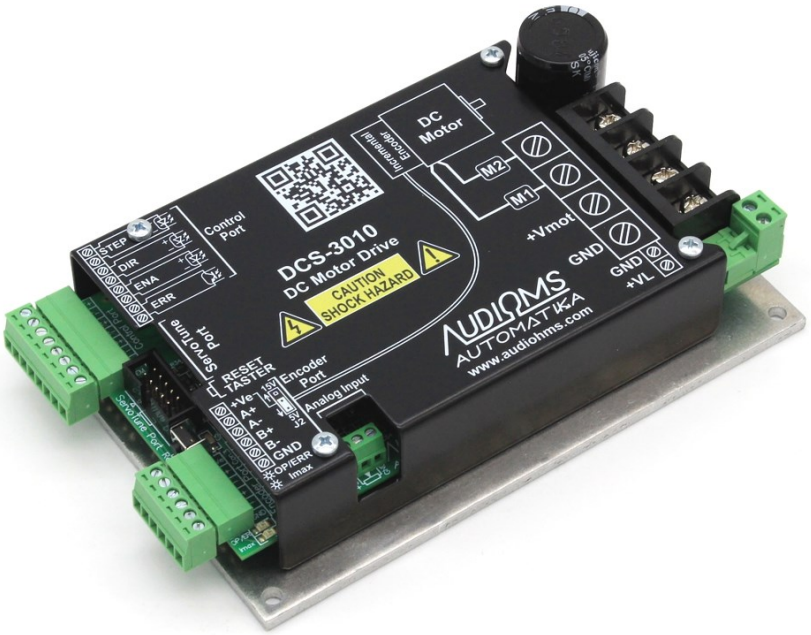
DCS-3010(-HV)

BRUSH DC MOTOR DRIVE



User's manual

AUDIOMS AUTOMATIKA

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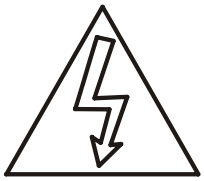
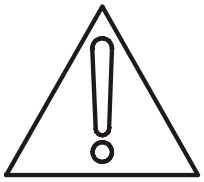
CONTENT

1 SAFETY PRECAUTION



When working with servo drive DCS-3010(-HV) v.5 there are dangers and risks that can lead to equipment damage, also injuries of people present near-by.

For the installation procedure of servo drive DCS-3010(-HV) it is required to have a high level of knowledge in the fields of electronics, computer technology and mechanics. Also it is required to obey safety measures for working with high voltages and mechanical dangers caused by operation of powerful, heavy machines.



Drive installation can perform only person who has appropriate knowledge.

Supply voltages over 50 VDC can be danger of death. If supply voltage is over 50 V DC, aluminum heat sink has to be properly grounded.

Use only galvanic isolated power supply for drive DCS-3010(-HV). Opto-isolated space between input-output command lines and controller electronics on drive printed circuit board (PCB) is around 5mm.

For **stop in case of emergency** it is recommended to interrupt power line of DC motor and, if it is possible, activate motor brake.

If temperature on drive exceeds 70 ^{o}C over-temperature protection will be activated. It is recommended for drive to be placed in enclosures with good cooling and to ensure additional cooling if it is needed. In case when it is used fan for cooling, recommendation is using filter for dust.

Drive should not be used in places where, in case of failure, people safety is in danger, financial losses are big, or there exist other losses.

During drive operation should be used all required precautious.

Does not exclude the possibility that this document contains errors. In addition the manufacturer assumes no responsibility for any damage caused by the use of this drive, which has occurred as a result of compliance or non-compliance with this instruction manual.

2 DESCRIPTION

DCS-3010 V.5 is a microcontroller based PWM drive for permanent magnet DC (PMDC) motors with supply voltage up to 115 VDC (optionally up to 180 VDC) and current up to 30 A. Drive is based on a 16-bit microcontroller with implemented PID control algorithm. As the feedback of DC motor position an incremental encoder with phase-shifted square signal is used. Encoder interface enables 1x, 2x and 4x incremental encoder resolution.

The redesigned version v.5 brings detachable connectors for driver control as well as for connection to an incremental encoder. In addition, the option of selecting the supply voltage of the incremental encoder from 5V and 15V, which are provided from the driver, is now available.

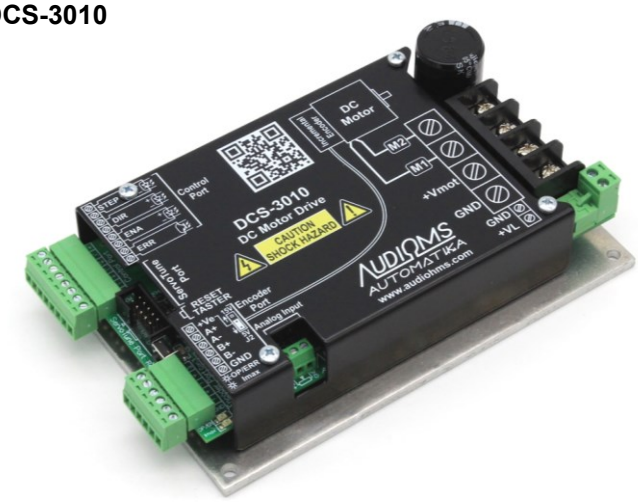
Adjustment of all DC servo drive DCS-3010(-HV) parameters is performed by using the free configuration software ServoTune3. ServoTune3 software has implemented PID auto tune algorithm.

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

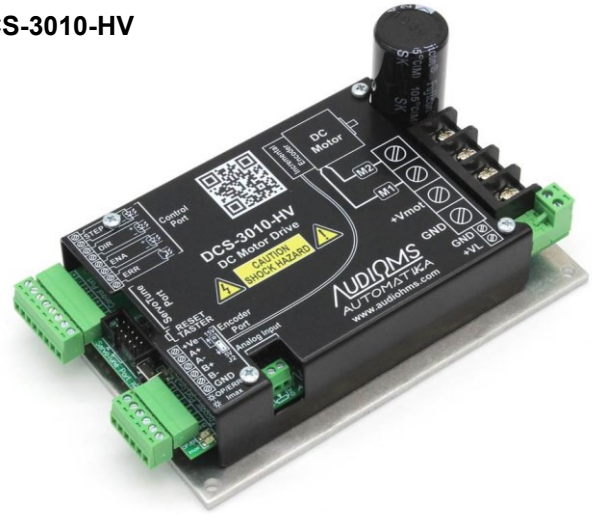
- STEP/DIR/ENABLE,
- CW/CCW/ENABLE,
- Encoder follower in 1x, 2x and 4x decoding,

as well as via analog input within the range 0–5 V with and without feedback (there is the connector on the drive for connecting an external potentiometer).

DCS-3010



DCS-3010-HV



Build-in soft start enables DC motor 1s after powering on decreasing electric shock on start.

There is an opto-isolated output on drive named Track Error which is activated if adjusted value of tracking error offset is exceeded. That output can be used for activation of external circuit for DC motor emergency stop. Drive has over-voltage and over-temperature protection.

If electric current is higher, drive can be placed on additional heat sink.

For DC motor supply voltages higher than 70 VDC it is recommended to use Motor brake circuit MB-2.

2.1 APPLICATION

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

3 SPECIFICATIONS

Model	**DCS-3010**	**DCS-3010-HV**
Type	PWM closed loop PMDC Servo drive with PID controller algorithm	
PWM frequency	10–20 kHz, software set up	
Number of axis	1	
DC motor supply voltage	10–115 V DC	20-180 VDC
Over voltage protection	120 VDC	210 VDC
DC motor current	3–30 A max, software set up	
Logic circuit power supply	18–28 V DC / 500 mA (recommended 1 A)	
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	
Command line current	~ 10 mA at 5 V	
Output	Opto-isolated Track Error	
Frequency of STEP command	< 600 kHz	
Command line pulse width	> 0.5 µs	
Feedback	Incremental encoder with phase-shifted quadrature signal	
Encoder resolution	×1, ×2 and ×4 multiplication, software set up	
Encoder power supply	Source on drive +5 V DC / 250 mA or +15 V DC / 200 mA	
Parameter set up	Via IDC10 connector and isolated programming interface IPI-USB	
Build in protections	Over-voltage and over-temperature	
Dimensions (W x L x H)	165 mm x 105 mm x 45 mm	165 mm x 105 mm x 60 mm
Weight	~ 500 g	

NOTE: specifications are subject to change without notice

4 DRIVE APPEARANCE

Drive DCS-3010(-HV) v.5 has 6 connectors (from Con. 1 to Con. 6) as it is shown in the Figure 4.1.

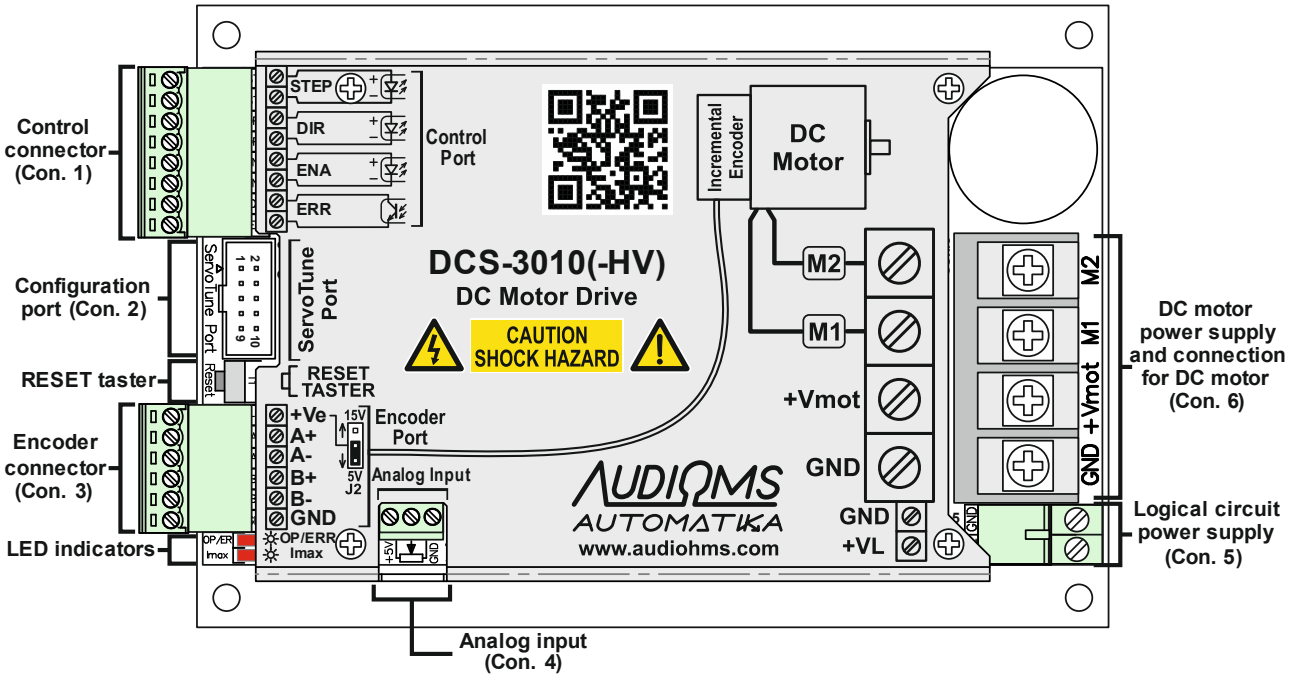


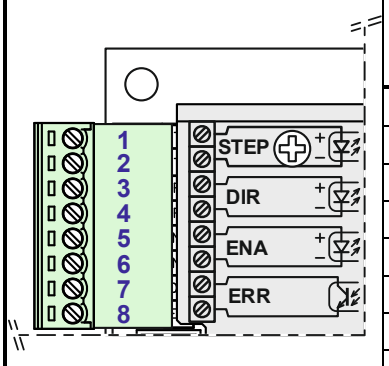
Figure 4.1 Connector positions on drive DCS-3010(-HV)

4.2 Control connector

Digital controls (STEP/DIR/ENA, CW/CCW/ENA or Encoder) are brought over the 8-pin detachable connector (control connector – Con. 1) as well as Track Error output. Track Error output that is activated when the tracking error exceeds the set value of the offset.

Pin arrangement is presented in Table 4.1, and a schematic diagram of these pins is shown in Figure 4.2.

Table 4.1 Pins description of the Control connector (Con.1)



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

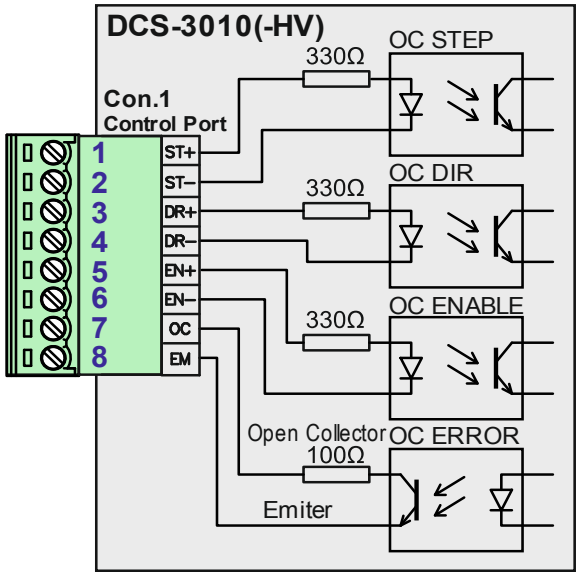


Figure 4.2 Schematic representation of opto-isolated inputs and outputs

There is a 330 Ω resistor at the opto-couplers for STEP, DIR and ENABLE command (Figure 4.2, resistors R1, R2 and R3) that limits the current to approximately 10 mA at the command voltage of 5V (TTL logical level).

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

EXAMPLE: If the drive DCS-3010(-HV) is control by using the PLC with 24 VDC logic levels, it is necessary in each of the lines 2, 4 and 6 to the connector Con. 1 add the 2.2 kΩ resistor.

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

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

4.2.1 Connection of the Control Connector

A complete line of Audioms Automatika motion controllers can be used to control DC servo drives DCS-3010(-HV).

Figure 4.3 gives the recommended way to connect the ETH-BOX motion controller to three (optionally possible to connect two to six) DC servo drivers DCS-3010(-HV). Outputs O1-O6 are used as STEP/DIR commands, while the ENA output is common (O24). The error output from all DCS-3010(-HV) servo drivers is common and is fed to the IN32 input of the ETH-BOX motion controller.

For more details on the ETH-BOX motion controller, refer to its user manual.

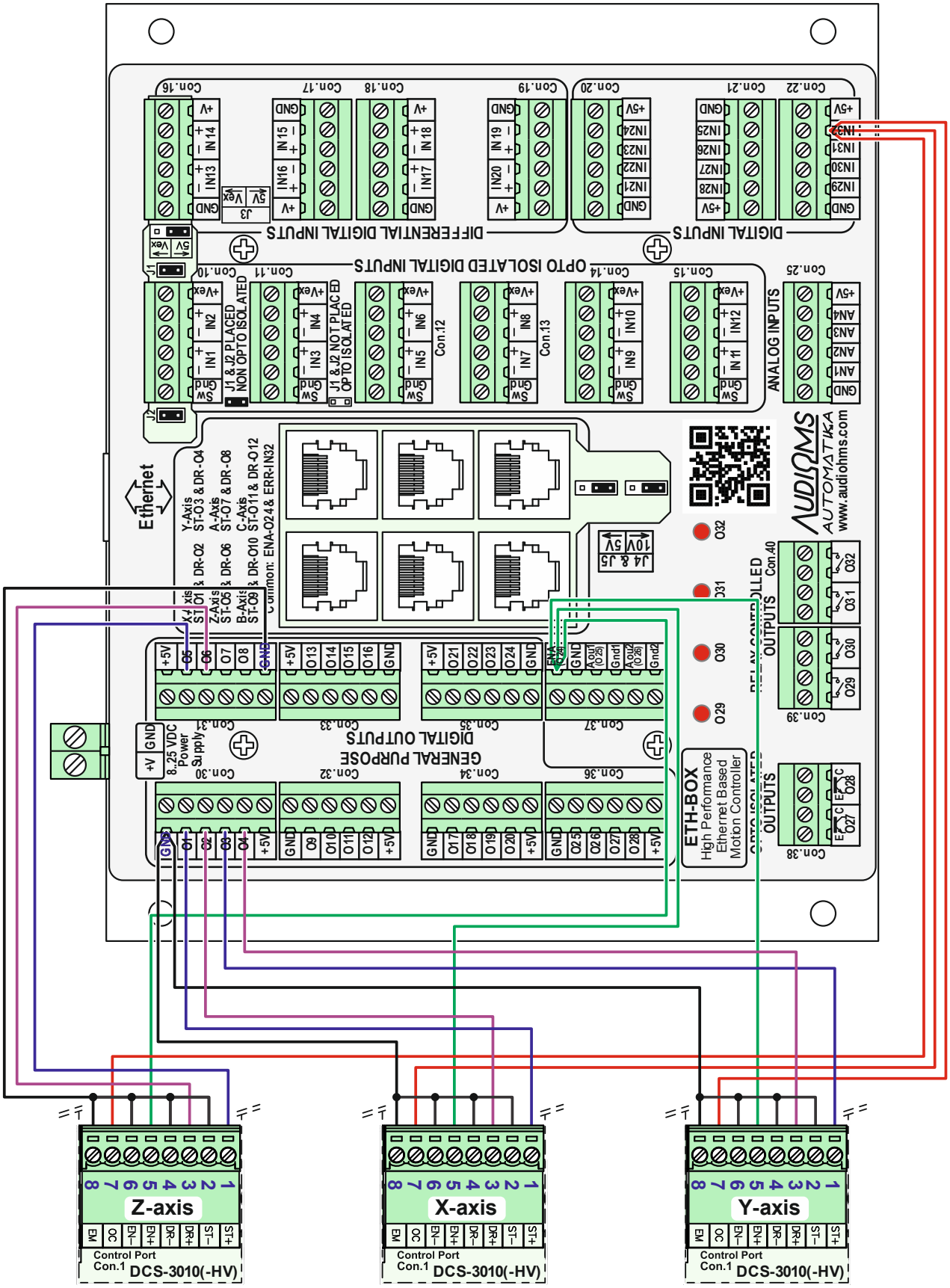


Figure 4.3 Control system with ETH-BOX motion controller

Figure 4.4 gives the recommended way to connect the ETH-MCI motion controller to four (optionally possible to connect two to six) DC servo drivers DCS-3010(-HV). Outputs O1-O8 are used as STEP/DIR commands, while the ENA output is common (O20). The error output from all DCS-3010(-HV) servo drivers is common and is fed to the IN12 input of the ETH-MCI motion controller.

For more details on the ETH-MCI motion controller, refer to its user manual.

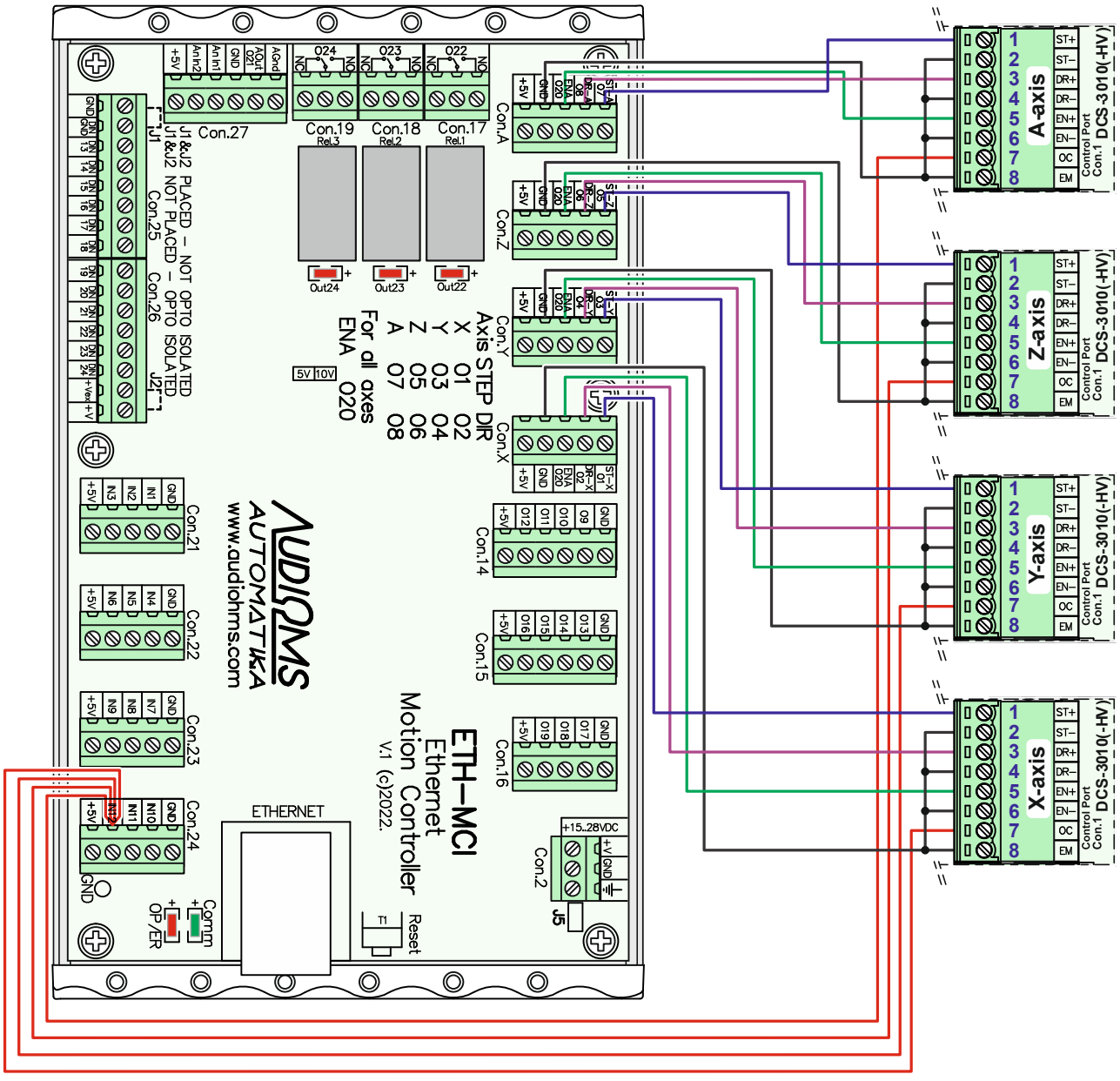


Figure 4.4 Control system with ETH-MCI motion controller

Figure 4.5 and Figure 4.6 give the recommended way to connect the ISO-USB-BOX motion controller, as well as the USB-MC motion controller and the USB-UIO1 breakout board to four DC servo drivers DCS-3010(-HV) (optionally it is possible to connect two to six drivers). Outputs O1-O8 are used as STEP/DIR commands, while the ENA output is shared (O12). The error output from all DCS-3010(-HV) servo drivers is common and is fed to the IN5 input of the ISO-USB-BOX motion controller.

For more details on the ISO-USB-BOX motion controller, as well as the USB-MC motion controller and the USB-UIO1 breakout board, refer to the user manual of the mentioned products.

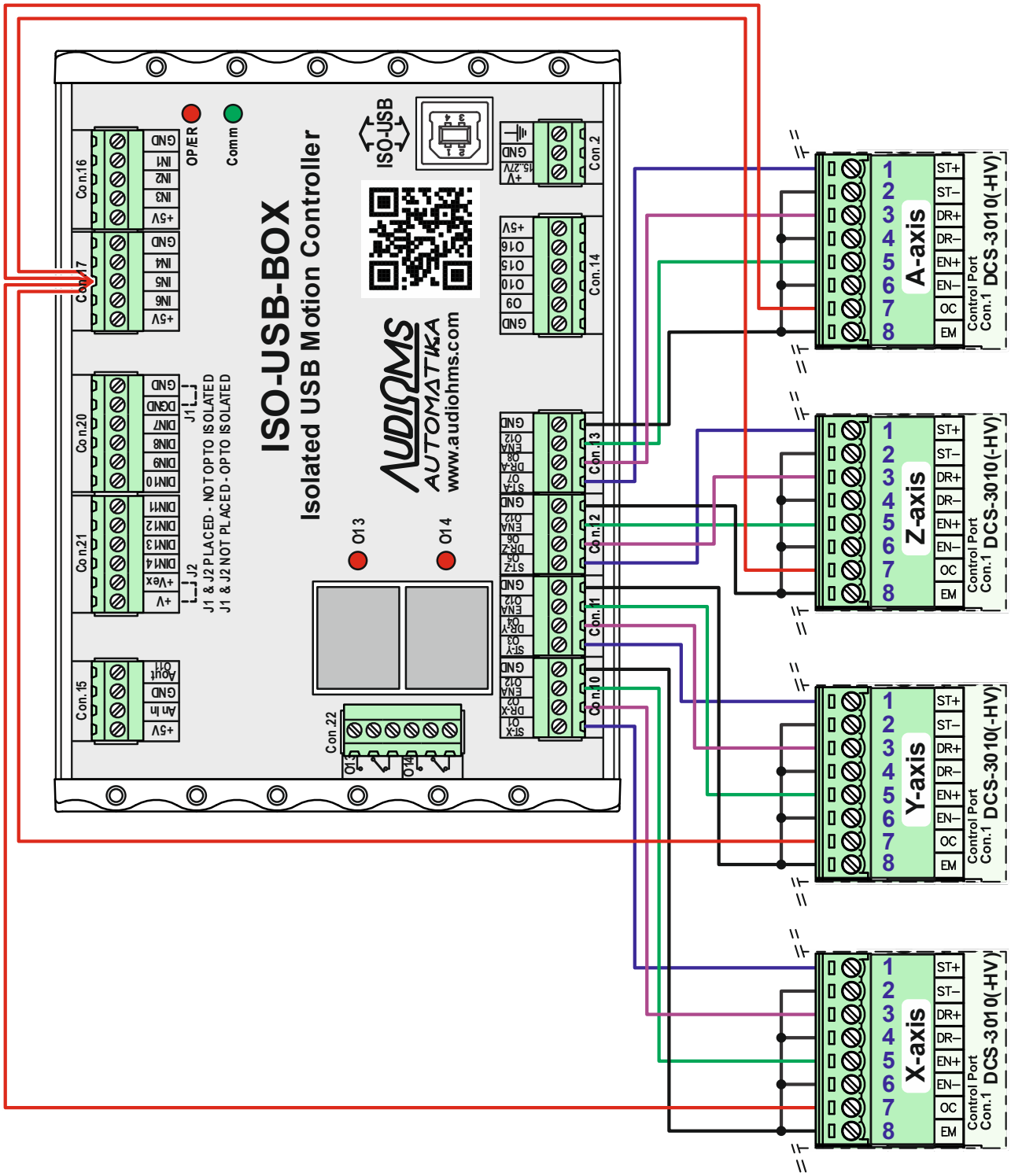


Figure 4.5 Control system with ISO-USB-BOX motion controller

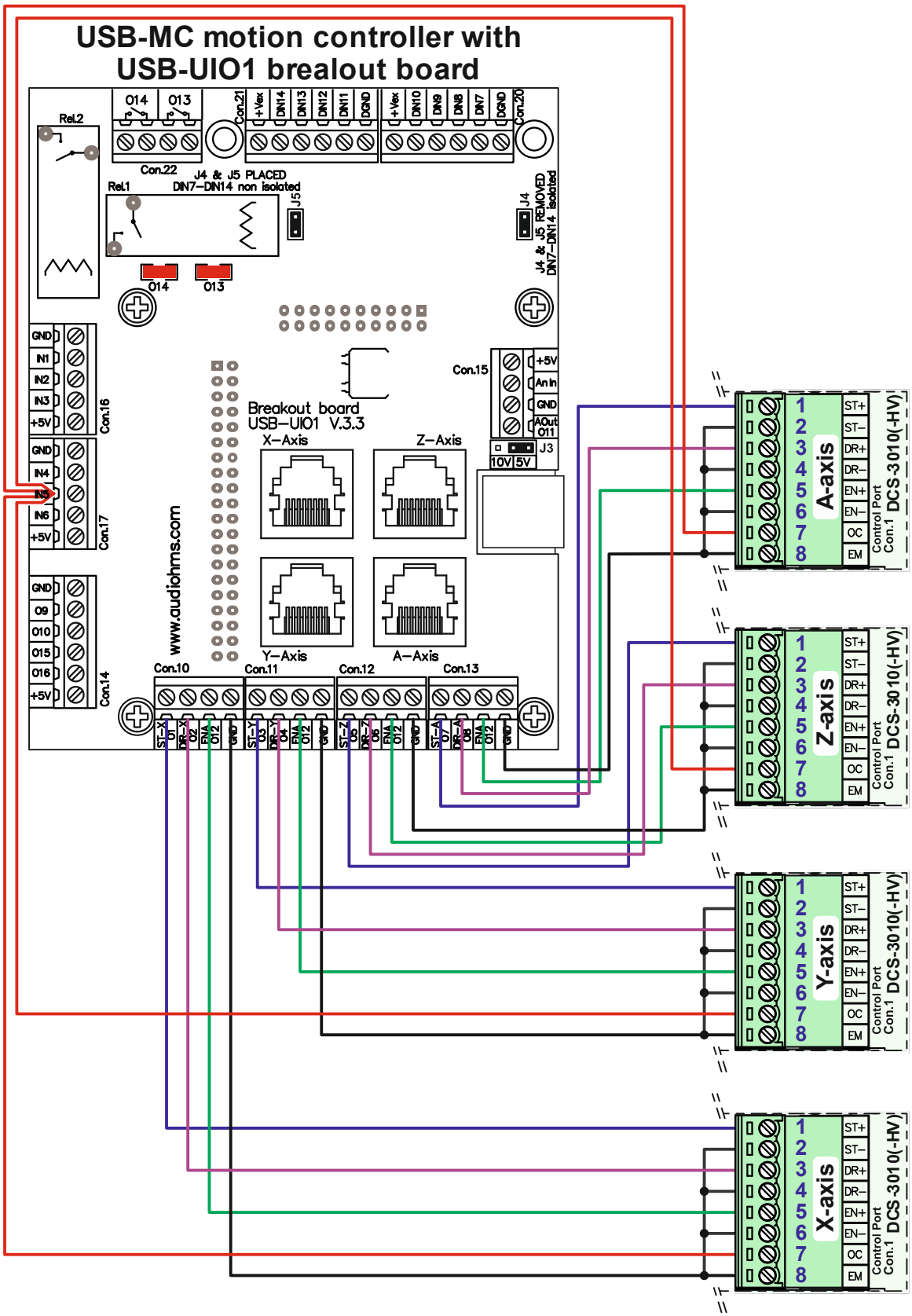


Figure 4.6 Control system with USB-MC motion controller and USB-UIO1 breakout board

Figure 4.7 gives the recommended way of connecting the breakout board R3 to four DC servo drivers DCS-3010(-HV) (optionally it is possible to connect two or three drivers). Outputs O2-O9 are used as STEP/DIR commands, while the ENA output is common.

The error output from all DCS-3010(-HV) servo drivers is common and is connected to input SW5 (IN5) of the breakout board IO3-R3 (shown by dashed lines).

For more details, refer to the breakout board IO3-R3 user manual.

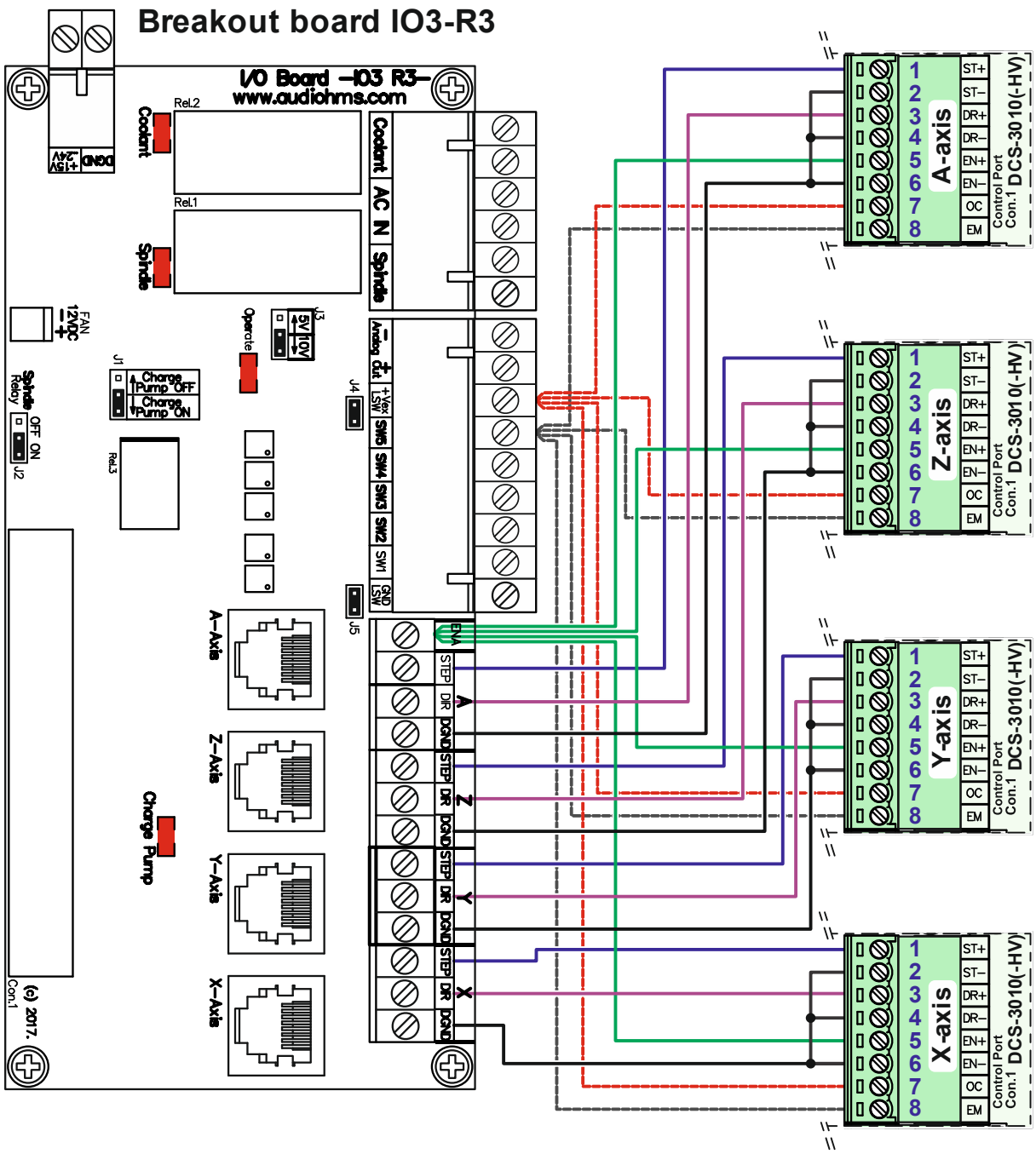


Figure 4.7 Control system with IO3-R3 breakout board

4.2.2 Servo driver control using PLC

DC servo driver DCS-3010(-HV) can also be controlled via a PLC that has a built-in module for generating the desired motion profiles. Connection is possible to both types of PLC, with outputs of the NPN type (Figure 4.8), as well as with outputs of the PNP type (Figure 4.9). It should be noted that the input interface (Control port) of the DCS-3010(-HV) servo driver can be configured to receive the following control modes:

- STEP/DIR,
- CW/CCW and
- via an incremental encoder (Encoder follower or Quadrature encoder mode).

PLCs generally have logic voltage levels of 24V, so it is necessary to add one resistor each to the STEP, DIR and ENABLE lines. Resistors R should be dimensioned so that the current on the STEP, DIR and ENABLE lines does not exceed 15 mA. In the case of a logic voltage level of 24V, the value of the resistor R (Figure 4.8 and Figure 4.9) should be 1.2–2.4 kΩ.

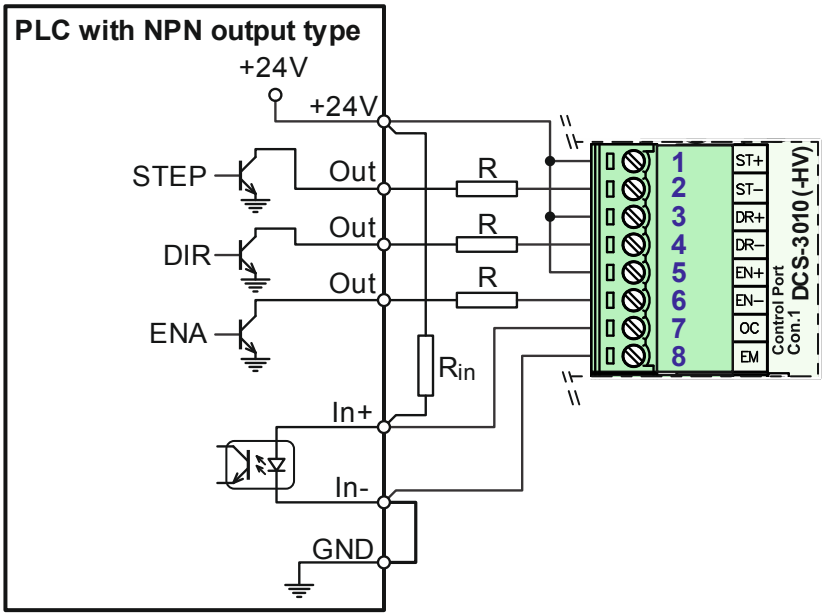


Figure 4.8 Connecting to a PLC with NPN type outputs

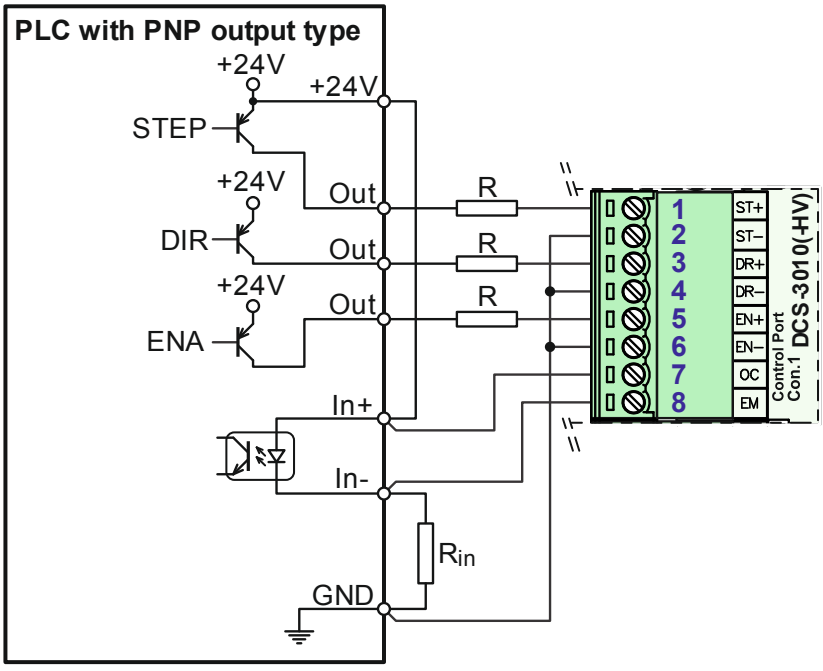


Figure 4.9 Connecting to a PLC with PNP type outputs

Figure 4.7 and Figure 4.8 also show two options for connecting the opto-isolated digital output from the DCS-3010(-HV) servo driver. The digital output from the DCS-3010(-HV) servo driver shows the error status of the driver. Resistor R_{in} (Figure 4.7 and Figure 4.8) determines the current of the input diode on the opto-isolator of the PLC; roughly, it can be in the range of 1.2–2.4 kΩ.

4.2.3 Servo driver control using an incremental encoder

In addition to STEP/DIR control, the input port of the DCS-3010(-HV) servo driver can be configured to receive a CW/CCW as well as an encoder signal. Setting up the input interface is described in more detail in chapter 9.10.1.

Figure 4.10 gives a proposal for connecting a Manual Pulse Generator as a control signal generator (Quadrature encoder signal). In this case the incremental encoder is powered by an internal +5V power supply from the DCS-3010(-HV) servo driver available on Con.5.

In order for the mentioned encoder control option to work, it is necessary to set the input interface type in the ServoTune3 configuration software as: Encoder x1 /ENABLE, Encoder x2 /ENABLE or Encoder x4 /ENABLE (see chapter 9.10.1).

NOTE: A 5V / 150mA power source is available on the Con.5 (Analog Input) connector.

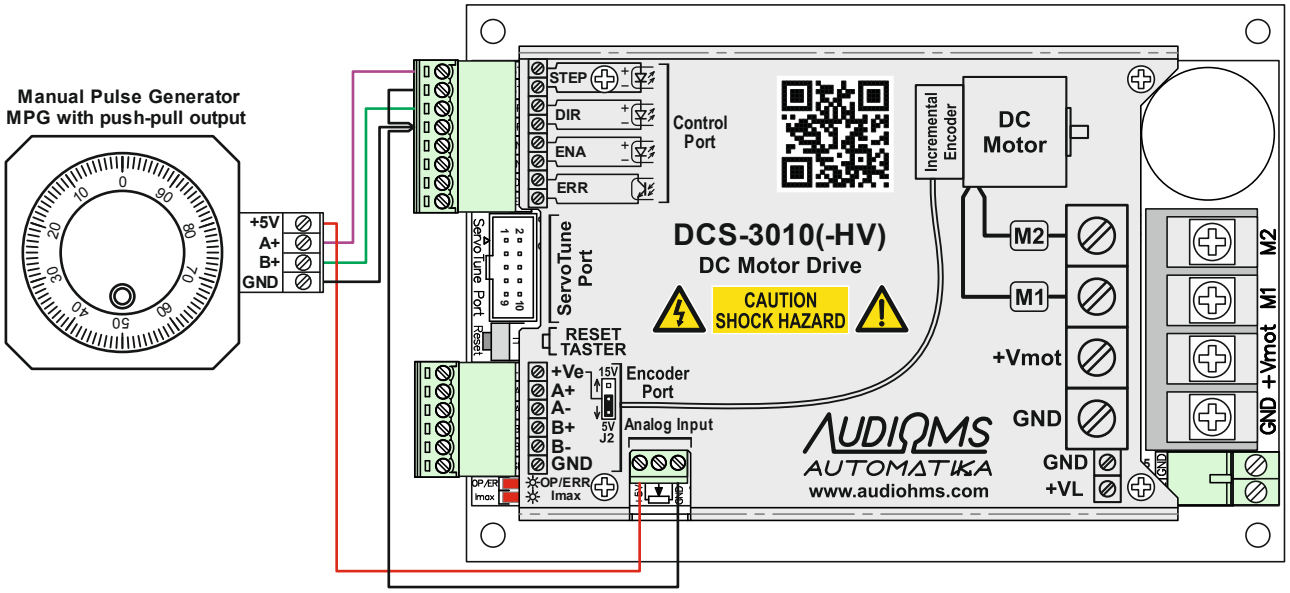


Figure 4.10 Servo driver DCS-3010(-HV) control using MPG-a

Figure 4.11 gives a control option with an incremental encoder.

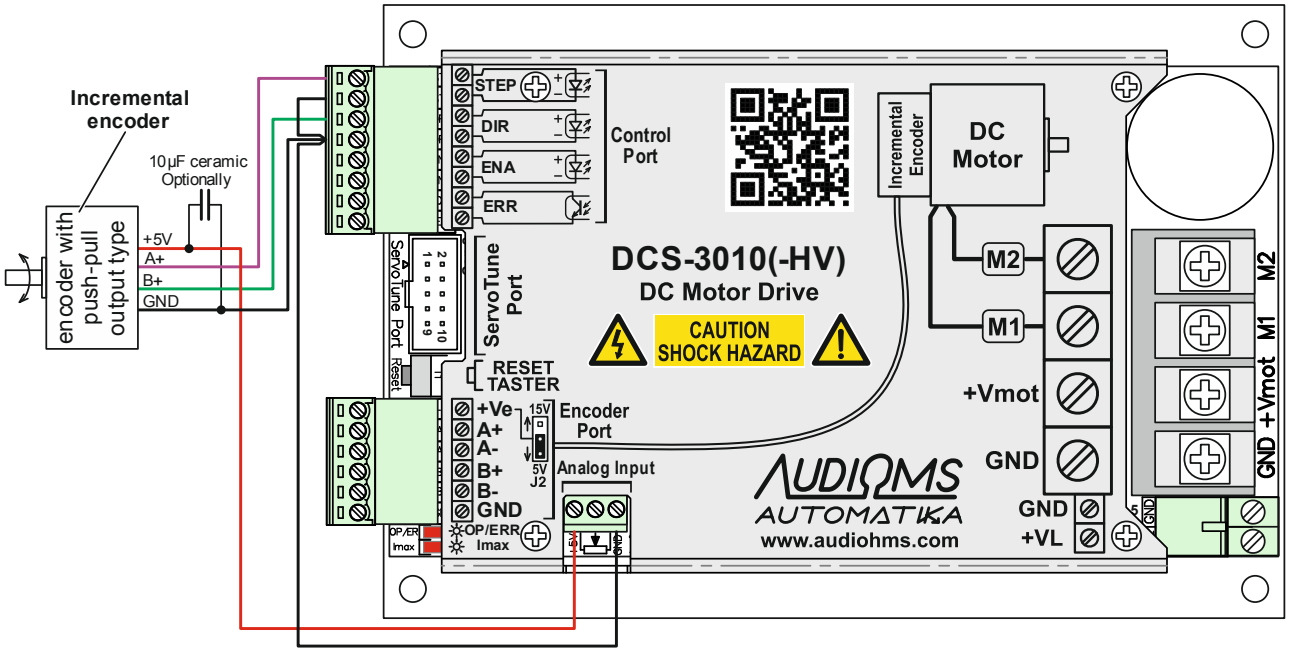


Figure 4.11 Servo driver DCS-3010(-HV) control using an incremental encoder

4.3 The configuration port

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

Isolated programming interfaces IPI-USB can be connected to the DC servo drive DCS-3010(-HV) via the configuration port marked as Con.2 in Figure 4.1 (10-pin IDC connector) (see Figure 4.12).

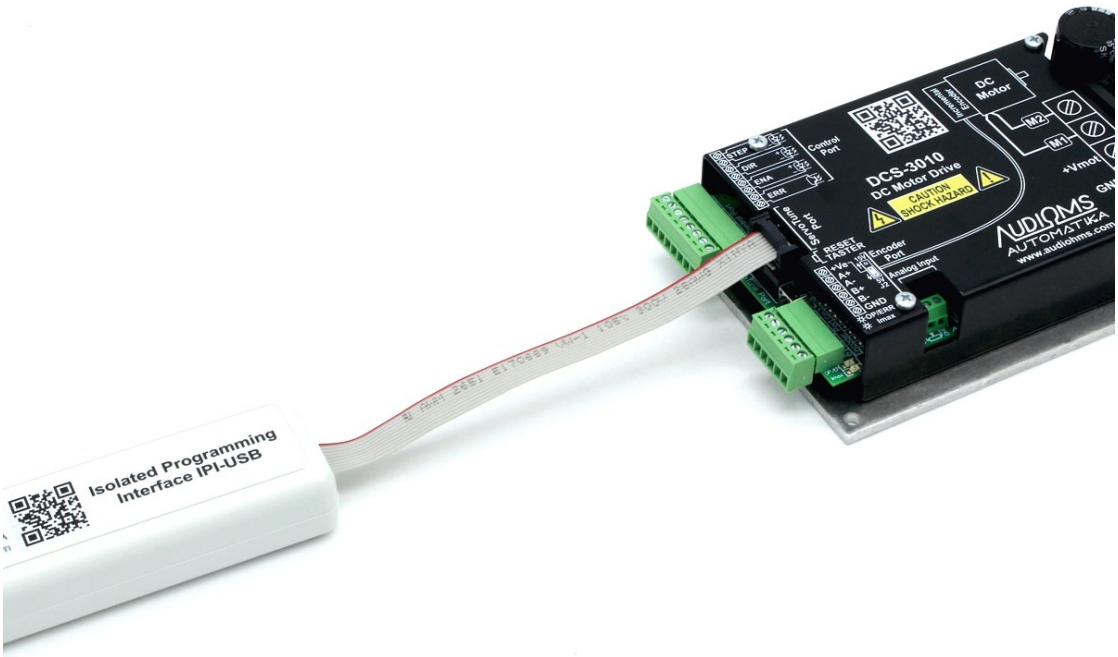
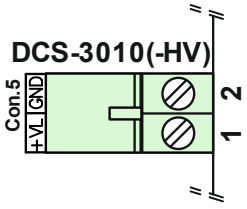


Figure 4.12 Servo driver DCS-3010(-HV) control using an incremental encoder

4.4 Logic circuit power supply

Logic circuit power supply of drive DCS-3010(-HV) is performed via a connector Con.5 (see Figure 4.1 and Table 4.2). Logic circuit supply voltage should be from 18–28 V DC / 0.5 A (optionally 1 A). It is not necessary that this source to be stabilized; it is enough that after rectification apply electrolytic capacitor with minimum capacitance 470 μF.

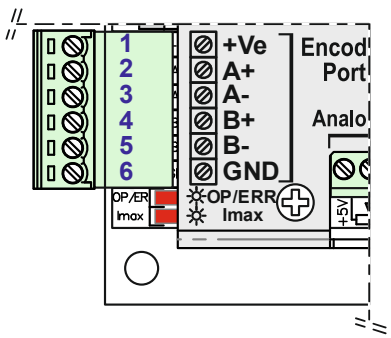
Table 4.2 Description of pins (terminals) in the 2-pin connector Con. 5

	Pin No.	Name	Description	Function
	1	+VL	Power supply +18–28V DC / 0.5 A (optionally 1 A)	Logic circuit power supply
	2	GND	GND	

4.5 Connecting the incremental encoder

For DC motor position feedback quadrature incremental encoder is used on DC servo drive DCS-3010(-HV). Encoder can be connected via encoder connector (connector Con.3 in Figure 4.1). Functions of this 6-pin detachable connectors are provided in Table 4.3.

Table 4.3 Description of the pins of the 6-pin encoder connector (Con.3)



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

Use an incremental encoder with phase-shifted square TTL outputs. On the DCS-3010(-HV) driver is the source of power supply for incremental encoder +5V / 250 mA max.

As feedback by position, it is recommended to use an incremental encoder with differential (complementary) outputs (A+, A-, B+ and B- outputs, Figure 4.13).

In order to reduce the impact of high-frequency electrical interference, it is recommended to use a shielded cable for the connection of the incremental encoder. The cable for connecting the incremental encoder should not be longer than the specific application requires.

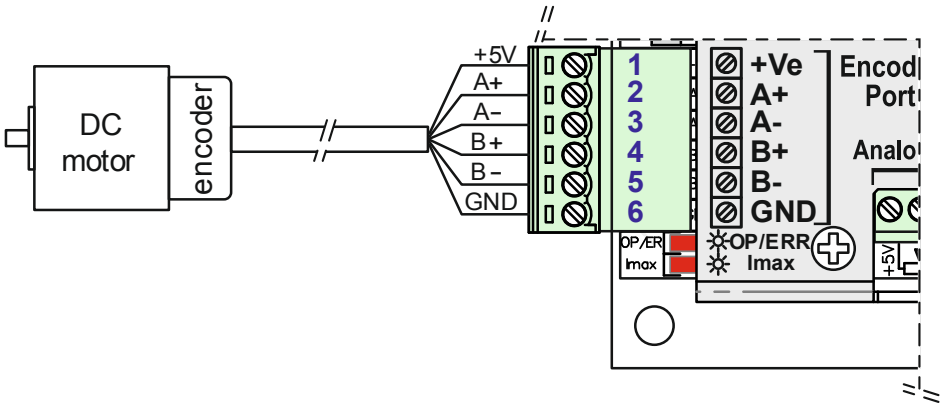


Figure 4.13 Connecting the incremental encoder with differential (complementary) outputs to the servo driver DCS-3010(-HV)

To connect an incremental encoder with single-ended outputs to the DCS-3010(-HV) servo driver, it is recommended to use the SED2 encoder interface (Figure 4.14). Encoder interface SED2 is a line driver that converts a single-ended input signals (A, B and Z) from an incremental encoder into differential (complementary) outputs (A+, A-, B+, B-, Z+ and Z-). A+, A-, B+ and B- outputs are used for DCS-3010(-HV) servo driver operation.

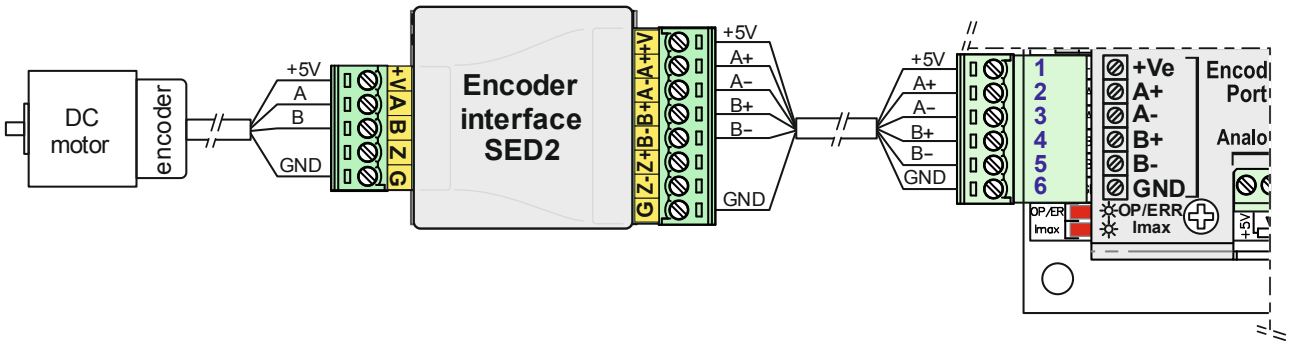


Figure 4.14 Connecting an incremental encoder with single-ended outputs to a DCS-3010(-HV) servo driver using the SED2 encoder interface – **recommended connection method**

An incremental encoder with single-ended outputs can be connected directly to the DCS-3010(-HV) servo driver (Figure 4.15).

NOTE: Connecting an incremental encoder with single-ended outputs to the DCS-3010(-HV) servo driver (Figure 4.15) is NOT RECOMMENDED FOR LONGER CABLE LENGTHS.

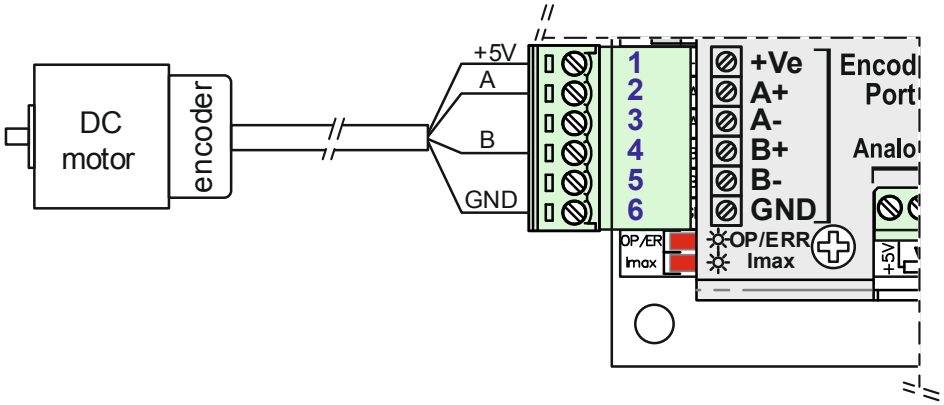


Figure 4.15 Connecting an incremental encoder with single-ended outputs to the DCS-3010(-HV) servo driver – **not recommended**

4.6 Supplying an incremental encoder with a supply voltage higher than 5V

4.6.1 Powering encoder using internal power source from the DCS-3010(-HV) servo driver

In addition to the 5 VDC source, a 15 VDC source is also available on the DC servo driver DCS-3010(-HV) to power the incremental encoder. The selection of the supply voltage of the incremental encoder can be made using jumper J2, which can be accessed after removing the metal cover from the servo driver DCS-3010(-HV) (Figure 4.16). In order to remove the cover, it is necessary to unscrew the four screws located on the upper side of the DCS-3010(-HV) driver cover.

NOTE: Before removing the cover, turn off the power to the DCS-3010(-HV) driver.

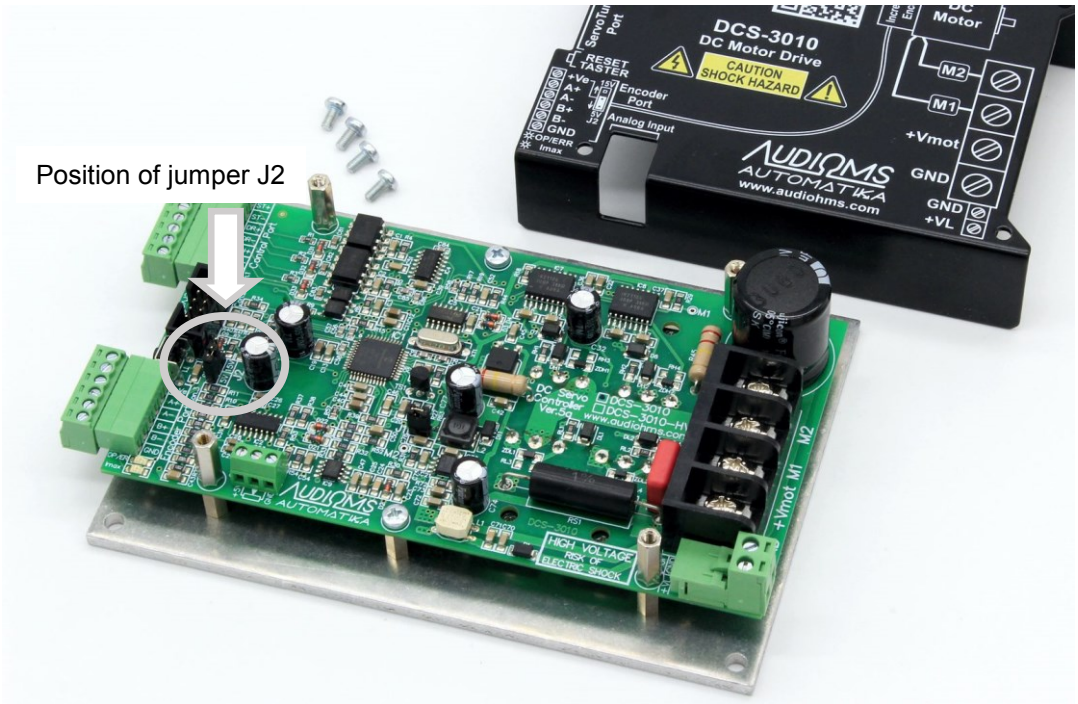
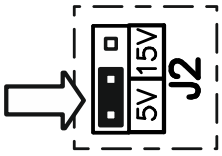
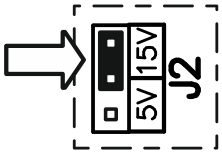


Figure 4.16 Position of jumper J2 on servo driver DCS-3010(-HV)

Table 4.4 gives the positions of the jumper J2 for selecting the +5 VDC or +15 VDC power supply of the incremental encoder.

Table 4.4 Description of jumper J2 positions

Jumper J2 position	Description
	Position of jumper J2 in case of selection of internal power source for incremental encoder of +5 VDC / 250 mA
	Position of jumper J2 in case of selection of internal power supply for incremental encoder of +15 VDC / 200 mA

NOTE: After selecting the desired supply voltage of the incremental encoder, it is necessary to return the cover of the DCS-3010(-HV) servo driver.

It should be noted that it is possible to connect an incremental encoder as shown in Figure 4.13, Figure 4.14 and Figure 4.15 depending on the type of incremental encoder available.

4.6.2 Powering encoders with differential outputs using an external power source

Figure 4.16 gives one possible way of connecting an incremental encoder with differential outputs (A+, A-, B+ and B-) that requires a supply voltage higher than 15 VDC directly to the DCS1 servo driver. At the same time, the same source from which the logic circuit of the DCS1 driver is powered was used to power the incremental encoder.

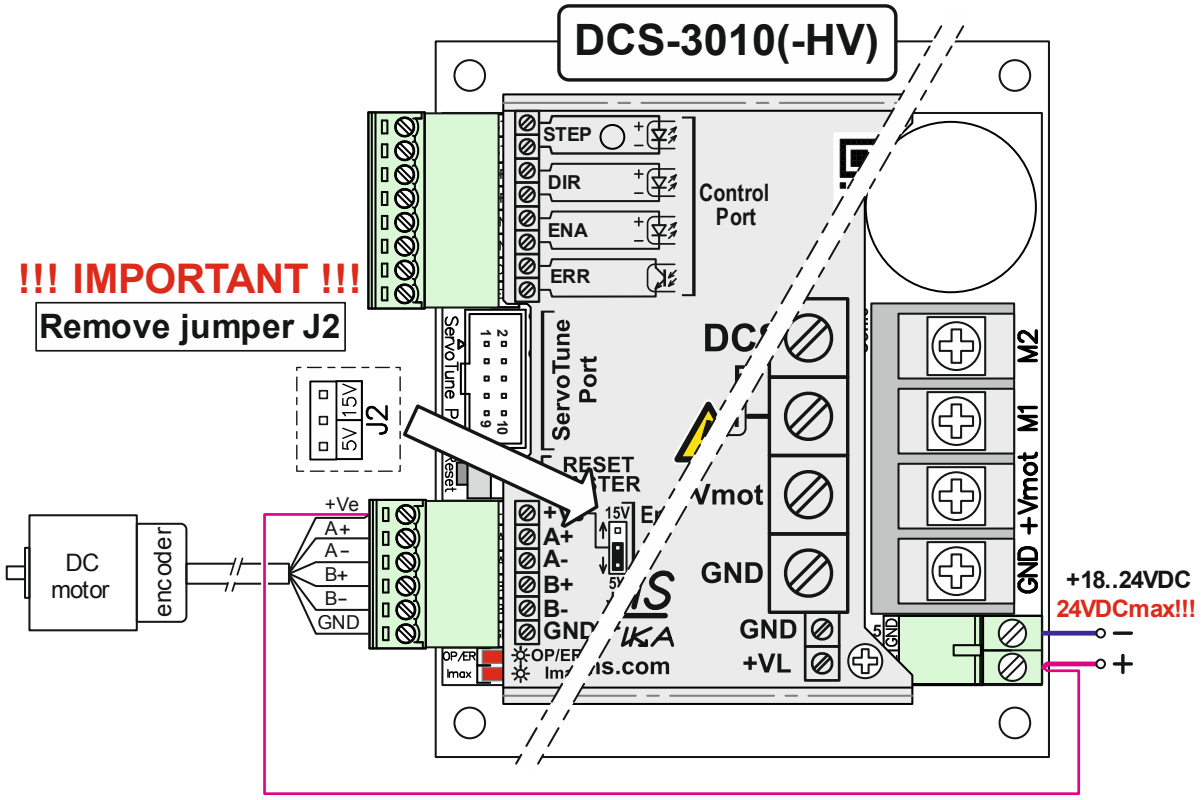


Figure 4.17 Connection of incremental encoder that requires a supply voltage higher than 15VDC

IMPORTANT NOTE: In case the incremental encoder is connected as shown in Figure 4.17, jumper J2 must be removed. Figure 4.16 gives the position of jumper J2. OTHERWISE, THE DCS1 DRIVER MAY BE PERMANENTLY DAMAGED. ALSO THE MAXIMUM SUPPLY VOLTAGE IN THIS CASE IS 24VDC. CHECK THE SPECIFICATIONS OF THE SPECIFIC INCREMENTAL ENCODER.

Figure 4.18 gives the option of connecting an incremental encoder with differential outputs that requires a supply voltage higher than 15VDC. To power the incremental encoder, an additional independent power source us used. This power supply that must be galvanically isolated from the power supply of the logical part of the DCS1 servo driver circuit.

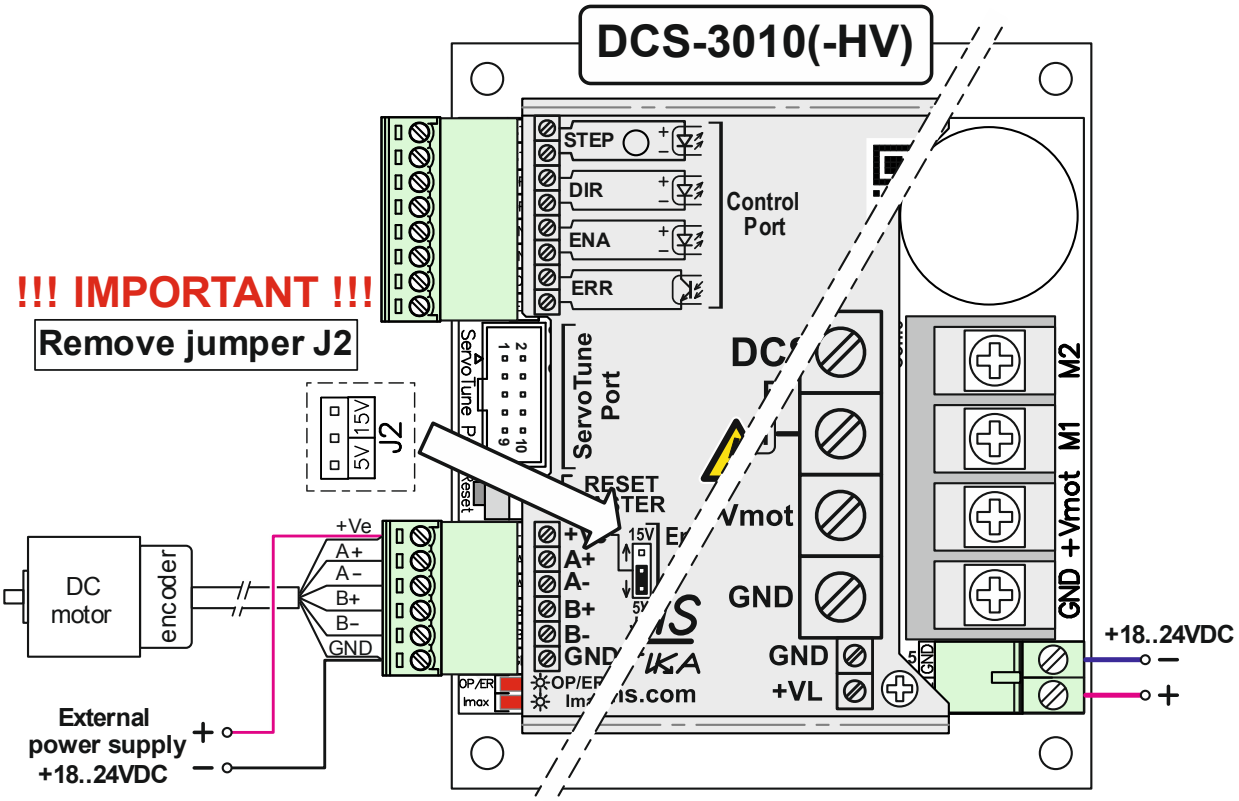


Figure 4.18 The method of connecting the incremental encoder which requires a supply voltage higher than 15VDC – realized with an additional power supply source

4.6.3 Powering encoders with single-ended outputs using an external power source

If an incremental encoder with single-ended outputs A and B is used that requires a supply voltage higher than 15VDC, then the use of the encoder interface SED2 is recommended.

Figure 4.19.a gives the recommended wiring diagram of an incremental encoder with single-ended outputs (A and B) that requires a supply voltage higher than 15VDC to a DCS-3010(-HV) DC servo driver. The SED2 encoder interface was used to connect the incremental encoder, while the same power supply from which the logic circuit of the DCS-3010(-HV) driver is powered was used for incremental encoder supply.

IMPORTANT NOTE: It is necessary to remove the jumper from the encoder interface SED2 (as shown in Figure 4.19.b and Figure 4.19.c). In this way, the connection between the +V lines from the left and right connectors of the encoder interface SED2 is broken. OTHERWISE, THE DCS-3010(-HV) DRIVER MAY BE PERMANENTLY DAMAGED.

CHECK THE SPECIFICATIONS OF THE SPECIFIC INCREMENTAL ENCODER.

An additional independent power supply of up to 24VDC can be used to power the incremental encoder. Figure 4.19.d gives the recommended wiring diagram of an incremental encoder with single-ended outputs (A and B) in the case when an additional independent power supply source is used. The additional power source must be galvanically isolated from the supply of the logic part of the DCS-3010(-HV) driver circuit.

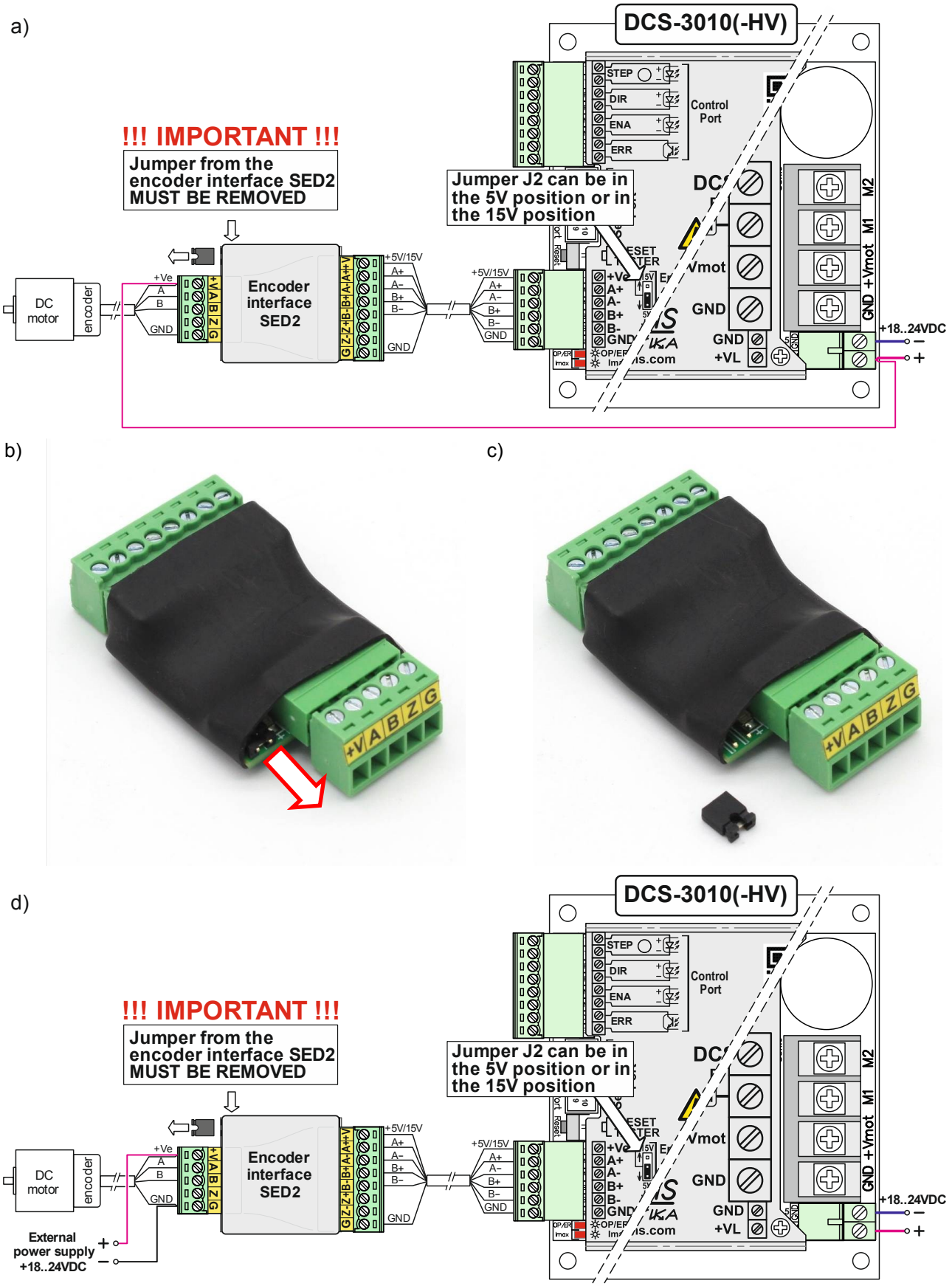


Figure 4.19 The method of connecting an incremental encoder with single-ended outputs that requires a supply voltage higher than 15VDC, a) connection diagram, b) position of the jumper on the encoder interface SED2, c) the jumper removed from the encoder interface SED2 and d) connection option when using an independent power supply source to supply the incremental encoder

4.7 Analog input

DC servo drive DCS-3010(-HV) has the ability to control DC motor via the reference voltage of 0–5 V which is applied to the analog input connector (Con. 4 in Figure 4.1). External potentiometer with nominal resistance of 1–10 kΩ can be directly connected at the analog input connector as shown in Figure 4.20.a.

NOTE: A 5V / 100 mA power supply is available on the Con.5 connector.

Figure 4.20.b the connection of external motion path generator. Voltage at the motion path generator output should not exceed 5 V DC.

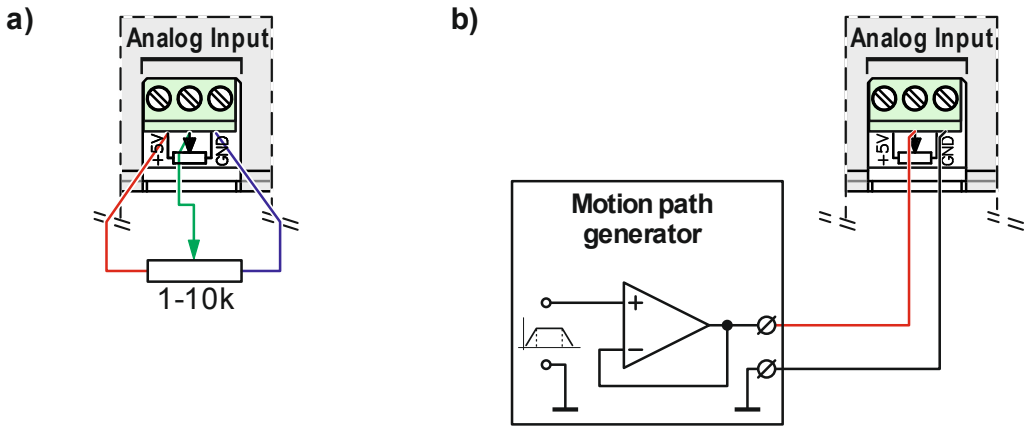
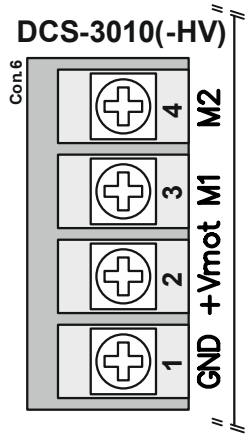


Figure 4.20 Voltage reference analog input DC servo drive DCS-3010(-HV) generated over, a) external potentiometer and b) motion path generator

4.8 DC motor power supply and connection for DC motor

DC motor power supply and connection for DC motor is located on the connector Con. 6 (see Figure 4.1 and Table 4.5).

Table 4.5 Description of pins (terminals) of connector Con. 6



Pin No.	Name	Description	Function
1	GND	Ground	DC motor power supply
2	+Vmot	+10–115VDC (DCS-3010)	
		+20–180VDC (DCS-3010-HV)	
3	M1	DC motor terminal	Connecting DC motor
4	M2	DC motor terminal	

DC motor power supply voltage V_{mot} should be 10–15% higher than nominal supply voltage of DC motor, i.e.:

$$V_{mot} = 1{,}15 \cdot U_n \tag{1}$$

NOTE: Power supply voltage of DC motor V_{mot} must not exceed the maximum value of the drive DCS-3010(-HV) supply voltage.
If after connecting the DC motor to terminal M1 and M2 and after the arrival of the supply voltage, the motor starts rotating, and then stops and OP/ER LED indicator starts to flash 2 times (Tracking error indicator; see Table 7.1), it is necessary to replace motor terminals M1 and M2 (DC motor terminal M1 connect to terminal M2 and DC motor terminal M2 connect to terminal M1).

EXAMPLE:
Nominal DC motor supply voltage DC is $U_n = 48VDC$. What is the voltage required to power a DC motor?

$$V_{mot} = 1{,}15 \cdot U_n = 1{,}15 \cdot 48 = 55{,}2VDC \approx 55VDC$$

Calculating the voltage of the secondary windings of the transformer used to supply DC motor is calculated using the expression:

$$U_{sek} = 1{,}2 + \frac{V_{mot}}{1{,}41} \tag{2}$$

EXAMPLE:
For the previously calculated supply voltage of DC motor $V_{mot} = 55DVC$, secondary winding power transformer voltage is:

$$U_{sek} = 1{,}2 + \frac{V_{mot}}{1{,}41} = 1{,}2 + \frac{55}{1{,}41} = 40{,}2VAC \approx 40VAC$$

The current of transformer secondary winding depends on the characteristics of the connected DC motor and it should be 50–100% higher than motor's nominal current. It is necessary to know that the DC motor in certain operating modes can pull much more current than it is nominal.

5 CONNECTING THE COMPLETE CONTROL SYSTEM

IMPORTANT: When connecting the complete control system, it is necessary, above all, to pay special attention to the connection of the power supply system in order to avoid an unwanted loop when connecting the ground (avoidance of the so-called "ground loop").

Figure 5.1 gives an example of a complete control system of a CNC machine implemented using a DC servo driver DCS-3010(-HV).

The power supply is realized using two transformers. The first one is used to power the DC servo motor (Figure 5.1 - Transf.1). The motor brake MB-2 with brake resistor is connected in the rectifier circuit for the power supply of the DC servo motor.

The second transformer is designed to power the logic parts of the DC servo driver DCS-3010(-HV) circuit as well as to power the motion controller (Figure 5.1 - Transf.2). Use galvanically isolated power sources on the second transformer (Transf.2), which is realized with separate secondary windings in the transformer. In this way, an unwanted ground loop is avoided.

In the given example of the CNC machine control system (Figure 5.1), an ISO-USB-BOX motion controller is used. In addition to it, it is possible to use any Audioms Automatika doo motion controller.

Figure 5.1 does not show all the details about the connection of the control system, such as the connection of the Error tracking output from the DC servo driver, the connection of limit switches, etc.

Figure 4.3, Figure 4.5, Figure 4.6 and Figure 4.7 give more details about connecting the Error tracking output from the DC servo driver DCS-3010(-HV) to the available Audioms Automatika doo motion controllers.

More details about connecting other peripherals are available in the user manual for the specific motion controller selected.

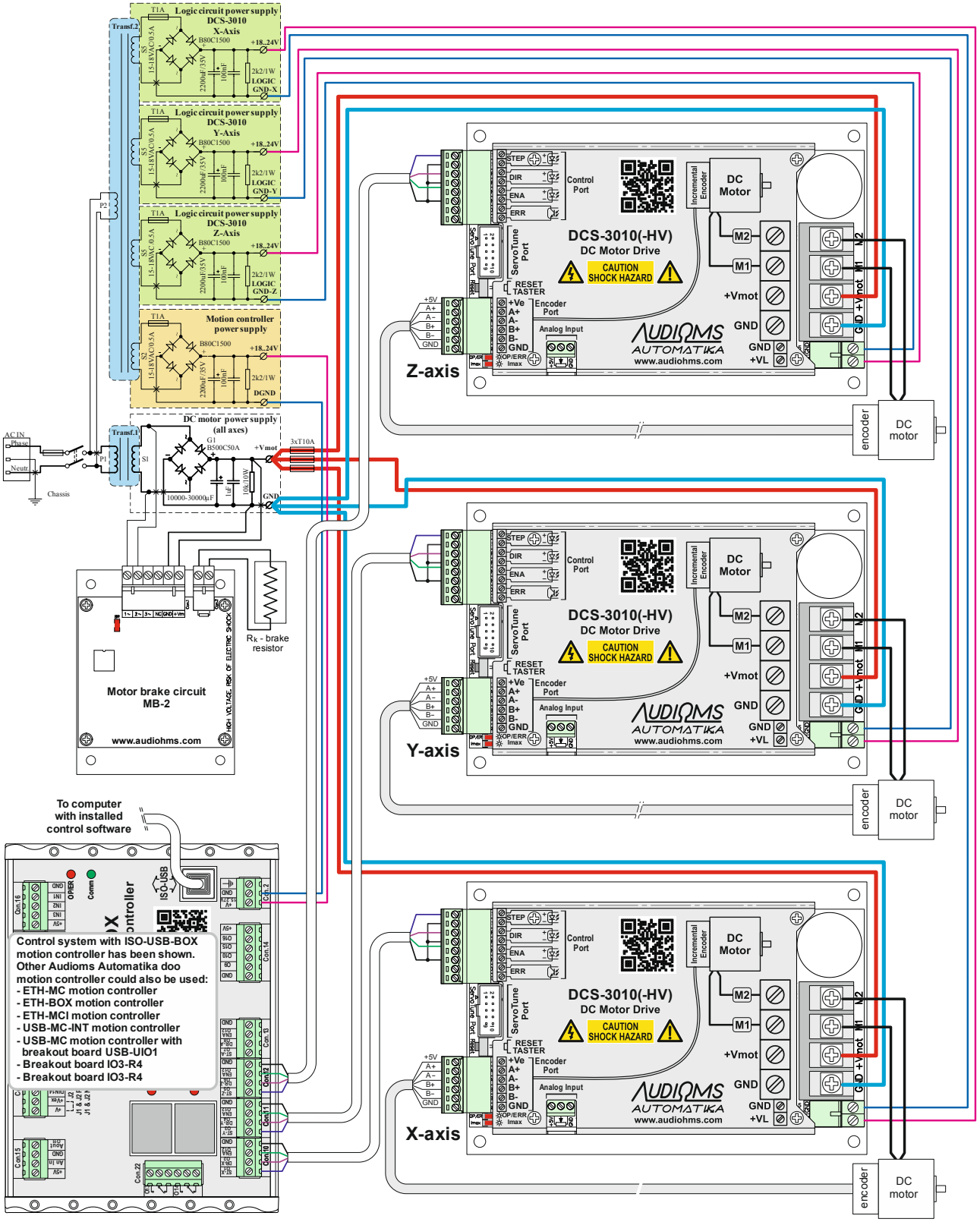


Figure 5.1 CNC machine control system

6 RESET BUTTON

RESET button is placed between configuration port Con.2 and connector for encoder Con.3 (see Figure 4.1). By pressing the RESET button it is possible to cancel the present error of DC servo drive.

In addition, pressing the RESET button performs the disable of output H-bridge, so it is possible to rotate the rotor of DC motor without disconnection of supply voltage.

7 LED INDICATORS

There are 2 LED indicators on the drive as follows:

- multifunctional red **OP/ER** LED indicator (Table 7.1), and
- red LED indicator **Imax** shows exceeding the maximum set current DC motor.

Table 7.1 Description of the state multifunctional **OP/ER** LED indicator

OP/ER	**Description**	
○	The control electronics is not under voltage	
●	Drive ready to start – ENABLE	
1 x ☀	Drive ready to start – DISABLE	
Errors	**Description**	**Action needed**
2 x ☀	Tracking error	- Increase the value of Error offset - Press the RESET button
3 x ☀	Encoder error	- Check the condition of the encoder and encoder cable - Turn off error detection of encoder - Press the RESET button
4 x ☀	Over-temperature protection is activated *	- Provide better cooling of the drive - Press the RESET button
5 x ☀	Over-voltage protection **	- Provide a source with the lower voltage for DC power supply
6 x ☀	Circuits for setting the level of the maximum current error	- Press the RESET button - Contact the authorized service
7 x ☀	Error of microcontroller	- Press the RESET button - Contact the authorized service

** The limit of activation over-temperature protection is set at 70 °C.*

*** The limit of activation over-voltage protection is set at 120 VDC (DCS-3010 servo drive), i.e. 210 VDC (DCS-3010-HV servo drive).*

8 WARRANTY

Manufacturer guarantees that all DC servo drives DCS-3010(-HV) will work in proper upon delivery. Before delivery all DC servo drives DCS-3010(-HV) are tested on power supply voltage which is near to nominal voltage with connected DC motor and output current up to 20 A. Supply voltage which that exceeds the maximum allowed value, incorrectly connected power supply, incorrectly connected and defective DC servo motor, strong electromagnetic discharge (close to contactor) etc. can damage the drive.

9 ServoTune3 – INSTRUCTIONS MANUAL

To adjust the parameters of drive DCS-3010(-HV) use the configuration software **ServoTune3** (Figure 9.1). The software consists of a single file and to install it is necessary to copy the file to the desired folder on your computer.

The configuration software  ServoTune3 will works on Windows XP, Windows Vista or Windows 7/8/10 operating system.

Software ServoTune3 enables:

- Adjusting the PID controller constants,
- Adjusting the encoder resolution multiplication,
- Adjusting the steps multiplier,
- Enable/disable of drive DCS-3010(-HV),
- Setting the number of steps to capture the response of DC motor on step function and drawing diagrams of the motor position response, diagram of voltage and current change,
- Adjusting values of Tracking error offset,
- Read the current value of the position of DC servo motor,
- Recording of log file with the values of set position, current position difference and values of the DC motor electric current,
- Selection of input interface type (STEP/DIR/ENA, CW/CCW/ENA, encoder 1x, 2x or 4x or analog input with and without feedback),
- Selection of PWM frequency,
- Setting options of digital filter for encoder input,
- Setting the maximum electric current through DC motor etc.

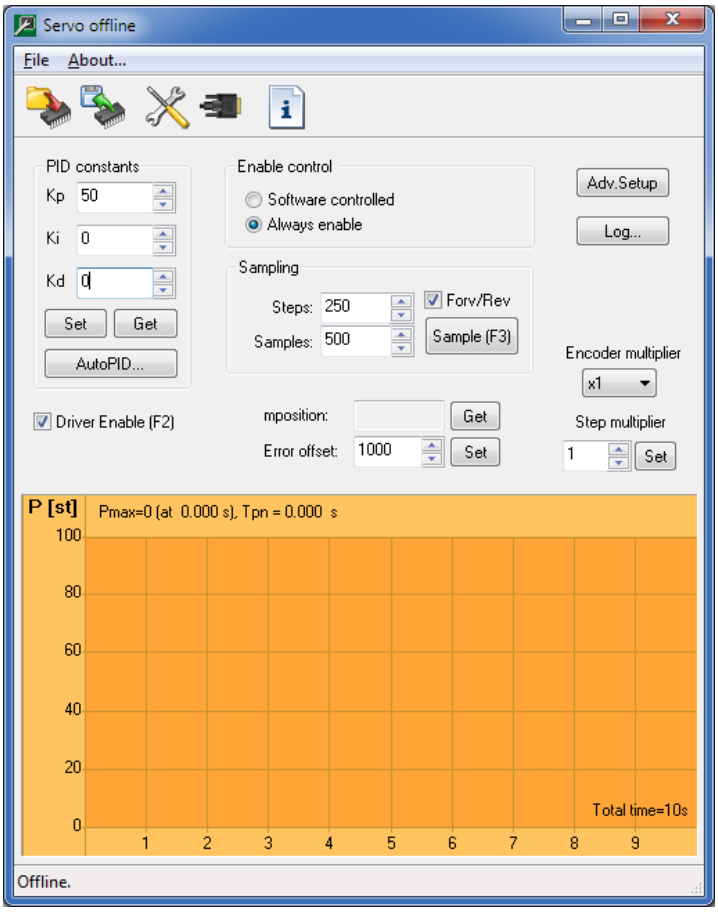


Figure 9.1 ServoTune3

NOTE: Software ServoTune3 is used for adjustment of working parameters of drive DCS-3010(-HV). This software is not appropriate to control DC motor.

DC servo drive for driving DC motors with high supply voltage DCS-3010-HV is supported by ServoTune version V3.10 and later.

9.1 COM port selection

Connection between software ServoTune3 and PC with drive DCS-3010(-HV) is achieved via isolated programming interfaces IPI-USB. Setting parameters for the COM port is done through dialogue from the Figure 9.2 which is accessed by selecting option **File -> Communication setup** or by pressing the icon  . Set the serial number of the COM port that is connected to the interface for programming as well as the desired baud rate. If check box 'Save to EEPROM' is activated, selected value of baud rate will be saved in microcontroller EEPROM.

NOTE: Option "This is Bluetooth port" should be left unchecked.

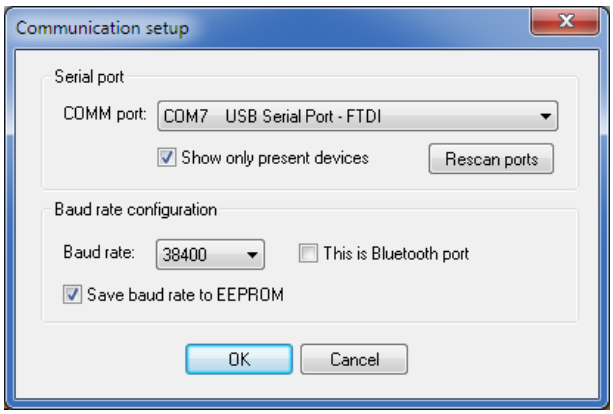


Figure 9.2 Communication setup dialog

At the ServoTune3 application top will appear label that the drive is online with version of firmware (Figure 9.3) if communication between PC and drive is established. From drive DCS-3010(-HV) all parameters will be read and printed in the appropriate fields.

Figure 9.3

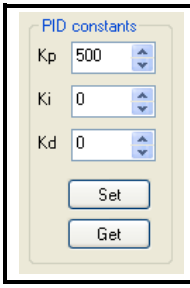
In the case that communication is not achieved with the drive DCS-3010(-HV), after starting software ServoTune3 warning dialog will appear, as it is shown in Figure 9.4 and **servo offline** status in main window, as it is shown in Figure 9.1.

Figure 9.4 Error opening COM port

This error occurs when the parameters are not set up correctly (number of COM port and baud rate) or when the programming interface is not connected to the drive. In some cases, may occur a breakdown in communication with the drive DCS-3010(-HV) and then it is necessary shut down the ServoTune3 software, restart the drive DCS-3010(-HV) by pushing RESET button and start the ServoTune3 software again.

9.2 Setting the PID controller constants

Drive DCS-3010(-HV) is based on the 16-bit RISC microcontroller with PID control algorithm in it. Setting these constants is performed in fields that are shown in the table below.



Name	Description	Minimum	Maximum	Default
Kp	Proportional gain constant	0	32768	50
Ki	Integral gain constant	0	32768	0
Kd	Derivative gain constant	0	32768	0

Pressing the button **Get** from EEPROM values for Kp, Ki and Kd will be read. To write new values in EEPROM microcontroller, it is necessary to press the **Set** button.

NOTE: During setting PID constants take all precautions as it may cause oscillation in DC servo motor – machine mechanics system.

9.3 Setting the encoder resolution multiplication

Drive DCS-3010(-HV) has the capability of software adjustment for encoder resolution multiplication. So it is possible to encoders with relatively small number of pulses per revolution to obtain 2 or 4 times higher resolution.

	Name	Description	Values
Enc: x1	Enc	Encoder resolution multiplication	x1, x2 and x4

EXAMPLE:
Encoder with resolution 500PPR (pulses per revolution) will have:

- 500PPR for encoder multiplication 1x,
- 500PPR x 2 = 1000PPR for encoder resolution multiplication 2x and
- 500PPR x 4 = 2000PPR for encoder resolution multiplication 4x.

9.4 Setting the steps multiplier

Steps multiplier shows how many steps do the DC servo motor for each pulse on the STEP command line. This parameter is useful in the case of using the high-resolution encoder, but STEP command generator has no possibility of generating pulses of sufficiently high frequency.

	Name	Description	Minimum	Maximum	Default
Step multiplier 1 Set	Step multiplier	Step multiplication	1	50	1

To write desire values in EEPROM microcontroller, it is necessary to press the **Set** button.

NOTE: Higher values for the step multiplier can lead to unsmooth movement, especially at low speed.

9.5 Control of enable input on drive DCS-3010(-HV)

Options for control of drive DCS-3010(-HV) enable input are shown in Table below.

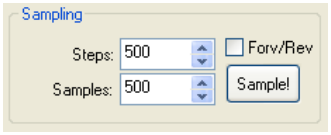
	Name	Alternatives
Enable control Software controlled Always enable	Enable control	**Software controlled** – In this mode ENABLE input at control connector Con.1 (Figure 4.1) is activated. If there is logical unit at the ENABLE input, the drive is active and will carry out the commands that come from STEP and DIR command lines. In the case that at ENABLE input is logic zero then the drive DCS-3010(-HV) is disabled, commands STEP and DIR are not carried out and DC motor is not under voltage (this option is often used if it is necessary to manually rotate the DC motor). **Always enable** – In this mode ENABLE input at control connector Con.1 (Figure 4.1) is not activated. Drive is always activated (enabled).

From software ServoTune3 can be performed selection of ENABLE mode of drive DCS-3010(-HV) during setting parameters. The change of check box can be performed by pressing the function key F2.

	Name	Description	Options
Driver Enable (F2)	Drive Enable	Drive Enable	ENABLE – selected (DC servo motor is under voltage) DISABLE – not selected (DC servo motor is not under voltage)

9.6 Record response of DC motor to the step function

In order to adjust the parameters of PID controllers easier, ServoTune3 software provides the ability to record the response of DC servo motor and attached mechanics to which is connected to a step function. In addition, it is possible to set a desired number of steps.

	Name	Description	Parameters		Min	Max
			Name	Description		
	Sampling	Recording response	Steps	Number of steps	1	32767*
			Samples	Number of read values	1	32767
	Steps	Performing a desired number of steps without recording the response	Steps	Number of steps	1	32767*

** Maximum value of Steps should be lower than set value of Error offset. Otherwise tracking error will appear and DC servo motor will be disabled. Cancelling of tracking error is performed by pressing the RESET button or by switching off the DCS-3010(-HV) drive power supply.*

Activate the appropriate function is performed by pressing the **Sample** or **Run**.

Pressing the **Sample** button, or by pressing the function key F3, DC servo drive will handle the given number of **Steps**. By setting the check box **For/Rev** for each pressing of **Sample** button DC motor will handle a given number of step alternately in one and then the other direction of rotation.

After the execution of Sample command will be drawn diagrams of DC motor response at step function, and charts of the changes of voltage and current through the DC servo motor (Figure 9.5).

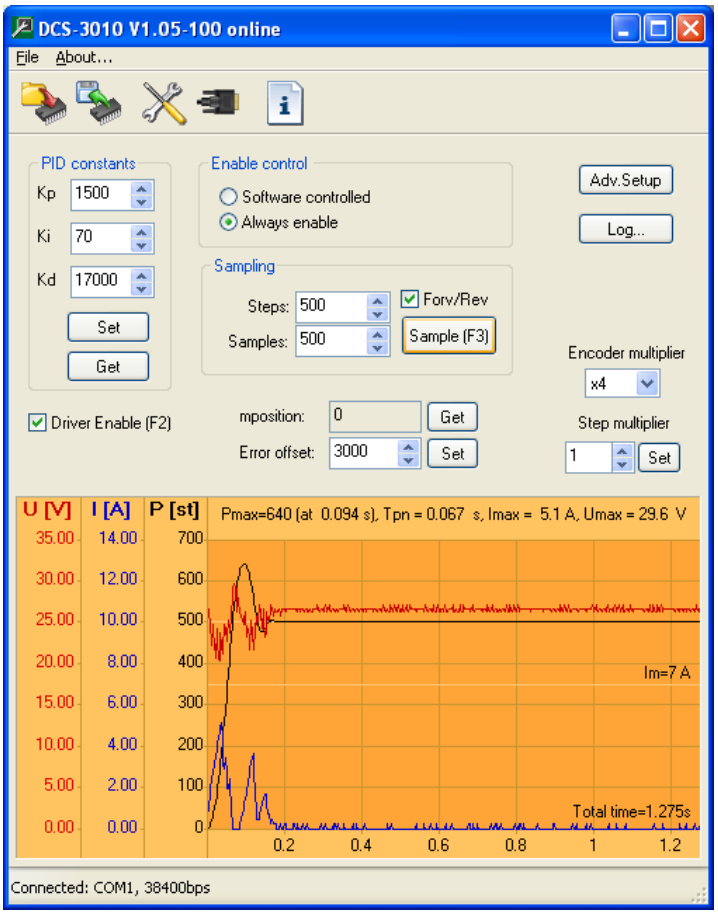


Figure 9.5

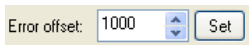
The recorded values of the DC motor position, power supply voltage and current through the DC servo motor will be saved in a file called `odziv.dat` which is located in the folder that contains software ServoTune3. The following is a small sample of the file `odziv.dat`.

```
% ****** ServoTune sampling output ********
% Date and time: 07.10.2024 07:27:39
%  Time[s]  Position Current[mA] Voltage[V]
  0.000000         0         244      26.63
  0.001500         1         488      27.12
  0.004000         9        1220      26.13
  0.006500        26        1464      24.65
  0.009000        48        1953      25.15
  0.011500        76        2441      22.19
  0.014000       111        2685      24.65
  0.016500       152        2685      23.67
  0.019000       200        3173      22.68
  0.021500       254        3417      20.71
  0.024500       315        3906      24.16
  0.027000       396        4150      22.68
  0.029500       471        4394      20.71
  0.032000       553        4638      20.21
```

The first column of the file is the time, the second column is the current position of the DC motor, the third column represents the value of the current through the DC motor in milliamps (mA) and the fourth column is the change of supply voltage DC motor in volts (V). The values from the file `odziv.dat` can easily be imported into the software for drawing diagrams (Octave, Excel, MATLAB, i.e.).

9.7 Setting values of tracking error offset

Setting of tracking error offset can be performed by entering the desired values in a field named Error offset.



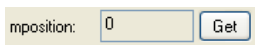
Name	Description	Minimum	Maximum	Recommendation
Error offset	Tracking Error offset	0	32767	bigger than 100

To save desire values of tracking error offset into EEPROM it is necessary to press the **Set** button.

If the difference of set position and the current position DC servo motor exceeds the set value of tracking error offset, Track Error output activates (to the control port), and **OP/ER** indicator will denote Additionally, DC servo motor will be DISABLED. Cancelling the tracking error offset is achieved by pressing RESET button or switching off the drive DCS-3010(-HV) power supply.

9.8 Read the current value of the DC motor position

Reading current position of DC servo motor, i.e. encoder position (**mposition**) is obtained by pressing the button **Get**.



Name	Description
mposition	Current position of DC servo motor

9.9 Saving and loading configurations

Once adjusted configurations can be saved in a configuration file by selecting **File -> Save config...** or by pressing the button  .

Also the configuration file with all the settings can be loaded into the DC servo drive DCS-3010(-HV) by choosing option **File -> Load config...** or by pressing button  .

9.10 Advanced Setup

Pressing the button **Adv. Setup** (Figure 9.6) or icon  opens dialog box with a choice of options for advanced settings (Figure 9.7).

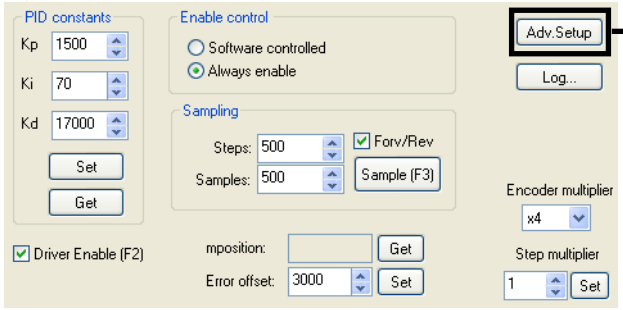


Figure 9.6

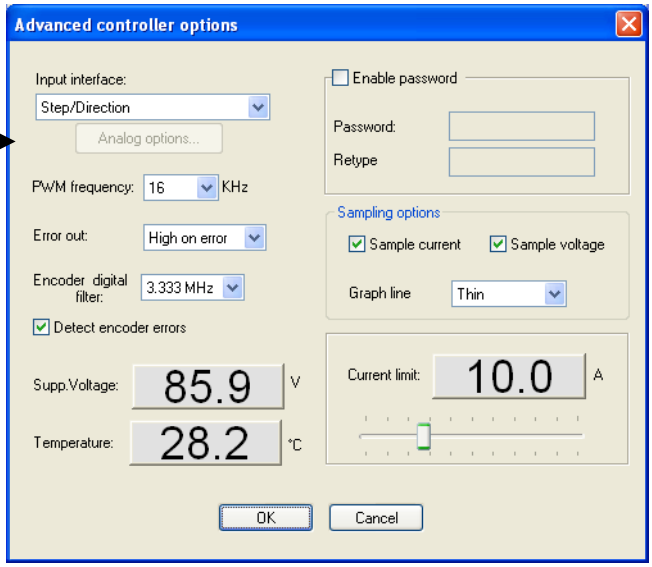


Figure 9.7

Advanced settings include the range of options:

- type of input interface,
- frequency of PWM,
- the logic level at Error output in case of error,
- digital filter for encoder,
- encoder error detection,
- password protection of parameters,
- selection of parameters that will be shown in the main diagram, and
- maximum current of DC motor.

In order to accept change of any of the above values in the EEPROM microcontroller it is necessary to press the button OK (Figure 9.7).

9.10.1 Type of Input interface

Control of DC motor is carried out through three command lines. The first two command lines in this manual called STEP/DIR, while the third is ENABLE (see Figure 4.2). Optional input interface provides a choice of control modes via the above three command lines, or via the analog inputs in the following modes:

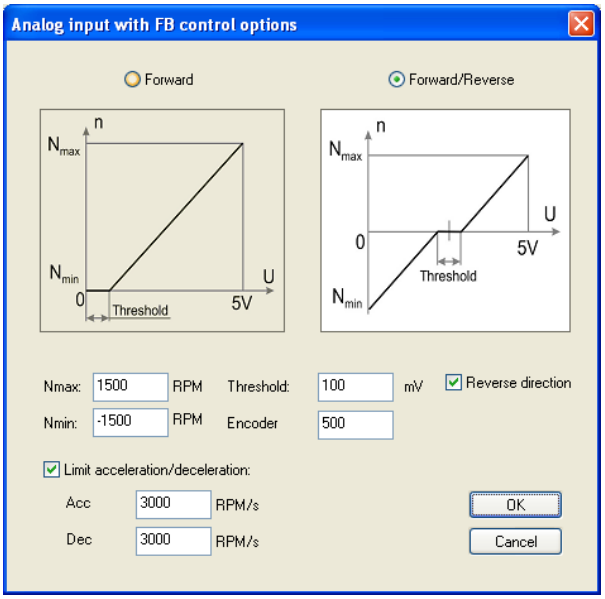
- Step/Direction i.e. STEP/DIR/ENABLE,
- StepUp/StepDown i.e. CW/CCW/ENABLE,
- Encoder x1 /ENABLE,
- Encoder x2 /ENABLE,
- Encoder x4 /ENABLE,
- Analog input with feedback (Analog with FB), and
- Analog input without feedback (Analog without FB).

NOTE: Configuration of input interface type Encoder 1x, 2x and 4x are not fully tested.

DC servo drive DCS-3010(-HV) has the ability to control DC motor via the voltage signal of 0–5 V which is applied to the analog input (Con. 4 in Figure 4.1). At the analog input can be directly connected potentiometer with nominal resistance 1–10 kΩ (Figure 4.20.a) or external motion path generator (Figure 4.20.b). Look section 4.7 of this manual.

If you choose one of the options from the analog input, **Analog option** button will become active, and after its activation will appear one of the dialogue shown in Figure 9.8.

a)



b)

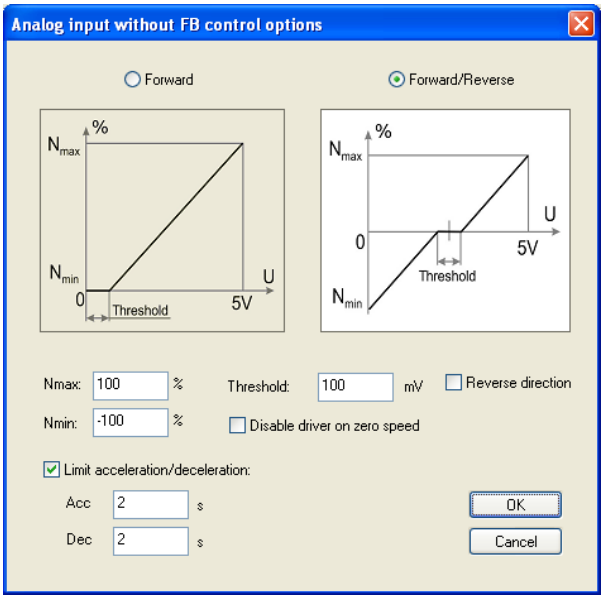


Figure 9.8 Dialog box for setting parameters, a) analog input with feedback (Analog with FB) and b) analog input without feedback (Analog without FB)

Dialog box for setting parameters of analog input provides a choice:

- One or two directions of rotation of DC motor (Forward or Forward/Reverse),
- Change the direction of rotation DC motor (Reverse direction),
- Maximum Nmax and minimum Nmin revolution speed.
  - In case of choosing the analog input with feedback (Analog with FB) values Nmax and Nmin are in revolutions per minute (RPM).
  - In case of choosing the analog input without feedback (Analog without FB) values Nmax and Nmin are in percent (%) in relation to power voltage of DC motor.
- Width of inactive zone (Threshold) expressed in mV.
- Number of encoder lines (Encoder) in case of choosing analog input with feedback (Analog with FB).
- Options of disabled DC motor in case that adjusted speed is equal to zero in case of choosing analog input without feedback (Analog without FB).
- Parameters of acceleration (Acc) and slowing down (Dec) (Limit acceleration/deceleration).
  - In case of choosing the analog input with feedback (Analog with FB) values Acc and Dec are in revolutions per minute per one second (RPM/s).
  - In case of choosing the analog input without feedback (Analog without FB) values Acc and Dec are in second (s).

9.10.2 Setting the PWM frequency

This option provides the ability to adjust the PWM frequency:

- 10 kHz,
- 12 kHz,
- 14 kHz,
- 16 kHz (default),
- 18 kHz and
- 20 kHz.

For frequency of PWM bellow 20 kHz can be heard "whistling" coming from DC motor.

9.10.3 Logic level on Error output in case of error

The selection of logic level in case of errors at Error output is presented in the table below.

	Name	Option of choice – description
Error out: High on error	Error out	**High on error** – In the case of error Error output will be at logical high level **Low on error** – In the case of error Error output will be at logical low level **Always low** – Error output will always be at logical low level independently of the existence of errors

9.10.4 Digital filter for encoder

An adjustment of digital filter for encoder is performed through selection of upper cut-off frequencies:

- switched off digital filter (Turn OFF),
- the frequency of filter 6.667 MHz,
- the frequency of filter 3.333 MHz (default),
- the frequency of filter 1.667 MHz,
- the frequency of filter 416.7 kHz,
- the frequency of filter 208.3 kHz,
- the frequency of filter 104.2 kHz,
- the frequency of filter 52.1 kHz and
- the frequency of filter 26.0 kHz.

Option of digital filtering of signals from the encoder can be useful in the environment with strong electromagnetic interference, which can lead to errors in reading the incremental encoder position.

9.10.5 Detecting encoder errors

If this option is enabled, the drive checks if there is a change at levels of both encoder inputs (A and B). If this is not the case, the output stage will be disabled and OP/ER LED indicator will show the encoder error.

NOTE: This option has not been fully tested, and it is recommended that the checker remains off.

9.10.6 Reading power supply voltage of DC motor and temperature of drive

In the appropriate fields (framed fields in Figure 9.9) is performed reading power supply voltage of DC motor in volts (Supp. Voltage) and temperature of DC servo drive DCS-3010(-HV) close to the microcontroller in °C (Temperature).

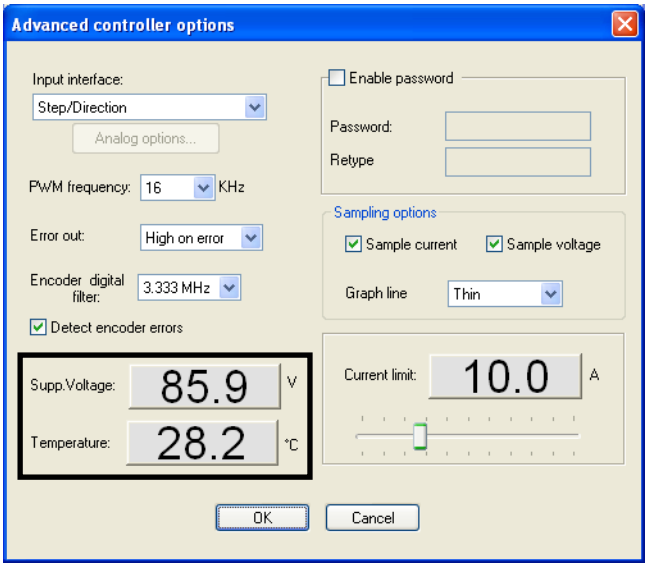


Figure 9.9

9.10.7 Entering the password

The ServoTune3 software provides the ability to enter password to prevent unauthorized changes to the parameters of DC servo drive DCS-3010(-HV).
In order to activate this option it is necessary to select a checker **Enable password** first as it is shown in Figure 9.10 thereby **Password** and **Retype** become active and in them is then possible to enter the password. When the password is entered then during each of the next start-up of ServoTune3 software and the connection to the DC servo drive DCS-3010(-HV) dialog window (Figure 9.11) for the typing of password will open, which becomes a requirement for approach settings.

NOTE: Keep your password safe. Otherwise you will not be able to access to the ServoTune3 software and tune parameters.

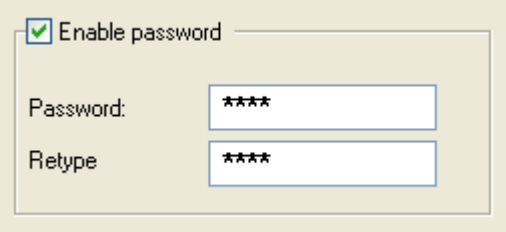


Figure 9.10 Password dialogue

Figure 9.11 Password dialogue on ServoTune3 software startup

9.10.8 Selection of options of the main diagram

The part of dialogue in the advanced settings (Advanced setup) shown in Figure 9.12 (Sampling options) allow choosing of:

- What parameter will be shown in the main diagram and
- The thickness of the diagram line that will be plotted (Thin, Medium and Thick).

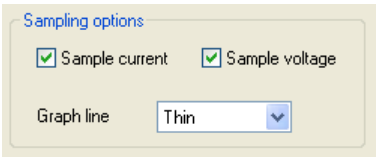


Figure 9.12

9.10.9 Setting the maximum DC motor current

Over the slider shown in Figure 9.13 maximum current of DC motor is adjusted. The adjusted value is readable in the appropriate field. Maximum current through DC motor can be adjusted in the range of 3–30 A.

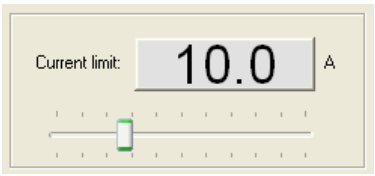


Figure 9.13

9.10.10 LOG File recording

Recording of Log file with the values of present position and position error, as well as present current and voltage at DC motor is activated by pressing the **Log** button (Figure 9.14) which opens the **Loging** dialog (Figure 9.15).

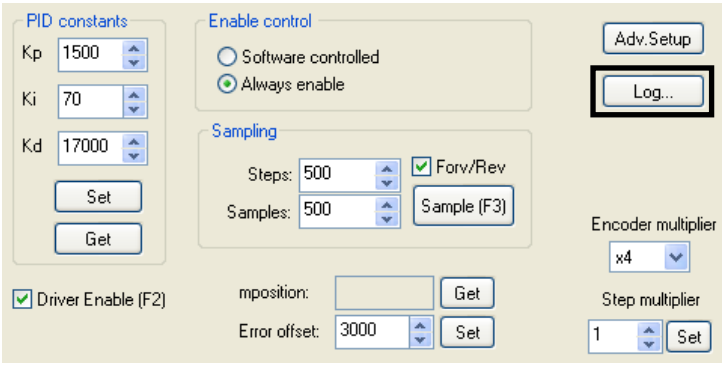


Figure 9.14 Position of **Log** button

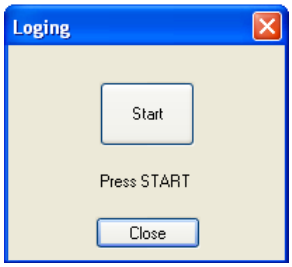


Figure 9.15 Log dialog

Start recording a log file activates by pressing **Start** and **Stop** recording by pressing this button again. Data will be stored in a file called `servo.log` that is located in the same folder as the ServoTune3 software. The following is a small part of the `servo.log` file.

```
% *********** ServoTune log output file ************
% Date and time: 07.12.2019 19:00:05
%  Time[s]    Position  PosDiff Current[mA] Voltage[V]
  0.020960        -401        0           0      98.23
  0.023580        -401        0           0      98.23
  0.025676        -401        0           0      98.23
  0.027772        -401        0           0      97.78
  0.029868        -401        0           0      98.23
  0.032488        -401        0           0      98.23
  0.034584        -401        0           0      98.89
  0.036680        -400        1           0      98.23
  0.000000        -396        5           0      98.23
  0.001572        -386       13           0      98.23
  0.003668        -373       20           0      97.78
  0.005764        -349       32         119      97.02
  0.007860        -325       39         833      95.45
  0.009956        -296       44        1310      94.02
  0.012576        -263       39        1905      93.25
  0.014672        -226       38        2381      92.15
```

At that:

- **The first** column is time in seconds,
- **The second** column is present position of DC motor,
- **The third** column is position error (tracking error), i.e. difference between specified and current position of DC servo motor is expressed in the steps,
- **The fourth** column represents the value of the current through the DC motor expressed in mA, and
- **The fifth** column is supply voltage of DC motor expressed in V.

Data from file `servo.log` file can be easily loaded into any software for drawing and for further analyzing. (Octave, Excel, MATLAB, etc.).

In Figure 9.16, Figure 9.17 and Figure 9.18 is shown an example of parameter changes from one recording `servo.log` data file.

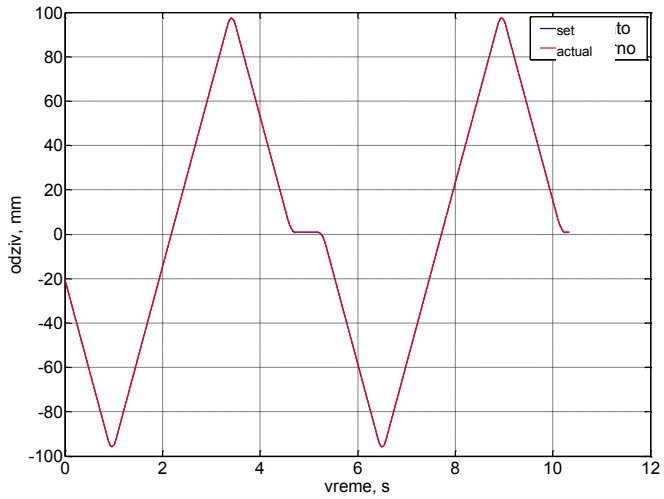


Figure 9.16 Diagram of set and actual position of DC servo motor

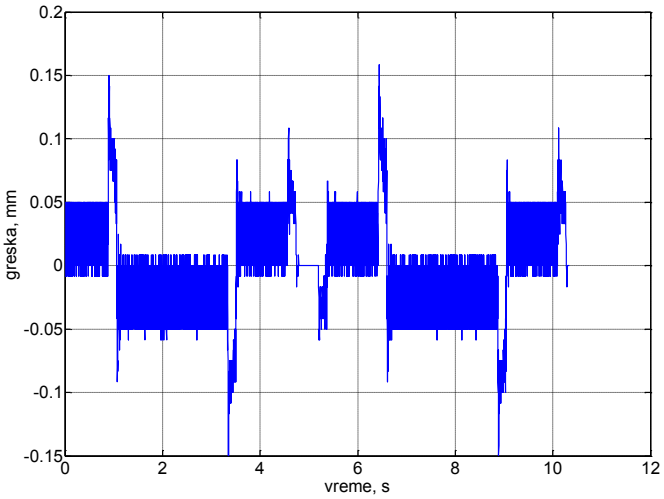


Figure 9.17 Diagram of the positioning error calculated in mm

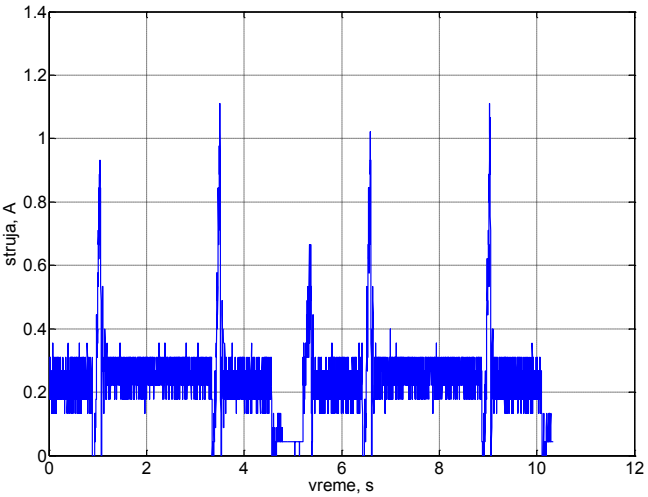


Figure 9.18 Diagram of the electric current through the DC servo motor

10 PID CONSTANTS SETUP PROCEDURE

NOTE: During setting of PID constants take all precautions as it may cause oscillation of DC servo motor-mechanics.
When setting up start from low value of maximum current through the DC motor during which should check the behavior of DC motor. After this gradually increase the set value of maximum DC motor current.

The values of the PID constants depend on:

- Characteristic of DC motor (moment of inertia, supply voltage, maximum electric current etc.),
- Physical characteristics of mechanics, which is connected at DC motor (mass, damping etc.),
- Resolution of the incremental encoder mounted on the DC motor,
- Selected encoder resolution multiplication (x1, x2 or x4), and
- Some other factors (ambient temperature, lubricant, etc.).

Adjusted PID constants are valid only for that configuration. If there is a change of configuration (some of the above parameters) it is necessary to readjust the PID constants.

The following is a description of the adjustment of PID constants. Encoder resolution in this case is 500 PPR, encoder resolution multiplication is x4, so that the overall encoder resolution is 2000 PPR.

STEP 1: Initial value of PID constants is:

- Proportional constant Kp = 50,
- Integral constant Ki = 0 i
- Derivate constant Kd = 0.

Slowly increase the constant Kp until you get response similar to the response shown in Figure 10.1.

STEP 2: Increase constant Kd until the system response is not "calm" as is shown in Figure 10.2. The constant Kd may be significantly larger than the constant Kp.

STEP 3: Gradually increase the constants Kp and Ki to the response as shown in Figure 10.3. Here it should be noted that the constant Ki is much smaller compared to the other two constants.

Repeat steps 2 and 3 to the point where the shaft of DC motor behaves as "locked“. Also check the motor running at various revolution speeds (must not occur oscillation and vibration during operation).

STEP 4: Final values of the PID constants and the response of the motor are shown in Figure 10.4.

It is necessary to check determined PID constants during the work of the machine and, if it is necessary, to correct them.

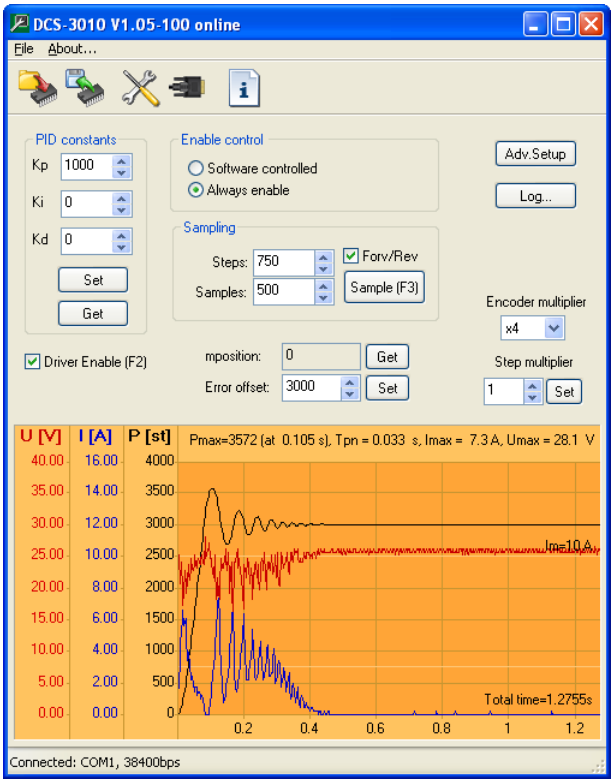


Figure 10.1

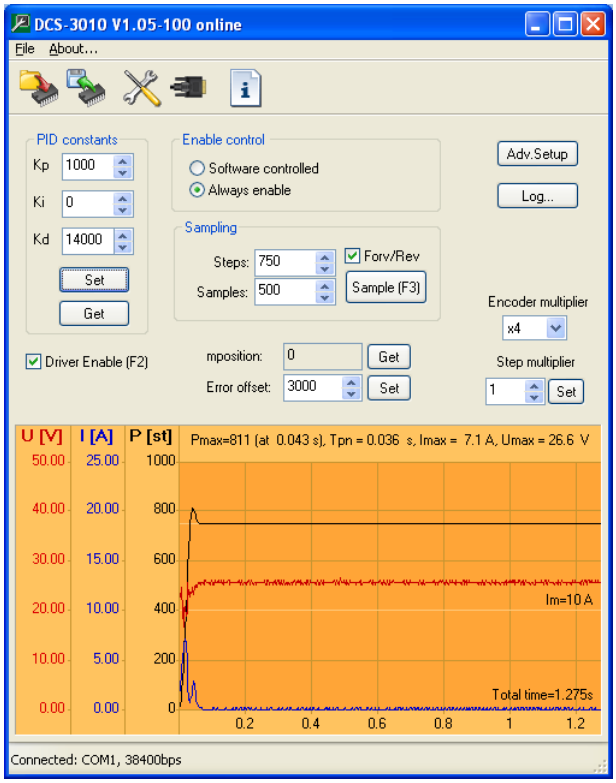


Figure 10.2

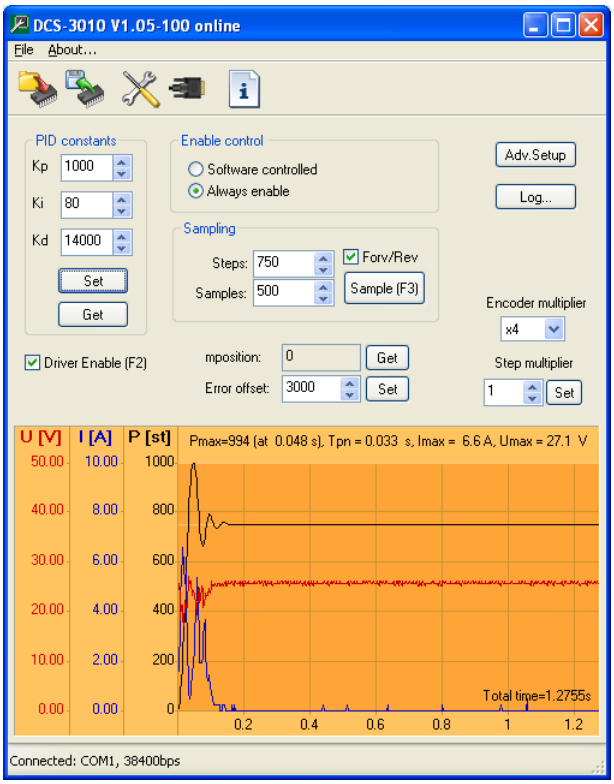


Figure 10.3

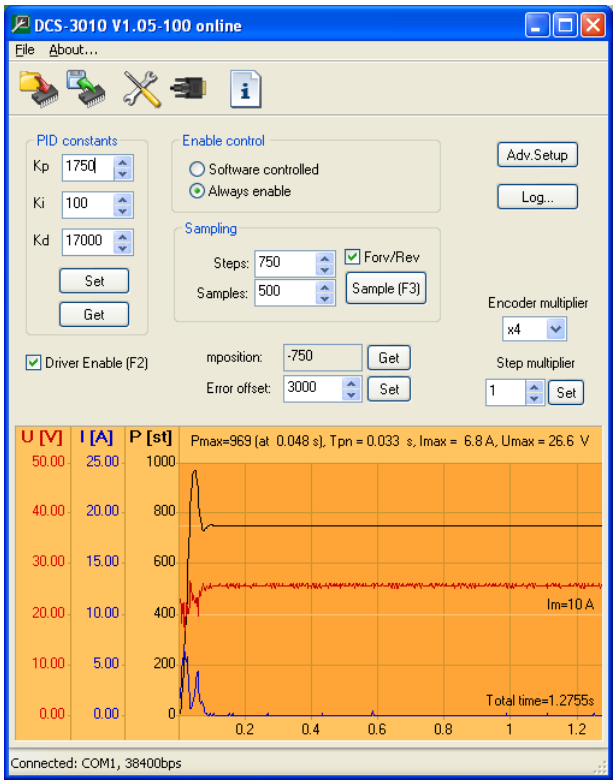


Figure 10.4

10.1 Automatic adjustment of PID parameters

The auto-configuring and adjusting PID parameters is available from ServoTune3 software version v3.07. The dialog for automatic adjustment of PID parameters opens by pressing button **AutoPID** (Figure 10.5). This will display a warning dialog shown in Figure 10.6.

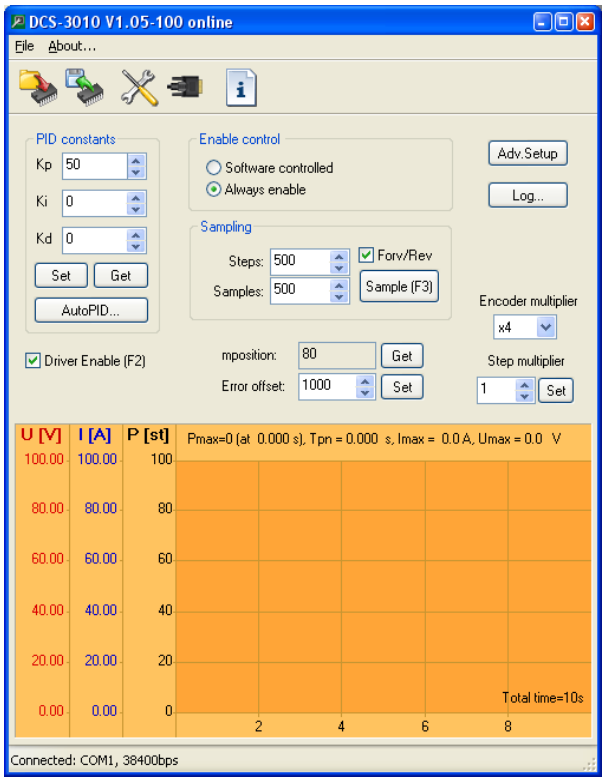


Figure 10.5

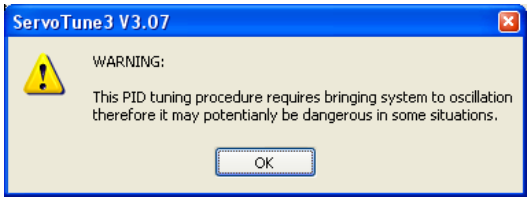


Figure 10.6

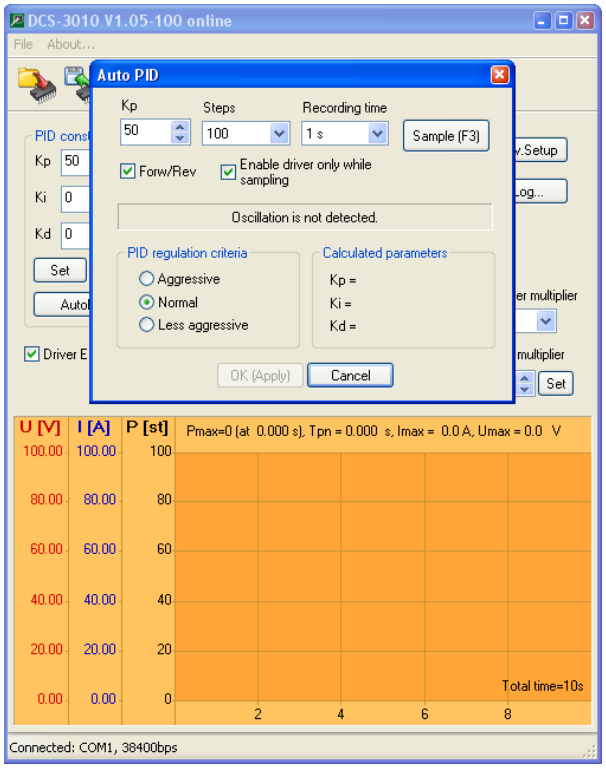


Figure 10.7

NOTE: Method for automatic adjustment of PID constants involves bringing DC servo drive – DC servo motor system and mechanical equipment in an unstable state, so it is necessary to mention that the system will oscillate.

Setup procedure of PID parameters in this way the user performs at own risk.

Within **AutoPID** dialog, which is shown in Figure 10.7, it is possible to set the following parameters:

- Proportional constant **Kp**.
- Number of **Steps** to define the step function. Pull-down menu provides a choice of predefined values for the number of steps: 100, 150, 200, 250, 300, 400, 500, 750 and 1000. Choose one value of the number of steps corresponding to approximately 5-10% of the number of steps required to DC motor make a full circle.

  EXAMPLE: Encoder has 500PPR and selected the option Encoder multiplier x4. In this case it is necessary 500 x 4 = 2000 steps to the DC motor make a full revolution. Recommended values for Steps would be 100, 150 or 200.
- The duration of the measurement of **Recording time** that can be selected via the pull-down menu: 1s, 2s, 3s, 4s and 5s. Whereas during the recording system response required bringing the system into oscillation it is recommended that this time be as short as possible.
- Alternately reversing DC motor when recording step function (option **Forw/Rev**). It is recommended that this option should be active.
- Option **Enable drive only while sampling**. It is recommended that this option should be active.

The process of automatic adjustment of the of PID constants involves gradually increasing the constant Kp. With every change of constants **Kp**, it is necessary to press the **Sample (F3)** or function key **F3** to record the system response. The parameter **Kp** is increased gradually and gently, until it comes to the appearance of the oscillation of the system, such as that shown in Figure 10.8, Figure 10.9and Figure 10.10. It is important to note that in these figures are not shown all the steps in gradual increasing of the parameter **Kp**.

ServoTune3 software will recognize that there is a system oscillation, as is shown in Figure 10.10 (**Oscillation is detected ...**) and will suggest PID controller constants **Kp, Ki, and Kd** according to the given criteria. There is a choice of the following criteria:

- **Aggressive**,
- **Normal** or
- **Less aggressive**.

Pressing the **OK** button (**Apply**) calculated PID parameters will be stored in EEPROM microcontroller.

Check the behavior of DC servo motor according PID parameters calculated on this way (Figure 10.11).

If necessary, perform manual fine tuning of PID parameters.

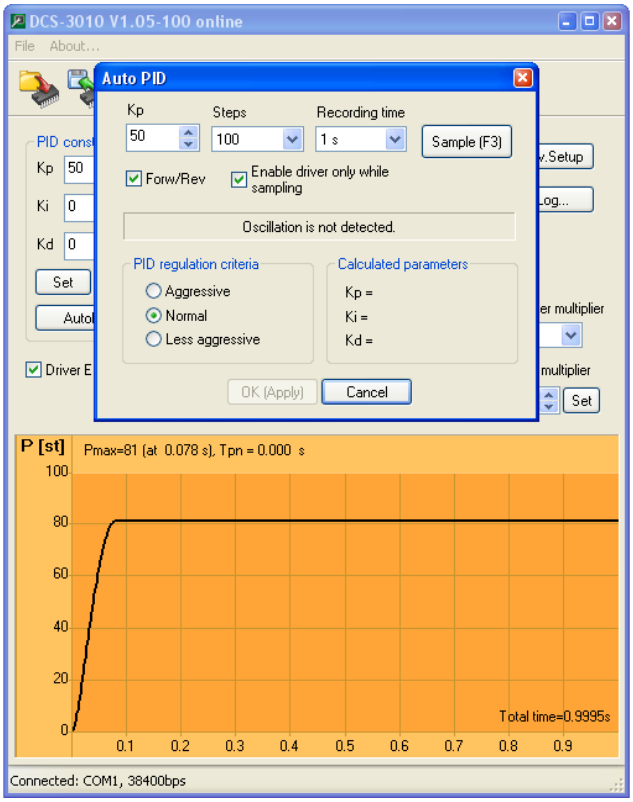


Figure 10.8

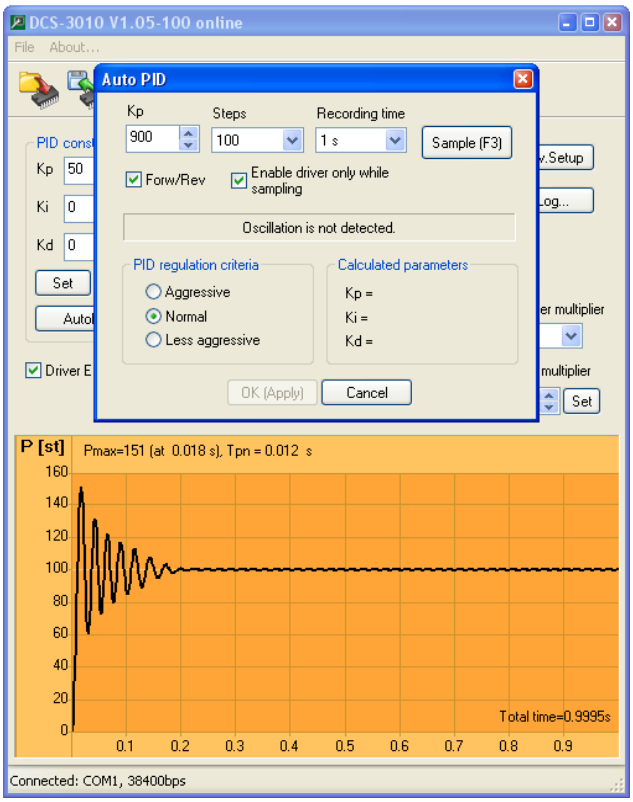


Figure 10.9

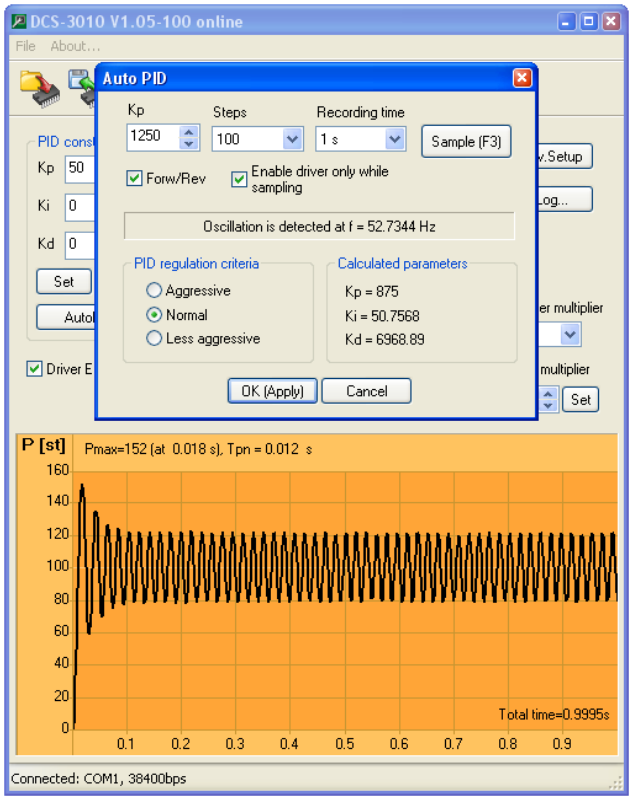


Figure 10.10

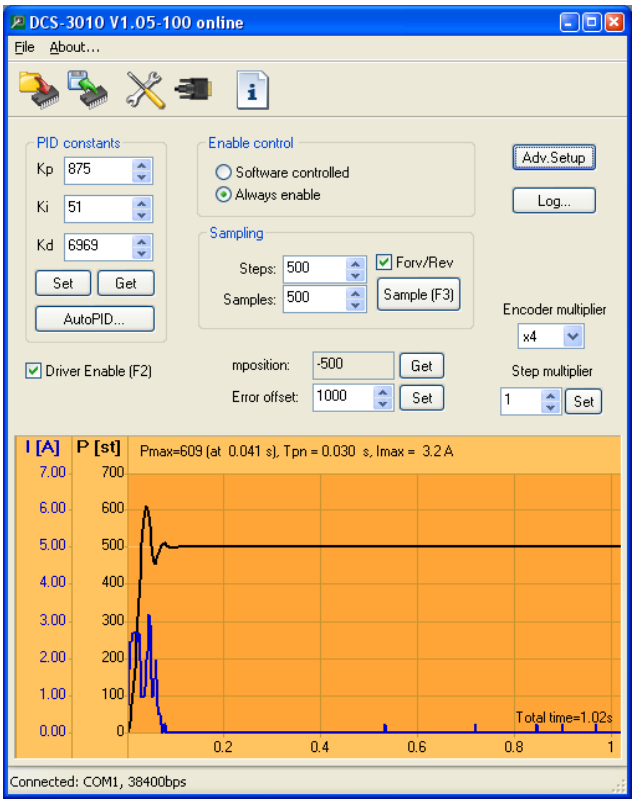


Figure 10.11

DOCUMENT REVISION:

- Ver. 1.0, January 2014, Initial version
- Ver. 1.01, March 2014, Minor corrections
- Ver. 1.07, January 2015, Minor corrections
- Ver. 1.10, December 2017, Minor corrections
- Ver. 1.11, May 2018, New product photo and other minor corrections
- Ver. 2.0, January 2019, Redesigned DC servo drive DCS-3010(-HV)
- Ver. 2.1, March 2019, Added motor brake circuit MB-2 in CNC control system
- Ver. 2.15, November 2020, Minor revision
- Ver. 2.21, May 2021, Minor revision
- Ver. 2.31, November 2023, New photos of product
- Ver. 3.0, October 2024, New version of the driver v.5; detachable connectors are placed on the control and encoder port, the power supply 5V and 15V for incremental encoders are now available; the user's manual have been updated accordingly
- Ver. 3.01, December 2024, Minor revision
- Ver. 3.03, July 2025, Added Figure 4.4 Control system with ETH-MCI motion controller with following description