Technical Note

Crystal Oscillator/Resonator Guidelines for eZ80® and eZ80Acclaim!® Devices

TN001305-0307

General Overview

ZiLOG's eZ80® MPU and eZ80Acclaim!® Flash microcontrollers feature on-chip oscillators for use with external crystals and resonators. These oscillators generate various primary system clock frequencies for the internal eZ80 CPU, for on-chip peripherals, and for the real-time clock (RTC), depending on the available features for the selected device. This Technical Note provides general guidelines for selecting crystals, RTC circuit configurations and parameters, and the layout of the printed circuit board.

The primary system oscillator is designed for fundamental operation up to 20 MHz and for third overtone crystals at 50 MHz operation. Fundamental frequency operation above 20 MHz is not recommended. Applications requiring the eZ80 SYSCLK to operate in the frequency range of 21–49 MHz must use external clock sources.

1–10 MHz Crystal Oscillator Operation

For eZ80Acclaim! devices using the on-chip Phase-Locked-Loop and a programmable frequency multiplier, the primary crystal oscillator circuit is restricted to the operational frequency range of 1–10 MHz. Table 1 describes the recommended specifications for 1 MHz and 10 MHz crystals. The crystal circuit configuration is illustrated in Figure 1.

Table 1. 1–10 MHz Crystal Specifications

Parameter	1 MHz	10 MHz	Units	Comments
Frequency	1	10	MHz	
Resonance	Parallel			
Mode	Fundamental			
Series Resistance (RS)	750	35	Ω	Maximum
Load Capacitance (CL)	13	30	pF	Maximum
Shunt Capacitance (CO)	7	7	pF	Maximum
Drive Level	1	1	mW	Maximum

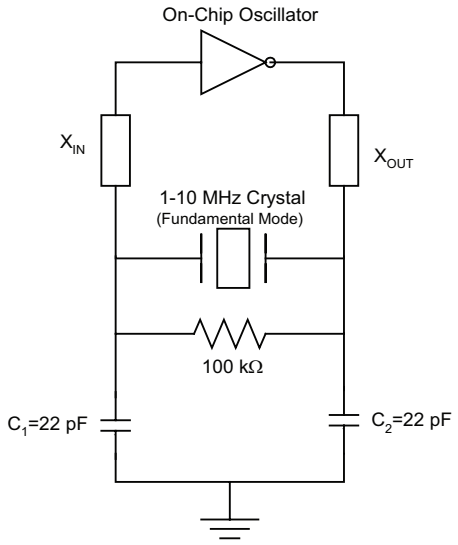

Figure 1. 1–10 MHz Crystal Circuit

11–20 MHz Crystal Oscillator Operation

Figure 2 illustrates a configuration recommended for connection with an external 20 MHz, fundamental mode, parallel-resonant crystal. Table 2 on page 3 provides the recommended crystal specifications. Resistor R_1 limits the total power dissipation by the crystal.

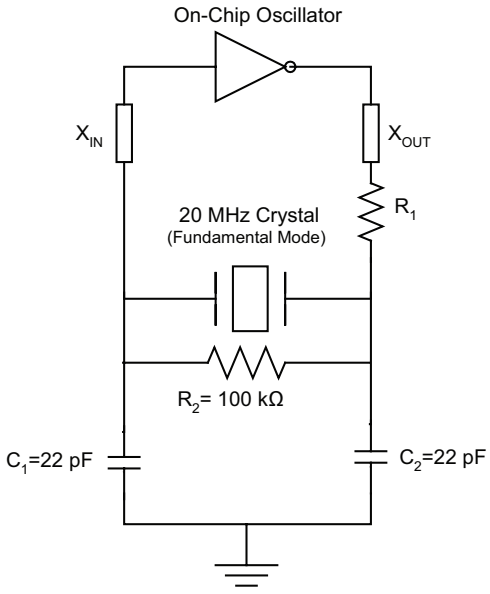

Figure 2. Recommended Crystal Oscillator Configuration (20 MHz Operation)

Note: *The value of R_1 must be adjusted if crystals with different equivalent series resistance (ESR) are used.*

Table 2. Recommended Crystal Oscillator Specifications, 20 MHz Operation

Oscillator Type	Parameter	Value	Units	Comments
	Frequency	20	MHz	
	Resonance	Parallel		
	Mode	Fundamental		
Standard	Series Resistance (RS)	25	Ω	Maximum
	Load Capacitance (CL)	20	pF	Maximum
	Shunt Capacitance (CO)	7	pF	Maximum
	Drive Level	1	mW	Maximum
	Resistor R1	220	Ω	±10%
	Crystal (reference)			
	Precision Devices Inc.	L420000XFCD20BX		Part number
Low Drive	Series Resistance (RS)	40	Ω	Maximum
	Load Capacitance (CL)	20	pF	Maximum
	Shunt Capacitance (CO)	7	pF	Maximum
	Drive Level	500	µW	Maximum
	Resistor R1	1.1	kΩ	±10%; see Figure 2
	Crystal (reference)			
	Precision Devices Inc.	L420000XFCD20BA		Part number

ZiLOG recommends one of the crystal solutions (standard or low drive) provided in Table 2. If it is not possible to obtain crystals that meet the parameters in Table 2 then, it can be obtained by using different performance crystals by adjusting the R_1 value displayed in Figure 2. Contact Crystal vendor technical support while considering non-recommended solutions. For selecting the value of R_1, see the graph in Figure 3.

Example

The available crystal has an ESR of 40 Ω and a recommended drive level of 10–100 µW. In Table 2, the drive level is defined as 500 µW, maximum. The graph in Figure 3 indicates that a 6800 Ω resistor for an 80 µW drive level should be acceptable.

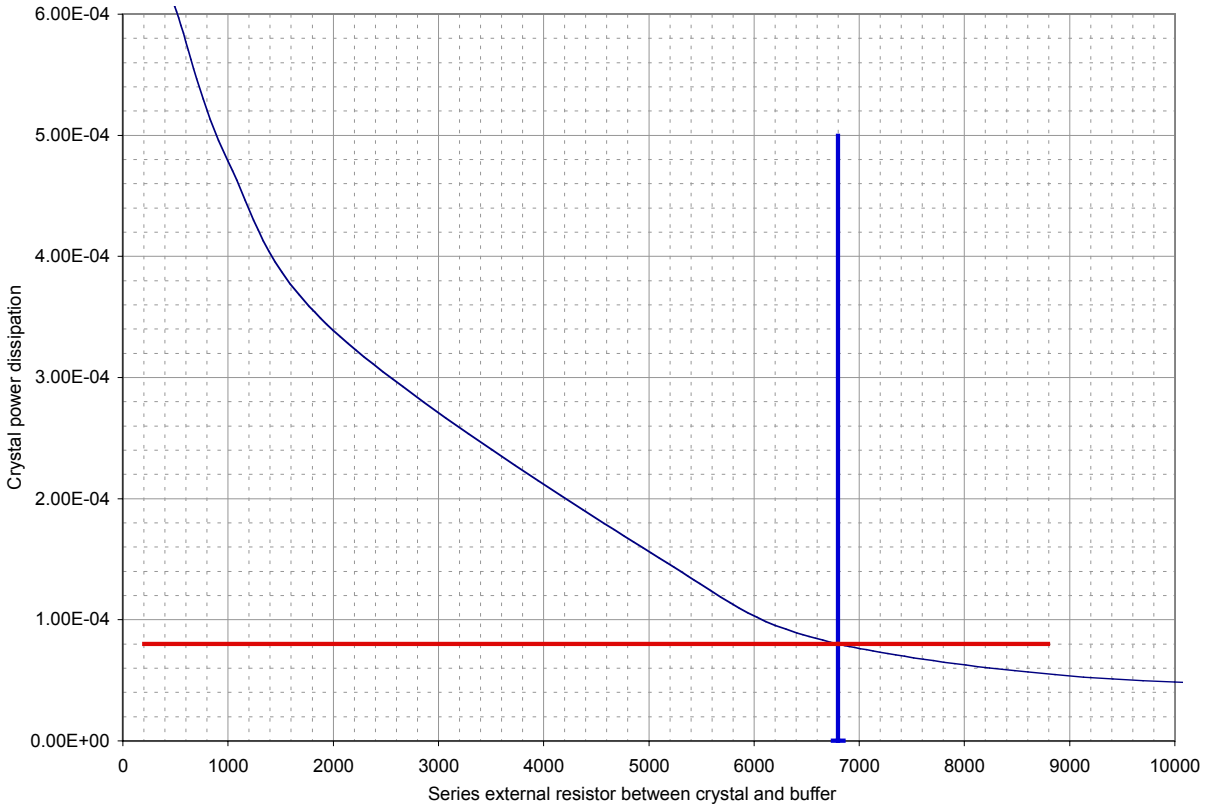

Figure 3. 20 MHz Crystal Power Dissipation for 22 pF Caps on Each End of XTAL

Figure 3 is empirical data derived from ZiLOG's eZ80L92 device, with 22 pF placed on both ends of the crystal (V_{DD} = 3.3 V). Power dissipation is based on a 40 Ω series resistance crystal. R_{EXT} is the resistor (R_1) placed between the oscillator buffer output and the X_{OUT} pin.

These numbers are based on measurements with a Tektronix current probe of type 131. Measurements are corrected for the 6 db down-response of the current probe at 20 MHz. The current values are converted from peak sinusoid values to Root Mean Square (RMS).

50 MHz Crystal Oscillator/Resonator Operation

Figure 4 illustrates a recommended configuration for connection with an external 50 MHz, third overtone, resonator from MURATA. Recommended specifications are provided in Table 3. Printed circuit board layout must not add more than 4 pF of stray capacitance to either the X_{IN} or X_{OUT} pins. For more detailed information, refer to www.murata.com or http://search.murata.co.jp/Ceramy/IC_en.do.

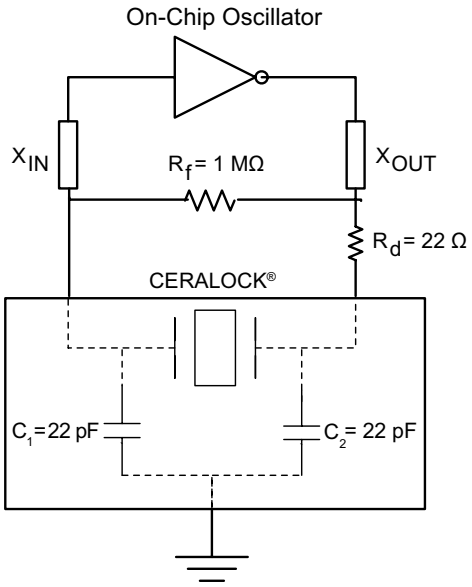

Figure 4. Recommended Resonator Configuration (50 MHz Operation)

Table 3. Recommended Resonator Specifications (50 MHz Operation)

Parameter	Value	Units	Comments
Frequency	50	MHz	
Resonance	Parallel		
Mode	Third Overtone		
Series Resistance (R_d)	22	Ω	Recommended
Parallel Resistance (R_f)	1	MΩ	Recommended
Load Capacitance (C_1=C_2)	22	pF	Internal to Resonator
CERALOCK® Resonator MURATA Part Number	CSTCV50M0X54Q-R0		

Figure 5 illustrates an alternate recommended configuration for connection with an external 50 MHz, third overtone, parallel-resonant crystal. Table 4 provides the recommended crystal specifications. Printed circuit board layout must not add more than 4 pF of stray capacitance to either the X_{IN} or X_{OUT} pins. If oscillation does not occur, try removing C_1 for testing and decreasing the value of C_2 by the estimated stray capacitance to decrease loading.

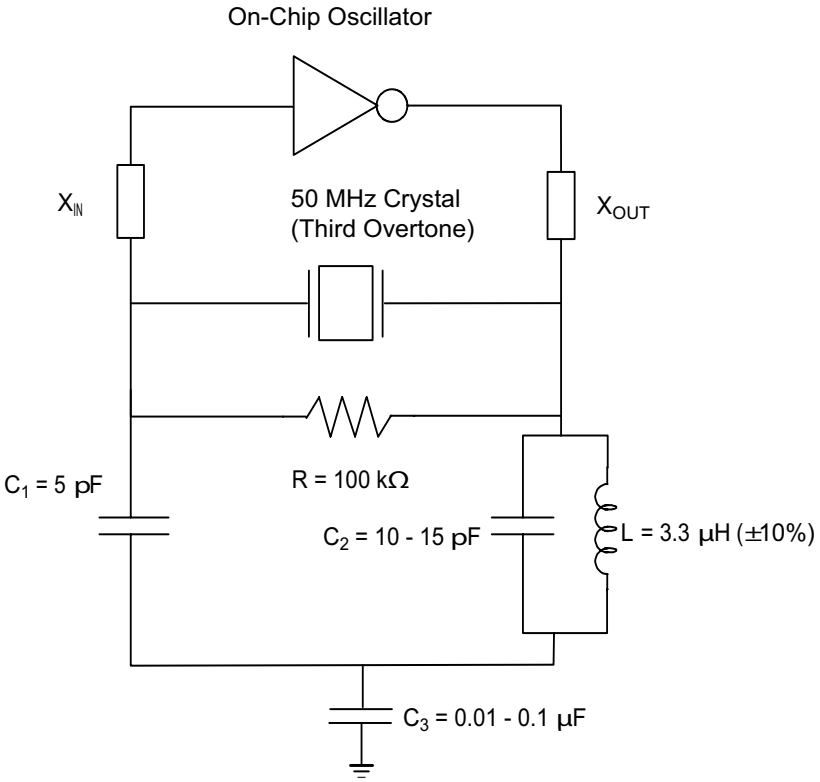

Figure 5. Alternate Recommended Crystal Oscillator Configuration (50 MHz Operation)

Table 4. Alternate Recommended Crystal Oscillator Specifications (50 MHz Operation)

Parameter	Value	Units	Comments
Frequency	50	MHz	
Resonance	Parallel		
Mode	Third Overtone		
Series Resistance (RS)	65	Ω	Recommended
	85	Ω	Maximum
Load Capacitance (CL)	20	pF	Maximum
Shunt Capacitance (CO)	7	pF	Maximum
Drive Level	100	µW	Recommended
Drive Level	2	mW	Maximum
Crystal (reference)			
Precision Devices Inc.	L450000X3CB20XX		Part number

The tank circuit in Figure 5 is approximately set at the second overtone frequency, or approximately 33 MHz for a 50 MHz third overtone crystal. This configuration does not require high tolerance (expensive) components, because it is intended only to suppress the fundamental oscillation of the crystal. A third overtone 50 MHz crystal features a 50 MHz/3 fundamental crystal, even though it is cut to provide a stronger third overtone resonance.

32 kHz Real-Time Clock Crystal Oscillator Operation

Figure 6 illustrates the recommended configuration for connecting the Real-Time Clock oscillator with an external 32 kHz, fundamental mode, parallel-resonant crystal. The recommended crystal specifications are provided in Table 5.

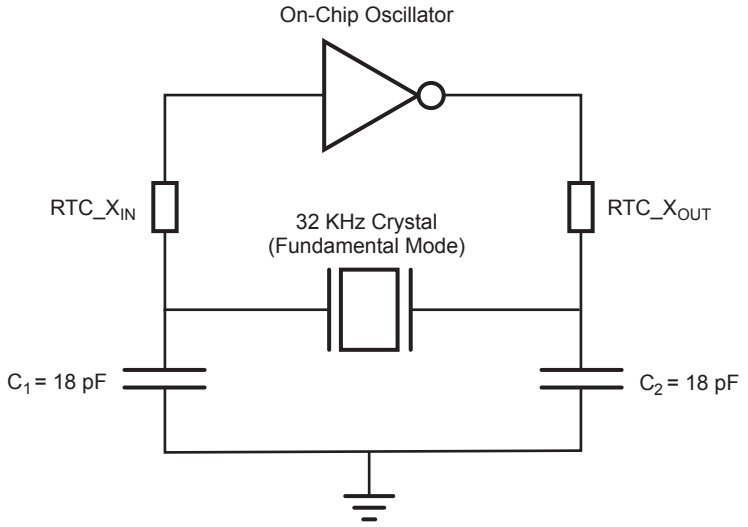

Figure 6. Recommended Crystal Oscillator Configuration (32 kHz Operation)

Table 5. Recommended Crystal Oscillator Specifications, 32 kHz Operation

Parameter	Value	Units	Comments
Frequency	32	kHz	32768 Hz
Resonance	Parallel		
Mode	Fundamental		
Series Resistance (RS)	50	kΩ	Maximum
Load Capacitance (CL)	12.5	pF	Maximum
Shunt Capacitance (CO)	3	pF	Maximum
Drive Level	1	µW	Maximum

A printed circuit board layout must not add more than 4 pF of stray capacitance to either the RTC_X_{IN} or RTC_X_{OUT} pins. If oscillation does not occur, reduce the values of capacitors C_1 and C_2 to decrease loading. An on-chip MOS resistor sets the crystal drive current limit. This configuration does not require an external bias resistor across the crystal. An on-chip MOS resistor provides the biasing.

Warning: DO NOT USE IN LIFE SUPPORT

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As used herein

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