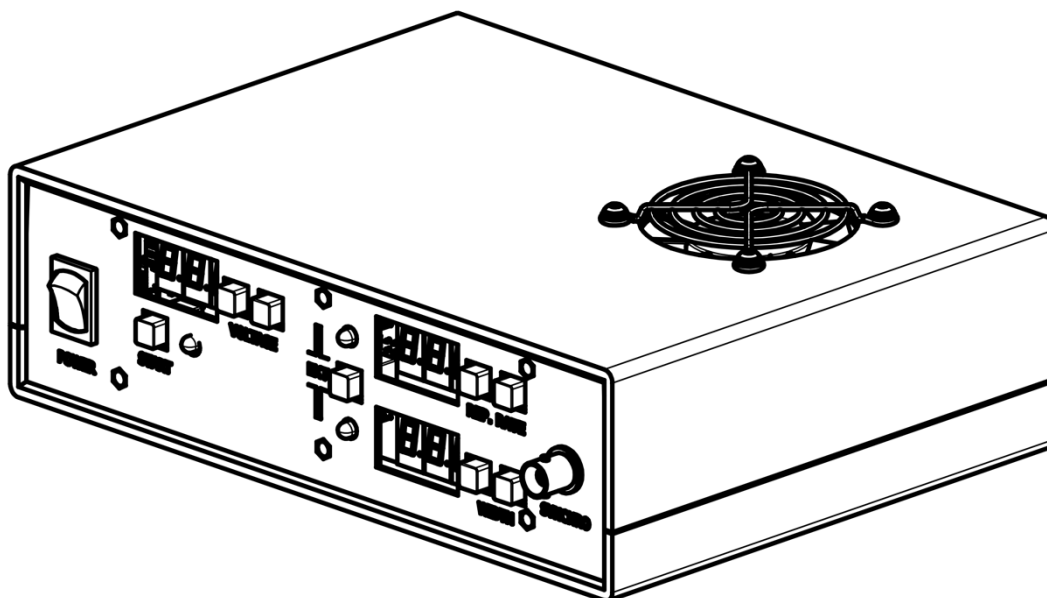


# QBU-BT-series Pockels cell driver

## User manual



**Warning!** This equipment may be dangerous.  
Please read the entire user manual carefully before using the product.

**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.



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## Overview / Appearance

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The QBU-BT series Pockels cell driver produces high voltage pulses with high repetition rates, fast rise and fall times, adjustable voltage amplitude and pulse width.

The voltage level, operating frequency and pulse width can be selected by the user within the working range via RS-232 or from the front panel.

Triggering is by internal clock or by signal from an external device.



## Cooling

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The driver is cooled with a built-in fan. No external cooling is required.

## Contents of delivery

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By default, the package contains:

- QBU-BT Pockels cell driver – 1pc
- Power cord (European plug) – 1pc
- HV OUTPUT cable (50cm length) – 1pc

USB/RS-232 adapter as well as RS-232 cable are not included in the scope of supply. There are also no engineering software utilities for the QBU-BT provided by OEM Tech. However, customizations are possible on request.

## Front panel description

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POWER switch – turns the driver on / off

VOLTAGE indicator – shows installed voltage (in kV units)

VOLTAGE buttons – increase / decrease voltage

WIDTH indicator – shows installed pulse width (in  $\mu$ s and ms units, pulse width of  $\mu$ s range has  $\sqcup$  sign instead of the last digit)

WIDTH buttons – increase / decrease pulse width

REP. RATE indicator – shows installed repetition rate (in Hz and kHz units, repetition rate of Hz range has  $\sqcap$  sign instead of the last digit)

REP. RATE buttons – increase / decrease repetition rate

EXT button – switches the module between three modes

- pulses up – when this mode is selected normal state of the output is 0V, during the pulse output voltage is switched to high voltage  
when this mode is selected green LED nearby the  $\sqcup$  sign is on
- pulses down – when this mode is selected normal state of the output is high voltage level, during the pulse output voltage is switched to zero  
when this mode is selected green LED nearby the  $\sqcap$  sign is on
- external synchronization mode – in this mode module receives from SYNCHRO connector and repeats at its output external logical signal  
when this mode is selected both LEDs are on

SYNCHRO connector – synchronization input for operations in external synchronization mode (triggering level 5V, input impedance 220 $\Omega$ )

START button – enables output and starts operations in selected mode with selected parameters; the second pressure on this button stops operations  
when START button is pressed the red LED nearby indicates this

## Back panel description

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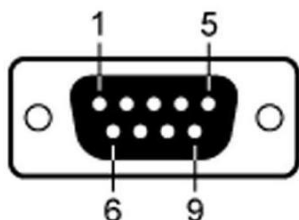


MAINS connector (a power cord is supplied with the driver) – connects the module to the mains (100-240 VAC, 50/60 Hz). This connector also contains a 2A fuse.

HV OUTPUT connector (a mating cable is supplied with the driver) – connects the load to the module.

RS-232 connector (a mating cable is supplied on request) – connects the driver to the computer.

### RS-232 (9-PIN DSUB MALE):



PIN (color)	DESIGNATION	DESCRIPTION
1, 6, 7, 9	-	N/C
2 (green)	RS-232 RX	RS-232 RX
3 (blue)	RS-232 TX	RS-232 TX
4, 8	-	Interconnected to each other
5 (black)	GND	Common ground of the QBU-BT

## Safety

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**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.
- Do not remove the coverage case from the Pockels cell driver.
- Do not repair the driver yourself, there are no user serviceable parts inside.
- Do not operate with load disconnected.
- 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 turn on the driver if it has been damaged by water, chemicals, mechanical or electrical shock.

## Operations

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1. Connect a Pockels cell to the driver, connect the driver to the mains.
2. Turn on the POWER switch.
3. Select desired VOLTAGE, REP. RATE, PULSE WIDTH, and desired OPERATING MODE with the corresponding buttons.
4. Press the START button. The module will now start to operate. This should be indicated by the corresponding LED.
5. Press the START button again to stop the operations.
6. Turn off the POWER switch.

## Operations (RS-232 interface)

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1. Make sure the POWER switch is off, make sure the computer is switched off.
2. Connect the Pockels cell driver to the computer with the appropriate cable.
3. Turn on the POWER switch, turn on the computer.
4. Run HyperTerminal or similar software.
5. Send commands to the driver to set the desired operating parameters. Send the "r" command (or "r 1" command) to the driver to start the operations.
6. Send "i" command (or "r 0" command) to the driver to stop operations.
7. Turn off the POWER switch.

**Note:** it's possible, but not recommended, to use RS-232 and front panel user interfaces at the same time

## Technical notes

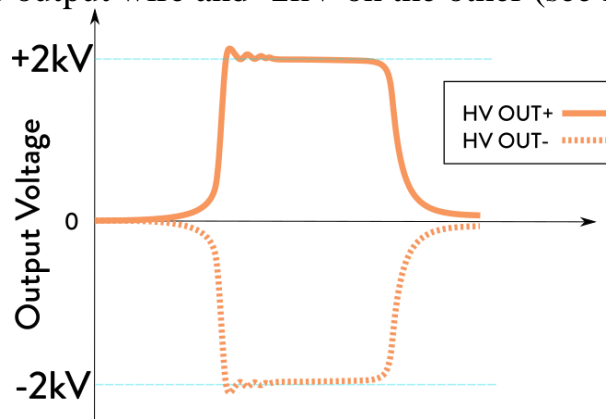
- **The performance of the module greatly depends on the load capacitance.**

The best performance is achievable at load capacitance typical to Pockels cells used in laser industry (5-7pF).

**Higher load capacitance decreases the 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.

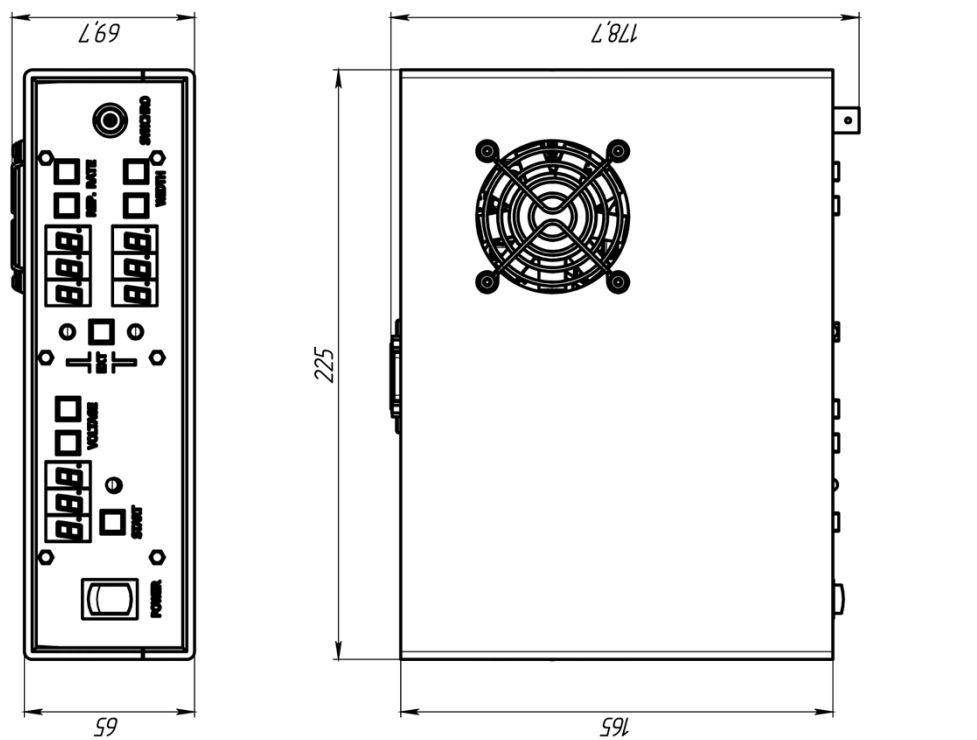
## Specifications

### ELECTRICAL SPECIFICATION

<b>Input</b>	100-240VAC, 50/60 Hz; 1.0A max
<b>Output</b>	
 <p>push up scheme      pull down scheme      repetition of external signal mode</p> <p>high level is adjustable</p>	
Working modes	Pulses up mode, pulses down mode, repetition of external signal mode (= external synchronization mode)
HV high level (pulse amplitude)	adjustable in $HV_{MIN}$ – $HV_{MAX}$ range (see also <i>How to order?</i> section)
HV low level (pulse basement)	fixed, 0V
Pulse width	200ns – DC in external synchronization mode; 1 $\mu$ s – 1/f (f is repetition rate in Hz) in internal synchronization modes
Max. repetition rate	see <i>Performance</i> section
Rise time / fall time	<15ns (10-90% level, guaranteed at load capacitance 11pF and below)
Jitter	$\pm 1$ ns
Delay time	<100ns
<b>Protections</b>	from overheating (approx. 72 °C)
<b>Environment</b>	
Operation temperature	+10...+40°C
Storage temperature	-20...+60°C
Humidity	0...90%, non-condensing

### MECHANICAL SPECIFICATION

Size (LxWxH)	Approx. 225x180x70mm (see also the dimensional drawing below)
Weight	<1.5kg



## Performance

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For continuous operation in internal synchronization modes (pulses up and pulses down modes) we guarantee the performance table as follows:

23 pF load capacitance								
Output voltage, kV	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
Repetition rate, kHz	56	40	31	24	18	15	12	9

In external synchronization mode, the driver usually shows slightly higher performance.

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

Higher load capacitance decreases the performance.

<b>Note:</b> modules with the higher performance are available on request
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## How to order?

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QBU-BT-XXYY-LJ-[ZZZ], where:

- XX codes the maximum output voltage ( $HV_{MAX}$ , user selectable up to 6000V),
- YY codes the minimum output voltage ( $HV_{MIN}$ , 40% of  $V_{MAX}$ ),
- LJ codes low jitter option (supplied by default). In LJ version of the driver jitter is as low as  $\pm 1$ ns, delay time is shorter than 100ns,
- [ZZZ] codes optional version different with output connectors:  
SMA – version of the product with SMA-type output connectors (see *Appendix B* for the details), available only for low voltage versions of the product (1500V and below), suitable for driving of unipolar Pockels cells of low capacitance (e.g. EO phase and amplitude modulators).

Examples (the most popular modifications):

Part number	$HV_{MAX}$	$HV_{MIN}$
QBU-BT-6024-LJ	6000	2400
QBU-BT-5020-LJ	5000	2000
QBU-BT-4016-LJ	4000	1600
QBU-BT-3012-LJ	3000	1200
QBU-BT-2008-LJ	2000	800
QBU-BT-1506-LJ QBU-BT-1506-LJ-SMA	1500	600
QBU-BT-1004-LJ QBU-BT-1004-LJ-SMA	1000	400

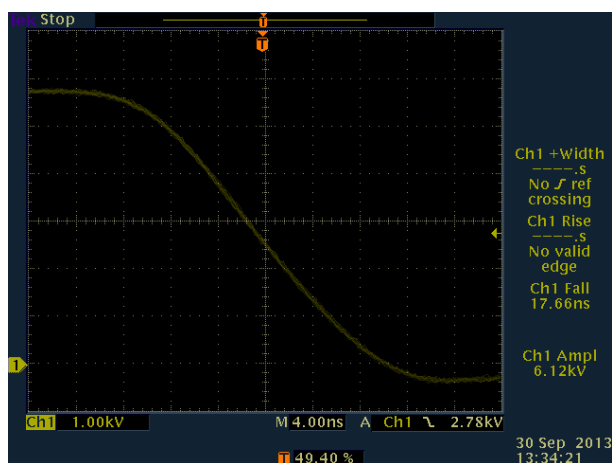
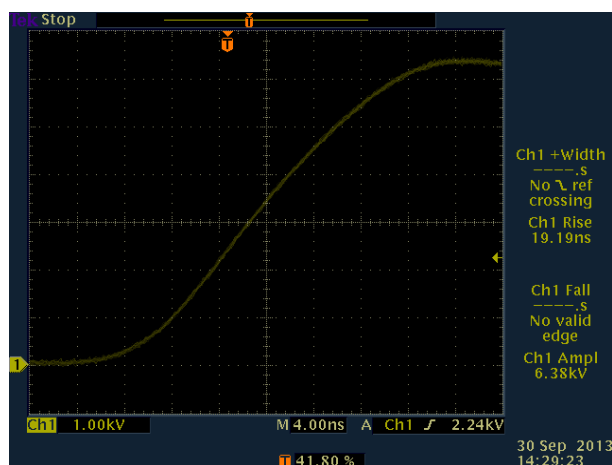
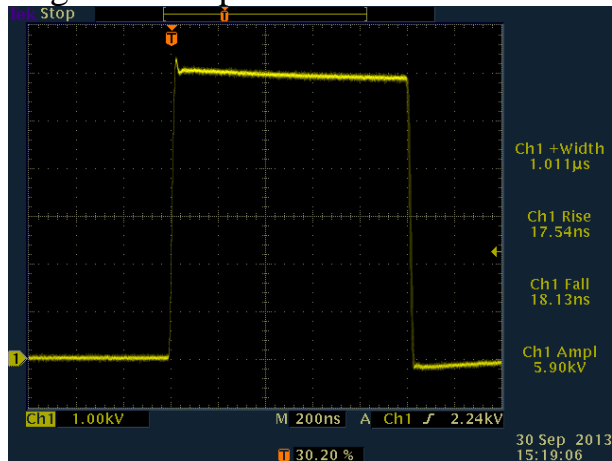
Other modifications are available on request.

## Output oscillograms

Product: QBU-BT-6024-LJ

Load: 11pF HV capacitor + HV Probe (approx. 13pF)

Regime: 6kV pulses



## Appendix A. RS-232 communicative protocol

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

Command format is: {command} {data (optionally)} {end-of-line}

- command is 1 character long (see list below)
- data is ASCII-string of adjusting value
- end-of-line symbols are \r\n or \n

List of available commands:

- f {frequency} – set repetition rate (in Hz)
- p {pulse width} – set pulse width (in microseconds)
- v {voltage} – set voltage (in volts)
- s {sync} – set synchronization type (0 – positive pulse, 1 – negative pulse, 2 – external synchronization)
- r – start
- i – stop
- alternatively, QBU-BT can be started/stopped with “r 1” and “r 0” commands respectively
- F – get frequency set point
- P – get pulse width set point
- V – get voltage set point
- S – get synchronization status
- R – get start/stop status
- T, mT – get temperature monitor
- U, mV – get voltage monitor
- mO – get overheating status (OHt)
- M – get voltage monitor, temperature monitor and overheating status
- ? – get all the parameters (in V, P, S, OHt, F, R order)
- Q – get current version of the firmware
- !e {0/1} – turns on/off echoing of symbols in RS-232 (turned off by default)
- !E – get echoing status

Example: v 2500 sets voltage to 2500 volts.

## **Appendix B. Low voltage version with SMA-type output connectors**

Version of the product with SMA-type output connectors, available only for low voltage versions of the product (1500V and below), suitable for driving of unipolar Pockels cells of low capacitance (e.g. EO phase and amplitude modulators).



In this version, 1000V voltage set point means that +500V (relatively to the ground) will be delivered to HV+ SMA connector and -500V (relatively to the ground) will be delivered to HV- SMA connector. One connector or both can be used at the same time. 23pF maximum load capacitance can be connected to HV+ and/or HV- connectors.