QBU-BT series Pockels cell driver

User Manual

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

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Overview

QBU-BT series Pockels cell driver produces high voltage pulses with high repetition rates, fast risetimes and fast falltimes, adjustable voltage amplitude and pulse width.

Description

Front panel:

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 us and ms units, pulse width of us range has ⌴ 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 ⌙ 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 ⌋⌊ 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 ⌊⌋ 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
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:

MAINS connector (supplied with the driver) – connects module to the mains (110/230 VAC, 50/60 Hz). This connector contains also 5A fuse.
HV OUTPUT connector (supplied with the driver) – connects the load to the module
RS-232 connector (optionally) – connects module to the computer

Safety

Warning! This equipment produces high voltages that can be very dangerous. Don't be careless around this equipment

- Do not remove coverage case from the Pockels cell driver
- Do not self-repair the driver
- Do not operate with disconnected load
- Avoid casual contacts of personnel with output cables and with the load
- Do not connect / disconnect cables while driver is turned on
- Do not turn the driver on if it was already damaged with water, chemicals, mechanical or electrical shock

Operations

1. Connect Pockels cell to the driver, connect driver to the mains
2. Turn POWER switch on
3. Select desired VOLTAGE, REP. RATE, PULSE WIDTH, and desired OPERATING MODE using corresponding buttons
4. Press START button. Since that moment module starts operations. It must be indicated with corresponding LED
5. Press START button again to stop operations
6. Turn POWER switch off

Operations (RS-232 interface)

1. Ensure that POWER switch is off, ensure that computer is off
2. Connect Pockels cell driver to the computer using corresponding cable
3. Turn POWER switch on, turn the computer on
4. Run HyperTerminal or analogous software
5. Send to the driver commands that set desired parameters of operations. Send to the driver “r” command to start operations
6. Send to the driver “i” command to stop operations
7. Turn POWER switch off

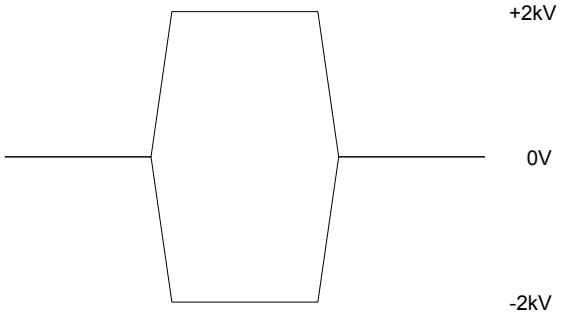
Note: it’s possible but it’s not recommended to use RS-232 and front panel user interfaces at the same time

Technical notes

- Performance of the module greatly depends on load capacitance. Full performance (see Performance section) is achievable only under condition of 11 pF load and below.

Note: higher load capacitance decreases maximal allowed repetition rate

- **Module's output is bipolar.** It means that 4kV pulse is physically formed by applying +2kV to positive output wire and –2kV to negative (see figure)



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

- **Sometimes output is delayed.** If no switching of output voltage occurs for a long time (about 150 us) the driver needs to refresh its state. During refreshment it's prohibited to switch the output.

  As a result if pulse width is more than 150 us or if the distance between two sequential pulses is more than 150 us, sometimes switching of the high voltage output may be delayed. The delay time is about 1 us.

Specifications

ELECTRICAL SPECIFICATION

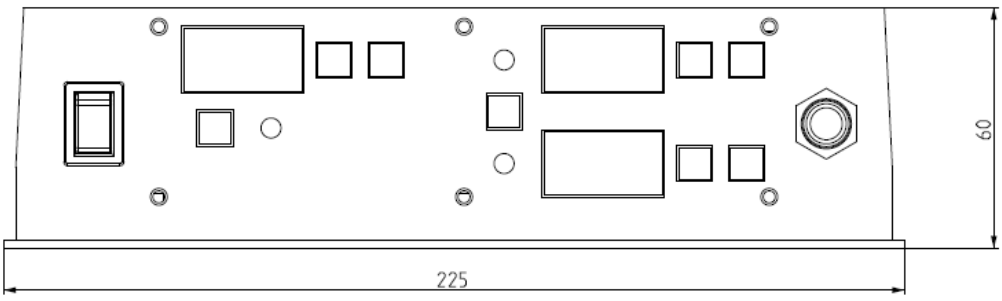
Input	110/230 VAC, 50/60 Hz; 1.0 A max
Output	
	
Working modes	Pulses up mode, pulses down mode, repetition of external signal mode (= external synchronization mode)
Pulse amplitude	adjustable in HVmin – Hvmax range (see Part numbers section)
Pulse basement	fixed, 0 V
Pulse width	1 us – DC in external synchronization mode; 1 us – 1/f (f is repetition rate in Hz) in internal synchronization modes
Max. repetition rate	see Performance section
Risetime / falltime	< 20 ns [1]
Jitter	± 10 ns (± 1 ns in LJ-modification)
Delay time	1 us (100 ns in LJ-modification)
Protections	from overheating
Environment	
Operation Temperature	0...+40 C
Storage Temperature	-20...+60 C
Humidity	90%, non-condensing

[1] 10-90% level, warranted at load capacitance 23 pF and below

MECHANICAL SPECIFICATION

Size (LxWxH)	225 x 200 x 60 mm
Weight	1,5 kg

OUTLINE DIMENSIONS



Performance

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

11 pF load capacitance								
Voltage, kV	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
Max. rep. rate, kHz	56	40	31	24	18	15	12	9

External synchronization mode shows usually a little higher performance.

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

Higher load capacitance decreases the performance.

Note: modules with the higher performance are available on request

How to order?

QBU-BT-XXYY-ZZ, where
XX codes the maximal output voltage (V_{MAX}, user selectable up to 6000V), YY codes the minimal output voltage (V_{MIN}, 40% of V_{MAX}).
ZZ codes options:

LJ – low jitter option (mandatory for 6kV modification, optional for others) – jitter is as low as ± 1ns, delay time is as short as 100ns;
SP – short pulse option – minimal pulse width is as short as 100ns; another advantage of short pulse option is a little faster rise and fall times (a few ns).

Examples (the most popular modifications):

Part Number	**HVmax**	**HVmin**
QBU-BT-6024-LJ	6000	2400
QBU-BT-5020 QBU-BT-5020-LJ	5000	2000
QBU-BT-4016 QBU-BT-4016-LJ	4000	1600
QBU-BT-3012 QBU-BT-3012-LJ	3000	1200
QBU-BT-2008 QBU-BT-2008-LJ	2000	800

Other modifications are available on request.

Example: QBU-BT-6024-LJ

RS-232 interface description

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 frequency (repetition rate)
- 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
- ? – get all adjusted parameters (format: frequency pulse_width voltage synchronization op_mode)
- F – get adjusted frequency
- P – get adjusted length
- V – get adjusted voltage
- T – get temperature monitor
- U – get voltage monitor
- M – get both voltage and temperature monitors
- Q – get current version
- e {0/1} – turns on/off echoing of symbols in RS-232 (turned on by default)

Example: v 2500 sets voltage to 2500 volts.

Typical output

QBU-BT-6024-LJ-SP,
Capacitance load 11pF + HV Probe (about 13pF), 6kV pulses