the wiring of the group common pin. If the common pin is connected to power (5v to 28v), then the inputs of this group can be used with external NPN devices (external current sinking devices). If the common is connected to the GND of some external power, then the inputs can be used with external PNP devices (external current sourcing devices).
- Note that the input circuit of the opto couplers includes two diodes. This enables the usage as NPN of PNP.
- Clearly, one group can be wired to interface external NPN devices and another group can be wired to interface PNP devices. However, within a group, all interfaces should be the same, as they are based on the connection of the group common pin

Electrical interfaces – Analog inputs:

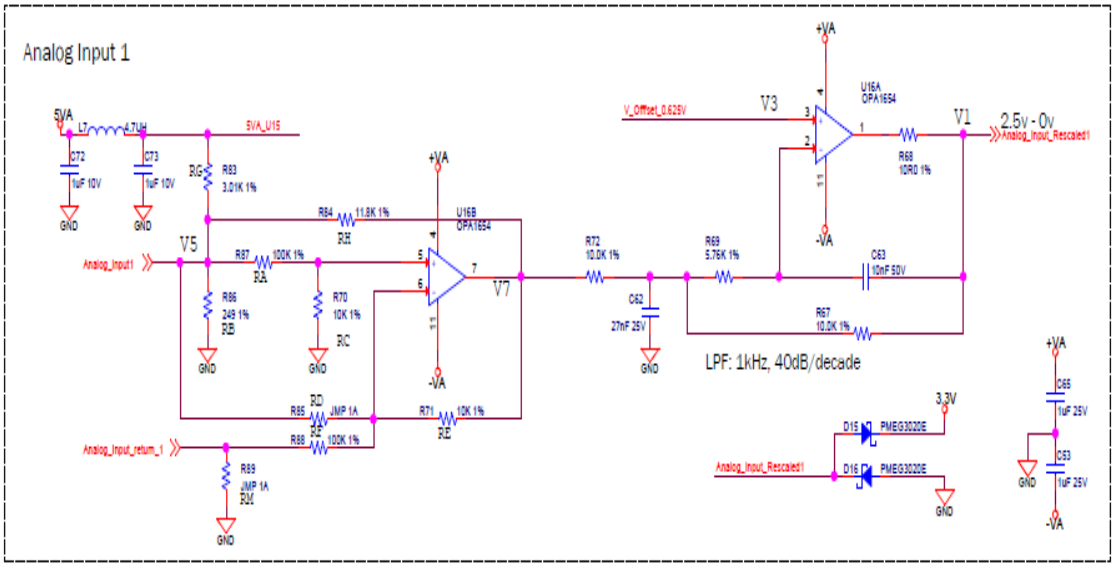

Figure 6 Analog Input

INPUT	VIN=-12V till +12V (Differencial)	VIN=-12V till +12V (Single Ended)	(4-20)mA (Single Ended)	FORCE SENSOR	PT100 SENSOR
RA	100 kOHm 1%	86.6 kOHm 1%	38.3 kOHm 1%	NC	11.0K 1%
RB	NC	NC	249R	NC	NC
RC	10 kOHm 1%	10kOHm 1%	10 kOHm 1%	0 OHm	NC
RD	NC	NC	NC	0 OHm	NC
RE	10 kOHm 1%	0 OHm	0 OHm	RFSR-min + 20% (*) (MAX. FORCE)	105K 1%
RF	100 kOHm 1%	NC	NC	NC	0 OHm
RG	NC	NC	NC	NC	3.01K 1%
RH	NC	NC	NC	NC	11.8K 1%
RM	NC	NC	NC	NC	12.4K 1%
	Default State				

Figure 7

- The analog input is -12v to +12v, 12 bits.
- Input circuit drawing is quite complex, in order to optionally support variety of analog input sources. However, default assembly (see black mark) is for standard differential analog input, with a simple input circuit, having an input resistance of ~60K ohms.
- Input circuit bandwidth: 1KHz, -40 db/dec.

- For dedicated (non-differential) analog input formats, as shown in the above table, or for any other type, please consult designer for dedicated hardware variants of the product.
- The software provides parameters to control the analog input reading, as follows:
  - Filter.
  - Offset.
  - Dead band.
  - Gain.

Electrical interfaces – Discrete, Isolated, outputs:

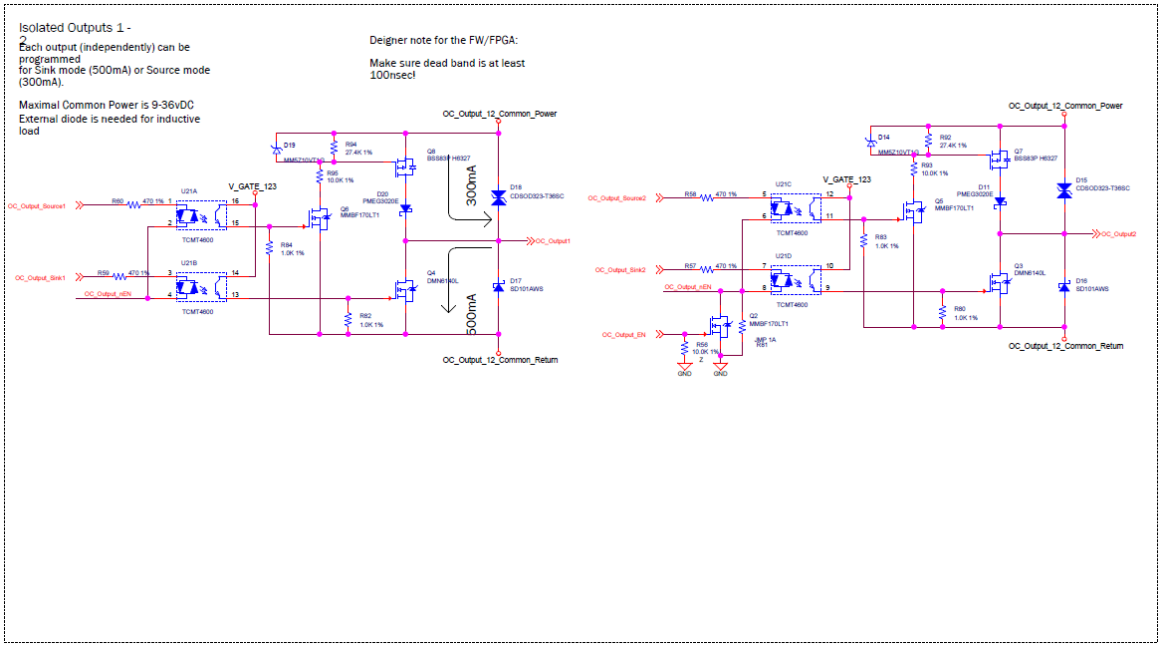

Figure 13 Digital Output

- The interface circuit is identical for outputs 1 to 2
- Each output can be programmed (by a software parameter) to act as a current sourcing output (up to 300mA) or as a current sinking output (up to 500mA).
- Common power is shared by all 2 outputs.
- The outputs are designed for resistive loads. For inductive loads, an external flyback diode is required.
- Common power can go up to 45 volts. Yet, typical usage should be limited by 36v.
- Discrete outputs specifications:

  - ❖ Discrete outputs common power voltage range is 5v to 36v.
  - ❖ Maximal load current, per each output:

    a. SINK mode, at any common power voltage: 500mA
    b. SOURCE mode, at 24v common power voltage: 300mA.
    c. SOURCE mode, at 5v common power voltage: 60mA
    (Output high voltage > 4.5v).

  Notes:

  1. Higher currents (but less than absolute maximal value of 250mA) can be driven at SOURCE mode with 5v common power voltage. However, the output high voltage will drop significantly.
  2. For additional and more detailed data, please write to our support team.

Amplifier – J8 – I/O Port 1

This section describes the details of first IO Port.

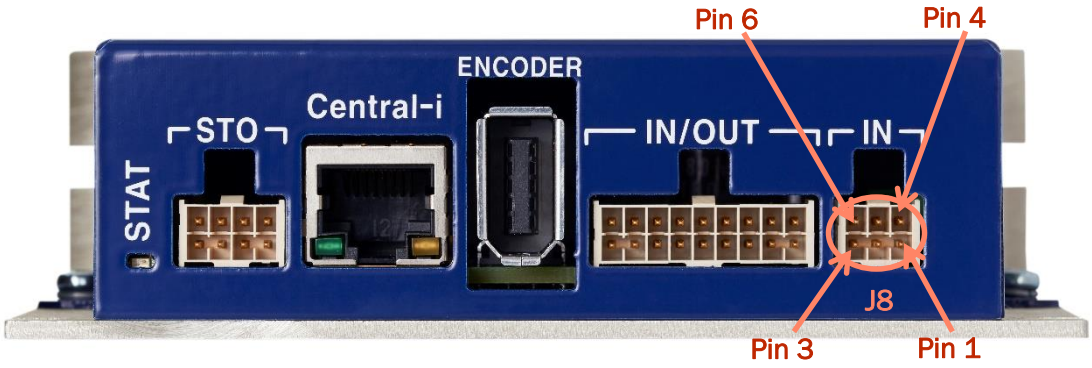

Figure 8 I/O Port 1

Description: The graph above is about the first IO port on the amplifier board.
Manufacturer: Samtec Inc
P/N (product side): IPL1-103-01-L-D-RA-K
Cable connector P/N: IPD1-03-D-K
Crimp P/N: CC79L-2630-01-L
Other options are possible; please, consult with the manufacturer.

Pinout for J8 (I/O Port 1) is described below.

Pin #	Name	Type	Description
1	5V_SW1	PWR -OUT	5v supply for external I/O circuits. Limited to 0.5A
2	OC_Input2	IN	24V IO Power SW: DInPort (bit 1)
3	OC_Input_123_Common	PWR - IN	Discrete, isolated, output 1 (programmable sink or source)
4	GND	PWR - OUT	GND for 5V and differential signals
5	OC_Input3	IN	Discrete, isolated, input 3 (NPN or PNP, depending on connection of the common pin of this group)SW: DInPort (bit 3)
6	OC_Input1	IN	Discrete, isolated, input 1 (NPN or PNP, depending on connection of the common pin of this group)SW: DInPort (bit 1)

Amplifier – J5 – Communication Port

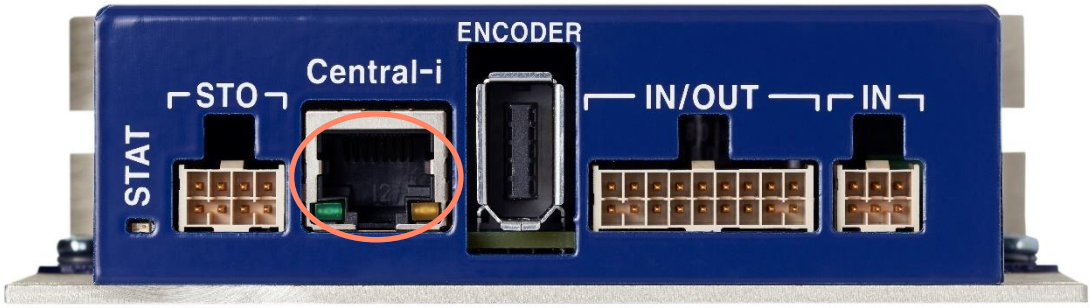

Figure 15 Communication Port

Description:	CONNECTOR, RJ45, PLUG, 8P8C, 1 PORT
Manufacturer:	TE
P/N (product side):	5-554720-2
Cable:	CAT5

Note:

1. All of them are used to connect with another PCB board— CIGI-COM01-1A-02-01 to realize the communication between the master controller CIG1-MAS and the product. (The details of the board can be referred to in the hardware manual of CIGI-COM01-1A-02-01)
2. The RJ45 connector is between the two connectors to communicate with the master controller CIG1-MAS product variants via the Central-I Protocol

Environmental conditions

The table below shows the operating conditions for which this product can operate within

Requirement	Units	Allowed range
Operational temperature	°C	0 to 50
Storage temperature	°C	-20 to 70
Humidity	%	<90

References

[1] Central-i PN SN Definitions 6 March 2016.docx, 06-03-2016, V1.3