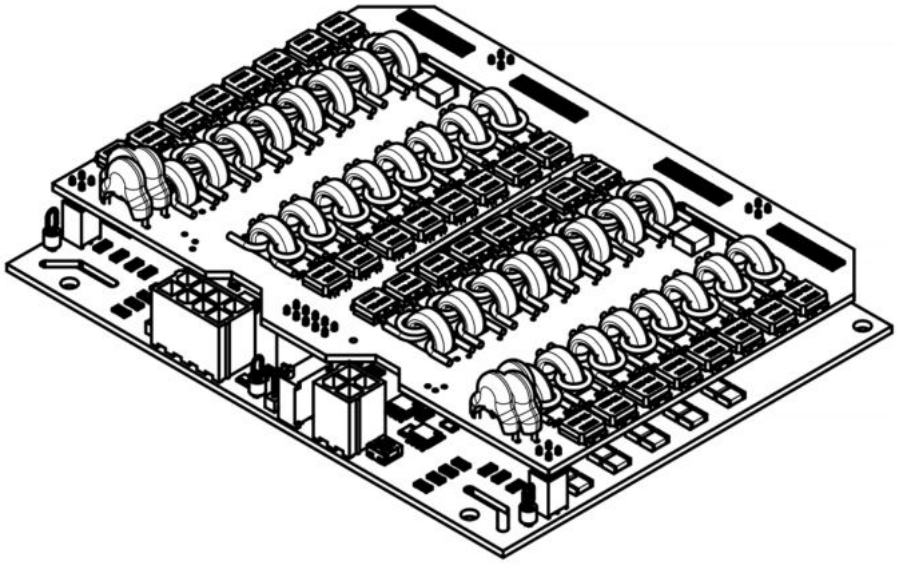
QBU-10kV Pockels cell driver
(QBU-9036, QBU-8032, QBU-7028 Pockels cell drivers)

User manual



Warning! This equipment produces high voltages that can be very dangerous. Please read this user manual before starting any operations.

Important note: please measure the output with symmetrical (differential) high voltage probe only. Measurement made with inappropriate equipment is a common cause of driver's failure.

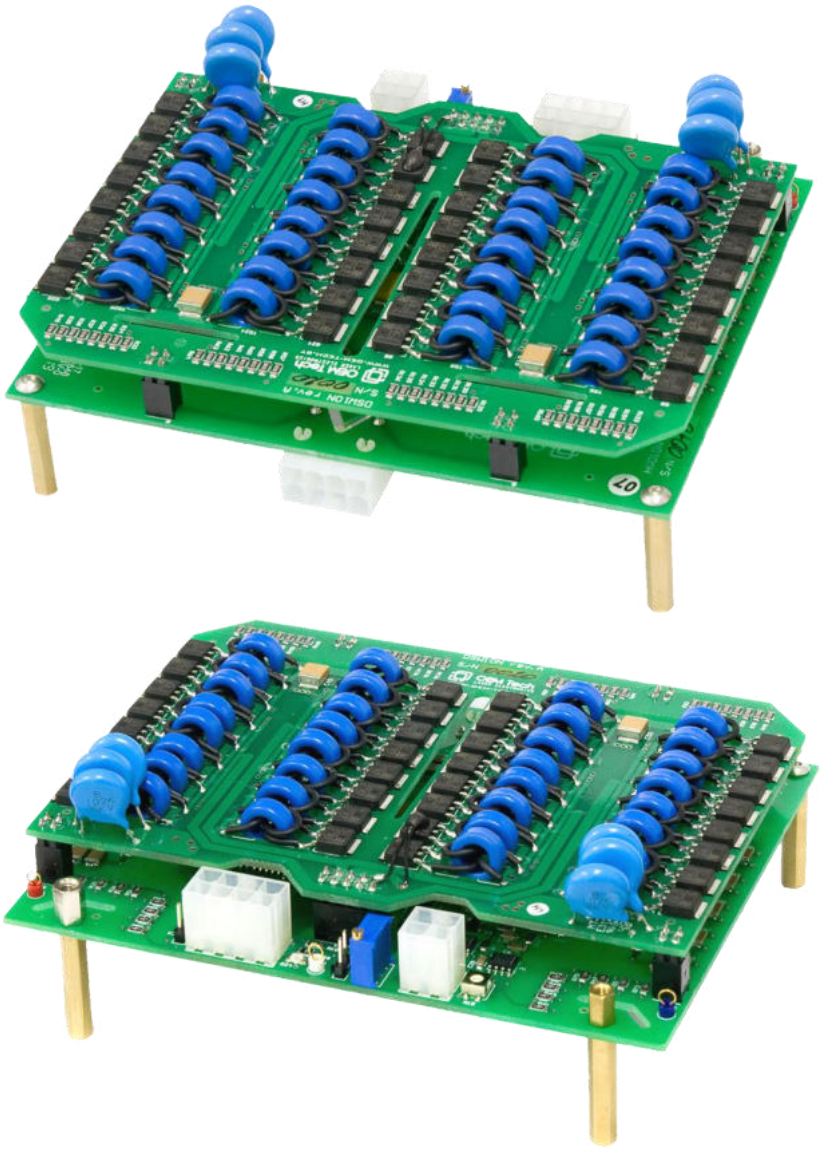
Table of content

Overview / Appearance

QBU-10kV (QBU-9036, QBU-8032, QBU-7028) Pockels cell drivers produce high voltage pulses with high repetition rate, fast rise and fall times, adjustable voltage amplitude and pulse width. High output voltage (up to 10 kV) allows to use Pockels cells under half-wave voltage schemes or deal with larger crystals.

The modules require +24 V DC power supply and pulse generator to set an operating frequency and pulse width.

Two control types are available: manual and automatic, when an output voltage level can be programmed in working range by user either manually (through onboard configuration trimpot) or remotely (applying a DC voltage to the respective pin).



Cooling

No active cooling is required for low repetition rate operation. For full performance (up to three times higher repetition rates), forced air cooling withan external fan is needed. See the *Performance* section for details.

The “rule of thumb” is as follows:

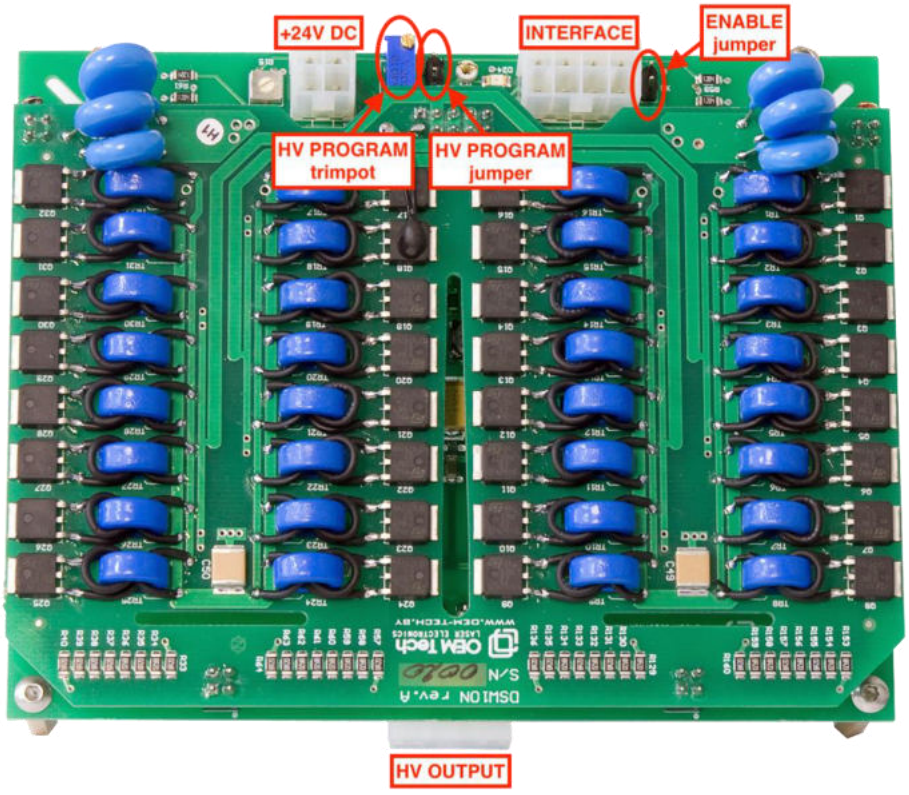
- Never exceed 24VDC current consumption of 500mA with conductive cooling
- Never exceed 24VDC current consumption of 1500mA even with forced-air cooling

Contents of delivery

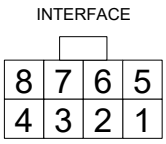
By default, the following items are supplied together with the driver:

- +24V input cable (50cm length) – 1pc
- INTERFACE cable (50cm length) – 1pc
- HV OUTPUT cable (50cm length) – 1pc

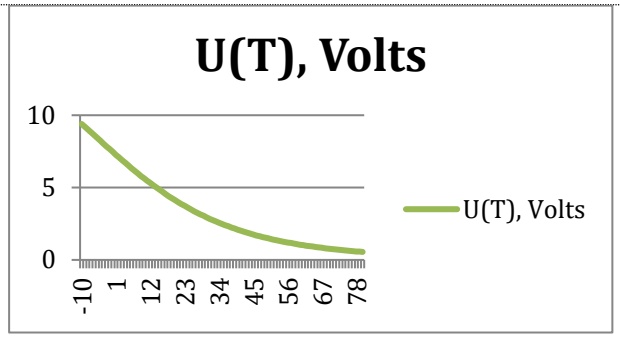
Connectors, pins, interface signals



INTERFACE (Molex 39-30-1060):

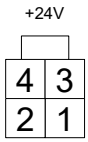


PIN (color)	DESIGNATION	DESCRIPTION
1 (white)	**Pulse**	While “0” or ”1” is applied to PIN1, the high voltage output is maintained correspondingly at **0V** or **HV** level, respectively. Sequences of incoming pulses with a period shorter than approx. 200 ns will be ignored by the driver.
2 (violet)	**Temperature Monitor**	This pin returns a voltage that indicates the internal temperature of the driver. The approximate U(T) dependence is given below.

		
3 (red)	**+15 V**	Provides +15V DC output level; maximum current capability is 100mA.
4 (blue)	**Enable**	HV output is enabled / disabled by PIN4 (“1” – enable, “0” – disable).
5, 6 (black)	**Interface Return**	PIN5 and PIN6 are connected to the driver’s ground circuit.
7 (yellow)	**HV Monitor**	The voltage at PIN7 is a monitor signal proportional to the measured value of the high voltage output. **HV_{MAX}** corresponds to 10V at PIN7, **HV_{MIN}** corresponds to 4V at PIN7.
8 (green)	**HV Program**	A positive DC voltage applied to PIN8 sets a high voltage value **HV.** **HV_{MAX}** corresponds to 10V at PIN8, **HV_{MIN}** corresponds to 4V at PIN8.

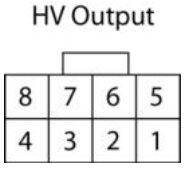
“0” means logical 0 low level (0V), “1” means logical 1 high level (5V)

+24V (Molex 39-30-1040):



PIN (color)	DESIGNATION	DESCRIPTION
1, 2 (red)	**+24V DC**	INPUT positive 24V DC for powering the Pockels cell driver
3, 4 (black)	**RETURN**	Return from power supply producing +24V DC

HV OUTPUT (Molex 39-30-1060):



PIN (color)	DESIGNATION	DESCRIPTION

1 (blue)	**Negative**	HV Negative
4 (red)	**Positive**	HV Positive
2, 3, 5-8	**N/C**	-

ENABLE JUMPER:

One can use ENABLE jumper instead of ENABLE signal of INTERFACE. It isn't recommended to use ENABLE jumper and ENABLE signal at the same time.

HV PROGRAM JUMPER AND HV PROGRAM TRIMPOT:

One can use HV PROGRAM jumper instead of HV PROGRAM signal of INTERFACE. If this jumper is set on, the output voltage is defined with HV PROGRAM trimpot state. It isn't recommended to use HV PROGRAM jumper and HV PROGRAM signal at the same time.

Safety

Warning! This equipment produces high voltages that can be very dangerous. Be careful in a high-voltage appliances area.

- Assemble the entire setup before powering the device.
- Avoid casual contacts of personnel with output cables and with the load.
- Do not connect or disconnect cables while the driver is powered on.
- Do not operate with load disconnected.
- Be very careful when setting jumpers and using the HV PROGRAM trimpot; accidental contact with the board can be fatal; in the same sense, it's recommended not to control the driver manually, but remotely via the interface connector.
- Take care of the environment around the driver; do not place any objects close to any side of the driver.
- Do not turn on the driver if it has been damaged by water, chemicals, mechanical or electrical shock.
- Do not repair the driver yourself, there are no user serviceable parts inside.

Operations (manual control)

1. Connect +24VDC power supply, a pulse generator and a Pockels cell to the driver
2. Set up the HV PROGRAM jumper
3. Switch on +24VDC power supply
4. Set the ENABLE jumper
5. Use the HV PROGRAM trimpot to set the desired output voltage
6. Send drive pulses from pulse generator to PIN1 of INTERFACE. Set pulse width longer than 200ns
7. To power down the driver, switch off the +24VDC power supply or remove the ENABLE jumper

Operations (automatic control)

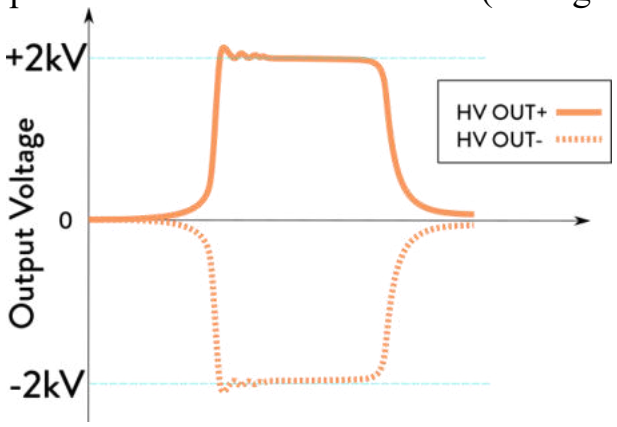
1. Connect +24V, INTERFACE and HV OUTPUT connectors to the board
2. Remove the HV PROGRAM jumper, remove the ENABLE jumper
3. DISABLE the high voltage output
4. Apply the correct nominal DC INPUT power to the module
5. Set up the required output voltage by applying a DC voltage to the HV PROGRAM PIN8 of INTERFACE
6. ENABLE the high voltage output
7. Send drive pulses to PIN1 of INTERFACE. Set pulse width longer than 200ns
8. To power down the driver, remove DC INPUT power or DISABLE high voltage output

Technical notes

- **The performance of the module greatly depends on the load capacitance.**
  The best performance is achievable at load capacitance typical to Pockels cells used in laser industry (5-7pF).

Higher load capacitance decreases maximum allowed repetition rate

- **Module's output is bipolar.**
  This means that e.g. 4kV pulse is physically formed by producing +2kV on one output wire and -2kV on the other (see figure below).



  Nevertheless, all descriptions of HV output are given in terms of voltage differences. Please keep this in mind!

- **Sometimes output is delayed.**
  If no switching of the output voltage occurs for a long time (about 100us) the driver needs to refresh its state. During refreshment, the driver cannot switch the output, so if it receives a command to switch at such a time, it delays the transition until the end of refreshment.

  As a result, if the pulse width is more than 100us, or the distance between two sequential pulses is more than 100us, the switching of the high voltage output may sometimes be delayed. The delay time is approximately 150ns.

- **Output voltage measurement.**
  Please measure the output with symmetrical (differential) high voltage probe only. Measurement made with inappropriate equipment is a common cause of driver's failure.

In terms of performance, please keep in mind, that differential probes have significant capacitance, which should be counted as a part of the load capacitance.

Specifications

ELECTRICAL SPECIFICATION

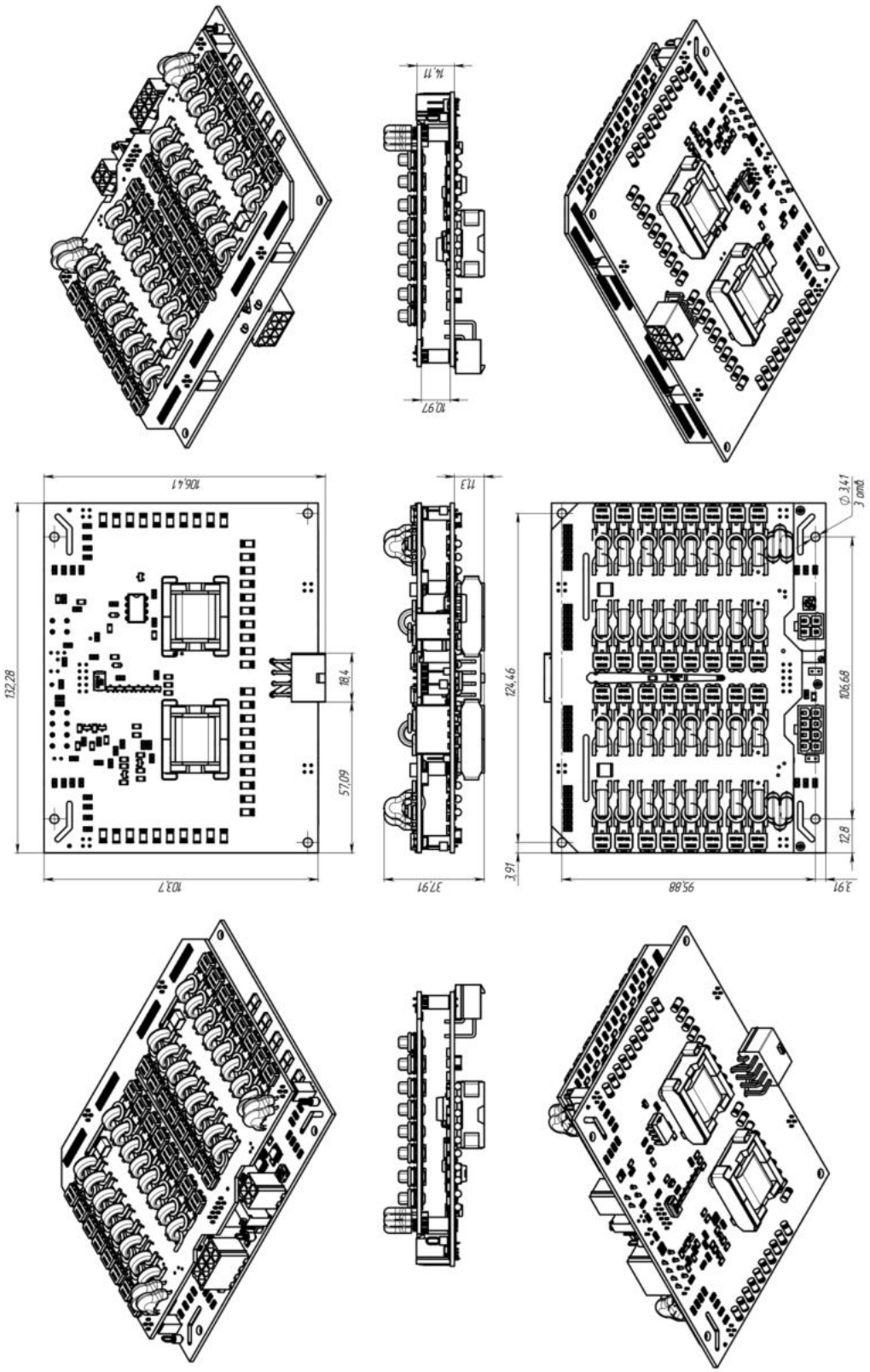
Input	+24V DC; 1.5A max
Output	
Working mode	repetition of the input TTL signal 
Pulse amplitude	adjustable in HV_{MIN} – HV_{MAX} range (see also *How to order?* section)
Pulse basement	fixed, 0V
Pulse width	200ns – DC
Max. repetition rate	see *Performance* section
Rise time (fall time)	<20ns (<25ns) [1]
Jitter	±1.5ns
Delay time	<150ns
Protections	from overheating (approx. 72 °C)
Environment	
Operation temperature	+10...+40 °C
Storage temperature	-20...+60 °C
Humidity	0...90%, non-condensing

[1] 10-90% level, guaranteed at load capacitance 11 pF and below

MECHANICAL SPECIFICATION

Size (LxWxH)	133x104x50mm (see also the dimensional drawing below)
Weight	<0.2kg

Dimensions


14.11
10.97
106.41
132.28
18.4
57.09
103.7
11.3
37.91
124.46
95.88
3.91
106.68
12.8
Ø 3.41
3 omd

How to order?

There are a few modifications different with the output voltage. The most popular are listed below:

Part number	HV_{MAX}	HV_{MIN}
QBU-10kV	10000	4000
QBU-9036	9000	3600
QBU-8032	8000	3200
QBU-7028	7000	2800

Other modifications are available on request.

Example: QBU-10kV

Performance

The table below contains the maximum repetition rate in dependence on output voltage and cooling conditions. Other setup parameters – total load capacitance 11pF, ambient temperature 25 °C:

Output voltage, kV	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.0
Repetition rate, kHz (conductive cooling)	>25	>15	>10	>7.5	>5	>4	>3	>2
Repetition rate, kHz (*appropriate* forced-air cooling)	>75	>50	>30	>25	>20	>15	>10	>7

In the burst mode (= short time operation) the performance increases approximately twice and can reach 100kHz value at low operating voltage and low load capacitance.

Higher load capacitance and higher ambient temperature decreases the performance.