

Technical Presentation for Frequency Management Products

频率控制产品的技术资料

BACKGROUND ON QUARTZ CRYSTALS – 石英晶体的背景资料

- First used in 1918 as a piezoelectric element in an oscillator.
- Piezoelectric from Greek meaning “pressure electric”.
- Material is SiO₂ Silicon Oxide.
- Low intrinsic losses (High Q).
- Easily processed, low cost.
- Easy to grow in large quantities, high purity and perfection.
- 首次在1918年作为压电元件用在振荡器中.
- Piezoelectric来自希腊语，意思是“压电的”.
- 材料是SiO₂, 二氧化硅.
- 内在损耗低（高Q值）.
- 容易加工，成本低
- 容易大量生产，纯度高

QUARTZ CRYSTAL OSCILLATORS – 石英晶体振荡器

- Main Functions and Advantages are:
 - ▶ Precision Timing – Excellent Frequency Source.
 - ▶ Accurate Reference for Reception and Carrier Signal for Data Transmission.
 - ▶ High Frequency stability VS Time and Temperature.
 - ▶ Low Phase Noise / Jitter.

- 主要功能和优点是：
 - ▶ 精确计时--- 极好的频率源.
 - ▶ 是接收和传送信号的精确参考.
 - ▶ 高频率稳定性VS时间和温度.
 - ▶ 低相位噪声/抖动.

QUARTZ CRYSTAL OSCILLATORS – 石英晶体振荡器

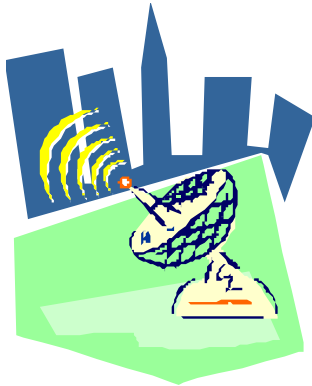
■ Disadvantages are:

- ▶ Susceptible at certain cases to severe mechanical stress.
(Shock and Vibrations)
 - 1 – Degrades the phase Noise
 - 2 – Poor Short Term Stability
- ▶ Low Pullability in comparison to VCO.

■ 缺点是:

- ▶ 在某些情况下易受严重机械应力的影响（冲击和震动）。
 - 1-降低相位噪声。
 - 2-短期温度性差。
- ▶ 与VCO相比牵引差。

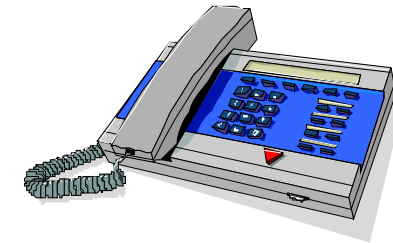
GENERAL APPLICATIONS - 一般运用



Base Stations
基站



GPS
全球定位系统



Office Phone System
办公电话系统



Computers & Peripherals
电脑&周边产品



Facsimile
传真



Telephones
电话

APPLICATIONS – 运用

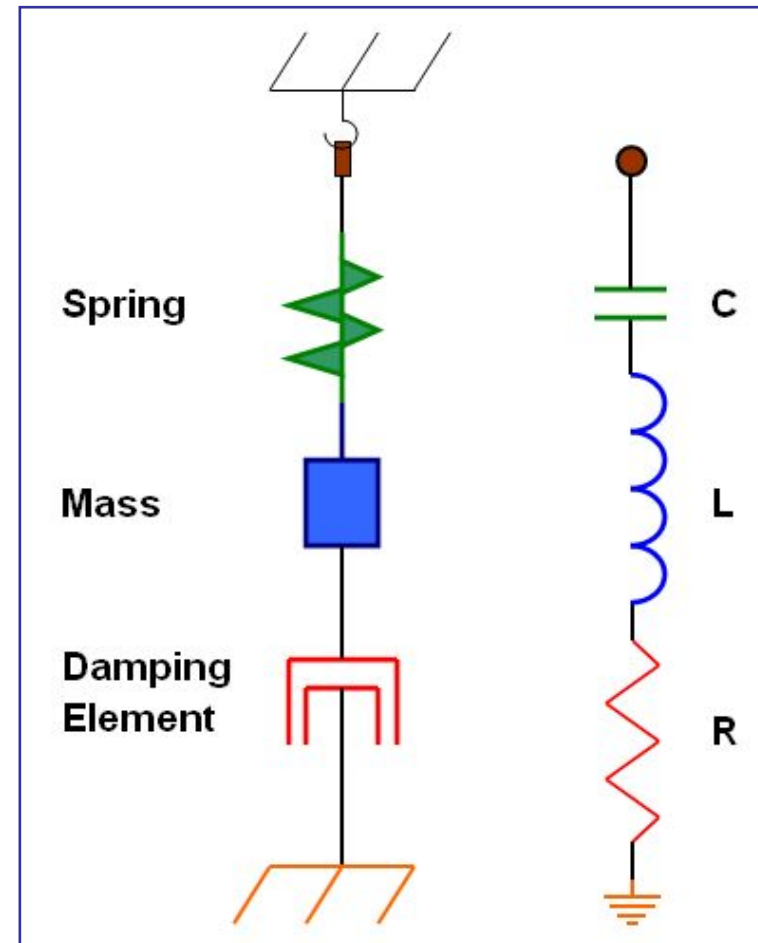
- **All Microprocessor Based Systems**
TTL, CMOS, HCMOS, ACMOS, ECL Logic Compatible
- **Computers and Peripherals**
Main Frames, PC's, Laptops, Work Stations, Modems, Drives, Add-on Cards, Keyboards
- **Consumer Products**
Cordless, Cellular Phones, Pagers, PDA's, Fax, Set-Top Boxes, Toys, Televisions, Radios
- **Telecommunications**
Central Office, Advanced Desk Set Units, Digital Multiplex Equipment, LAN
- **RF Communications Equipment**
FM / Cellular Applications, Mobile and Base Station Equipment, Wireless Applications
- **Frequency Sensitive Instrumentation**
Frequency Counters, Signal Generators, Spectrum Analyzers, Automatic Test Equipment, Oscilloscopes, RF Alarm and POS Systems, Data Exchange, Process Control Instruments
- **Military / Commercial**
Navigation, Distance Measurement Equipment, Military Communications, Guidance

CRYSTAL IS THE HEART – 晶体就是心脏



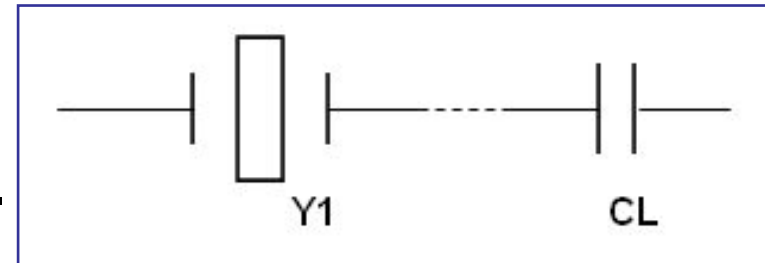
MECHANICAL EQUIVALENT ILLUSTRATION – 机械等效图解

- The mechanical model consists of a Spring, a Mass and a Damping Element.
 - The equivalent electrical circuit is a series branch of a Capacitor, an Inductor and a Resistor.
-
- 机械模式包括一个弹簧，一个质量和一个阻尼元件。
 - 等效电路是一个电容器，一个电感器和一个电阻器的串联。

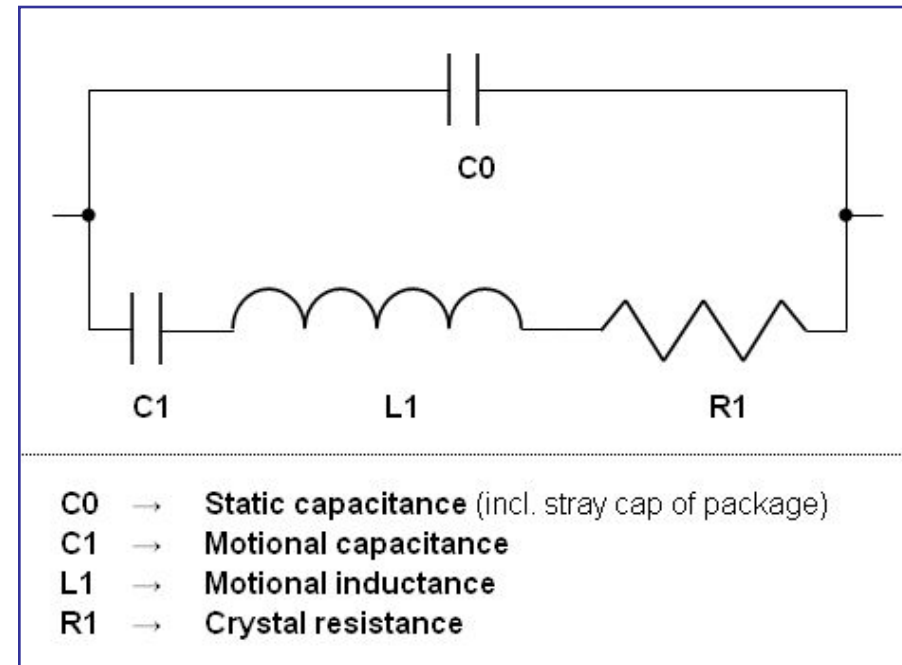


EQUIVALENT CIRCUIT - 等效电路

- The symbol of a Quartz Crystal Y1 and the Load Capacitor CL.
- 石英晶体Y1和负载电容CL的标志.

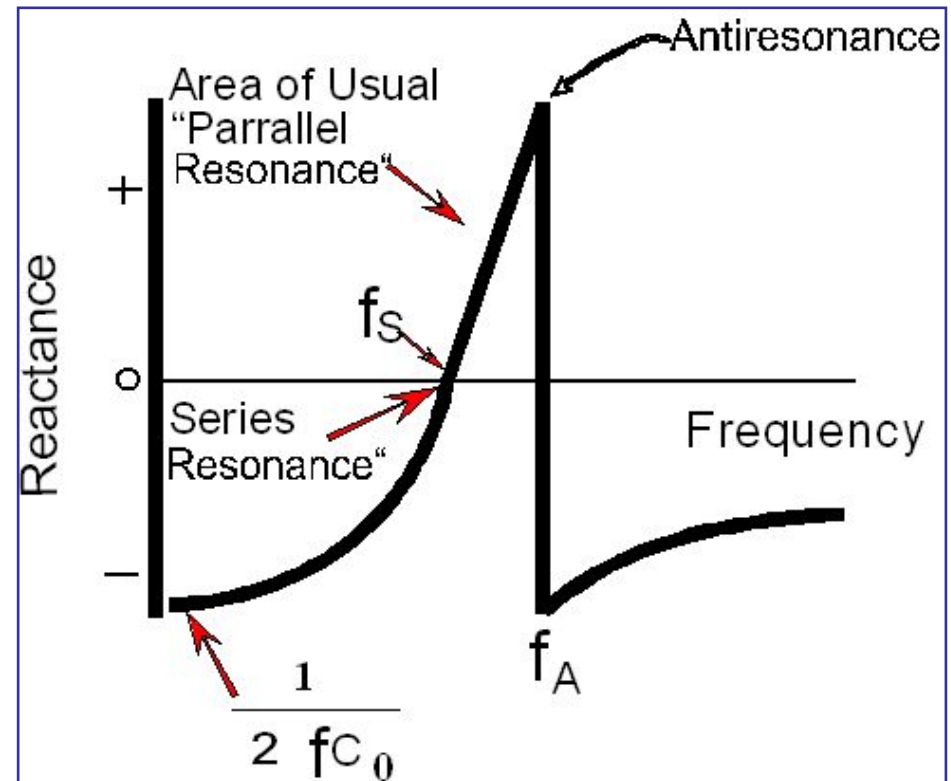


- The Equivalent Circuit of a Crystal consists of a series branch of capacitor C1, inductance L1 and resistor R1 with the shunt capacitor C0 in parallel.
- 石英晶体的等效电路包括由电容C1, 电感L1, 电阻R1组成的串联支路, 其与静态电容C0并联.

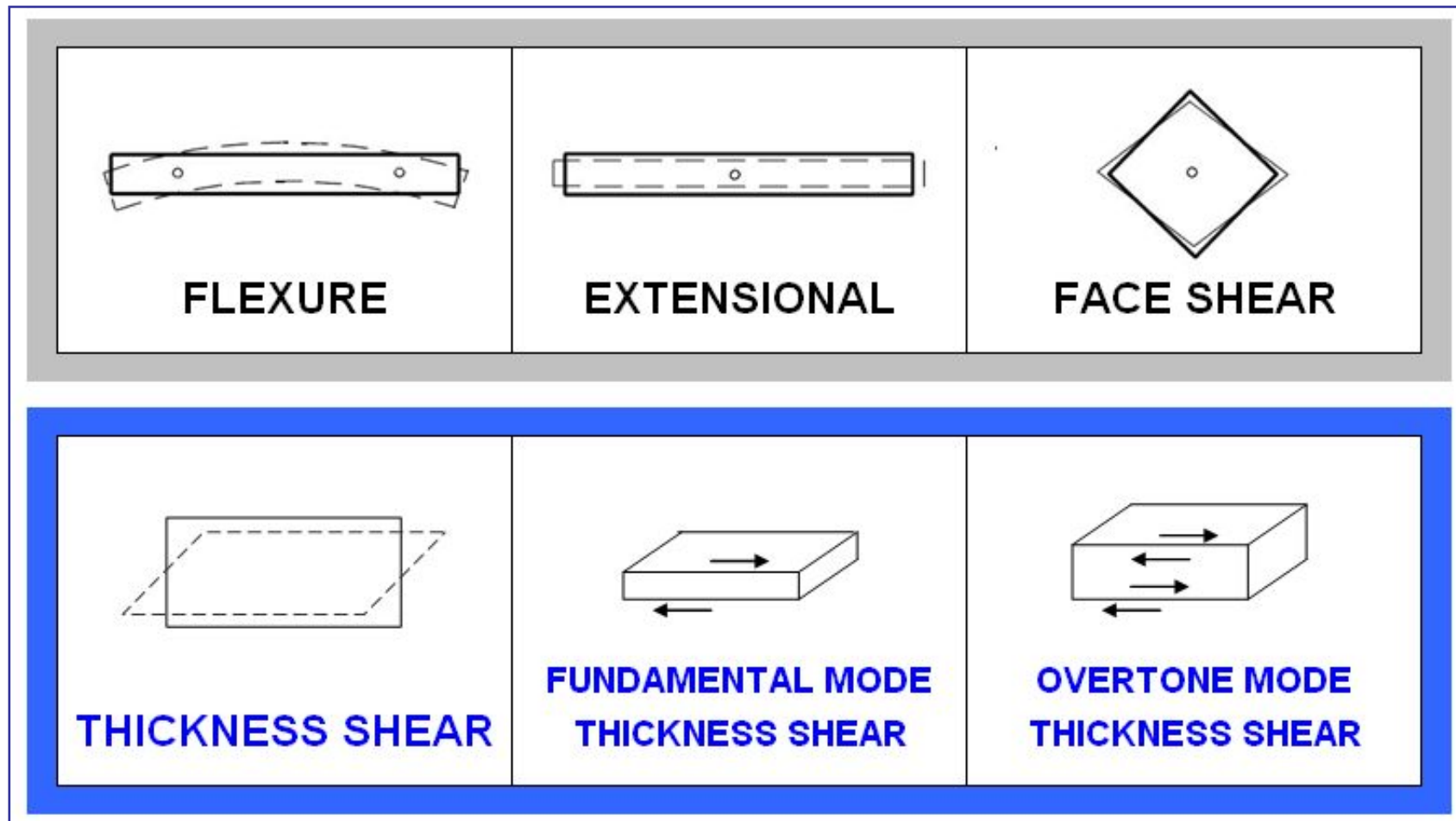


CRYSTAL'S SPECTRAL RESPONSE – 晶体的光谱反应

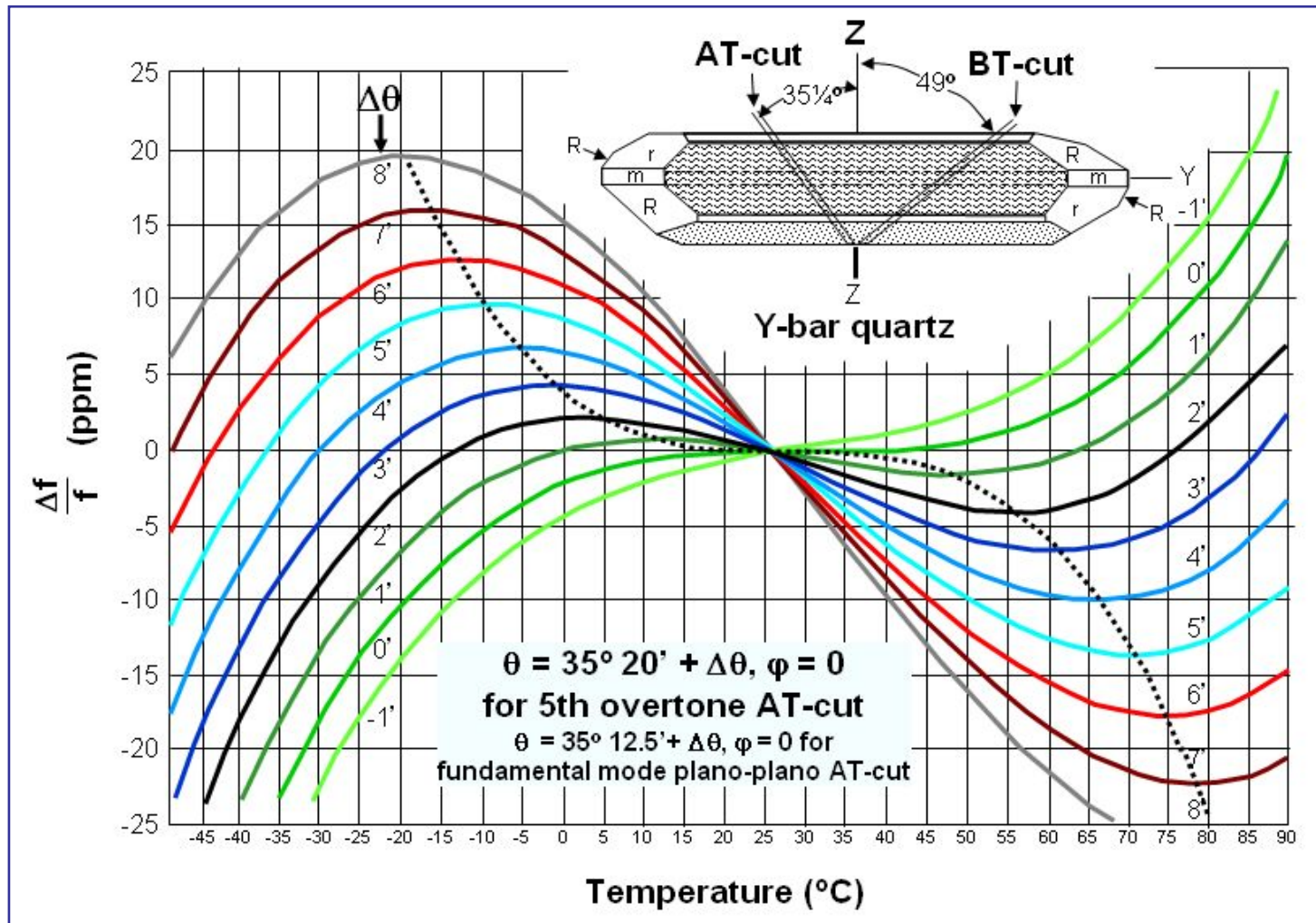
- In parallel mode a capacitor is used to adjust frequency.
- In series mode it requires additional inductance to calibrate down capacitance.
- 在并联模式中使用电容来调整频率.
- 在串联模式中需要另外的电感来校低电容.



DIFFERENT QUARTZ SHEAR MODES – 不同的石英切变模式



AT-CUT ANGLE VS TEMPERATURE BEHAVIOR – AT切角度VS温度表现



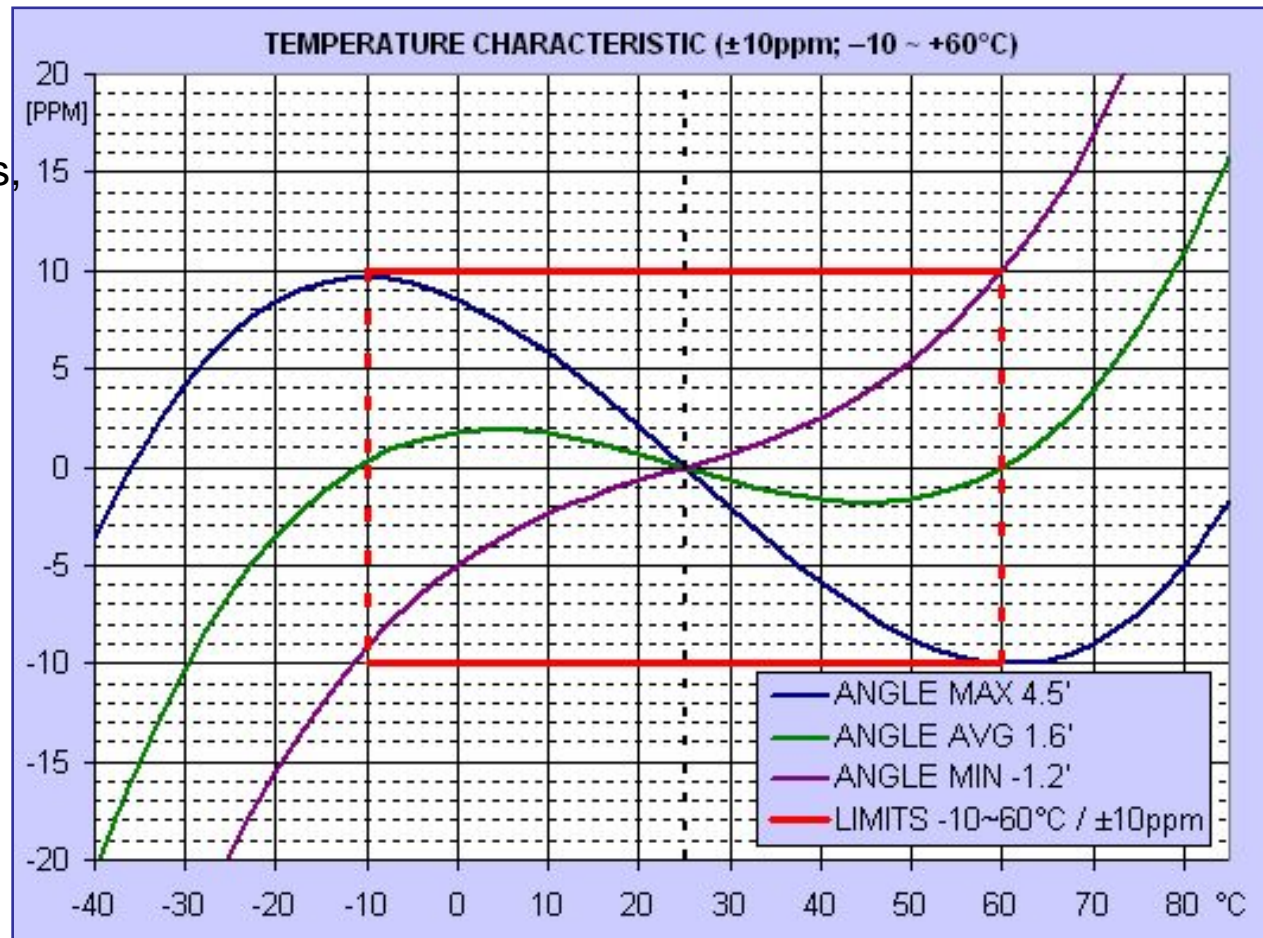
AT-CUT TEMPERATURE CHARACTERISTIC - AT切温度特性

Factors that affect behavior:

- Fundamental or Overtone used
- Geometry of plates
- Size, shape, thickness, density and stress of electrodes
- Drive level
- Impurities and strains in quartz material
- Rate of temperature change

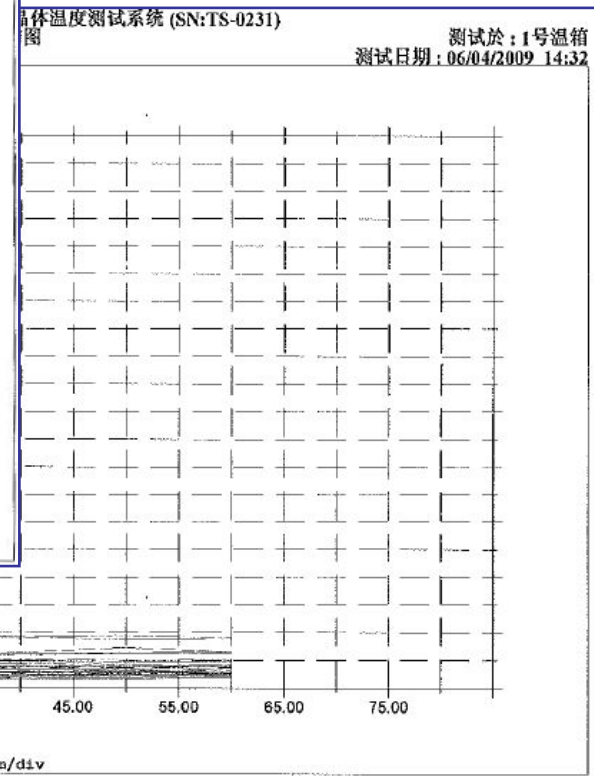
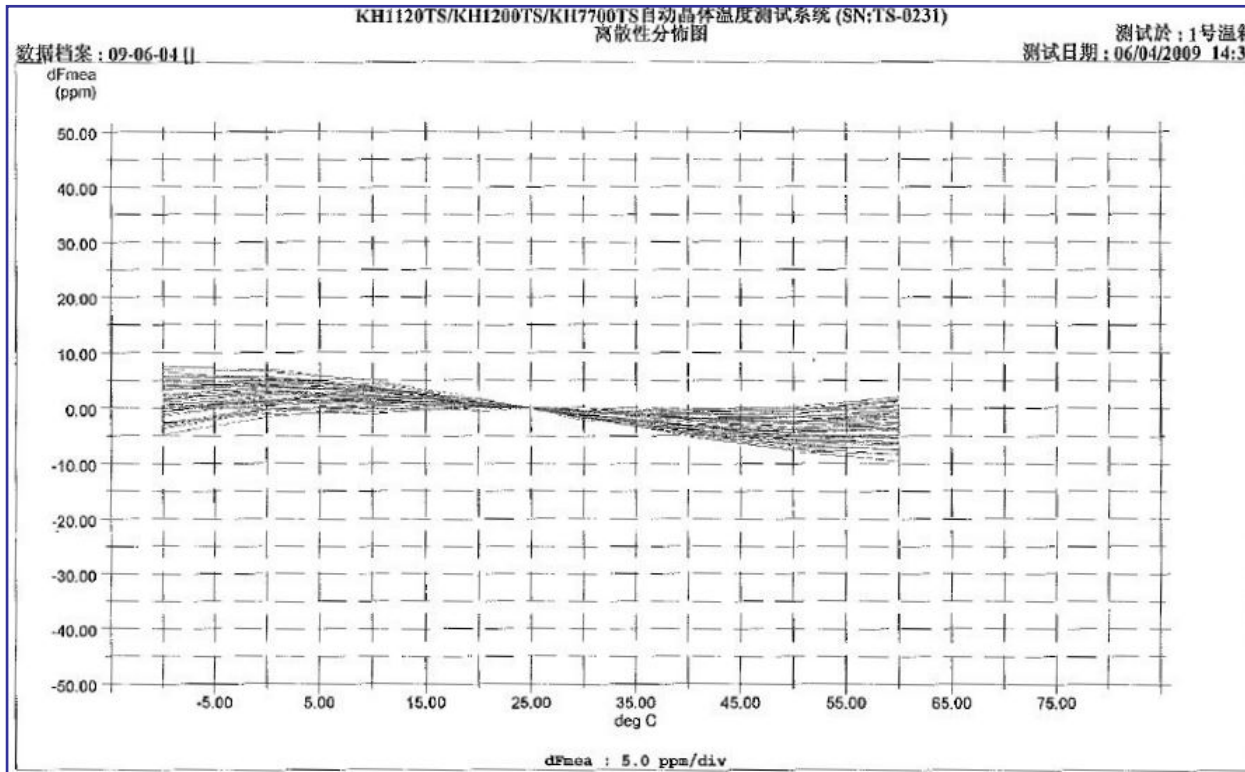
影响表现的因素.

- 使用基频或泛音
- 晶片几何
- 尺寸, 形状
- 激励电平
- 杂质
- 温度变化速度



TEMP CHARACTERISTIC – 温度特性 27MHz ± 10ppm (-10/+60)

▼ Behavior of Resistance 电阻表现



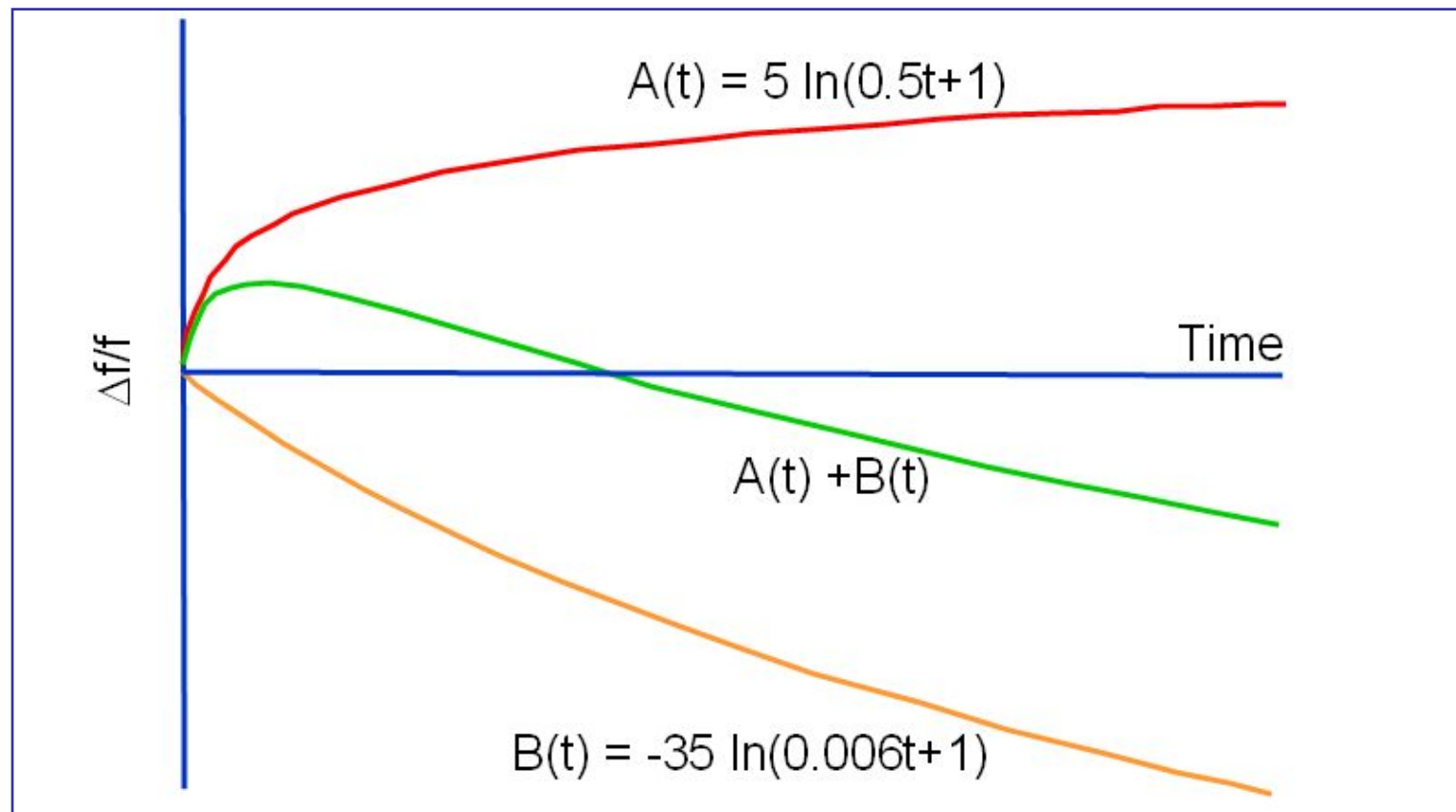
▲ Behavior of Frequency 频率表现

TYPICAL AGING BEHAVIOR – 典型的老化表现

■ Factors that affect behavior:

- Stress
- Impurities
- Temperature
- Manufacturing aspects

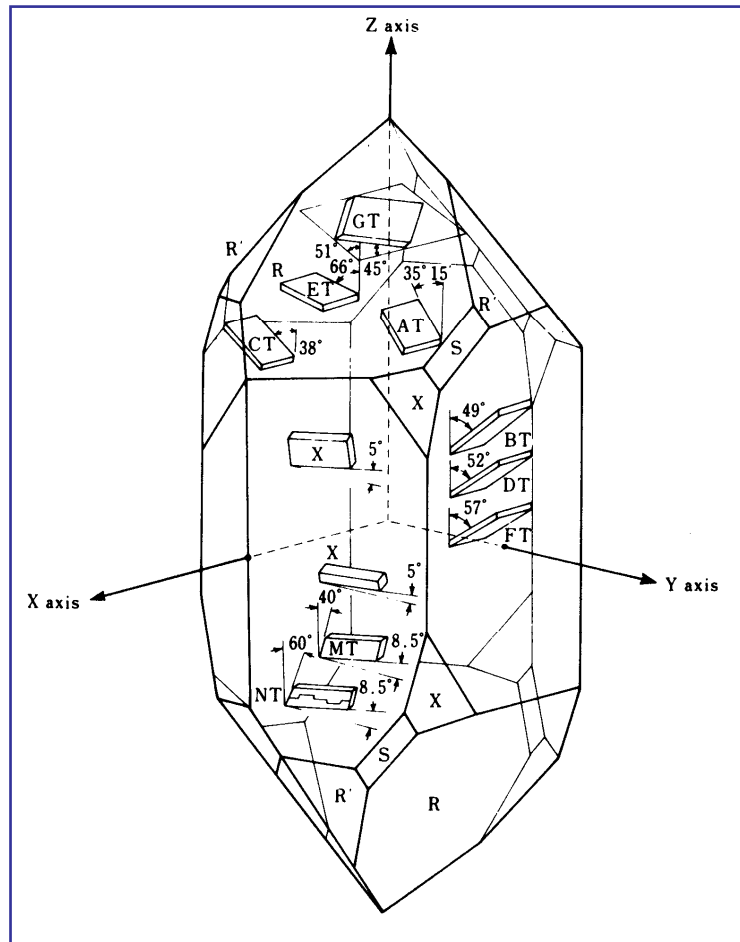
- 应力
- 杂质
- 温度
- 生产方面



HYDROTHERMAL GROWTH OF QUARTZ - 石英的水热法生长

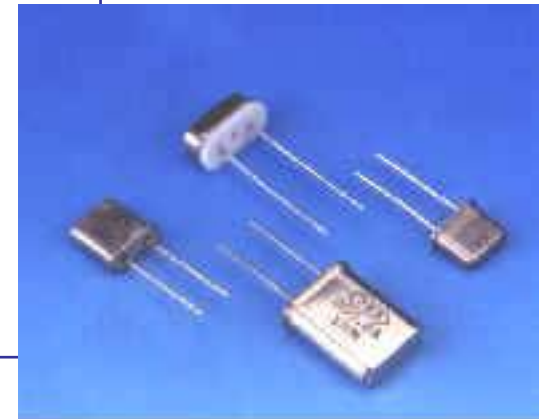
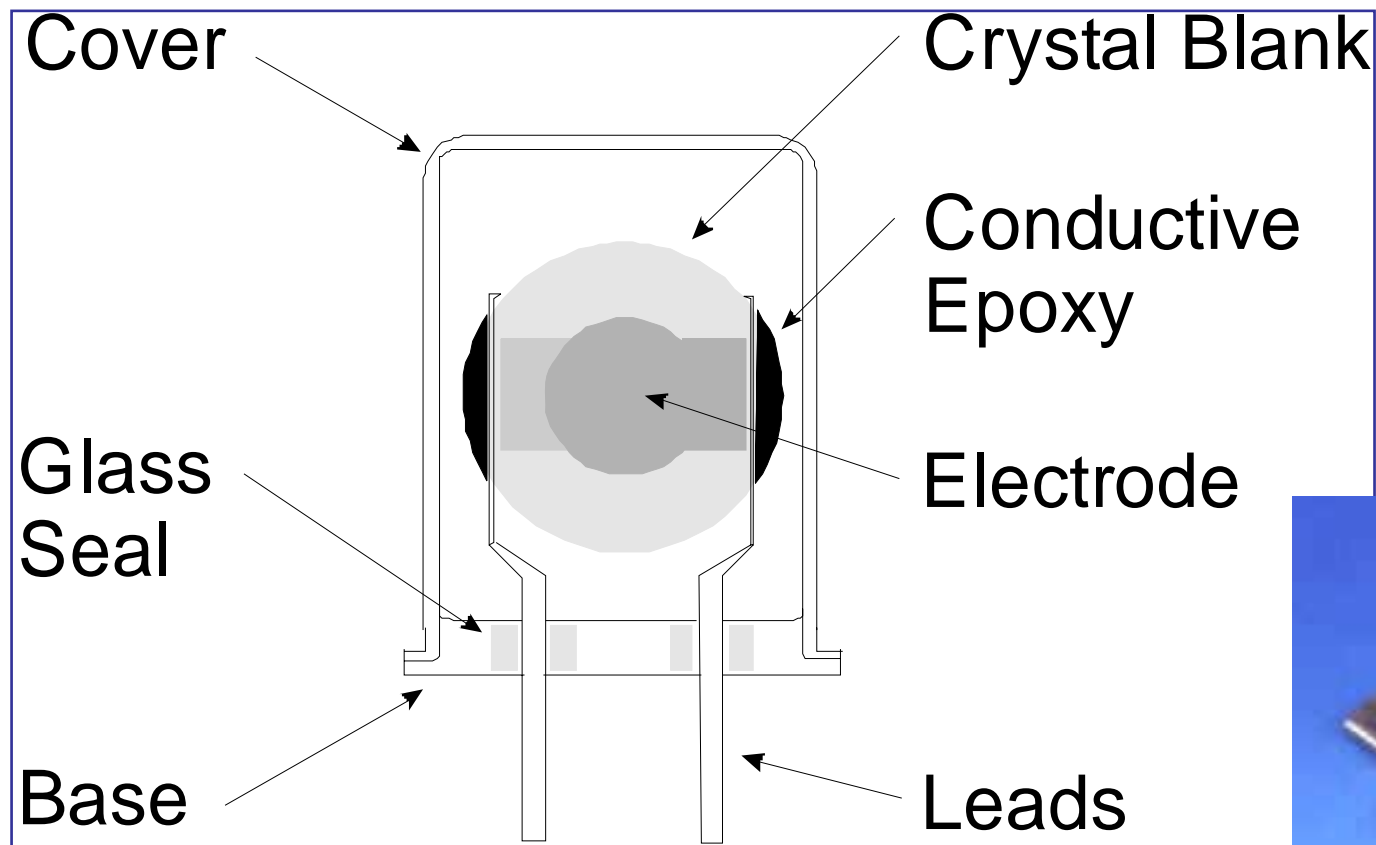
- The autoclave is filled to some predetermined factor with water plus mineralizer (NaOH or Na_2CO_3).
- The baffle localizes the temperature gradient so that each zone is nearly isothermal.
- The seeds are thin slices of usually Z cut single crystals.
- The nutrient consists of small pieces of single crystal quartz (lascas).
- The temperature and pressure are typically about 350°C and 800 to 2000 atmospheres; T2-T1 is typically 4°C to 10°C.
- The nutrient dissolves slowly (30 to 60 days per run), diffuses to the growth zone and deposits onto the seeds.

SYNTHETIC RAW QUARTZ BAR – 人工石英棒



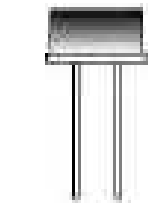
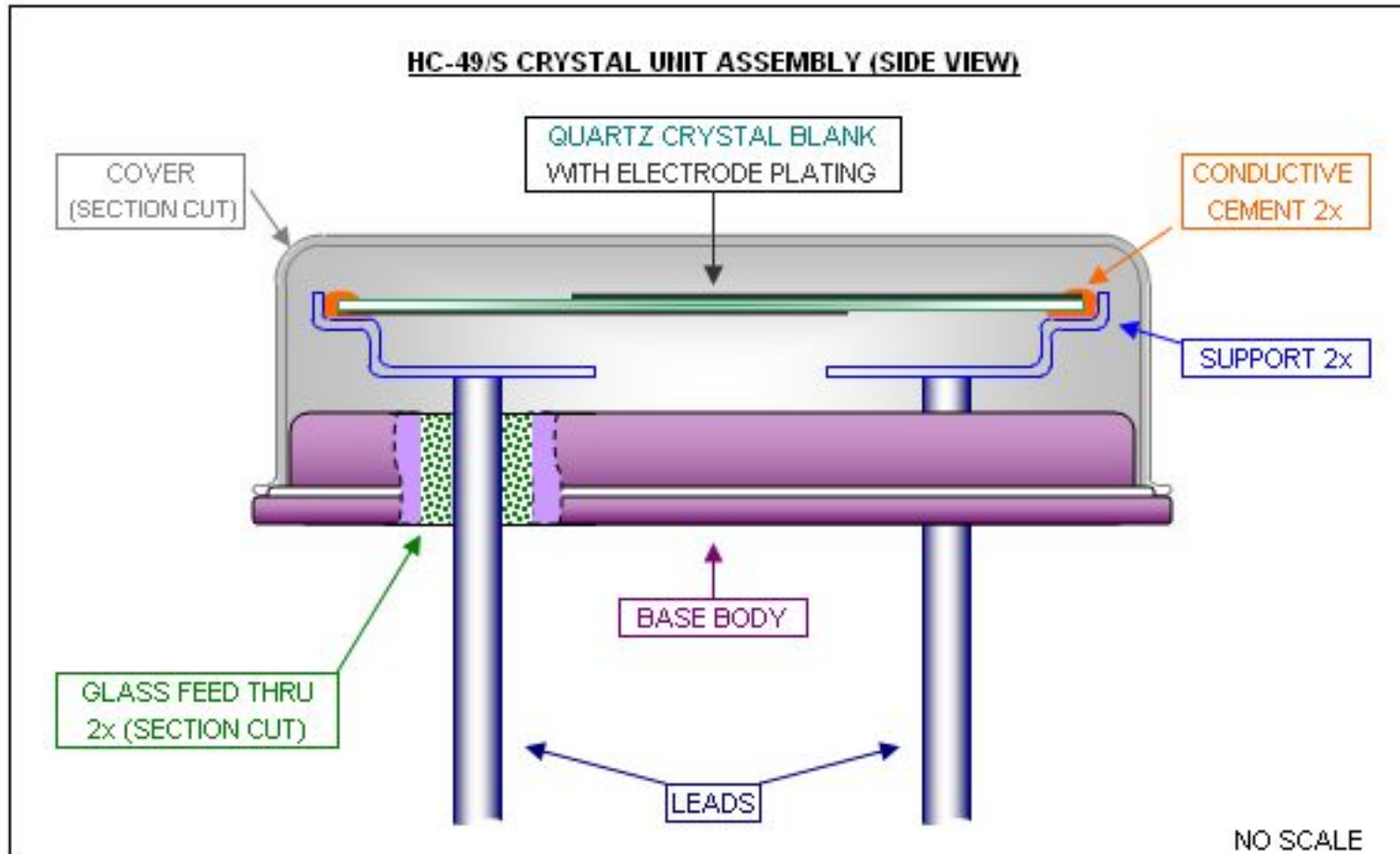
INTERNAL CONSTRUCTION – 内部構造

■ HC-49/U package



INTERNAL CONSTRUCTION – 内部構造

■ HC-49/S package



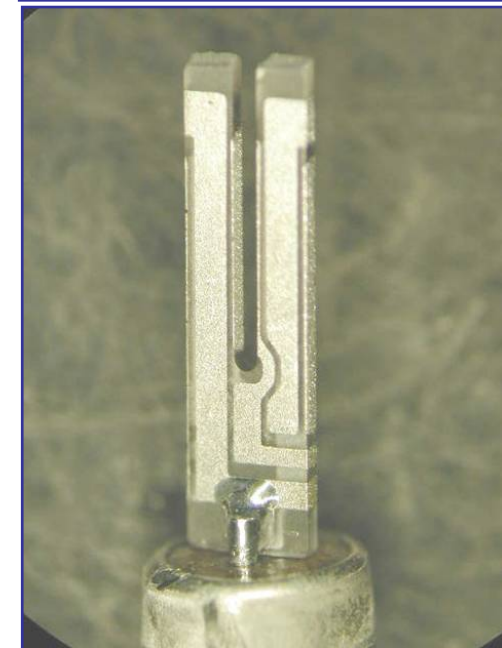
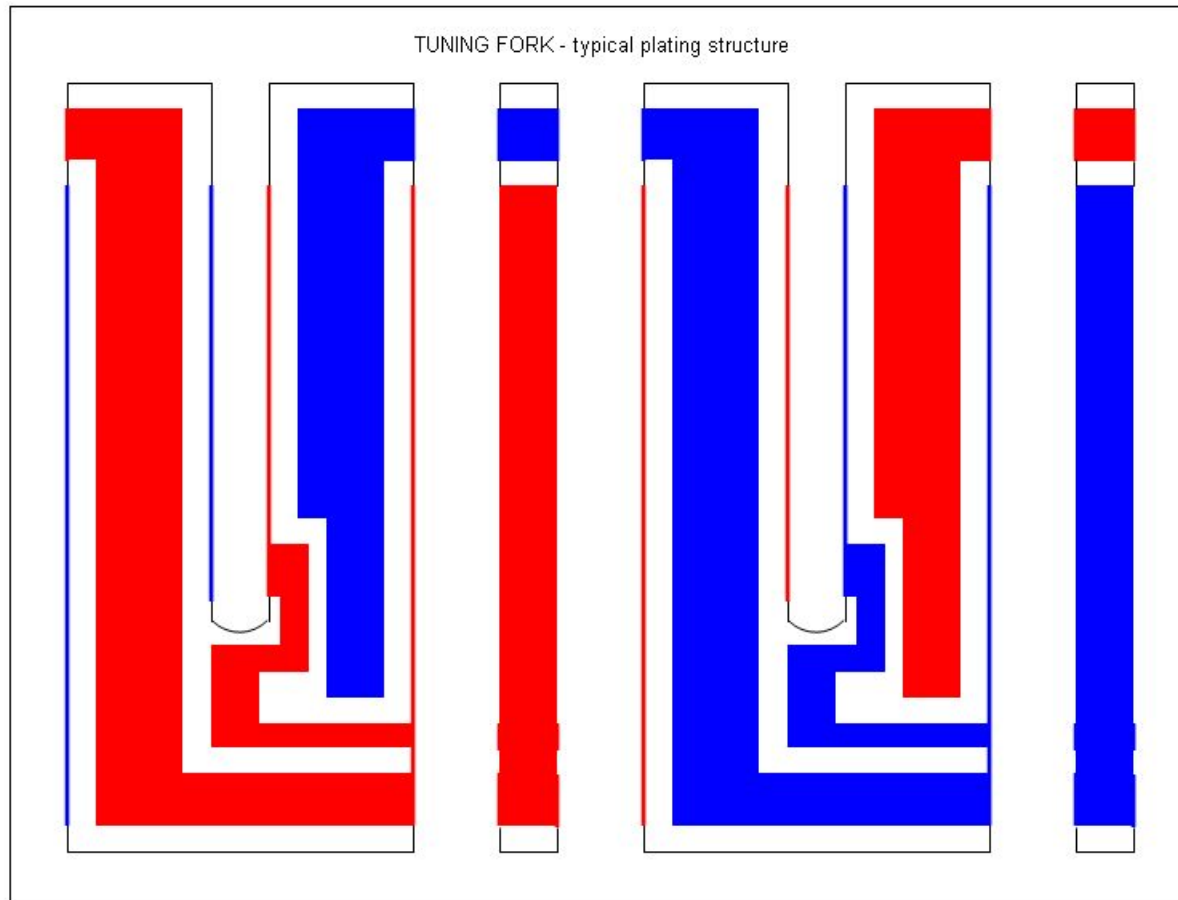
Thru hole



SMD

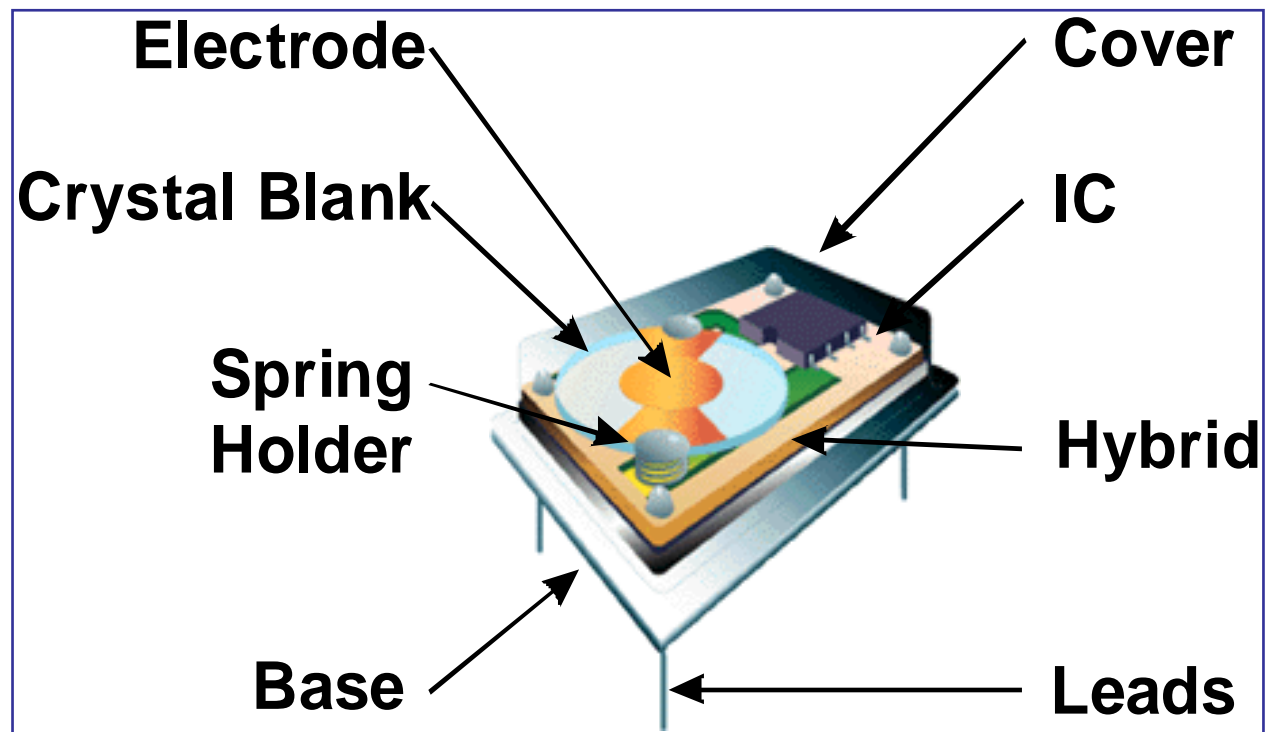
INTERNAL CONSTRUCTION – 内部構造

■ Tuning Fork Quartz Crystal (wrist watch)



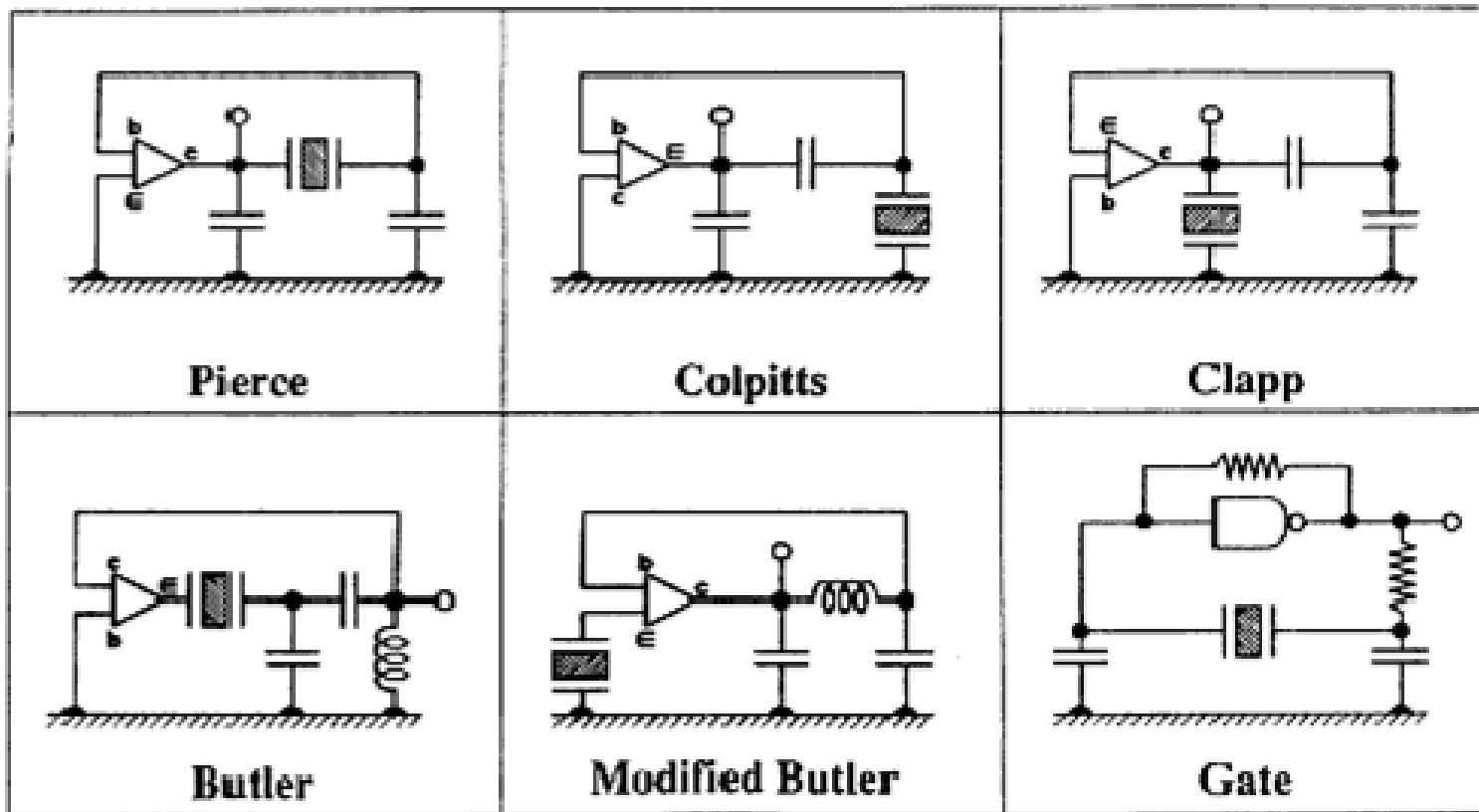
INTERNAL CONSTRUCTION – 内部构造

- Clock Oscillator DIP 14 and DIP 8 package



DIFFERENT OSCILLATOR CONFIGURATIONS – 不同的振荡器配置

- Clock Oscillator circuit designs



CRYSTAL VOCABULARY – 晶体词汇

- **Frequency:**
Number of waves or cycles per second that the quartz crystal vibrates or oscillates.
Normally assign in MHz or kHz at 25 C.
- **Frequency Tolerance:**
The allowed deviation in PPM from the nominal frequency at 25degC.
Specify in Part Per Million (ppm)
- **Stability over temperature:**
The allowed deviation in PPM between a lower and higher temperature.
- **频率：**石英晶体一秒内振动或震荡波或循环的次数。一般用25度时MHz或kHz表示。
- **调整频差：**与25度时的标称频率之间允许的偏差PPM值。
- **温度频差：**高低温之间允许的偏差PPM值。

CRYSTAL VOCABULARY – 晶体词汇

■ Aging:

Cumulative change in frequency over time. Specified in PPM per year.

■ Load Capacitance:

Dynamic or effective capacitance of the complete circuit as measured across the crystal terminals. The load capacitance must be specified when the crystal is operating in a parallel resonant (anti resonant) circuit.

■ Series Resonance:

When a crystal operates at series resonance it appears resistive in the circuit and its impedance is near zero. The load capacitance is not required.

■ 老化：随着时间频率的累计变化。以PPM/年定义。

■ 负载电容：从晶体引脚量测的完整电路的动态或有效电容。
当晶体工作在并联谐振（反谐振）电路中时必须定义负载。

■ 串联谐振：当晶体串联谐振工作时，他在电路中显示出有阻抗的，而且其阻抗接近0。负载是不需要的。

CRYSTAL VOCABULARY – 晶体词汇

■ Equivalent Series Resistance (ESR):

The internal or equivalent resistance of the circuit measured at the series resonant frequency. Lower frequencies have higher ESR values.

■ Drive Level:

The level of power or current in the crystal during operation.

■ Mode of Oscillation:

A crystal can work at many frequencies, either on its FUNDAMENTAL frequency or one of the odd OVERTONES, it must be specified because it has to match with oscillator design.

■ ESR: 在串联谐振频率测量时的电路内部或等效电阻。频率越低ESR越高。

■ 激励电平: 晶体工作时的功率或电流电平。

■ 振荡模式: 晶体可以以很多频率工作, 或是基频频率或是某个奇数泛音, 必须进行定义, 因为它必须与振荡器的设计相符。

CRYSTAL SPECIFICATION 晶体规格 - WORKSHEET

1. Nominal Frequency: _____ MHz
2. Load Capacitance: _____ pF
3. Tolerance at 25° C: ± _____ PPM
4. Operating Temperature Range: from _____ ° C to _____ ° C
5. Frequency Stability over Operating Temperature Range: ± _____ PPM
6. Equivalent Series Resistance: _____ Ω
7. Aging: ± _____ PPM MAX per Year
8. Drive Level: _____ μW
9. Oscillation Mode: FUNDAMENTAL OVERTONE 3rd 5th
10. Package Size: _____
11. Application: _____
12. Requested QTY's: _____ pcs; Projected Usage / year: _____ pcs

Special Instruction:

OSCILLATOR SPECIFICATION 振荡器规格 - WORKSHEET

1. Nominal Frequency: _____ MHz
2. Output Type: HCMOS ; TTL ; Sinewave ; Clipped Sine ; ECL ; PECL
3. Output Load: _____
4. Operating Temperature Range: from _____ ° C to _____ ° C
5. Frequency Stability over Operating Temperature Range: \pm _____ PPM
6. Supply Voltage: _____ VDC \pm ____%
7. Supply Current: _____ mA MAX @25° C
8. Aging: \pm _____ PPM MAX per Year
9. Oscillation Mode: FUNDAMENTAL OVERTONE 3rd 5th
10. Package Size: _____
11. Application: _____
12. Requested QTY's: _____ pcs; Projected Usage / year: _____ pcs

Special Instruction:
