

DCS-100-A

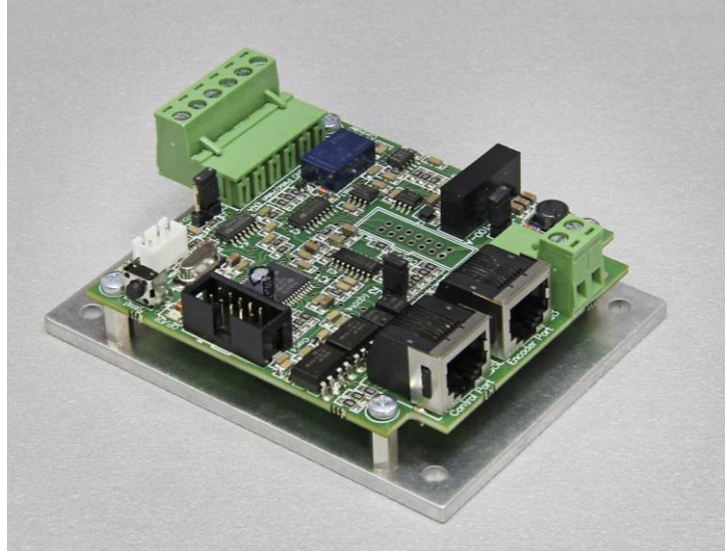
DC SERVO DRIVE WITH ANALOG OUTPUT $\pm 10V$

DESCRIPTION

DCS-100-A is microcontroller based drive with opto-isolated analog output $\pm 10V$. It is used to drive third party servo amplifiers. DCS-100-A is suitable for retrofit of CNC machines which has robust servo power amplifiers for DC motors with analog input.

Drive is based on 16-bit microcontroller with implemented PID control algorithm. As the feedback of DC motor position an incremental encoder with phase-shifted square signal (quadrature encoder) is used. Encoder interface enables 1x, 2x and 4x encoder resolution.

Adjustment of all parameters is performed by using the configuration software ServoTune3.



The input control interface enables control via opto-isolated lines in next modes:

- STEP/DIR/ENABLE,
- CW/CCW/ENABLE,
- Encoder follower in 1x, 2x and 4x decoding, and
- Via analog input within the range 0÷5 V with and without feedback.

Built-in soft start function enables DC motor 1s after power on in order to decrease power surge on start.

There is an opto-isolated digital output on drive, named Track Error which is activated if preset value of tracking error offset is exceeded. That output can be used for activation of external circuit for DC motor emergency stop.

Use power supply 8÷24 VDC. Drive has reverse polarity protection.

APPLICATION

- CNC machines retrofit
- Coordinate tables
- Positioning
- Robots
- Education

2. SPECIFICATIONS

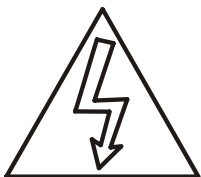
Type	Closed loop DC Servo drive with opto-isolated analog output ± 10 V and PID control algorithm
Number of axis	1
Input control interface	Digital control modes via opto-isolated lines STEP/DIR/ENA, CW/CCW/ENA and Encoder follower (1x, 2x and 4x) Analog 0÷5 V with and without feedback
Frequency of STEP command	< 600 kHz
Command line pulse width	> 0.5 μ s
Command line current	~10 mA at 5 V
Output	Opto-isolated analog ± 10 V
Auxiliary outputs	<ul style="list-style-type: none"> - Opto-isolated Tracking Error - Two inverted PWM signals (TTL) - Enable output (TTL)
Feedback	Incremental encoder with phase-shifted square signal
Incremental encoder resolution	$\times 1$, $\times 2$ and $\times 4$ multiplication, settable by software
Incremental encoder power supply	Source on drive +5 V DC / 250 mA
Drive parameter set up	Via IDC10 connector and programming interface (IPI-USB or Bluetooth BT-PI)
Power supply	8÷24 VDC, 250 mA – reverse polarity protection
Dimensions (W x L x H)	102 mm x 77 mm x 31 mm
Weight	~150 g

NOTE: specifications are subject to change without notice

3. SAFETY PRECAUTION

During operation of drive DCS-100-A it is possible to encounter dangers and risks that may lead to destruction of equipment, and also injuries to people nearby.

For the process of installation of servo drive DCS-100-A it is required to have a high level of knowledge of electronics, computer technology and mechanics. Also, it is necessary to abide by the safety measures for working with high voltage and mechanical dangers that come from operation of heavy and powerful machinery.



Voltages above 50VDC can be lethal

To power drive DCS-100-A use only galvanically isolated power supply.

In case of **Emergency stop**, it is recommended to cut power line of DC servo motor and, if it is possible, to activate motor brake. In case of emergency it is not advised to use opto-isolated ENABLE input for stopping DC motor.

It is recommended to locate drive in a case with good ventilation and to provide additional cooling if needed. If fans are used for cooling it is recommended to install dust filters.

Drive should not be used in places where its failure could lead to danger for people safety, substantial financial loss or any other loss.

During drive operation apply all required safety measures.

Possibility is not excluded that this document contains errors. Also, manufacturer does not take any responsibility for any type of damage caused by using this drive and that is in consequence of abidance or non-abidance to this instruction manual.



4. DRIVE APPEARANCE

DCS-100-A drive appearance and connectors locations are shown in Figure 1.

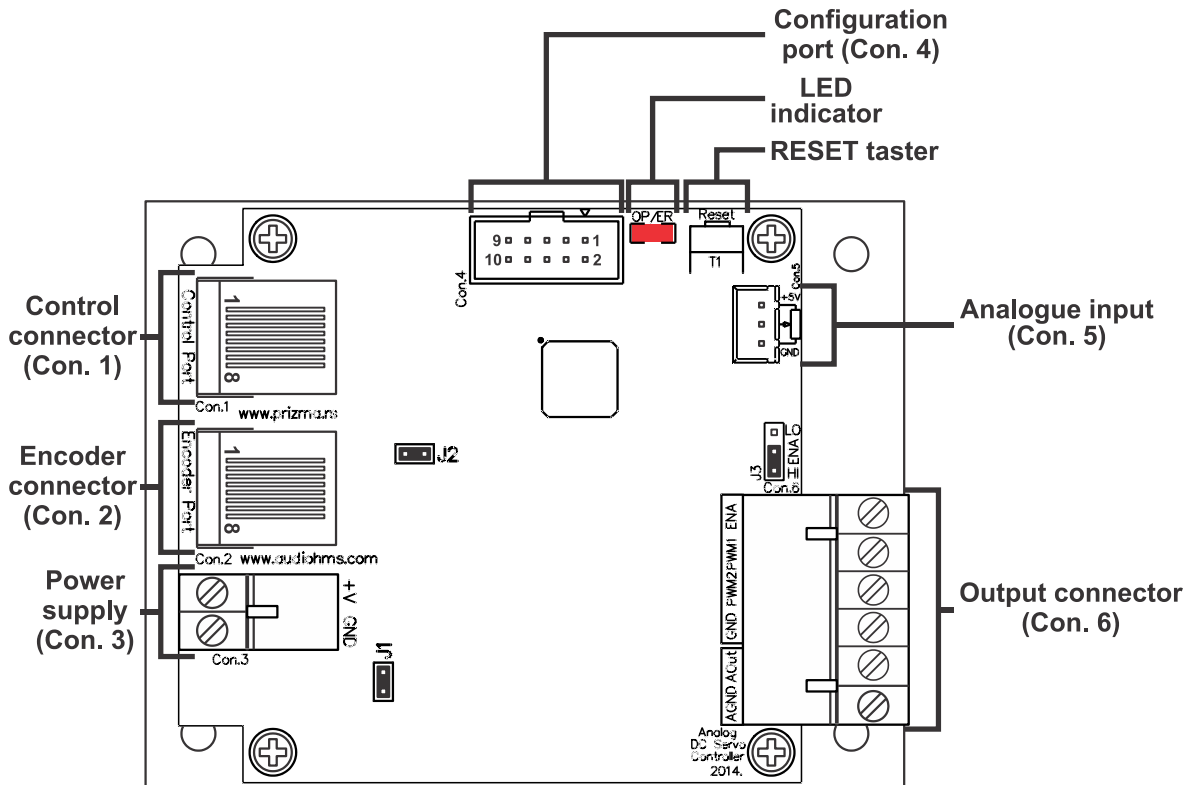


Figure 1 DCS-100-A drive appearance

4.1 Control connector

Digital control inputs (STEP/DIR/ENA, CW/CCW/ENA or Encoder), as well as Track Error output are brought over to the 8-pin RJ45 connector (control connector – Con. 1, see Figure 1). Track Error output will be activated when the tracking error exceeds configured value of tracking error offset.

Control connector is designed so that the input/output card IO3-R2 is connected via 1-1 network cable (Ethernet cable).

Pin arrangement is presented in the Table 1, and a schematic diagram of these pins is shown in the Figure 2.

Table 1 Pins description of 8-pin RJ45 control connector (Con.1)

Pin No	Selected type of digital control			INPUT / OUTPUT
	STEP/DIR/ENABLE	CW/CCW/ENABLE	Encoder follower	
1	STEP –	CW –	GND	Input 1
2	STEP +	CW +	A +	
3	DIR -	CCW -	GND	Input 2
4	DIR +	CCW +	B +	
5	ENABLE – (GND)			Input 3
6	ENABLE +			
7	Error output (emitter)			Output 1
8	Error output (Tracking Error – open collector)			

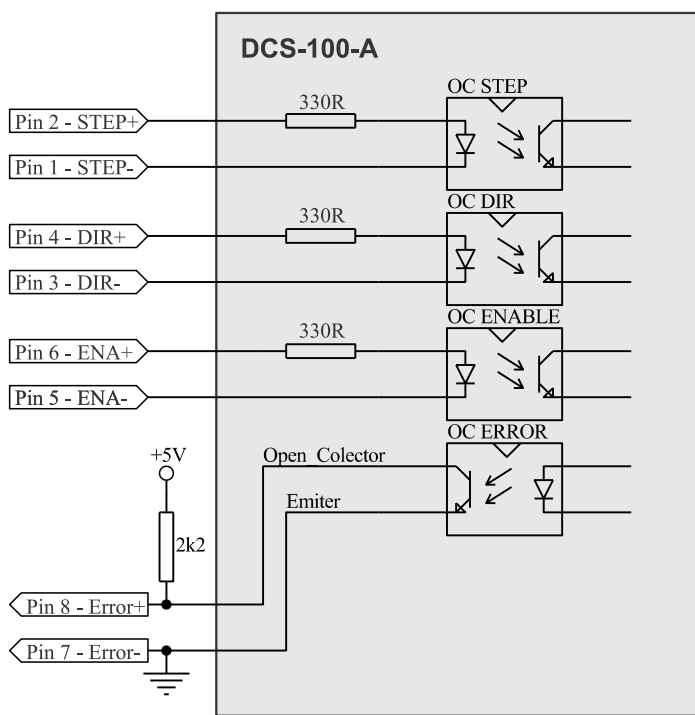


Figure 2 Schematic representation of opto-isolated inputs and outputs

There are 330 Ω resistors at opto-coupler inputs for STEP, DIR and ENABLE command, which limits the current to ~10 mA at the command voltage of 5 V (TTL logic level).

If the logic command voltage at inputs is higher, additional resistors should be placed at lines 2, 4 and 6 and at connector Con.1 to ensure that current does not exceed 15 mA.

EXAMPLE: If the drive DCS-100-A is controlled by using a PLC with 24VDC logic levels, it is necessary in each of lines 2, 4 and 6 (STEP+, DIR+ and ENA+ on connector Con. 1) to add 2.2 kΩ resistor.

It is necessary to note that in Track Error line an external pull-up resistor should be placed.

Opto-isolating distance between the input-output command lines of control connectors and control electronics on the drive's PCB is approximately 5 mm.

4.2 Incremental encoder connector

Incremental encoder is used for DC motor position feedback on DC servo drive DCS-100-A. Incremental encoder can be connected via encoder connector – shown as connector Con.2 in the Figure 1. Functions of the 8-pin RJ45 connectors are described in Figure 2.

Table 2 Description of encoder connector pins 8-pin RJ45 connector (Con.3)

	Pin No.	Name	Description	Function
	1	A+	A encoder channel (pull-up resistor 4.7 kΩ)	Incremental encoder connection
	2	A-	A\ encoder channel	
	3	B+	B encoder channel (pull-up resistor 4.7 kΩ)	
	4	B-	B\ encoder channel	
	5	NC	-	
	6	NC	-	
	7	+Ve	Encoder power supply source 5 V / 250 mA max	
	8	GND	GND – Encoder	

Use an incremental encoder with phase-shifted square TTL outputs. On the drive there is a power supply for incremental encoder +5V / 250 mA max.

On the DC servo drive DCS-100-A can be connected encoder with differential (complementary) outputs (A+, A-, B+ and B- outputs, Figure 3) or incremental encoders with single-ended outputs (A and B, Figure 4). Encoder interface SED1 at the A and B inputs has pull-up resistors of 4.7 kΩ.

NOTE: Connection of incremental encoder with single-ended outputs on DC servo drive DCS-100-A via DD1 encoder interface is not recommended for larger cable lengths. Also wires from incremental encoder with single-ended outputs for connection to the encoder interface should be as short as possible.

In order to reduce influence of high-frequency electrical noise is recommended to use shielded network cable Cat 5e for connection encoder interface SED1 or DD1 with DC servo drive.

Incremental encoder cable should not be longer than a specific application requires.

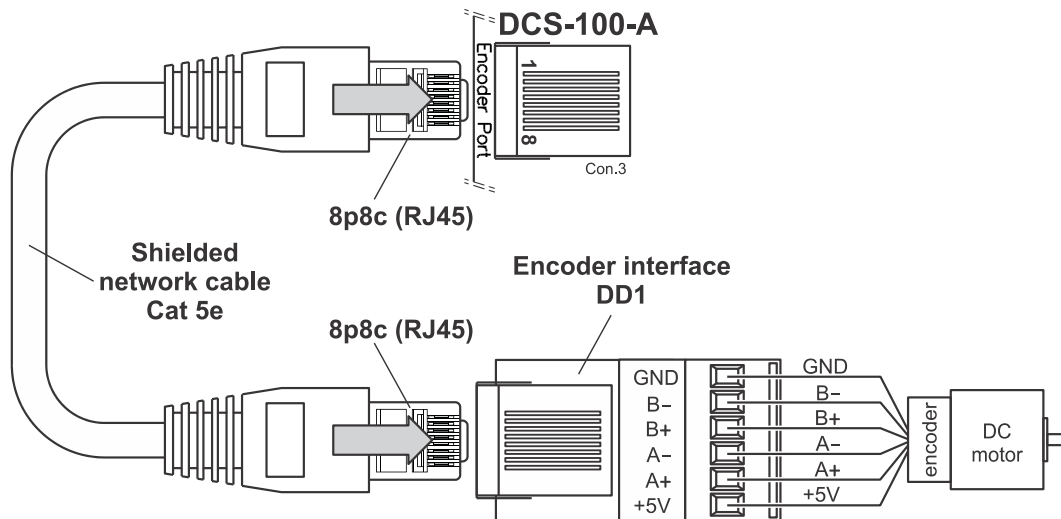


Figure 3 Connection of incremental encoder with differential (complementary) outputs via DD1 encoder interface on DC servo drive DCS-100-A (highly recommended configuration)

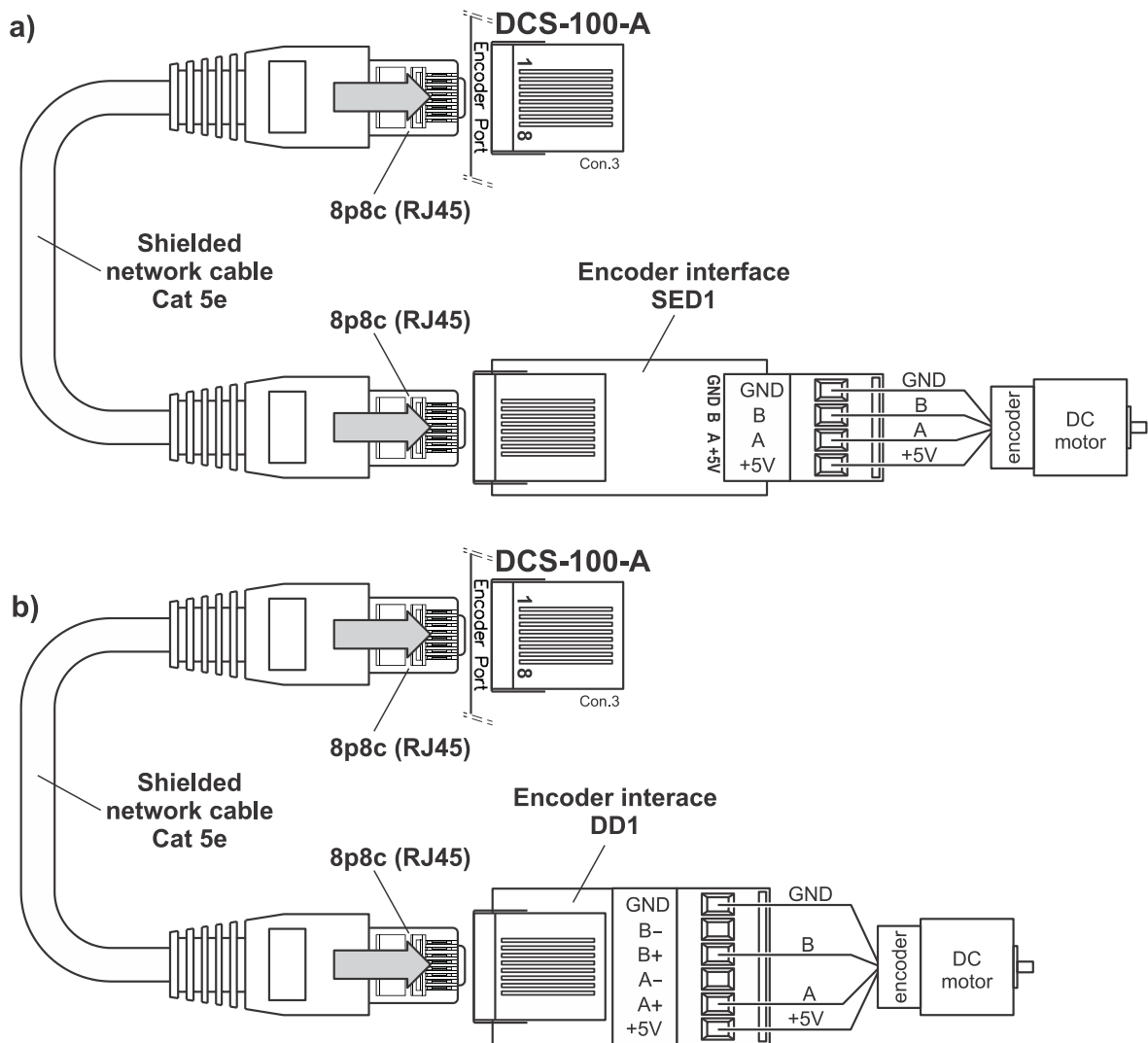


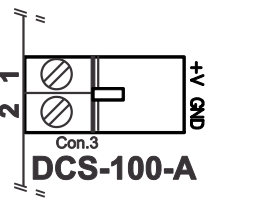
Figure 4 Connection of single-ended incremental encoder with DC servo drive DCS-100-A via, a) SED1 encoder interface and b) DD1 encoder interface

4.3 Power supply connector

Power supply to drive DCS-100-A is provided via connector Con.3 (see Figure 1). Logic circuit supply voltage should be from 8÷24 V DC / 250 mA (see Table 3). It is not necessary for this source to be stabilized; it is enough that after rectification, electrolytic capacitor is applied with minimum capacitance 470 µF.

Drive has reverse polarity protection.

Table 3 Description of pins (terminals) in 2-pin connector Con.3

	Pin No.	Name	Description	Function
	1	+V	Power supply +8÷24 V DC / 250 mA	Servo drive power supply
	2	GND	GND	

4.4 The configuration port

Parameter setting (PID controller constants, encoder resolution, tracking error offset, etc.) is performed by using IPI-USB or PI-BT interface for programming and configuration software ServoTune3.

Programming interfaces IPI-USB or PI-BT can be connected to the drive DCS-100-A via the configuration port marked as Con.4 in Figure 1 (10-pin IDC connector).

A detailed description of the setup parameters of DC servo drive DCS-100-A is given in the instructions for use the software ServoTune3.

NOTE: Configuration port ground is not galvanically separated from the drive ground. It is recommended to use insulation programming interface IPI-USB or bluetooth programming interface PI-BT.

4.5 Analog input

DC servo drive DCS-100-A has an ability to control DC motor by using control voltage of 0÷5 V which is applied to the analog input connector (Con.5 in Figure 1).

External potentiometer with nominal resistance of 1÷10 kΩ can be directly connected at the analog input connector as shown in Figure 5.a.

Figure 5.b shows the connection of external motion path generator. Voltage at the motion path generator output should not exceed 5 V DC.

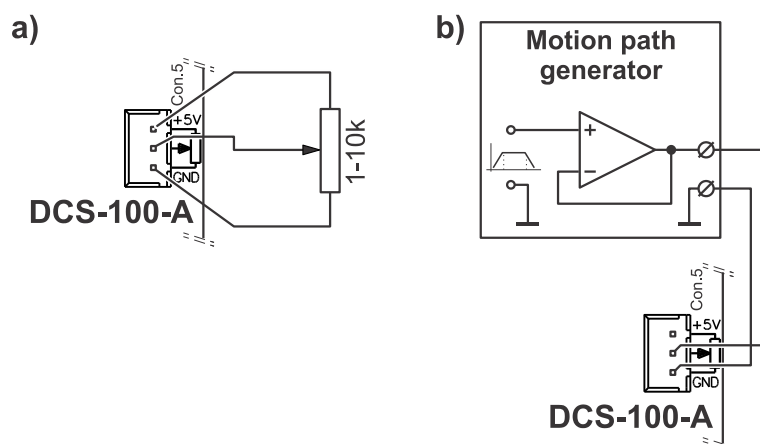
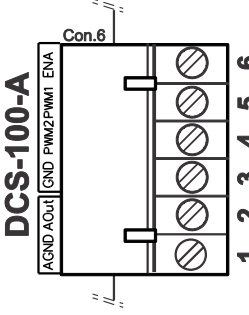


Figure 5 Voltage reference for analog input of DC servo drive DCS-100-a generated over:
a) external potentiometer and b) motion path generator

4.6 Output connector

Analog output ± 10 V, also the additional outputs PWM1, PWM2 and ENA, are located on connector Con.6 (Figure 1).

Table 4 Description of pins (terminals) on connector Con. 6

	Pin num.	Name	Description	Function
	1	AGND	GND for analog output	Analog output ± 10 V
	2	AOut	Analog output	
	3	GND	GND for additional outputs	Additional outputs
	4	PWM2	PWM2 output	
	5	PWM1	PWM1 output	
	6	ENA	ENA output	

NOTE: Ground for analog output (AGND) and ground for additional outputs (GND) are galvanically isolated.

5. Connecting servo drive

Recommended procedure for connecting DC servo drive with analog output DCS-100-A to analog servo drives (power amplifiers) from third party manufacturers, consists of following steps.

Step 1

Testing of analog servo drive (power amplifier) from third party manufacturers, is shown as simplified schematic in the Figure 6. For this test, two 9V batteries can be used, and also one potentiometer. Before applying power to analog servo amplifier of third party manufacturer, analog input should be set to 0 V by adjusting potentiometer.

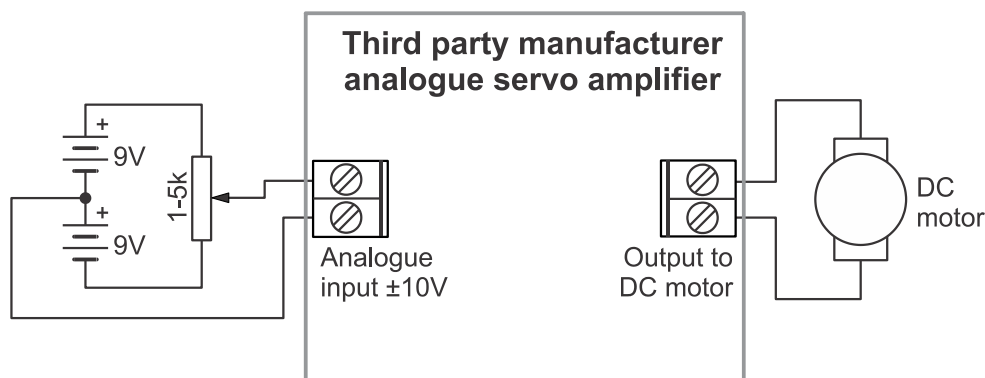


Figure 6 Testing analog servo drive from a third party manufacturer

After applying power to analog servo drive, gently move potentiometer knob in one, then in other direction and check if DC motor is responding to these changes.

After this, analog servo drive of third party manufacturer is ready for connecting to analog output of DCS-100-A.

Step 2

Connect incremental encoder to DC servo drive DCS-100-A as shown in Chapter 4.2.

Supply power to DCS-100-A via power connector (Con.3). Using voltmeter, check voltage on analog output of DC servo drive DCS-100-A (voltage between pins 1 and 2). This voltage level should be in range of $0\text{ V} \pm 10\text{ mV}$, which is offset of DCS-100-A drive. Then manually turn incremental encoder shaft, and output voltage should track this angle of encoder rotation (should be proportional to angle of rotation). Maximum voltage on DC servo driver analog output is $\pm 10,3\text{ V}$. During this test it is possible for tracking error to appear – refer to Chapter 6.

After check-ups shown in this and previous step, it is safe to proceed to connection of entire control system.

Step 3

Connect DC servo drive with analog output DCS-100-A to analog servo drive from third party manufacturer as show in the Figure 7.

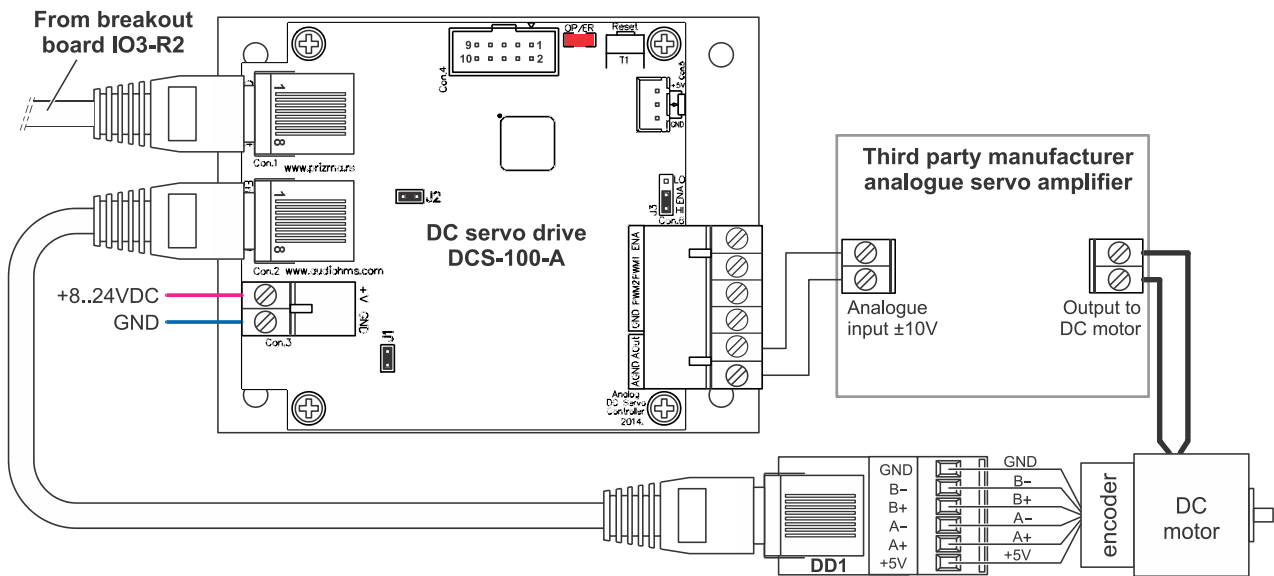


Figure 7 Connecting of servo drive with analog output DCS-100-A to form a control system

In the Figure 7 is shown wiring diagram in case of incremental encoder with differential outputs and encoder interface of DD1 type is used, which is highly recommended. For connecting incremental encoder that has non-symmetric (single-ended) outputs, see Chapter 4.2.

After supplying power to the system shown in the Figure 7, if all is connected properly, DC motor shaft should preserve its current position. If external force is applied (for example by hand) to rotate shaft away from this referent position, system should return shaft back approximately to the referent position. If DC motor shaft makes few turns (runs away) and Tracking Error is activated (see error codes in Chapter 6), it means that it is required to change positions of signal lines from incremental encoder. In case of incremental encoder with differential outputs see Figure 8, and if incremental encoder with single-ended outputs is used then change positions of A and B signal lines (Figure 9).

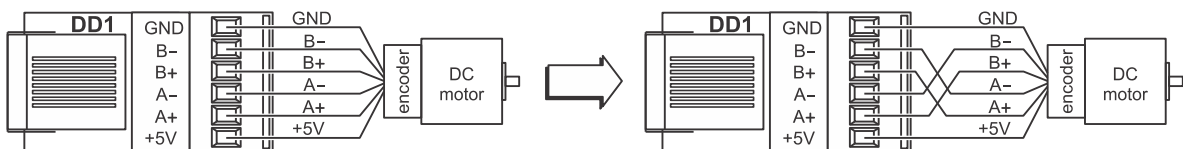


Figure 8 Signal lines position change for incremental encoder with differential outputs

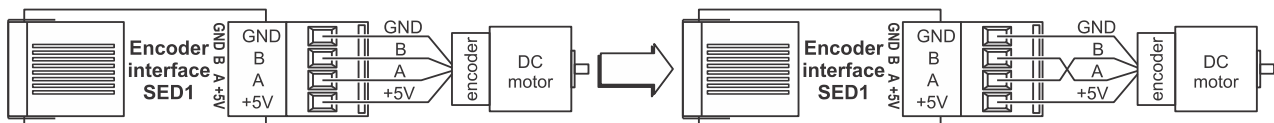


Figure 9 Signal lines position change for incremental encoder with non-symmetric (single-ended) outputs

Step 4

Set PID constants of DCS-100-A drive as explained in the software ServoTune3 user manual.

5. RESET TASTER

RESET taster is located between configuration port Con.4 and analog input connector Con.5 (Figure 1). By pushing RESET taster it is possible to clear current error of DC servo drive.

Besides that, pushing RESET taster leads to disabling analog output, or in other words, output relay connects analog output to analog ground.

6. LED INDICATORS

Drive contains multi-purpose red **OP/ER** LED indicator that indicates various states of DC servo driver with analog output DCS-100-A (Table 5).

Table 5 Description of states shown by **OP/ER** LED multi-purpose indicator

OP/ER	Description	
○	Servo drive control circuit is not powered – LED off	
●	Drive ready to work – ENABLE	
1 x ☀	Drive ready to work – DISABLE	
Errors	Description	How to clear error
2 x ☀	Tracking error	- Increase value of Error offset - Push RESET taster
3 x ☀	Incremental encoder error	- Check condition of incremental encoder and its cable - Turn off encoder error detection - Push RESET taster
7 x ☀	Microcontroller error	- Push RESET taster - Contact authorized service provider

WARRANTY

Manufacturer guarantees that all DC servo drives with analog output DCS-100-A are in good working order on delivery. All drives DCS-100-A are tested before shipping. Supply voltage that exceeds maximum allowed value, faulty incremental encoders, incorrectly connected or faulty DC servo motors, strong electromagnetic fields (in proximity to contractor) and similar, can damage the drive.

DOCUMENT REVISION:

- Ver. 1.0, June 2016, English version
- Ver. 1.1, November 2020, Minor revision

