QUANTUM TECHNOLOGY, INC.

108 Commerce Street, Lake Mary, FL 32746-6212
+407-333-9348 FAX: +407-333-9352
TOLL FREE (In U.S.A.): 1-800-232-4291
e-mail: staff@quantumtech.com WEB: www.quantumtech.com

QS-series
BBO Pockels Cells

The ***QS-series*** Pockels cell/Q-Switch is a product developed for high average power Lasers such as Diode-Pumped Solid State (DPSS) Lasers with powers more than 100 Watts. In this Pockels cell, BBO crystal material is used. This crystal does not suffer from problems similar to KD*P or $LiNbO_3$ materials, offering the following features:

- ***Very low resonance operation with the AC voltage, only a few % greater than the DC switch-out voltage.***
- ***No thermal blooming or photo-refractive damage.***
- ***Typical contrast ratios of >2000:1 without high temperature degradation and high average powers more than 100 watts.***
- ***Low insertion loss of 3 ~ 2% inside the Laser cavity.***
- ***Extremely small capacitance (~2pF), giving a very fast rise-time (<220 psec) in a lumped element 50 ohm system.***
- ***Material damage threshold is more than 4 GW/cm^2 typical @ 1064nm for a 10ns pulse. And is limited by the AR coating.***
- ***Can operate with average High Voltage as much as 1KV without electrode migration.***
- ***Usable for pulse extraction from UV (200nm) to Mid-IR (2000nm).***
- ***Cells with larger apertures up to 6mm are available with 5.7KV quarter-wave voltage at 1064 nm. Model QS-6-2HW***

Model QS-series Pockels cell/Q-Switch

The Model QS-series uses BBO crystal material, which has symmetry similar to $LiNbO_3$. The laser beam propagates along the optic Z-axis and the electrodes are applied along the X-axes. The transverse Pockels effect is utilized, and increasing the aspect ratio or number of BBO crystal cells can decrease quarter-

wave voltage. The contrast ratio is superior even at temperatures over 40°C, and the uniformity over the whole aperture is excellent. Unlike $LiNbO_3$, BBO is not pyro-electric, nor does it suffer for the most part from piezo-electric resonances. Also, it has an excellent resistance to thermal fracture.

Based on typical diode-pumped laser parameters, this Q-Switch Model QS-series extends simple compact Q-Switched operation of diode-pumped lasers to high average powers of 30-100W. Also, the low dispersion of the QS-series Pockels Cell eminently suits it for applications in short pulse, regenerative amplifiers. The Super Switch is ideal for Q-Switching of high power compact DPSS Lasers at sub-nanosecond speeds.

Model QS Q-switch Details

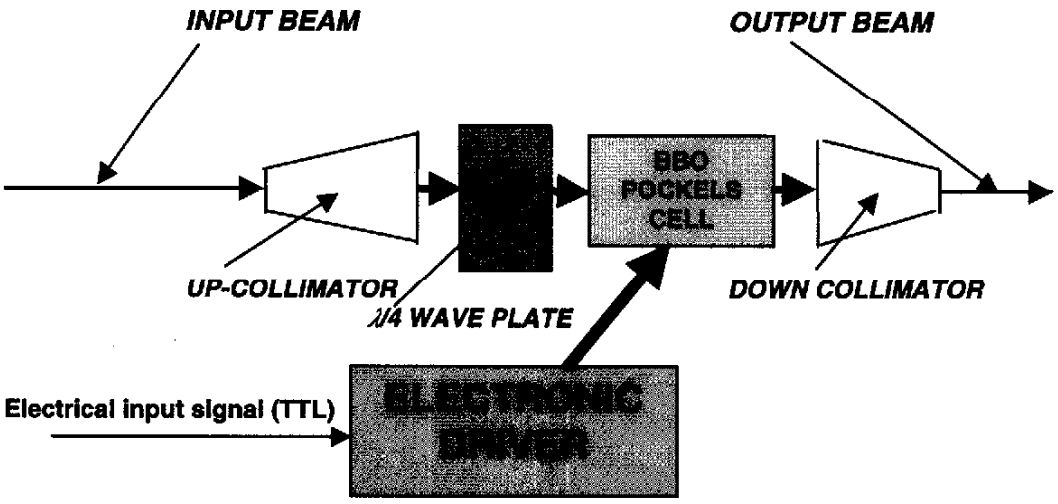
Parameter	**QS-3**	**QS-4**	**QS-5-2**	**QS-6-2**
Aperture (mm)	**3**	**4**	**5**	**6**
$V_{1/4}$ KV@1064nm	**4.6**	**6.2**	**3.8**	**4.6**
Insertion Loss (1064nm)			**<2~3% (Typical)**	
Contrast Ratio (1064nm)			**>2000:1 (Typical)**	
Wavefront Distortion (633nm)			**λ/10**	
Spectral Range (nm)			**200 - 2000**	
Typical Risetime (ps)			**220**	
Dimensions (mm)	**25 dia. 40 long**		**/**	**25 dia 60 long**

NOTES:

1) $V_{1/4}$ is directly proportional to the wavelength and inversely proportional to the aspect ratio of the crystal, L/D where D is electrode distance and L is the length.
2) In some applications the windows, although AR coated, add excessive insertion loss and may be eliminated. In these cases a 5-watt heater and thermostat for feedback control would be required to keep the temperature around 40°C. Heating of the cell is to prevent moisture from eventually affecting the polish on the face of the crystal in the absence of windows and should be continuous, even backed-up with a battery device in case of a power failure.

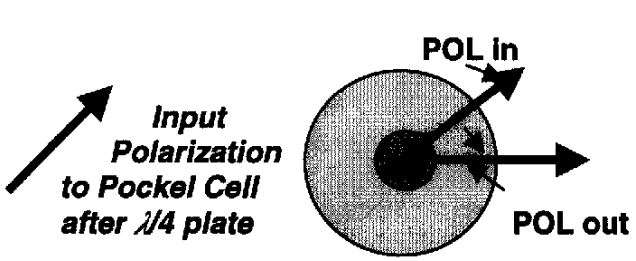
Quantum Technology, Inc. specializes in supplying entire turnkey systems and High Voltage Pulsers such as series HVP-500, our 5GP50, and 7GP10 drivers. Please contact Quantum Technology, Inc. at +407-333-9348 or e-mail us at staff@quantumtech.com for further information. Quantum technology has been in the electro-optics field for over thirty years. Let our experience work for you.

SKETCH

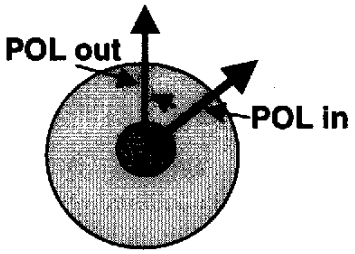


The input beam is 1.6mm at 100W. This power density is ~ 5KW/cm^2, which is too great for a BBO crystal. To reduce the power density the beam must be expanded to approximately 6mm diameter. Therefore an up-collimator is required with an expansion of ~ 3.75 times. To return to the same beam diameter a down-collimator is used at the output of the optical system. The reduction ratio is the same as the up-collimator. Collimators are not made by Quantum Technology, but you can check the following companies: CVI, Melles Griot, Santa Barbara Infrared, Aero Research, Newport Corp., etc. Check a Buyer's Guide for details.

To extend the life of the Pockels cell, it should be used in the quarterwave mode. This allows the Pockels cell to operate at a lower voltage, rather than the halfwave voltage. To do this a quarterwave plate is used in the optical train. The quarterwave plate rotates the input polarized beam by 45 degrees. The Pockels cell is operated from a relative positive to negative high voltage across its input terminals. Therefore, it either rotates the beam another 45 degrees, or returns it to the input polarization, depending on the relative voltage (+ to -) or (- to +) across its terminals. In other words, the beam is rotated + or - 45 degrees. Therefore, depending on the voltage polarity on the Pockels cell, the beam is either the same as the input polarization or 90 degrees rotated from the input.



POCKELS CELL INPUT + to -



POCKELS CELL INPUT - to +

If you add the effect of the quarter waveplate to the input of the Pockels cell, you will have a VERTICAL POLARIZATION on the system's output, or a HORIZONTAL POLARIZATION, depending on the relative +/- voltage on the Pockels cell input. The voltage itself is the quarterwave voltage. At 1064nm the quarterwave voltage for a dual crystal BBO Pockels cell is ~ 5.7KV dc, and ~ 6KV switching. Because of the relatively long periods of time, 0.5~1 sec, the DC value is most likely the operating value, but the driver should be able to accommodate either.

The reason for the dual cell Pockels cell is to reduce the quarterwave voltage. If a single crystal were used, the quarterwave voltage would be 2 X 6KV for example, which is 12KV. The crystal would arc at this level, and destroy itself.

I have quoted our Model QS-6-2HW Pockels cell. This cell would be coated with an AR coatings @ 1064nm. It also requires being water-cooled. In many cases, the water coolant is that of the laser head.

This Pockels cell has been tested under similar conditions in field tests conducted by the SONY® Corporation. This application was performed on a best effort basis with good results. Similarly, we would treat this application on the same best efforts basis.

BBO is the only crystal that can withstand high CW power leverls.