Technical Bulletin No. 13

Interpretation of Crystal Life Data from Thickness Monitors

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This Technical Bulletin provides general guidelines about Crystal Life or Health Data commonly seen on thickness monitors. If interpreted correctly, this data can be helpful in signaling when to replace the quartz crystal sensor.

What Does Crystal Life or Health Mean?

When a quartz crystal sensor is coated with material from the thin film evaporation process the frequency becomes lower or "shifts". This frequency shift is used to calculate the thickness of the evaporated material and the Crystal Life or Health. Crystal Life or Health is generally given as percentage of a 1.50 MHz shift of the crystal's resonant frequency. How the Crystal Life or Health is represented varies with different monitors, some starting with a value of 100% for a new crystal and others at 0%. A new crystal is generally defined as one with a frequency between 5.970-6.000 MHz. Typically a 1% decrease (or increase depending on the representation) of life is equal to approximately 0.015 MHz or 15,000 Hz shift over the 1.50 MHz range.

What Impacts the Crystal Life or Health Data?

Crystal Life or Health reading is impacted by the following major factors:

1) The types of materials being evaporated;
2) The density of material and the ultimate thickness of the film desired; and,
3) Physical conditions.

1) In high tensile or compressive stress materials such as: silicone dioxide, zirconium, titanium, chromium, magnesium fluoride, and titanium dioxide, mechanical forces can be transmitted through the electrode to the crystal plate causing frequency shifts. These stresses can deform the crystal plate and briefly halt the piezoelectric effect. This results in a sudden crystal failure regardless of the Crystal Life or Health.

2) Materials with high density such as silver cause a greater frequency shift than lower density material such as aluminum, and result in accelerated change in the Crystal Life or Health. Additionally, the amount of material being applied directly impacts Crystal Life or Health since mass build-up dampens vibration and ultimately causes crystal failure.

3) Physical conditions like chamber cleanliness, sensor head temperature, and location of the sensor head will also impact Crystal Life or Health. Temperature increases can cause geometric changes in the crystal structure causing the mode of vibration to change from shear wave and inducing frequency jumps. At temperatures above 120° C the temperature coefficient for an AT cut quartz crystal becomes heavily positive and results in frequency jumps. A sensor head too close to the source will be vulnerable to splattering of material. Splatter and large amounts of material added to the crystal surface and can lead to mass loading failure and at a minimum, a large change in the Crystal Life or Health. Similar effects can be seen when particulates from a dirty sensor head cap or chamber fall on a crystal.

When Do I Change the Crystal?

Fil-Tech suggests performing several test runs and recording the Crystal Life or Health when the evaporation rate becomes unstable. Next, record the Crystal Health or Life when the crystal fails. Finally, back off in 1-5% increments, correlating the onset of instability with the failure. The operator will now have a general replacement point as long as all basic quartz crystal sensor care and handling practices have been followed.