

QBD-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 / pulse parameters

QBD-BT series Pockels cell drivers produce high voltage pulses with high repetition rates, fast risetimes (falltimes) and adjustable voltage amplitude. Drivers are available in two modifications: QBD-BT-...-DN for pull-down scheme and QBD-BT-...-UP for push-up scheme.

Typical pulse shape (QBD-BT-...-DN modifications)	
Typical pulse shape (QBD-BT-...-UP modifications)	
Risetime/Faltime	$<20 \text{ ns}^{1,2}$
Recovery time	$5-10 \text{ us}^2$

HV pulse amplitude	adjustable in HVmin to HVmax range ³
Repetition rates	from single shot to 100 kHz and higher ²

¹ at 10-90% level

² depends on HV pulse amplitude and load capacitance

³ HVmin and HVmax values see in part number table

Description



Front panel:

POWER switch – turns the driver on / off

VOLTAGE indicator – shows installed voltage (in kV units)

VOLTAGE buttons – increase / decrease voltage

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

REP. RATE buttons – increase / decrease repetition rate

INT / EXT button – switches the module between two modes:

- internal synchronization mode – in this mode output pulses are initiated by internal clock
INT LED indicates if internal synchronization mode is selected
- external synchronization mode – in this mode output pulses are initiated by TTL synchronization pulses applied to SYNCHRO connector
EXT LED indicates if internal synchronization mode is selected

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
START LED located nearby indicates whether START button is pressed

Back panel:

MAINS connector (cable supplied with the driver) – connects module to the mains (100-240 VAC, 50/60 Hz). The connector also contains 5A fuse.
HV OUTPUT connector (cable supplied with the driver) – connects the load to the module
RS-232 connector (cable supplied with the driver) – 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, 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 1" command to start operations
6. Send to the driver "r 0" command to stop operations
7. Turn POWER switch off

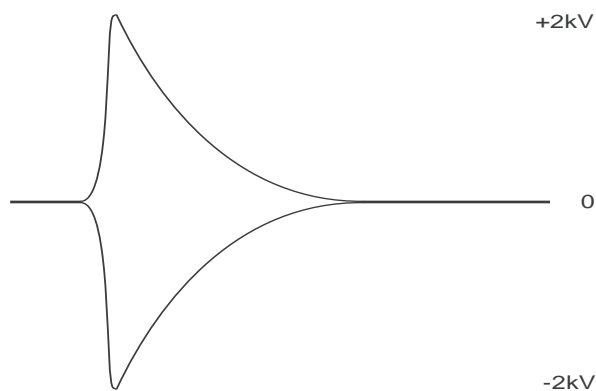
Note: it's possible but it's not recommended to use RS-232 and front panel user interfaces at the same time

Technical notes

- Performance of the module greatly depends on load capacitance. Full performance (see *Performance* section) is achievable only under condition of 23pF load capacitance 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	100-240 VAC, 50/60 Hz; 1.0 A max
Output	
	 <p>push up scheme pull down scheme high level is adjustable</p>
Working modes	Internal synchronization mode, external synchronization mode
Output voltage high level (pulse amplitude)	adjustable in HVmin – HVmax range (see Part numbers section)
Output voltage low level	fixed, 0 V
Max. repetition rate	see <i>Performance</i> section
Risetime (falltime)	< 20 ns ¹
Recovery time	depends on load (5-10us typ.)
Jitter	± 1 ns
Delay time	100 ns
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 180 x 70 mm
Weight	1,5 kg

Performance

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

23 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 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?

Standard part numbers are listed in table below.
Other modifications are available on request.

Part Number	HVmax	HVmin
QBD-BT-6024-DN QBD-BT-6024-UP	6000	2400
QBD-BT-5020-DN QBD-BT-5020-UP	5000	2000
QBD-BT-4016-DN QBD-BT-4016-UP	4000	1600
QBD-BT-3012-DN QBD-BT-3012-UP	3000	1200
QBD-BT-2008-DN QBD-BT-2008-UP	2000	800
QBD-BT-1004-DN QBD-BT-1004-UP	1000	400

Suffix “DN” means pull-down scheme, “UP” – push-up scheme (see also *Pulse parameters* section)

Example: QBD-BT-6024-UP

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 – sets output repetition rate, Hz
- F – returns output repetition rate set point
- v – sets output voltage, V
- V – returns output voltage set point
- mV – returns voltage monitor (actual voltage measured by internal monitor)
- mT – returns temperature monitor
- mO – returns overheating monitor

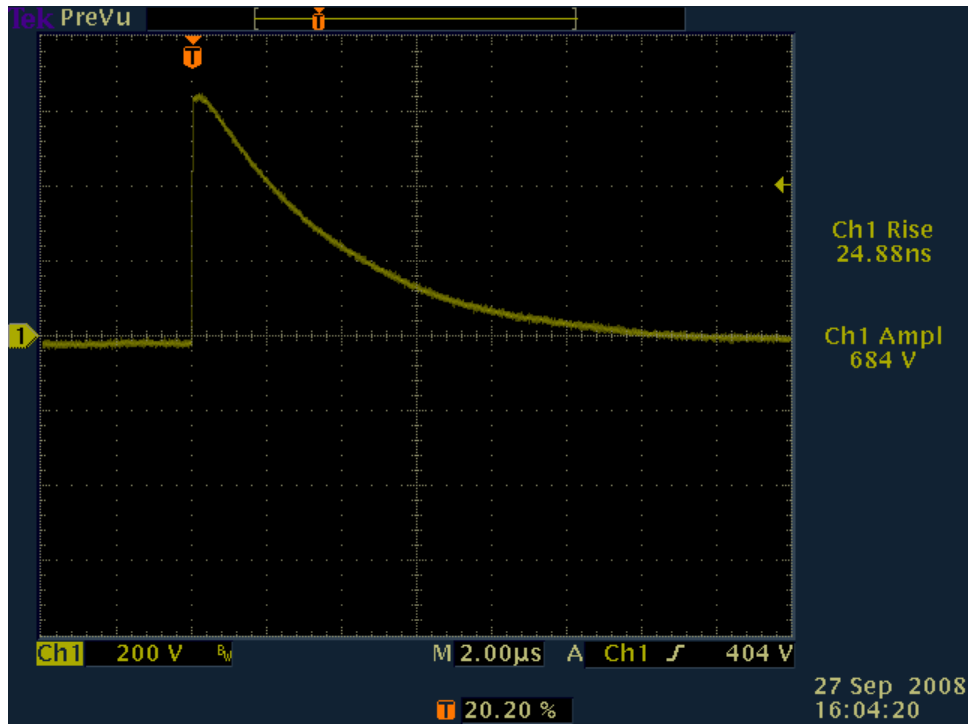
- s – sets synchronization mode (0 – external synchronization mode, 1 – internal synchronization mode)
- S – returns synchronization mode set point
- r – starts/stops operations ('r 1' – starts operations, 'r 0' – stops)
- R – returns status of operations

- Q – returns hardware and firmware versions
- e – turns on/off echoing of symbols in RS-232 (turned on by default)
- E – returns echoing status

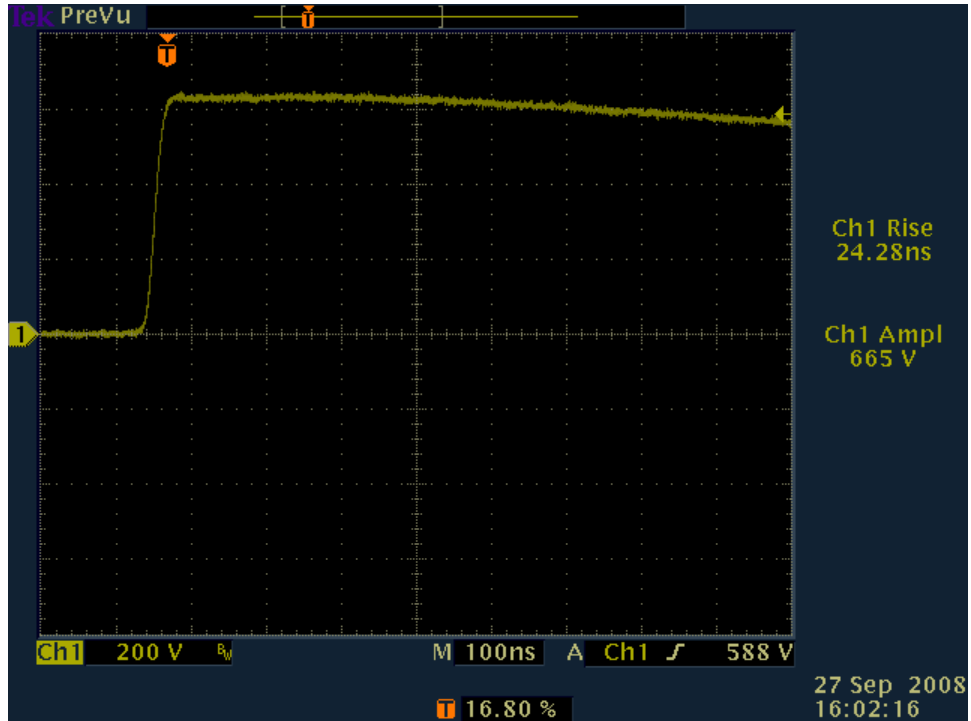
Example: 'v 2500' sets output voltage to 2500 volts.

Output oscillograms

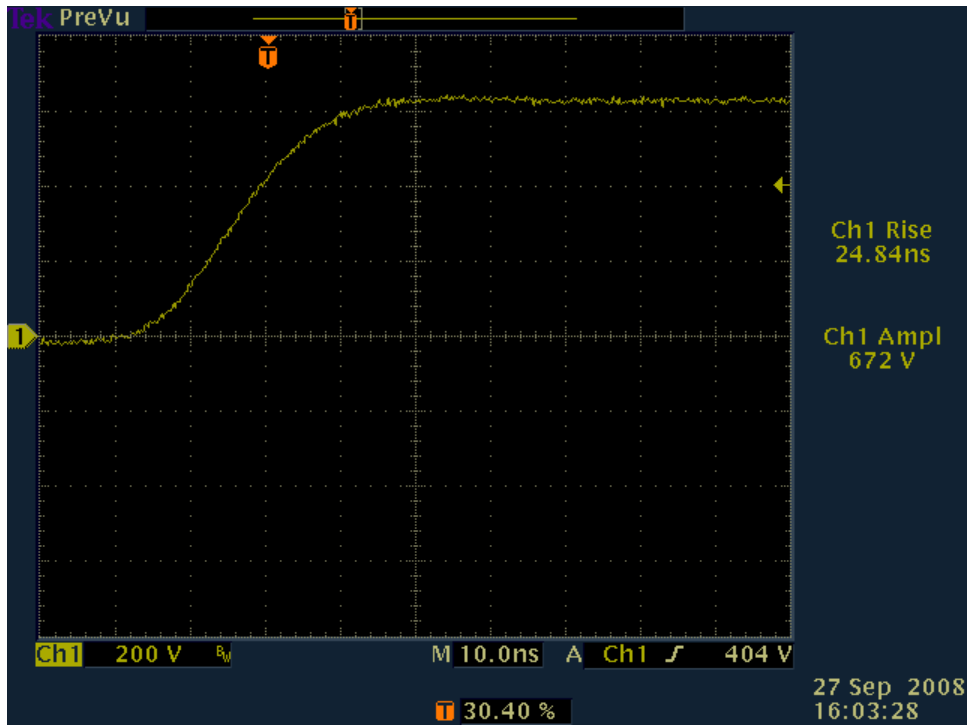
Typical output oscillograms are given below (QBD-BT-5020-UP).



time scale: 2 μ s / div



time scale: 100ns / div



time scale: 10ns / div