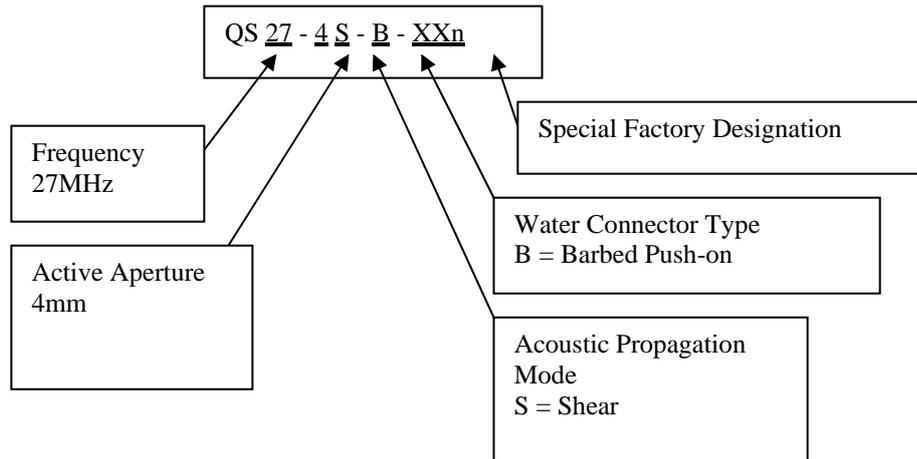




Acousto-Optic Q-Switch Selection Guide

When choosing a Q-switch there are a number of user definable parameters which can be selected in order to give the optimum performance in a specific laser system.

Here is an example part number for an industry standard type Q-switch from Gooch & Housego.



- **Operating Frequency** QS**27**-4S-B-XXn

24MHz and 27MHz have historically been the standard frequencies for A-O Q-switching in lamp-pumped 30W to 100W Nd:YAG (1064nm) laser systems.

For the shorter cavities employed in DPSS Nd:YAG systems higher RF frequencies, such as 41MHz and 68MHz, have been introduced because they are more effective than the lower frequencies in shorter cavities. This is because the larger acousto-optic deflection angles at the higher drive frequencies are more efficient in dumping optical energy from a shorter cavity.

- **Active Aperture** QS27-**4**S-B-XXn

This number defines the effective vertical height (in mm) of the acoustic beam which causes the Q-switch to operate. Standard apertures are 1, 1.6, 2, 3, 4, 5, 6.5 and 8mm.

Only that part of the optical beam passing through this region will be modulated.

There are a number of important factors when selecting the active aperture.

1. For high efficiency (defined as maximum loss modulation at lowest possible RF power) you should choose an active aperture as close as possible to the size of your optical beam. Acoustic energy which does not flow through the region of the Q-switch carrying the optical beam is not effective in modulating the laser. This acoustic power is wasted making the device less efficient.
2. If the optical beam is larger than the active aperture the regions of the optical beam falling outside of the active aperture will not be modulated.
3. For ease of alignment of the Q-switch in the laser the active aperture should be slightly larger than the optical beam. This allows for mechanical tolerances in the laser assembly.

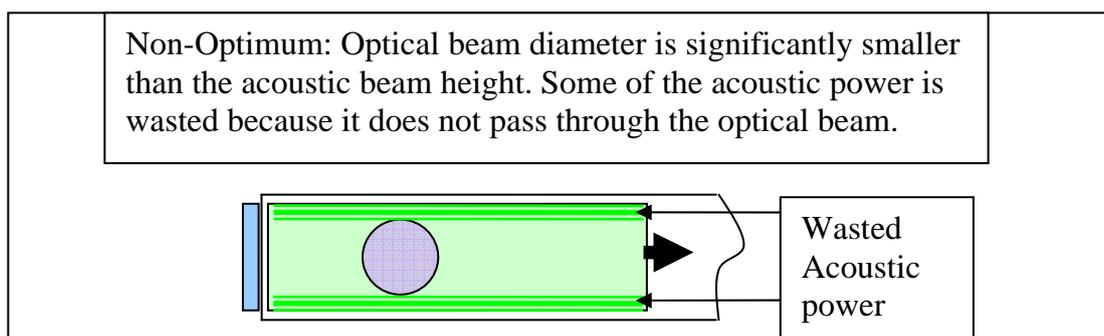
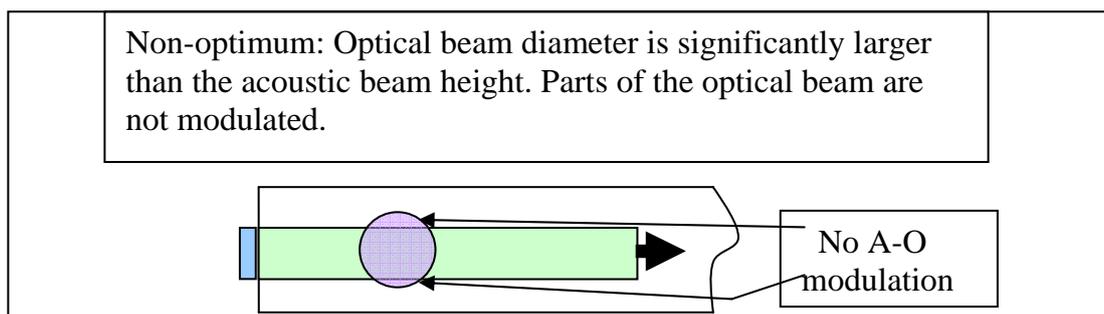
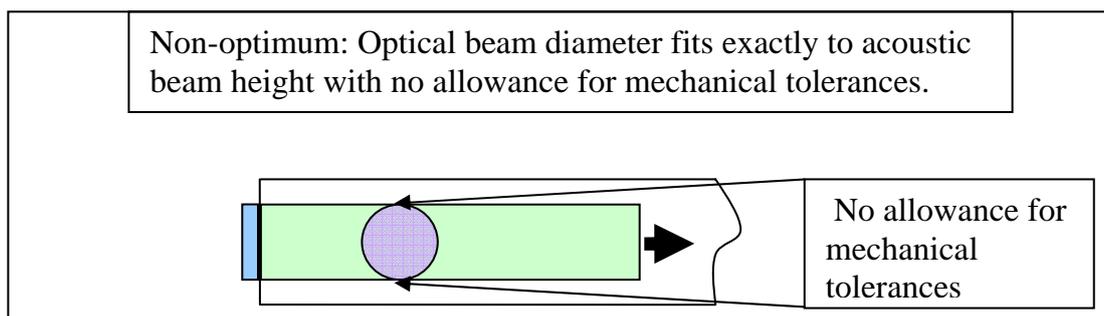
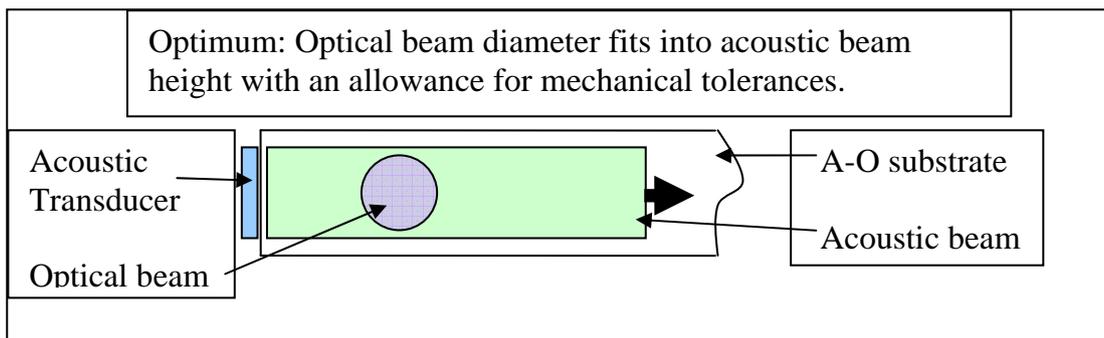
For example if you have a 1.7mm diameter laser then a -2 Q-switch would be appropriate (2mm active aperture, just a little larger than the optical beam diameter).

The following diagrams illustrate this in more detail, showing the effect of changing the active acoustic aperture for a fixed optical beam height. In most applications the laser system designer knows the optical beam properties and should select a Q-Switch with suitable active aperture dimensions as shown below.

The active acoustic aperture is defined in the Q-Switch part number.

The optical beam must pass through the acousto-optic cell in the region that carries the acoustic beam. The optical beam diameter shown in the diagrams represents the $1/e^2$ diameter.

All diagrams show the relationship between the optical and acoustic beams when viewed in the direction of propagation of the optical beam. The acoustic wave originates at the transducer shown on the left and travels to the right as indicated by the arrow.



- **Acoustic Mode** QS27-4**S**-B-XXn

There are three different configurations of acoustic wave which can be launched into the Acousto-Optic device to effect optical beam modulation.

1. **Shear waves** have the advantage of effecting all polarisations of light equally and are recommended for use in un-polarised lasers. Q-switches using this acoustic mode are defined by the letter S after the active aperture. (see **Note a.** below)
2. **Compressional waves** (defined by the letter C after the active aperture) exhibit higher efficiency than shear waves when the laser is linearly polarised (optical polarisation perpendicular to the base of the Q-switch). As such compressional wave devices are preferred for polarised lasers and will require less RF drive power than the equivalent shear wave device. (see **Note a.** below)
3. **Two orthogonal compressional waves.** For high power un-polarised lasers, this acoustic configuration can be used for more efficient modulation than an equivalent shear wave device. Such a dual acoustic channel device is defined by the letter D after the active aperture.

Note a: Although the compressional acoustic wave (defined by –C) does not effect all optical polarisations equally, some QS users have found that they can use a compressional mode device in some specific un-polarised laser application. This is very dependant on the laser design and the end user should determine the usefulness of this mode by trial and error.

Note b: Devices using Crystal Quartz as the A-O interaction medium are only offered as compressional (-C) mode devices. (NOT –S or –D)

The optimum optical polarisation for the crystal Quartz devices is perpendicular to the acoustic propagation direction. These devices have found some application in un-polarised systems. The users should determine the usefulness of this mode in an un-polarised laser by trial and error.

- **Water Cooling** QS27-4**S**-**B**-XXn

Q-switches requiring lower RF drive power can often be supplied without water cooling (conduction cooled).

Water cooling is used in devices where the RF power input is significant and it is not possible to extract the resulting thermal load by conduction alone.

The water supply is attached to the Q-switch via a pair of water connectors on the end bulkhead and the user can specify his preferred connector type as part of the Q-switch part number as follows:



S = Screw-on ('Swagelok')



B = Barbed Push-on



R = Right-angle

Examples

1. **QS24-5S-S**

Operating frequency is 24MHz for use in lamp-pumped Nd:YAG lasers with longer cavities.
Active aperture is 5.0mm for use with an optical beam diameter of ~ 4.0mm.
Acoustic mode is shear for use with unpolarised laser systems.
Water connectors are the 'Swagelok' screw-on type.
No special factory designation indicates the G&H industry standard design pictured above (i.e. with no specific custom modifications).

2. **QS68-2.5C-B-GH9**

Operating frequency is 68MHz to give large deflection angles for use in DPSS Nd:YAG lasers with short cavities.
Active aperture is 2.5mm for use with an optical beam diameter of ~ 2.0mm.
Acoustic mode is compressional for use with linearly polarised laser systems.
Water connectors are the barbed push-on type.
GH9 is a compact G&H housing design for high power DPSS Nd:YAG lasers.