Table 3 Table of Characteristics

Characteristic	Resonator	Crystal
Cost	Inexpensive	High
Freq Control	± 0.5%	±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 Rs on the amplifier’s input side. Also, Rf should feed directly back from XTAL to EXTAL. Rs will range from 100 Ω to 330 kΩ depending upon Vdd, the crystal frequency, and the amplifier’s drive.

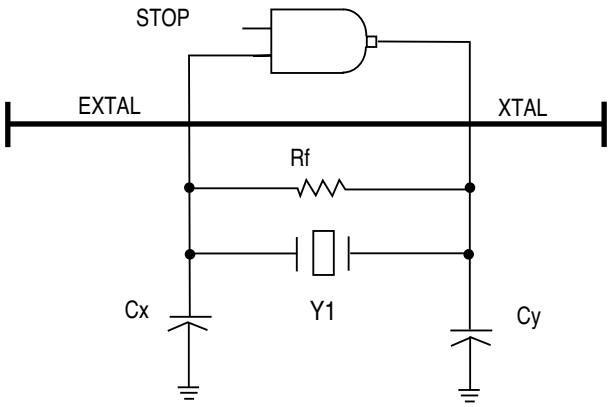

Figure 9 Typical Oscillator Circuit for Low Frequency Crystals

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