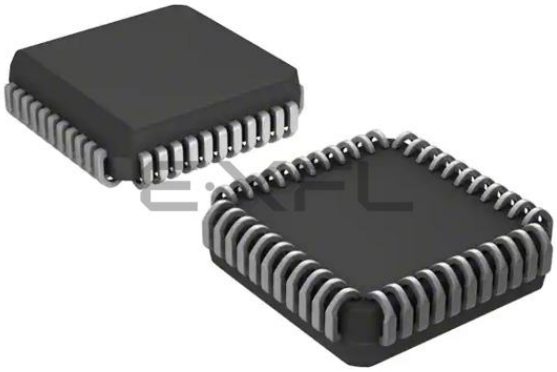

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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Obsolete
Core Processor	eZ8
Core Size	8-Bit
Speed	20MHz
Connectivity	I²C, IrDA, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, DMA, POR, PWM, WDT
Number of I/O	31
Program Memory Size	48KB (48K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	4K x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 3.6V
Data Converters	A/D 8x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 105°C (TA)
Mounting Type	Surface Mount
Package / Case	44-LCC (J-Lead)
Supplier Device Package	-
Purchase URL	https://www.e-xfl.com/product-detail/zilog/z8f4821vn020ec00tr

Use of All Uppercase Letters

The use of all uppercase letters designates the names of states, modes, and commands.

- Example 1: The bus is considered BUSY after the Start condition.
- Example 2: A START command triggers the processing of the initialization sequence.
- Example 3: STOP mode.

Bit Numbering

Bits are numbered from *0* to *n–1* where *n* indicates the total number of bits. For example, the 8 bits of a register are numbered from 0 to 7.

Safeguards

It is important that you understand the following safety terms, which are defined here.

Caution: *Indicates a procedure or file may become corrupted if you do not follow directions.*

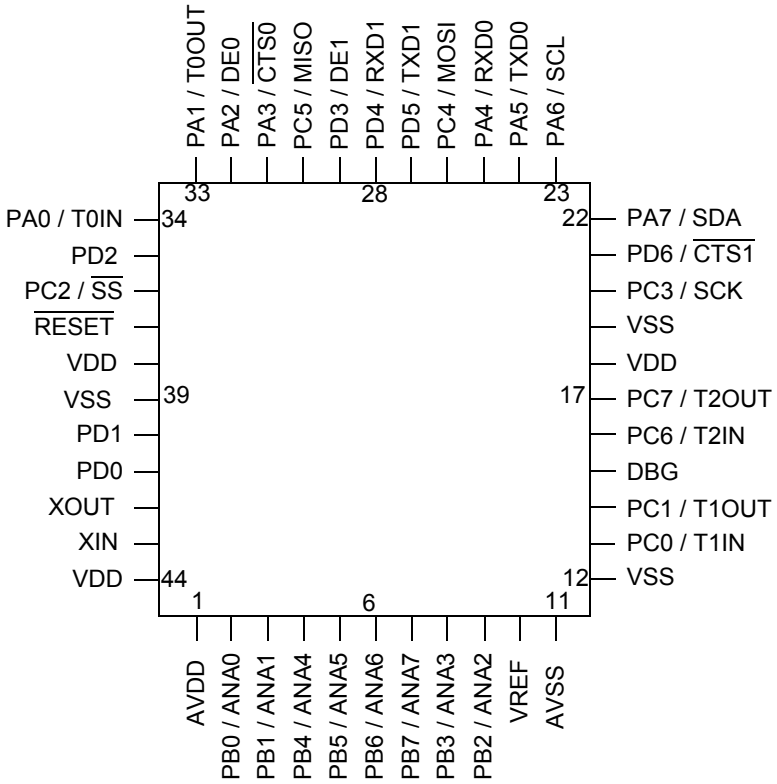


Figure 4. Z8 Encore! XP 64K Series Flash Microcontrollers in 44-Pin Low-Profile Quad Flat Package (LQFP)

Table 7. Z8 Encore! XP 64K Series Flash Microcontrollers Register File Address Map (Continued)

Address (Hex)	Register Description	Mnemonic	Reset (Hex)	Page No
Timer 3 (unavailable in the 44-pin packages)				
F18	Timer 3 High Byte	T3H	00	90
F19	Timer 3 Low Byte	T3L	01	90
F1A	Timer 3 Reload High Byte	T3RH	FF	91
F1B	Timer 3 Reload Low Byte	T3RL	FF	91
F1C	Timer 3 PWM High Byte	T3PWMH	00	92
F1D	Timer 3 PWM Low Byte	T3PWML	00	92
F1E	Timer 3 Control 0	T3CTL0	00	93
F1F	Timer 3 Control 1	T3CTL1	00	94
20-3F	Reserved	—	XX	
UART 0				
F40	UART0 Transmit Data	U0TXD	XX	114
	UART0 Receive Data	U0RXD	XX	115
F41	UART0 Status 0	U0STAT0	0000011Xb	115
F42	UART0 Control 0	U0CTL0	00	117
F43	UART0 Control 1	U0CTL1	00	117
F44	UART0 Status 1	U0STAT1	00	115
F45	UART0 Address Compare Register	U0ADDR	00	120
F46	UART0 Baud Rate High Byte	U0BRH	FF	120
F47	UART0 Baud Rate Low Byte	U0BRL	FF	120
UART 1				
F48	UART1 Transmit Data	U1TXD	XX	114
	UART1 Receive Data	U1RXD	XX	115
F49	UART1 Status 0	U1STAT0	0000011Xb	115
F4A	UART1 Control 0	U1CTL0	00	117
F4B	UART1 Control 1	U1CTL1	00	117
F4C	UART1 Status 1	U1STAT1	00	115
F4D	UART1 Address Compare Register	U1ADDR	00	120
F4E	UART1 Baud Rate High Byte	U1BRH	FF	120
F4F	UART1 Baud Rate Low Byte	U1BRL	FF	120
I^2C				
F50	I^2C Data	I2CDATA	00	156
F51	I^2C Status	I2CSTAT	80	157
F52	I^2C Control	I2CCTL	00	158
F53	I^2C Baud Rate High Byte	I2CBRH	FF	160
F54	I^2C Baud Rate Low Byte	I2CBRL	FF	160
F55	I^2C Diagnostic State	I2CDST	C0	161
F56	I^2C Diagnostic Control	I2CDIAG	00	163
F57-F5F	Reserved	—	XX	
Serial Peripheral Interface (SPI)				
F60	SPI Data	SPIDATA	XX	137

Reset and Stop Mode Recovery

Overview

The Reset Controller within the Z8 Encore! XP 64K Series Flash Microcontrollers controls Reset and Stop Mode Recovery operation. In typical operation, the following events cause a Reset to occur:

- Power-On Reset
- Voltage Brownout
- Watchdog Timer time-out (when configured via the WDT_RES Option Bit to initiate a Reset)
- External $\overline{\text{RESET}}$ pin assertion
- On-Chip Debugger initiated Reset (OCDCTL[0] set to 1)

When the 64K Series devices are in STOP mode, a Stop Mode Recovery is initiated by either of the following:

- Watchdog Timer time-out
- GPIO Port input pin transition on an enabled Stop Mode Recovery source
- DBG pin driven Low

Reset Types

The 64K Series provides two different types of reset operation (system reset and Stop Mode Recovery). The type of Reset is a function of both the current operating mode of the 64K Series devices and the source of the Reset. Table 8 lists the types of Reset and their operating characteristics.

GPIO Control Register Definitions

Four registers for each Port provide access to GPIO control, input data, and output data. Table 13 lists these Port registers. Use the Port A–H Address and Control registers together to provide access to sub-registers for Port configuration and control.

Table 13. GPIO Port Registers and Sub-Registers

Port Register Mnemonic	Port Register Name
PxADDR	Port A–H Address Register (Selects sub-registers)
PxCTL	Port A–H Control Register (Provides access to sub-registers)
PxIN	Port A–H Input Data Register
PxOUT	Port A–H Output Data Register
Port Sub-Register Mnemonic	**Port Register Name**
PxDD	Data Direction
PxAF	Alternate Function
PxOC	Output Control (Open-Drain)
PxDD	High Drive Enable
PxSMRE	Stop Mode Recovery Source Enable

Port A–H Address Registers

The Port A–H Address registers select the GPIO Port functionality accessible through the Port A–H Control registers. The Port A–H Address and Control registers combine to provide access to all GPIO Port control (Table 14).

Table 14. Port A–H GPIO Address Registers (PxADDR)

BITS	7	6	5	4	3	2	1	0
FIELD	PADDR[7:0]							
RESET	00H							
R/W	R/W							
ADDR	FD0H, FD4H, FD8H, FDCH, FE0H, FE4H, FE8H, FECH							

PADDR[7:0]—Port Address
The Port Address selects one of the sub-registers accessible through the Port Control register.

PADDR[7:0]	Port Control sub-register accessible using the Port A–H Control Registers
00H	No function. Provides some protection against accidental Port reconfiguration
01H	Data Direction
02H	Alternate Function
03H	Output Control (Open-Drain)
04H	High Drive Enable
05H	Stop Mode Recovery Source Enable
06H-FFH	No function

Port A–H Control Registers

The Port A–H Control registers set the GPIO port operation. The value in the corresponding Port A–H Address register determines the control sub-registers accessible using the Port A–H Control register (Table 15).

Table 15. Port A–H Control Registers (P*x*CTL)

BITS	7	6	5	4	3	2	1	0
FIELD	PCTL							
RESET	00H							
R/W	R/W							
ADDR	FD1H, FD5H, FD9H, FDDH, FE1H, FE5H, FE9H, FEDH							

PCTL[7:0]—Port Control
The Port Control register provides access to all sub-registers that configure the GPIO Port operation.

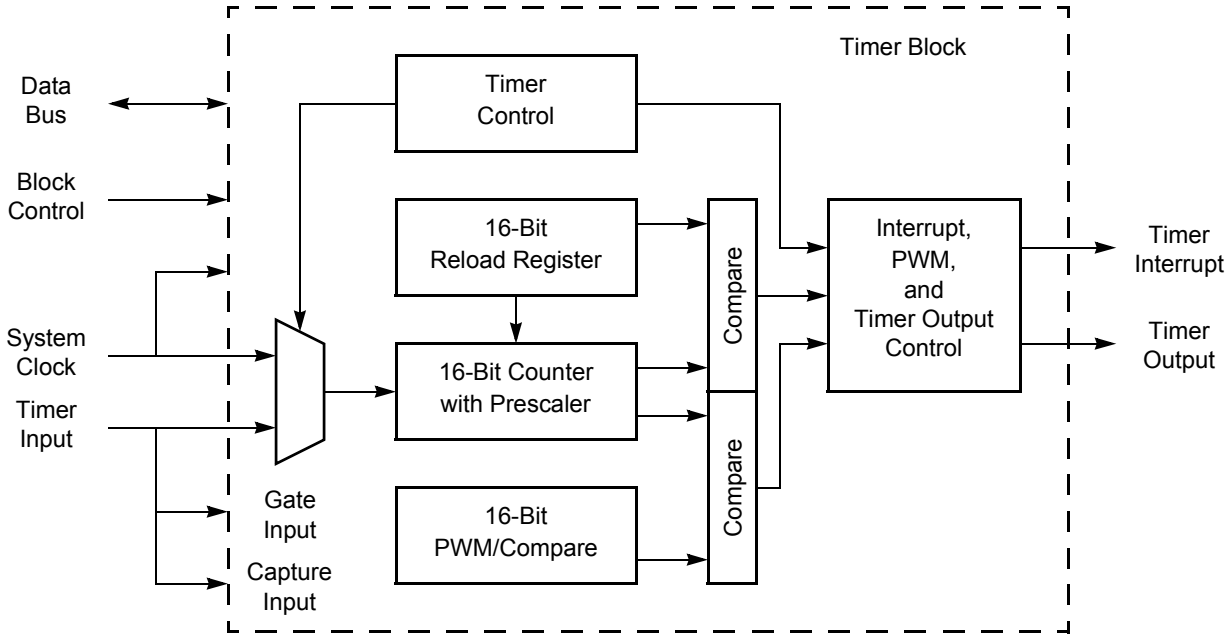


Figure 12. Timer Block Diagram

Operation

The timers are 16-bit up-counters. Minimum time-out delay is set by loading the value 0001H into the Timer Reload High and Low Byte registers and setting the prescale value to 1. Maximum time-out delay is set by loading the value 0000H into the Timer Reload High and Low Byte registers and setting the prescale value to 128. If the Timer reaches FFFFH, the timer rolls over to 0000H and continues counting.

Timer Operating Modes

The timers can be configured to operate in the following modes:

ONE-SHOT Mode

In ONE-SHOT mode, the timer counts up to the 16-bit Reload value stored in the Timer Reload High and Low Byte registers. The timer input is the system clock. Upon reaching the Reload value, the timer generates an interrupt and the count value in the Timer High and Low Byte registers is reset to 0001H. Then, the timer is automatically disabled and stops counting.

Also, if the Timer Output alternate function is enabled, the Timer Output pin changes state for one system clock cycle (from Low to High or from High to Low) upon timer Reload. If it is desired to have the Timer Output make a permanent state change upon

Caution: *The 24-bit WDT Reload Value must not be set to a value less than* `000004H`.

Table 49. Watchdog Timer Reload Upper Byte Register (WDTU)

BITS	7	6	5	4	3	2	1	0
FIELD	WDTU							
RESET	1							
R/W	R/W*							
ADDR	FF1H							

Note: R/W* - Read returns the current WDT count value. Write sets the desired Reload Value.

WDTU—WDT Reload Upper Byte
Most significant byte, Bits[23:16], of the 24-bit WDT reload value.

Table 50. Watchdog Timer Reload High Byte Register (WDTH)

BITS	7	6	5	4	3	2	1	0
FIELD	WDTH							
RESET	1							
R/W	R/W*							
ADDR	FF2H							

Note: R/W* - Read returns the current WDT count value. Write sets the desired Reload Value.

WDTH—WDT Reload High Byte
Middle byte, Bits[15:8], of the 24-bit WDT reload value.

Table 51. Watchdog Timer Reload Low Byte Register (WDTL)

BITS	7	6	5	4	3	2	1	0
FIELD	WDTL							
RESET	1							
R/W	R/W*							
ADDR	FF3H							

Note: R/W* - Read returns the current WDT count value. Write sets the desired Reload Value.

WDTL—WDT Reload Low
Least significant byte, Bits[7:0], of the 24-bit WDT reload value.

Table 70. I²C Data Register (I2CDATA)

BITS	7	6	5	4	3	2	1	0
FIELD	DATA							
RESET	0							
R/W	R/W							
ADDR	F50H							

I²C Status Register

The Read-only I²C Status register (Table 71) indicates the status of the I²C Controller.

Table 71. I²C Status Register (I2CSTAT)

BITS	7	6	5	4	3	2	1	0
FIELD	TDRE	RDRF	ACK	10B	RD	TAS	DSS	NCKI
RESET	1	0						
R/W	R							
ADDR	F51H							

TDRE—Transmit Data Register Empty
When the I²C Controller is enabled, this bit is 1 when the I²C Data register is empty. When this bit is set, an interrupt is generated if the TXI bit is set, except when the I²C Controller is shifting in data during the reception of a byte or when shifting an address and the RD bit is set. This bit is cleared by writing to the I2CDATA register.

RDRF—Receive Data Register Full
This bit is set = 1 when the I²C Controller is enabled and the I²C Controller has received a byte of data. When asserted, this bit causes the I²C Controller to generate an interrupt. This bit is cleared by reading the I²C Data register (unless the read is performed using execution of the On-Chip Debugger's Read Register command).

ACK—Acknowledge
This bit indicates the status of the Acknowledge for the last byte transmitted or received. When set, this bit indicates that an Acknowledge occurred for the last byte transmitted or received. This bit is cleared when IEN = 0 or when a Not Acknowledge occurred for the last byte transmitted or received. It is not reset at the beginning of each transaction and is not reset when this register is read.

Caution: *Software must be cautious in making decisions based on this bit within a transaction because software cannot tell when the bit is updated by hardware. In the case of write transactions, the I²C pauses at the beginning of the Acknowledge cycle if the next transmit data or address byte has not been written (TDRE = 1) and STOP and START = 0. In this case the ACK bit is not updated until the transmit interrupt is serviced and the Acknowledge cycle for the previous byte completes. For examples of how the ACK bit can be used, see* Address Only Transaction with a 7-bit Address *on page 148* and Address Only Transaction with a 10-bit Address *on page 150*.

10B—10-Bit Address
This bit indicates whether a 10- or 7-bit address is being transmitted. After the START bit is set, if the five most-significant bits of the address are 11110B, this bit is set. When set, it is reset once the first byte of the address has been sent.

RD—Read
This bit indicates the direction of transfer of the data. It is active high during a read. The status of this bit is determined by the least-significant bit of the I²C Shift register after the START bit is set.

TAS—Transmit Address State
This bit is active high while the address is being shifted out of the I²C Shift register.

DSS—Data Shift State
This bit is active high while data is being shifted to or from the I²C Shift register.

NCKI—NACK Interrupt
This bit is set high when a Not Acknowledge condition is received or sent and neither the START nor the STOP bit is active. When set, this bit generates an interrupt that can only be cleared by setting the START or STOP bit, allowing you to specify whether to perform a STOP or a repeated START.

I²C Control Register

The I²C Control register (Table 72) enables the I²C operation.

Table 72. I²C Control Register (I2CCTL)

BITS	7	6	5	4	3	2	1	0
FIELD	IEN	START	STOP	BIRQ	TXI	NAK	FLUSH	FILTEN
RESET	0							
R/W	R/W	R/W1	R/W1	R/W	R/W	R/W1	W1	R/W
ADDR	F52H							

Analog-to-Digital Converter

Overview

The Analog-to-Digital Converter (ADC) converts an analog input signal to a 10-bit binary number. The features of the sigma-delta ADC include:

- 12 analog input sources are multiplexed with general-purpose I/O ports
- Interrupt upon conversion complete
- Internal voltage reference generator
- Direct Memory Access (DMA) controller can automatically initiate data conversion and transfer of the data from 1 to 12 of the analog inputs

Architecture

Figure 34 displays the three major functional blocks (converter, analog multiplexer, and voltage reference generator) of the ADC. The ADC converts an analog input signal to its digital representation. The 12-input analog multiplexer selects one of the 12 analog input sources. The ADC requires an input reference voltage for the conversion. The voltage reference for the conversion may be input through the external VREF pin or generated internally by the voltage reference generator.

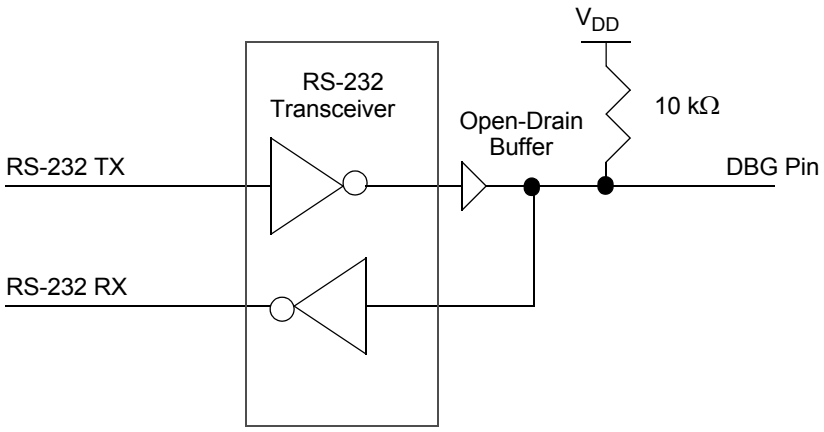


Figure 38. Interfacing the On-Chip Debugger's DBG Pin with an RS-232 Interface (2)

DEBUG Mode

The operating characteristics of the 64K Series devices in DEBUG mode are:

- The eZ8 CPU fetch unit stops, idling the eZ8 CPU, unless directed by the OCD to execute specific instructions.
- The system clock operates unless in STOP mode.
- All enabled on-chip peripherals operate unless in STOP mode.
- Automatically exits HALT mode.
- Constantly refreshes the Watchdog Timer, if enabled.

Entering DEBUG Mode

The device enters DEBUG mode following any of the following operations:

- Writing the DBGMODE bit in the OCD Control Register to 1 using the OCD interface.
- eZ8 CPU execution of a BRK (Breakpoint) instruction (when enabled).
- If the DBG pin is Low when the device exits Reset, the On-Chip Debugger automatically puts the device into DEBUG mode.

Exiting DEBUG Mode

The device exits DEBUG mode following any of the following operations:

- Clearing the DBGMODE bit in the OCD Control Register to 0.
- Power-On Reset
- Voltage Brownout reset

finish the interrupt service routine it may be in and return the BRK instruction. When the CPU returns to the BRK instruction it was previously looping on, it automatically sets the DBGMODE bit and enter DEBUG mode.

Software detects that the majority of the OCD commands are still disabled when the eZ8™ CPU is looping on a BRK instruction. The eZ8 CPU must be stopped and the part must be in DEBUG mode before these commands can be issued.

Breakpoints in Flash Memory

The BRK instruction is opcode 00H, which corresponds to the fully programmed state of a byte in Flash memory. To implement a Breakpoint, write 00H to the desired address, overwriting the current instruction. To remove a Breakpoint, the corresponding page of Flash memory must be erased and reprogrammed with the original data.

On-Chip Debugger Commands

The host communicates to the On-Chip Debugger by sending OCD commands using the DBG interface. During normal operation, only a subset of the OCD commands are available. In DEBUG mode, all OCD commands become available unless the user code and control registers are protected by programming the Read Protect Option Bit (RP). The Read Protect Option Bit prevents the code in memory from being read out of the 64K Series products. When this option is enabled, several of the OCD commands are disabled. Table 101 contains a summary of the On-Chip Debugger commands. Each OCD command is described in detail in the bulleted list following Table 101.
Table 101 indicates those commands that operate when the device is not in DEBUG mode (normal operation) and those commands that are disabled by programming the Read Protect Option Bit.

Table 101. On-Chip Debugger Commands

Debug Command	Command Byte	Enabled when NOT in DEBUG mode?	Disabled by Read Protect Option Bit
Read OCD Revision	00H	Yes	-
Read OCD Status Register	02H	Yes	-
Read Runtime Counter	03H	-	-
Write OCD Control Register	04H	Yes	Cannot clear DBGMODE bit
Read OCD Control Register	05H	Yes	-

On-Chip Oscillator

Overview

The products in the 64K Series feature an on-chip oscillator for use with external crystals with frequencies from 32 kHz to 20 MHz. In addition, the oscillator can support external RC networks with oscillation frequencies up to 4 MHz or ceramic resonators with oscillation frequencies up to 20 MHz. This oscillator generates the primary system clock for the internal eZ8™ CPU and the majority of the on-chip peripherals. Alternatively, the X_{IN} input pin can also accept a CMOS-level clock input signal (32 kHz–20 MHz). If an external clock generator is used, the X_{OUT} pin must be left unconnected.

When configured for use with crystal oscillators or external clock drivers, the frequency of the signal on the X_{IN} input pin determines the frequency of the system clock (that is, no internal clock divider). In RC operation, the system clock is driven by a clock divider (divide by 2) to ensure 50% duty cycle.

Operating Modes

The 64K Series products support four different oscillator modes:

- On-chip oscillator configured for use with external RC networks (<4 MHz).
- Minimum power for use with very low frequency crystals (32 kHz to 1.0 MHz).
- Medium power for use with medium frequency crystals or ceramic resonators (0.5 MHz to 10.0 MHz).
- Maximum power for use with high frequency crystals or ceramic resonators (8.0 MHz to 20.0 MHz).

The oscillator mode is selected through user-programmable Option Bits. For more information, see Option Bits on page 195.

Crystal Oscillator Operation

Figure 40 on page 212 displays a recommended configuration for connection with an external fundamental-mode, parallel-resonant crystal operating at 20 MHz. Recommended 20 MHz crystal specifications are provided in Table 104 on page 212. Resistor R1 is optional and limits total power dissipation by the crystal. The printed circuit board layout

must add no more than 4 pF of stray capacitance to either the X_{IN} or X_{OUT} pins. If oscillation does not occur, reduce the values of capacitors C1 and C2 to decrease loading.

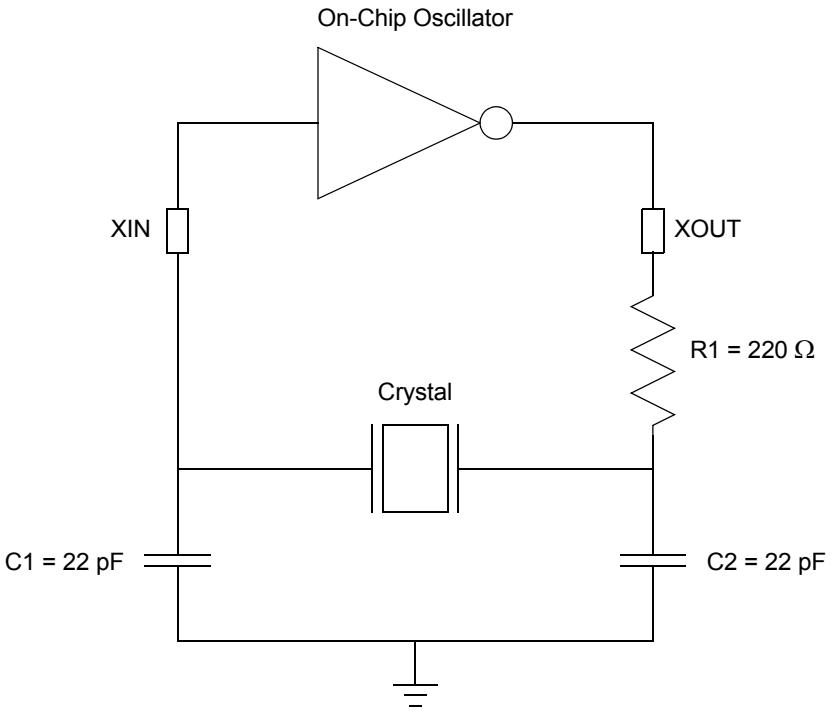


Figure 40. Recommended 20 MHz Crystal Oscillator Configuration

Table 104. Recommended Crystal Oscillator Specifications (20 MHz Operation)

Parameter	Value	Units	Comments
Frequency	20	MHz	
Resonance	Parallel		
Mode	Fundamental		
Series Resistance (R_S)	25	Ω	Maximum
Load Capacitance (C_L)	20	pF	Maximum
Shunt Capacitance (C_0)	7	pF	Maximum
Drive Level	1	mW	Maximum

Table 105. Absolute Maximum Ratings (Continued)

Parameter	Minimum	Maximum	Units	Notes
Maximum current into V_{DD} or out of V_{SS}		140	mA	
64-Pin LQFP Maximum Ratings at –40 °C to 70 °C				
Total power dissipation		1000	mW	
Maximum current into V_{DD} or out of V_{SS}		275	mA	
64-Pin LQFP Maximum Ratings at 70 °C to 125 °C				
Total power dissipation		540	mW	
Maximum current into V_{DD} or out of V_{SS}		150	mA	
44-Pin PLCC Maximum Ratings at –40 °C to 70 °C				
Total power dissipation		750	mW	
Maximum current into V_{DD} or out of V_{SS}		200	mA	
44-Pin PLCC Maximum Ratings at 70 °C to 125 °C				
Total power dissipation		295	mW	
Maximum current into V_{DD} or out of V_{SS}		83	mA	
44-Pin LQFP Maximum Ratings at –40 °C to 70 °C				
Total power dissipation		750	mW	
Maximum current into V_{DD} or out of V_{SS}		200	mA	
44-Pin LQFP Maximum Ratings at 70 °C to 125 °C				
Total power dissipation		360	mW	
Maximum current into V_{DD} or out of V_{SS}		100	mA	
40-Pin PDIP Maximum Ratings at –40 °C to 70 °C				
Total power dissipation		1000	mW	
Maximum current into V_{DD} or out of V_{SS}		275	mA	
40-Pin PDIP Maximum Ratings at 70 °C to 125 °C				
Total power dissipation		540	mW	
Maximum current into V_{DD} or out of V_{SS}		150	mA	

Note: This voltage applies to all pins except the following: VDD, AVDD, pins supporting analog input (Ports B and H), $\overline{\text{RESET}}$, and where noted otherwise.

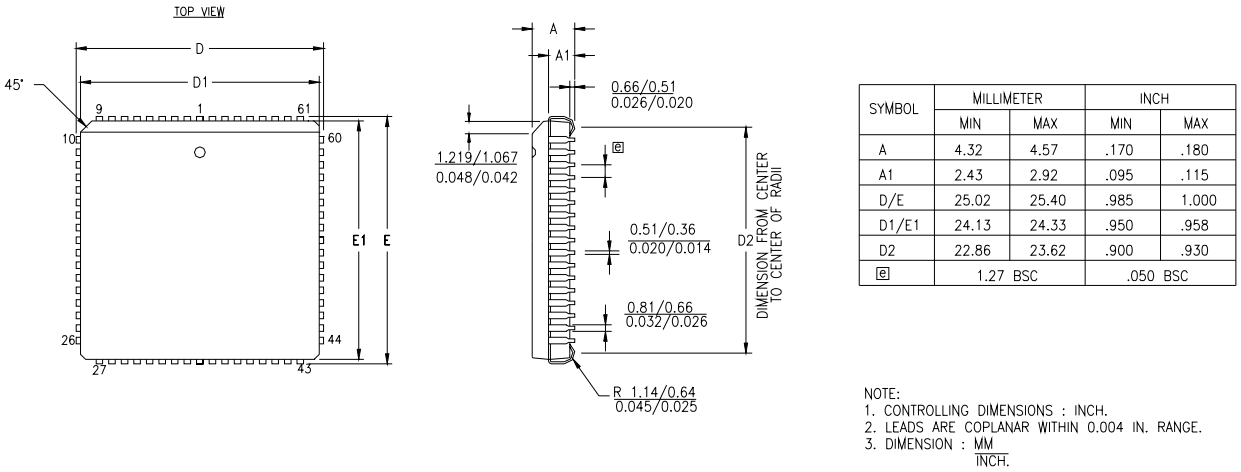
DC Characteristics

Table 106 lists the DC characteristics of the 64K Series products. All voltages are referenced to V_{SS}, the primary system ground.

Table 106. DC Characteristics

Symbol	Parameter	T_A = –40 °C to 125 °C			Units	Conditions
		Minimum	Typical	Maximum		
V_{DD}	Supply Voltage	3.0	–	3.6	V	
V_{IL1}	Low Level Input Voltage	-0.3	–	0.3*V_{DD}	V	For all input pins except $\overline{\text{RESET}}$, DBG, XIN
V_{IL2}	Low Level Input Voltage	-0.3	–	0.2*V_{DD}	V	For $\overline{\text{RESET}}$, DBG, and XIN.
V_{IH1}	High Level Input Voltage	0.7*V_{DD}	–	5.5	V	Port A, C, D, E, F, and G pins.
V_{IH2}	High Level Input Voltage	0.7*V_{DD}	–	V_{DD}+0.3	V	Port B and H pins.
V_{IH3}	High Level Input Voltage	0.8*V_{DD}	–	V_{DD}+0.3	V	$\overline{\text{RESET}}$, DBG, and XIN pins
V_{OL1}	Low Level Output Voltage Standard Drive	–	–	0.4	V	I_{OL} = 2 mA; VDD = 3.0 V High Output Drive disabled.
V_{OH1}	High Level Output Voltage Standard Drive	2.4	–	–	V	I_{OH} = -2 mA; VDD = 3.0 V High Output Drive disabled.
V_{OL2}	Low Level Output Voltage High Drive	–	–	0.6	V	I_{OL} = 20 mA; VDD = 3.3 V High Output Drive enabled T_A = -40 °C to +70 °C
V_{OH2}	High Level Output Voltage High Drive	2.4	–	–	V	I_{OH} = -20 mA; VDD = 3.3 V High Output Drive enabled; T_A = -40 °C to +70 °C
V_{OL3}	Low Level Output Voltage High Drive	–	–	0.6	V	I_{OL} = 15 mA; VDD = 3.3 V High Output Drive enabled; T_A = +70 °C to +105 °C
V_{OH3}	High Level Output Voltage High Drive	2.4	–	–	V	I_{OH} = 15 mA; VDD = 3.3 V High Output Drive enabled; T_A = +70 °C to +105 °C
V_{RAM}	RAM Data Retention	0.7	–	–	V	
I_{IL}	Input Leakage Current	-5	–	+5	µA	V_{DD} = 3.6 V; V_{IN} = VDD or VSS[1]
I_{TL}	Tri-State Leakage Current	-5	–	+5	µA	V_{DD} = 3.6 V

Figure 66 displays the 68-pin Plastic Lead Chip Carrier (PLCC) package available for the Z8X1622, Z8X2422, Z8X3222, Z8X4822, and Z8X6422 devices.

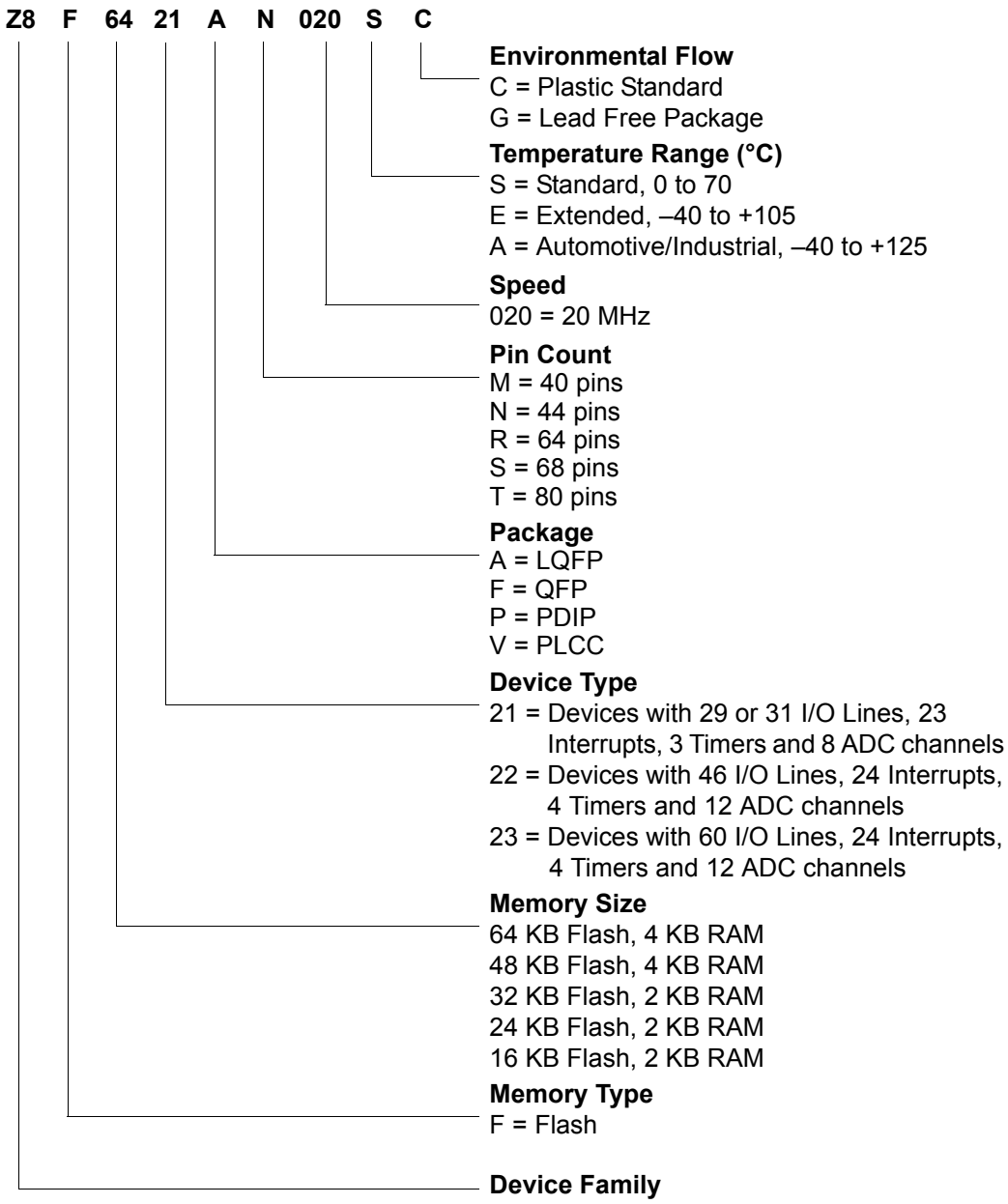


SYMBOL	MILLIMETER		INCH	
	MIN	MAX	MIN	MAX
A	4.32	4.57	.170	.180
A1	2.43	2.92	.095	.115
D/E	25.02	25.40	.985	1.000
D1/E1	24.13	24.33	.950	.958
D2	22.86	23.62	.900	.930
e	1.27 BSC		.050 BSC	

Figure 66. 68-Lead Plastic Lead Chip Carrier Package (PLCC)

For technical and customer support, hardware and software development tools, refer to the Zilog® website at www.zilog.com. The latest released version of ZDS can be downloaded from this website.

Part Number Suffix Designations



F

G

H

I