CUTTING ANGLES AND VIBRATION MODE

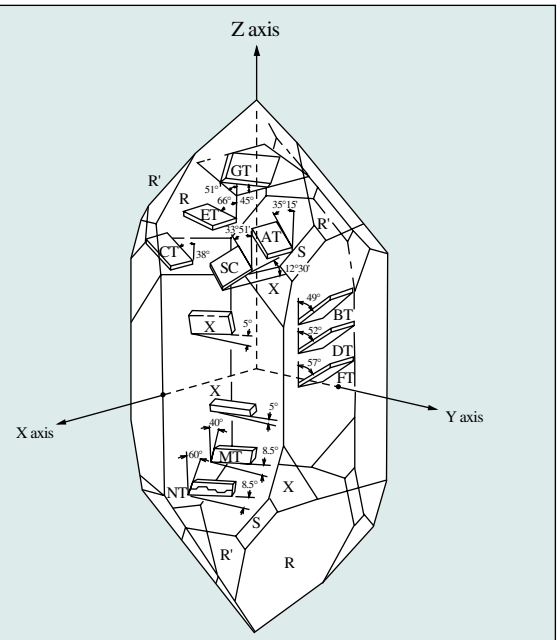
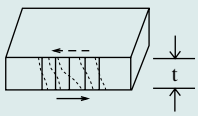
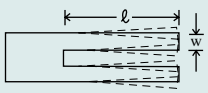
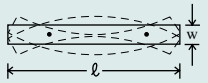
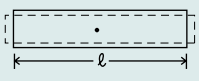
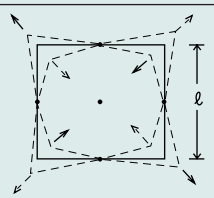


Fig. 2 Cut angles

Cutting angles differ depending upon the applications (oscillation frequencies and electrical characteristics). Fig. 2 shows the main cutting angles. And Table l shows vibration modes, frequency ranges and capacity ratios (typical values).

Taking the most popular AT-cut crystal wafer for example, it is in a plane which makes an angle of 35˚15' to the Z-axis and the wafer thickness is approximately 0.06 mm in the case of 25MHz fundamental-wave thickness-shear vibration.

■ Table 1 Basic Characteristics

Mode of Vibration	Cut	Frequency Range (kHz)	Frequency Formula (kHz)	Capacitance Ratio (Typical)
Thickness-shear 	AT Fundamental	800 ~ 5000 2000 ~ 80000	1670 /t 1670 /t	300 ~ 450 220
	AT 3rd Overtone AT 5th Overtone AT 7th Overtone AT 9th Overtone	20000 ~ 90000 40000 ~ 130000 100000 ~ 200000 150000 ~ 230000	$1670 \times \frac{n}{t}$	$n^2 \times 250$ n: Overtone Mode
	BT Fundamental	2000 ~ 35000	2560 /t	650
Length-width-flexure 	+ 2˚X	16 ~ 100	$700 \times w / \ell^2$	450
Length-width-flexure 	XY NT	1 ~ 35 4 ~ 100	$5700 \times t / \ell^2$ $5000 \times w / \ell^2$	600 900
Length-extensional 	+ 5˚X	40 ~ 200	$2730 / \ell$	140
Face-shear 	CT DT SL	250 ~ 1000 80 ~ 500 300 ~ 1100	$3080 / \ell$ $2070 / \ell$ $460 / \ell$	400 450 450

Note: With AT-cut 3rd overtone and 5th overtone, lower frequency are available.