# SDC-150A diode driver

## User manual
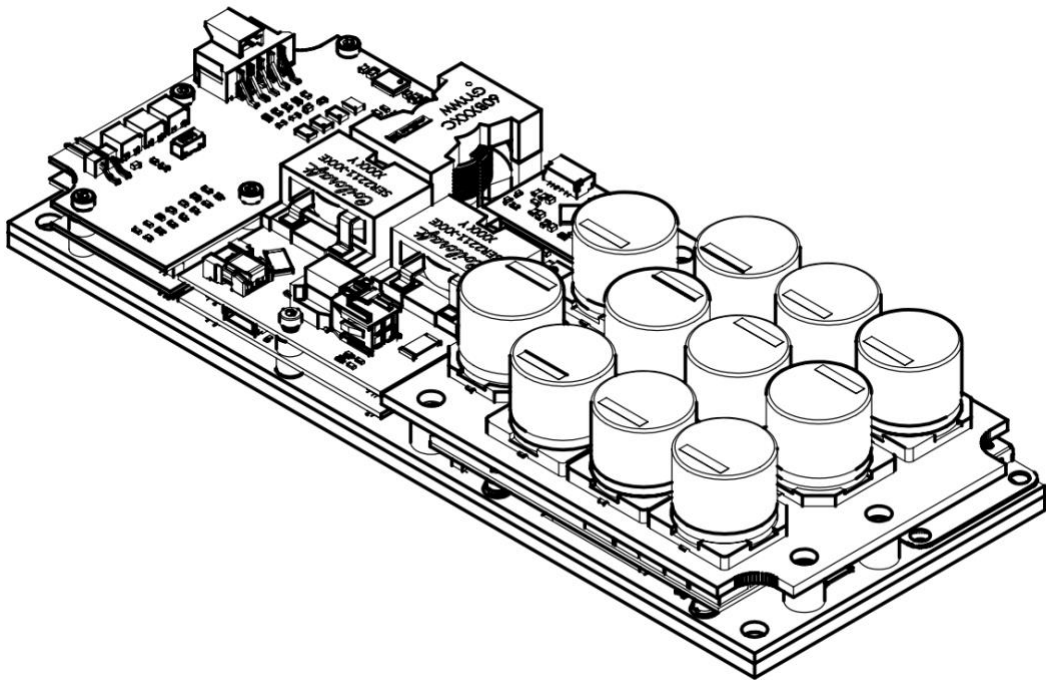
**Important note.** Please measure output with adequate load only (diodes). Resistive load connected to the output won't destroy the driver, but will severe distort its behavior.

## Description

SDC-150A is 'all-in-one' DPSS Nd:YAG controller which includes a pulsed current source to drive pumping diodes, TEC controller for their thermal stabilization and embedded Pockels cell driver for generation of Q-switched pulses.
Driver's input is 28 V DC (+/-7 V).

Driver's major features are:
- Very compact dimensions – 180x70x30 mm
- 28 V DC (+/-7 V) input
- Diode output – up to 200 A in high current versions, up to 400 V in high voltage versions, up to 300 us, up to 30 Hz (10-20 kW peak, 20-40 W average max) *
- TEC output – up to 5 A, 20 V (50 W max) *
- Pockels cell driver – SDC-150A can be equipped with Pockels cell driver of different modifications on customer's choice, say, for DKDP cells, for LiNbO3 cells and so on

*) Different parameters are available on request. See also How to order? section.
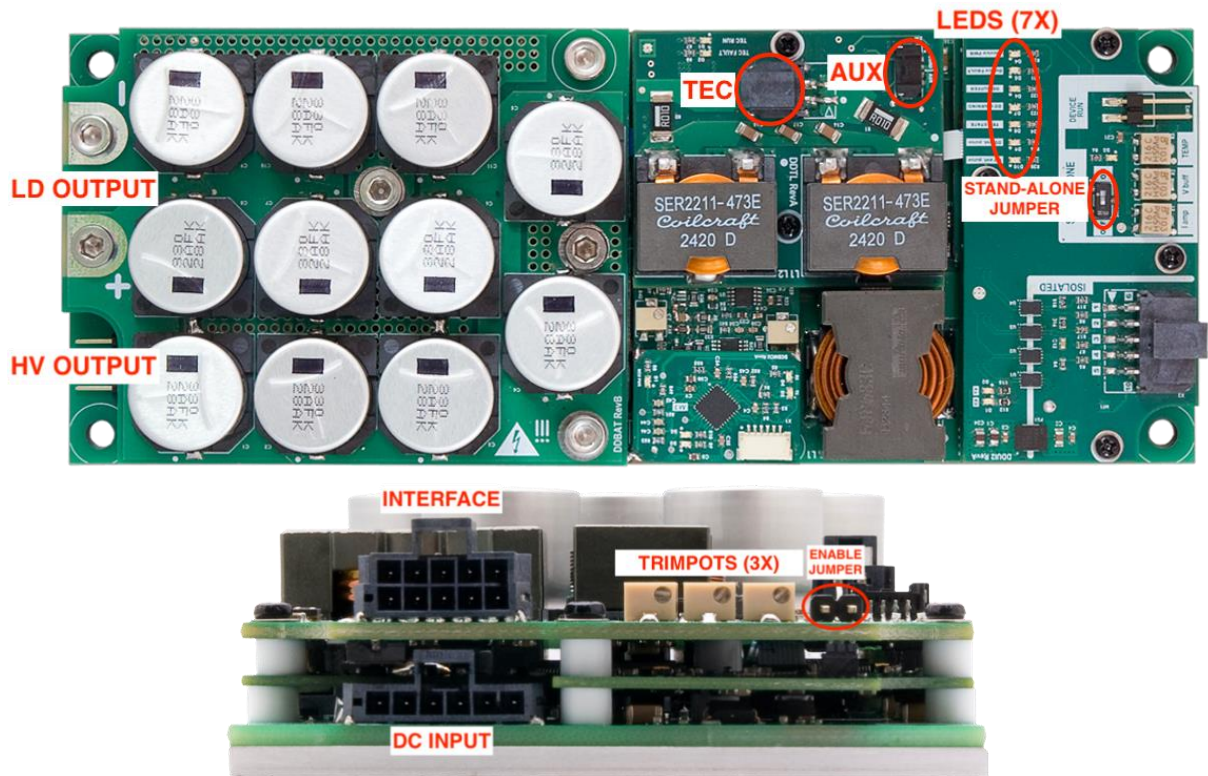
Base machine interface is RS-232 (RS-485 is available as an option, simple PC software is supplied together with the controller). Stand-alone operations are available 'from the box'.

The cooling, when needed, is performed through the heatsink attached to the bottom surface.

## Appearance

# Connections, signals, signal descriptions



| TYPE | DESIGNATION | DESCRIPTION |
|------|-------------|-------------|
| **Connector** | **DC INPUT** | Power input (28 V DC nominal) |
| **Connector** | **INTERFACE** | RS-232 (RS-485) interface<br>Synchro inputs, synchro output, other signals |
| **Screw terminals** | **LD OUTPUT** | Pulsed output to the laser diode |
| **Connector** | **TEC** | Peltier connection |
| **Connector** | **AUX** | TEC NTC and AUX NTC connections |
| **Connector** | **HV OUTPUT** | Pockels cell connection (high voltage output of SDC-150A) |
| **Jumper** | **STAND-ALONE JUMPER** | Defines the way output current and diode temperature are set |
| **Trimpot** | **VOLTAGE TRIMPOT** | Sets buffer voltage if *STAND-ALONE JUMPER* is on |
| **Trimpot** | **CURRENT TRIMPOT** | Sets output current if *STAND-ALONE JUMPER* is on |
| **Trimpot** | **TEMP TRIMPOT** | Sets diode temperature if *STAND-ALONE JUMPER* is on |

| Jumper | ENABLE JUMPER | Enables driver's outputs in Stand-alone mode of operations |
|:---:|:---:|:---|
| LED | STATUS LEDS | A number of LEDs depicting driver's status |

## DC INPUT: 6-pin Molex Nano-Fit (1054301106)
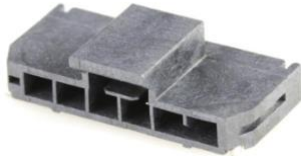


Input supply voltage (28 V DC nominal) is to be connected here.

| PIN (color) | DESIGNATION | DESCRIPTION |
|:---:|:---:|:---|
| 1, 2, 3 (black) | GND | Input supply voltage (28 V DC +/- 7 V) is to be connected here. |
| 4, 5, 6 (red) | $V_{IN}$ | |

## INTERFACE: 10-pin Molex Nano-Fit (1054051110)



INTERFACE connector provides both digital and analogue interfaces to the driver.

RS-232 modification of the driver:

| PIN (color) | DESIGNATION | DESCRIPTION |
|:---:|:---:|:---|
| 1 (white) | Synchro IN (LD) | Incoming synchronization pulses should be applied to this pin to trigger the current pulse if module is running in external synchronization mode. <br><br> 5V TTL, input impedance is approx. 470 Ohm |
| 2 (brown) | Synchro IN (PCD) | Incoming synchronization pulses should be applied to this pin to trigger the Pockels cell driver if module is running in external synchronization mode. <br><br> 5V TTL, input impedance is approx. 470 Ohm |
| 3 (yellow) | Synchro OUT | Synchro output signal (1ms pulse length, adjustable delay relatively to the current pulse) |

| | | |
|---|---|---|
| **4 (violet)** | **RS-232 TX** | The control device connection (RS-232 interface). |
| **5 (orange)** | **RS-232 RX** | |
| **10 (blue)** | **RS-232 GND** | |
| **7 (red)** | **Fault** | Module internal failure indication. Module rises Fault in the next cases: <br> - Overheating <br> - Unable to charge buffer capacitors <br> - Unable to stabilize the temperature <br> - Other failures |
| **8 (green)** | **IDC** | Door-interlock connection. Should be pulled to the ground to allow the operations. |
| **6, 9 (black)** | **Interface Return** | Common return of all interface circuits |

RS-485 modification difference (other signals are identical to RS-232 modification):

| PIN (color) | DESIGNATION | DESCRIPTION |
|---|---|---|
| **4 (violet)** | **RS-485 B** | The control device connection (RS-485 interface). |
| **10 (blue)** | **N/C** | |
| **5 (orange)** | **RS-485 A** | |

INTERFACE circuits schematics:
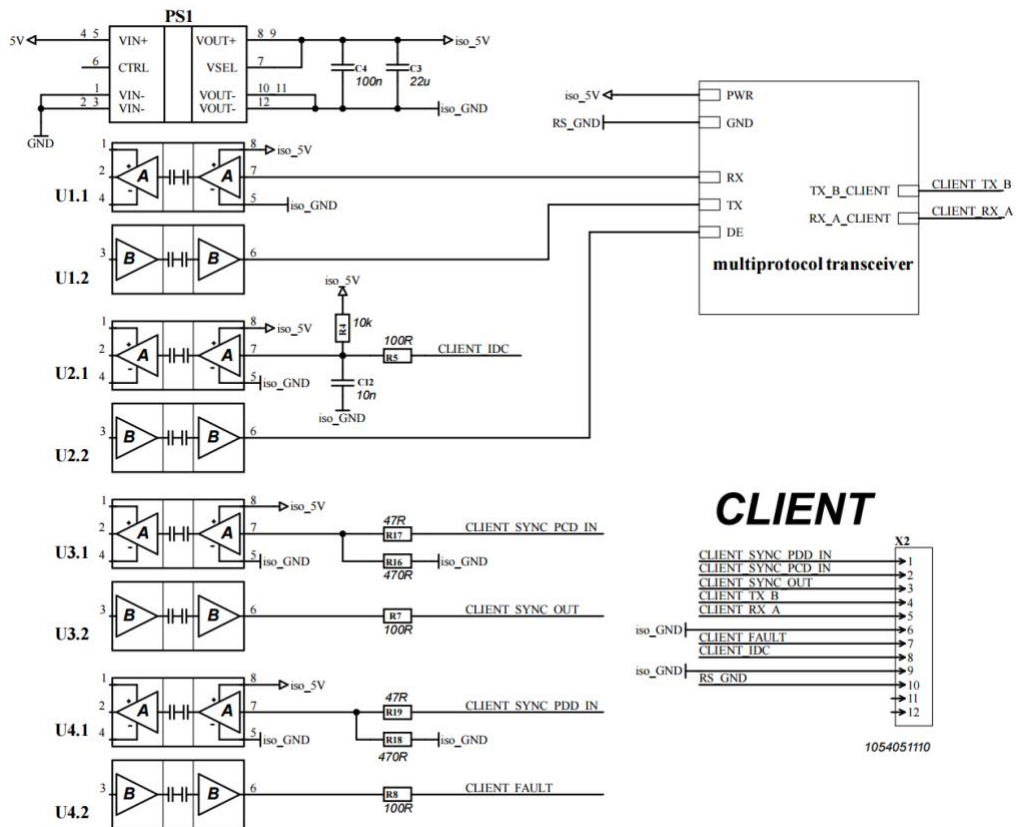
## LD OUTPUT: M4 thread (2pcs)

Output to the laser diode.

## TEC: 4-pin Molex Nano-Fit (1054051104)

Peltier connection.

| PIN (color) | DESIGNATION | DESCRIPTION |
|---|---|---|
| 1, 2 (black) | TEC- | Peltier connection (negative). Both pins are interconnected in parallel. |
| 3, 4 (red) | TEC+ | Peltier connection (positive). Both pins are interconnected in parallel. |

## AUX: 4-pin Molex Micro-Lock (5055670471)

TEC NTC connection. Auxiliary NTC connection.

| PIN (color) | DESIGNATION | DESCRIPTION |
|---|---|---|
| 1, 2 (violet) | TEC NTC | Main (TEC) NTC connection (10 kOhm) |
| 3, 4 (blue) | AUX NTC | Auxiliary NTC connection (10 kOhm, reserved for future use) |

## HV OUTPUT: Proprietary connector by OEM Tech

Pockels cell is to be connected here.

Red wire – HV output positive
Red wire – HV output negative

**STAND-ALONE JUMPER.** When *STAND-ALONE JUMPER* is ON, SDC-150A doesn't need active RS-232 connection to operate and works as a stand-alone device. In this case the output parameters are set either from memory or by *VOLTAGE TRIMPOT, CURRENT TRIMPOT* and *TEMP TRIMPOT* (see also *Modes of operations* section).

**VOLTAGE TRIMPOT, CURRENT TRIMPOT, TEMP TRIMPOT**. When *STAND-ALONE JUMPER* is ON and parameters are set accordingly to trimpots (see also software description), *VOLTAGE TRIMPOT* defines buffer voltage, *CURRENT TRIMPOT* defines output pulse current and *TEMP TRIMPOT* defines the TEC set point.

**ENABLE JUMPER.** Enables all driver's outputs in Stand-alone regime of operations.

**STATUS LEDS.** There are several LEDs indicating state of SDC-150A board.
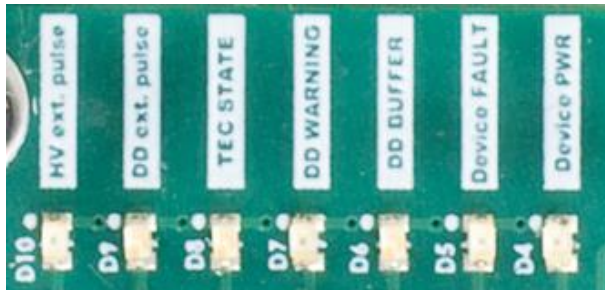


D10 – SYNC IN (PCD) LED (orange):
- blinks synchronously with PCD synchronization pulses coming from external pulse generator

D9 – SYNC IN (LD) LED (blue):
- blinks synchronously with LD synchronization pulses coming from external pulse generator

D8 – TEC STATE LED (blue):
- blinks if TEC is turned on and thermal stabilization is not achieved
- lights steadily if TEC is turned on and thermal stabilization is achieved

D7 – WARNING LED (orange):
- blinks if buffer voltage is too low to obtain the desired output current
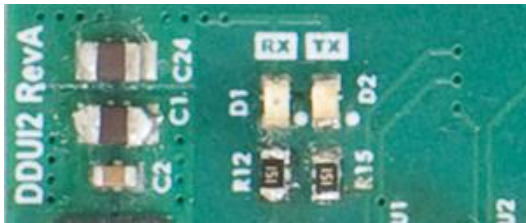
D6 – BUFFER LED (blue):
- lights steadily if buffer voltage power supply is enabled and works properly

D5 – FAULT LED (red):
- lights steadily if any of Fault conditions is met at the moment

D4 – POWER LED (green):
- lights steadily once DC power is applied to the driver

D1, D2 – RX and TX LEDs:
- blink when the driver transmits data via RS-232 (RS-485) interface

## Mounting and grounding

Driver should be mounted using four M4 screws.

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**Grounding policy**

Most of SDC-150A circuits have common ground. Only INTERFACE signals (both digital and analogue) are galvanically isolated from other circuits.

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**Important note**

Since diode driver has no galvanic insulation between input and output,
diode's anode will be under buffer voltage potential and
diode's cathode will be under floating potential different from the ground potential.
**Both diode's anode and cathode cannot be grounded in any way and
should be isolated from the ground**

## Modes of operations

### RS-232 mode and Stand-alone mode

SDC-150A has two control modes – RS-232 mode и Stand-alone mode:

- RS-232 mode – requires the active RS-232 connection and all the controls are performed by commands sent via RS-232 interface. To operate in this mode *STAND-ALONE JUMPER* should be set to OFF position.
- Stand-Alone mode – doesn't require the active RS-232 connection and SDC-150A starts operations immediately after DC power is applied to the board. To operate in this mode *STAND-ALONE JUMPER* should be set to ON position.

Switching between RS-232 mode and Stand-alone mode is not trivial. Please follow the instructions below.

### RS-232 mode to Stand-alone mode

1. Switch *STAND-ALONE JUMPER* to OFF position.
2. Apply power to SDC-150A.
3. Establish RS-232 connection between controlling device and SDC-150A.
   Further description supposes, that SDC-150A is connected to PC and controlled via software, although the same can be done from customer's controlling device by sending RS-232 command.
4. Set "**I, V, T control in Stand-alone mode**" to "**Parameters from memory**" and set up the essential parameters and regimes of SDC-150A, e.g.:
   4.1. TEC temperature
   4.2. output current
   4.3. pulse width
   *Note: Similarly, "**I, V, T control in Stand-alone mode**" can be set to "Manual control"*
5. Save parameters with **SAVE TO EEPROM** button.
6. Remove power from SDC-150A.
7. Switch *STAND-ALONE JUMPER* to ON position.
8. Apply power to SDC-150A.
9. Set ON the *ENABLE JUMPER* – driver will operate with saved parameters.

### Stand-alone mode to RS-232 mode

1. Remove power from SDC-150A board.
2. Switch *STAND-ALONE JUMPER* to OFF position.
3. Connect SDC-150A to the controlling device (PC or another one).
4. Apply power to SDC-150A.
5. Establish RS-232 connection between controlling device and SDC-150A.

**Specifications**

### ELECTRICAL

| DC INPUT: | |
|---|---|
| Input voltage | 28 V DC +/- 7 V |
| Current consumption | 10 A max |
| **OUTPUT 1 (DIODE DRIVER):** | |
| Description | Pulses delivered to the pumping diode |
| Load | Laser diode |
| Diode compliance voltage ($V_{MAX}$) | Up to 400 V (selectable at the moment of order) |
| Maximum output current ($I_{MAX}$) | Up to 200 A (selectable at the moment of order) |
| Note – maximum peak power ($I_{MAX}$ * $V_{MAX}$) shouldn't exceed 10-20 kW | |
| Output current (I) | 10 … 100 % of $I_{MAX}$ adjustable |
| Accuracy | <1 % of $I_{MAX}$ |
| Pulse width (t) | 50 … 300 us adjustable (other on request) |
| Pulse rise (fall) time | <20 us |
| Repetition rate (f) | 1 … 30 Hz adjustable (other on request) |
| Maximum output power (V*I*t*f) | >20 W by default (maximum parameters cannot be realized at the same time due to the maximum power limitation)<br><br>>40 W on request (with derated operating temperature) |
| Target regime | To be specified for exact version, e.g.:<br>150 A, 55 V, 220 us, 20 Hz for SDC-150A-55V-HP<br>110 A, 85 V, 220 us, 20 Hz for SDC-110A-85V-HP |
| Important note – since diode driver has no galvanic insulation between input and output:<br>• diode's anode will be under buffer voltage potential<br>• diode's cathode will be under floating potential different from the ground potential<br>• **both diode's anode and cathode cannot be grounded in any way and must be isolated from the ground** | |
| **OUTPUT 2 (TEC):** | |
| Load | Peltiers |
| Maximum output current | 5 A (other on request) |
| Maximum output voltage | 20 V (other on request) |
| Stabilization temperature | +20 … +60 ºC adjustable (other on request) |
| Accuracy | 0.1 ºC |
| Thermistor | 10 kOhm NTC |

| OUTPUT 3 (POCKELS CELL DRIVER – DKDP VERSION): | |
|---|---|
| Load | DKDP Pockels cell |
| Load capacitance | 5-7 pF typically |
| Pulse shape | Triangular (fast rise, relatively slow decay) |
| Rise time | 1-3 ns |
| Recovery time | 5 us typically |
| Pulse amplitude | 2800 … 3800 V adjustable by default, other on request |
| Bias voltage | No |
| Other | Adjustable delay relatively to the diode driver |
| OUTPUT 3 (POCKELS CELL DRIVER – LiNbO3 VERSION): | |
| Load | LiNbO3 Pockels cell |
| Load capacitance | <20 pF |
| Pulse shape | Triangular (fast rise, relatively slow decay) |
| Rise time | 2-4 ns |
| Recovery time | 5 us typically |
| Pulse amplitude | 1600 … 2100 V adjustable by default, other on request |
| Bias voltage | No |
| Other | Adjustable delay relatively to the diode driver |

Warning – Pockels cell's electrodes must be isolated from the ground and cannot be grounded in any way

| | |
|---|---|
| **COOLING** | Passive cooling through the cold-plate attached to the driver bottom; the customer's responsibility is to keep cold-plate temperature below 70 ℃ (e.g. by attaching cold-plate to the massive heatsink or to the system chassis) |
| **PROTECTIONS** | From overheating of internal components<br>From short-circuit at the output<br>From mismatched load at the output<br>Interlock door connection |
| **INTERFACES (DIGITAL)** | RS-232 machine interface (RS-485 on request) |
| **INTERFACES (TTL)** | • IDC<br>• Fault<br>• Synchro inputs<br>• Synchro output |
| ENVIRONMENT: | |
| Operating temperature | Driver is designed for –30 … +55 ℃ operating temperatures (we do our best to assure good performance in the required range of operating |

| | temperatures, though due to the absence of temperature chamber real testing in whole range of ambient temperatures is not performed by us) |
|---|---|
| Storage temperature | –40 … +85 °C |
| Humidity | 0 … 90 %, non-condensing |
| Shock / vibration | No special requirements |

### **MECHANICAL**

| | |
|---|---|
| **Size (LxWxH)** | 180x70x30 mm (see also the dimensional drawing below) |
| **Weight** | <0.5 kg |

## How to order?

Four standard modifications are available by default (please see the table below).
A plenty of other modifications are available on request.

| Modification | Description |
|---|---|
| SDC-150A-55V | • 150 A maximum output current<br>• 55 V maximum output voltage<br>• Maximum output power >20 W (target regime 150 A, 55 V, 220 us, 10 Hz) |
| SDC-150A-55V-HP | • 150 A maximum output current<br>• 55 V maximum output voltage<br>• Boosted output power; achieved by the cost of narrowed operating temperature range<br>• Maximum output power >40 W (target regime 150 A, 55 V, 220 us, 20 Hz)<br>• Operating temperature 0-40 °C |
| SDC-110A-85V | • 110 A maximum output current<br>• 85 V maximum output voltage<br>• Maximum output power >20 W (target regime 110 A, 85 V, 220 us, 10 Hz) |
| SDC-110A-85V-HP | • 110 A maximum output current<br>• 85 V maximum output voltage<br>• Boosted output power; achieved by the cost of narrowed operating temperature range<br>• Maximum output power >40 W (target regime 110 A, 85 V, 220 us, 20 Hz)<br>• Operating temperature 0-40 °C |

# DIMENSIONAL DRAWING
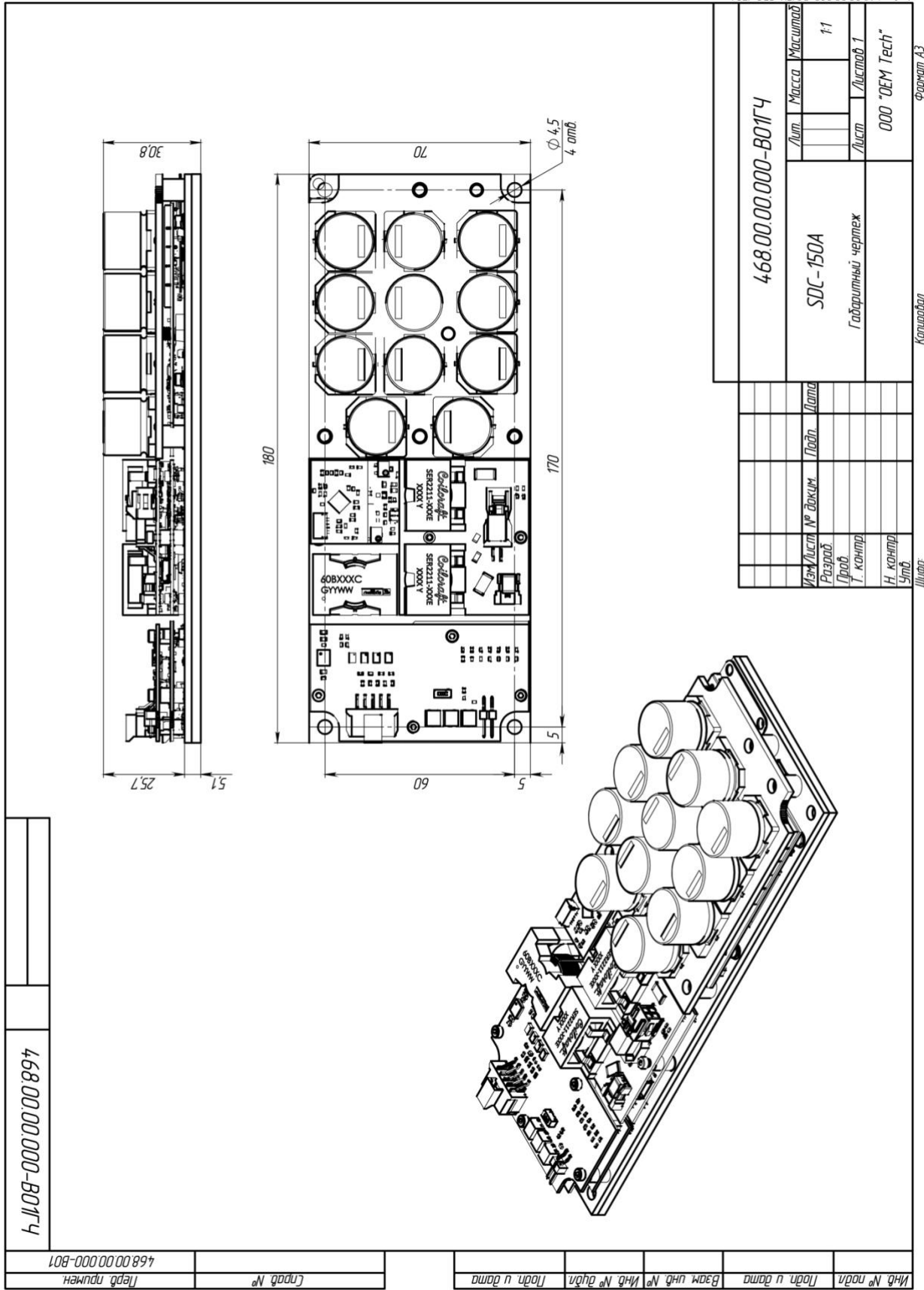
## Software description
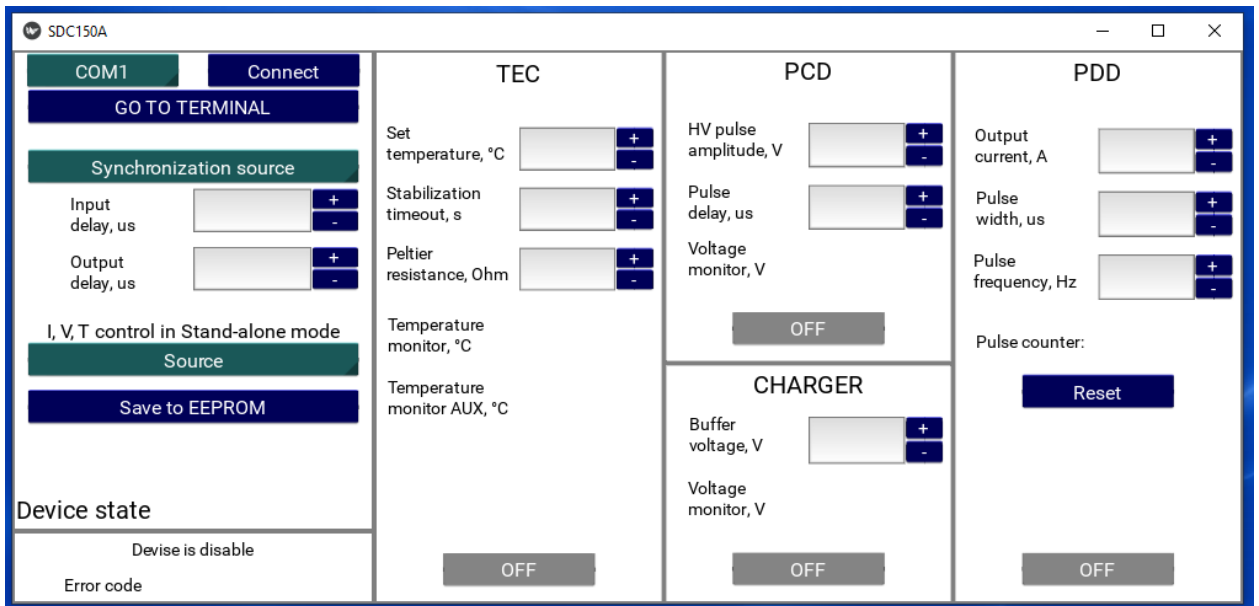


*Parameters section:*
- **COM** list — selects the COM port to connect the driver to
- **CONNECT** button — connects driver to the selected COM port
- **GO TO TERMINAL** button — runs terminal (to send textual commands to the driver)
- **SYNCHRONIZATION** list — selects synchronization (external or internal)
- **Input delay** — sets the delay between current pulses of PDD and the synchronization pulses
- **Output delay** — sets the delay between synchro output and current pulses of PDD
- **CONTROL** list — defines behavior of the driver in Stand-alone mode
- **SAVE TO EEPROM** button — saves all driver's parameters to EEPROM
- **Device state** — shows essential information about the driver

*TEC section:*
- **Set temperature** — temperature set point (e.g. 20 – 60 °C)
- **Stabilization timeout** — sets stabilization timeout (0 to infinite timeout)
- **Peltier resistance** — sets Peltier resistance (recommended for better performance)
- **Temperature monitor (TEC)** — real temperature measured with TEC NTC
- **Temperature monitor (AUX)** — temperature measured with AUX NTC
- **TEC state** — status of TEC
- **ON/OFF** button — starts/stops TEC

*PCD (Pockels cell driver) section:*
- **HV pulse amplitude** — sets pulse amplitude (e.g. 2800 – 3800 V)
- **Pulse delay** — sets pulse delay relatively to the start of current pulse
- **Voltage monitor** — DC buffer voltage of the Pockels cell driver
- **ON/OFF** button — enables/disables Pockels cell driver

*Charger section:*

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- **Buffer voltage** – sets buffer voltage (DC input of the diode driver)
- **Voltage monitor** – buffer voltage of the diode driver
- **ON/OFF** button – enables/disables capacitor charger

*PDD (pulsed diode driver) section:*
- **Output current** – sets pulse current (e.g. 15 – 150 A)
- **Pulse width** – sets pulse width (e.g. 50 – 300 us)
- **Pulse frequency** – sets repetition rate (e.g. 1 – 30 Hz)
- **Pulse counter** – pulse counter
- **RESET** button – resets pulse counter
- **ON/OFF** button – starts/stops diode driver

## RS-232 (RS-485) protocol description

RS-232 / RS-485 connection parameters: 38400 bps, 8 data bits, 1 stop bit, no parity.

Command format is: {command} {data (optionally)} {end-of-line}
• data is ASCII-string of adjusting value
• end-of-line symbols are \r\n or \n

Example: "tt 25.1" sets the temperature of TEC to 25.1 °C.

### List of available commands:

### Common commands:
\* – Returns firmware version
e – Turns on/off echoing of symbols in RS-232 (turned on by default)
E – Returns echoing status
SM – Saves all the parameters to EEPROM
RM – Clears EEPROM (resets all the parameters, including calibration data, to the default values; driver's restart is required after reset)
ec – Clears error code ('ec 0' to clear error code)
EC – Returns error code:
>  *0 – no error*
>  *1 – IDC*
>  *2 – common fault*
>  *3 – charger overheat*
>  *4 – IGBT overheat*
>  *5 – overvoltage (buffer voltage too high)*
>  *6 – temperature stabilization fault*
>  *7 – watchdog timeout*

mc – Sets the source of Voltage, Current and Temperature in Stand-alone mode ('mc 1' – buffer voltage, pulse current and TEC temperature are set by the corresponding trimpots, 'mc 0' – by the parameters set in the device's memory)
MC – Returns the source of Voltage, Current and Temperature
GC – Returns pulse counter
RC – Resets pulse counter
wdg – sets watchdog timeout, in seconds (0 – watchdog timer is disabled)
WDG – returns watchdog timeout set point
mF – returns Fault state (0 – no Fault)
mT – returns TEC stabilization status (1 – stabilized)

### Buffer voltage (charger) related commands:
cr – Turns the capacitor charging module on and off ('cr 1' turns on, 'cr 0' turns off)
cR – Returns capacitor charging module set point
cv – Sets the desired buffer voltage (in Volts, from $V_{MIN}$ to $V_{MAX}$)
cV – Returns buffer voltage set point
cmV – Returns voltage monitor (actual voltage measured by internal monitor)

### Diode driver related commands:
dr – Starts/stops current pulses ('dr 1' starts pulses, 'dr 0' stops pulses)
dR – Returns run status
di – Sets diode current (in Amperes, from $I_{MIN}$ to $I_{MAX}$)
dI – Returns diode current set point
dp – Sets pulse length (in microseconds, from $P_{MIN}$ to $P_{MAX}$)
dP – Returns pulse length set point
df – Sets pulse repetition rate (in Hertz, from $F_{MIN}$ to $F_{MAX}$)
dF – Returns pulse repetition rate set point

### TEC related commands:

tr – Starts/stops TEC ('tr 1' starts, 'tr 0' stops)

tR – Returns the actual state of the TEC

tt – Sets temperature set point (in Celsius degrees, from $T_{MIN}$ to $T_{MAX}$, basing on 10K NTC thermistor MF52C1103F3380 R/T curve)

tT – Returns temperature set point

tC – Returns the actual temperature (temperature monitor, basing on 10K NTC thermistor MF52C1103F3380 R/T curve)

taC – Returns the actual temperature of auxiliary NTC (AUX NTC pins of AUX connector)

ts – Sets TEC waiting time (in seconds, from $W_{MIN}$ to $W_{MAX}$, if temperature isn't stabilized within this time, this is considered as a fault, 'ts 0' means infinite TEC waiting time)

tS – Returns TEC waiting time set point

tpr – Sets Peltier resistance (in Ohms, from $R_{MIN}$ to $R_{MAX}$, correct setting is recommended for better PID regulation)

tpR – Returns Peltier resistance set point

## PCD related commands:

qr – Enables/disables Pockels cell driver ('qr 1' – enables, 'qr 0' – disables)

qR – Returns status of Pockels cell driver

qv – Sets output voltage (in Volts, from $HV_{MIN}$ to $HV_{MAX}$)

qV – Returns output voltage set point

qmV – Returns voltage monitor (actual voltage measured by internal monitor)

## Synchronizations:

s – Sets synchronization mode ('s 0' – external synchronization mode, 's 1' – internal synchronization mode)

S – Returns synchronization mode

~i – (in external synchronization mode) Sets delay between diode current pulse and the external synchronization pulse

~I – (in external synchronization mode) Returns delay between diode current pulse and the external synchronization pulse

~o – (in all modes) Sets delay between synchro output and diode current pulse

~O – (in all modes) Returns delay between synchro output and diode current pulse

~q – (in all modes) Sets delay between HV pulse and diode current pulse

~Q – (in all modes) Returns delay between HV pulse and diode current pulse

## Typical preset parameters (may vary for different versions of the product):

| Parameter | Min | Max | Step | Default |
|---|---|---|---|---|
| cv | 6 | 33 | 0.1 | 15 |
| di | 15 | 150 | 1 | 50 |
| dp | 50 | 300 | 1 | 100 |
| df | 0 | 30 | 0.01 | 5 |
| tt | 10 | 60 | 0.1 | 25 |
| ts | 0 | 180 | 1 | 30 |
| tpr | 0 | 5 | 0.01 | 1 |
| qv | 2000 | 4000 | 1 | 3600 |
| ~i | 0 | 1000 | 1 | 0 |
| ~o | -1000 * | 1000 | 1 | 0 |
| ~q | -1000 ** | 1000 | 1 | 100 |

\* negative delays are possible while ~i + ~o > 0

\*\* negative delays are possible while ~i + ~q > 0