



Freescale Semiconductor



Table 3 Table of Characteristics

Characteristic	Resonator	Crystal
Cost	Inexpensive	High
Freq Control	$\pm 0.5\%$	$\pm 0.002\%$
Temp. Range	-40 to 125 °C	-40 to 125 °C
Ease of Start	Easy	Hard to analyze
Package	Both available in thru-hole and SMT	

APPENDIX B AT-Strip Crystals.

The “AT” in AT-cut and AT-strip crystals specifies the angle of cut relative to the Z-axis to be 35 degrees. AT-cut crystals are thin, circular disks of quartz while AT-strip crystals are thin, rectangular pieces of quartz (the width is very small compared to the length). AT-cut crystals will fit in smaller packages and require less quartz which should make them less expensive.

AT-strip crystals function identically to the AT-cut type and the same Pierce oscillator circuit configuration is used. However, the smaller piece of quartz is not as resistant to mechanical shock or to excess electrical drive. **Care should be taken to calculate the drive level and ensure stabilizing capacitors are sized appropriately.** In general, for any given frequency, the series resistance and the maximum drive of an AT-strip crystal will be lower than that of an AT-cut crystal. (i.e., 4 MHz AT-cut: max ESR = 120 Ω , max drive = 5 mW; 4 MHz AT-strip: max ESR = 40 Ω , max drive = 1 mW)

The M68HC11 reference manual contains a statement warning against the use of AT-strip type crystals. This statement was made when AT-strip crystals were just being developed and the drive level was thought to be much lower than those specified today. There are many successful designs in production using AT-strip crystals with M68HC11's. Designers should not be inhibited from using either a ceramic resonator, AT-strip, or AT-cut crystals in their microcontroller application.

APPENDIX C 32-kHz Operation Specifics

The basic theory behind the operation of a low-frequency crystal is identical to that listed in earlier sections. The big difference is that relative impedances are much higher for low-frequency operation. In many cases, a resistor needs to be inserted in series with the crystal to keep it from being overdriven. See **Figure 9**. The correct placement of this resistor is very important. Do not place R_s on the amplifier's input side. Also, R_f should feed directly back from XTAL to EXTAL. R_s will range from 100 Ω to 330 k Ω depending upon V_{dd} , the crystal frequency, and the amplifier's drive.

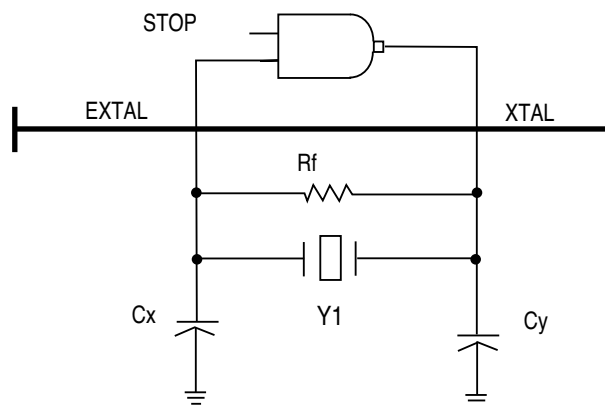


Figure 9 Typical Oscillator Circuit for Low Frequency Crystals

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