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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	IrDA, UART/USART
Peripherals	Brown-out Detect/Reset, LED, LVD, POR, PWM, WDT
Number of I/O	25
Program Memory Size	1KB (1K x 8)
Program Memory Type	FLASH
EEPROM Size	16 x 8
RAM Size	256 x 8
Voltage - Supply (Vcc/Vdd)	2.7V ~ 3.6V
Data Converters	-
Oscillator Type	Internal
Operating Temperature	-40°C ~ 105°C (TA)
Mounting Type	Surface Mount
Package / Case	28-SSOP (0.173", 4.40mm Width)
Supplier Device Package	-
Purchase URL	https://www.e-xfl.com/product-detail/zilog/z8f011ahj020ec

Block Diagram

Figure 1 displays the block diagram of the architecture of the Z8 Encore! XP® F082A Series devices.
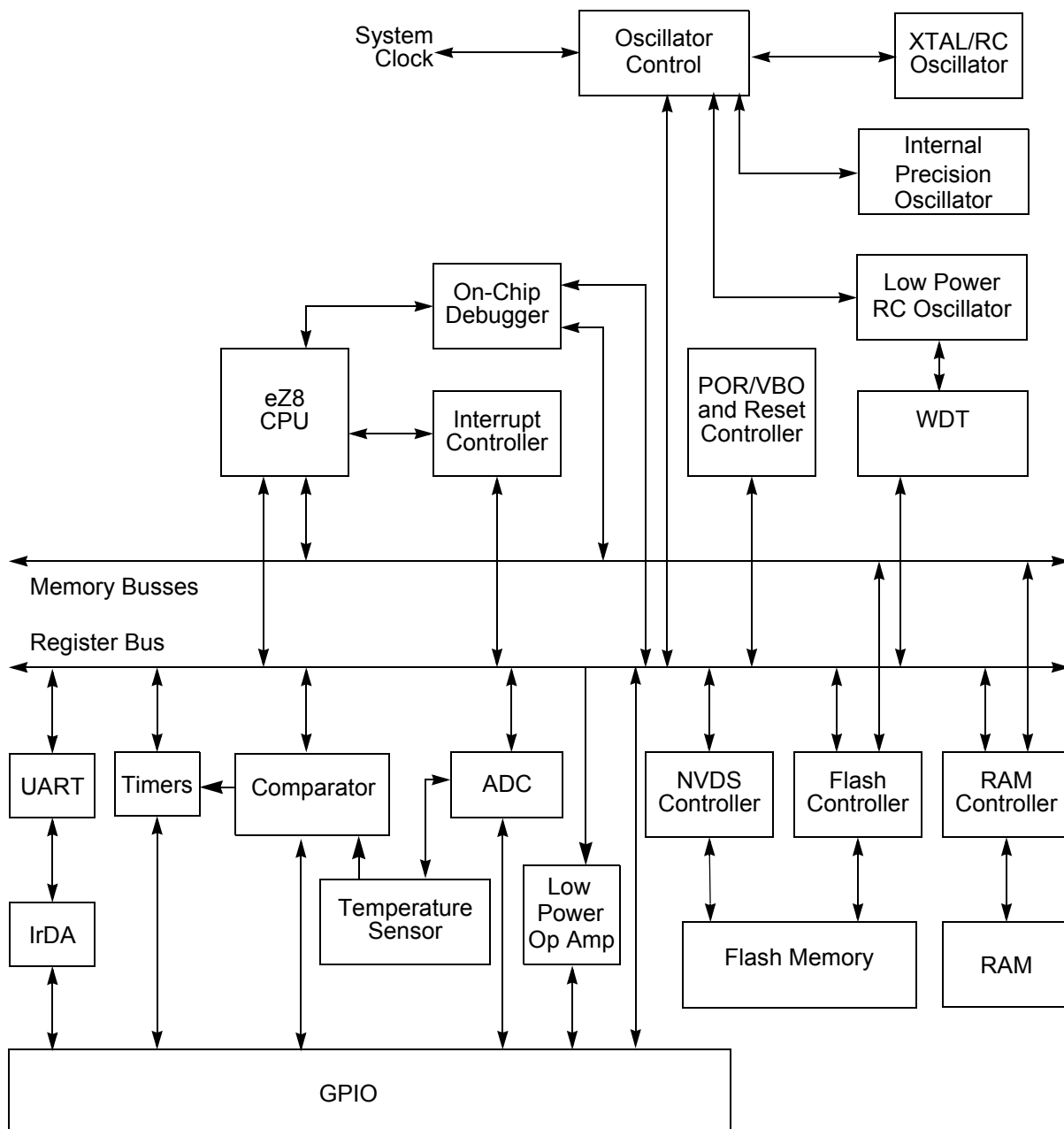
Figure 1. Z8 Encore! XP F082A Series Block Diagram

Reset, Stop Mode Recovery, and Low Voltage Detection

The Reset Controller within the Z8 Encore! XP® F082A Series controls Reset and Stop Mode Recovery operation and provides indication of low supply voltage conditions. In typical operation, the following events cause a Reset:

- Power-On Reset (POR)

- Voltage Brownout (VBO)

- Watchdog Timer time-out (when configured by the WDT_RES Flash Option Bit to initiate a reset)

- External $\overline{\text{RESET}}$ pin assertion (when the alternate RESET function is enabled by the GPIO register)

- On-chip debugger initiated Reset (OCDCTL[0] set to 1)

When the device is 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

The low voltage detection circuitry on the device (available on the 8-pin product versions only) performs the following functions:

- Generates the VBO reset when the supply voltage drops below a minimum safe level.

- Generates an interrupt when the supply voltage drops below a user-defined level (8-pin devices only).

Reset Types

The Z8 Encore! XP F082A Series provides several different types of Reset operation. Stop Mode Recovery is considered as a form of Reset. Table 8 lists the types of Reset and their operating characteristics. The System Reset is longer if the external crystal oscillator is enabled by the Flash option bits, allowing additional time for oscillator start-up.

and as long as four. A reset pulse three clock cycles in duration might trigger a reset; a pulse four cycles in duration always triggers a reset.

While the $\overline{\text{RESET}}$ input pin is asserted Low, the Z8 Encore! XP® F082A Series devices remain in the Reset state. If the $\overline{\text{RESET}}$ pin is held Low beyond the System Reset time-out, the device exits the Reset state on the system clock rising edge following $\overline{\text{RESET}}$ pin deassertion. Following a System Reset initiated by the external $\overline{\text{RESET}}$ pin, the EXT status bit in the Reset Status (RSTSTAT) register is set to 1.

External Reset Indicator

During System Reset or when enabled by the GPIO logic (see Port A–D Control Registers on page 46), the $\overline{\text{RESET}}$ pin functions as an open-drain (active Low) reset mode indicator in addition to the input functionality. This reset output feature allows a Z8 Encore! XP F082A Series device to reset other components to which it is connected, even if that reset is caused by internal sources such as POR, VBO or WDT events.

After an internal reset event occurs, the internal circuitry begins driving the $\overline{\text{RESET}}$ pin Low. The $\overline{\text{RESET}}$ pin is held Low by the internal circuitry until the appropriate delay listed in Table 8 has elapsed.

On-Chip Debugger Initiated Reset

A Power-On Reset can be initiated using the On-Chip Debugger by setting the RST bit in the OCD Control register. The On-Chip Debugger block is not reset but the rest of the chip goes through a normal system reset. The RST bit automatically clears during the system reset. Following the system reset the POR bit in the Reset Status (RSTSTAT) register is set.

Stop Mode Recovery

STOP mode is entered by execution of a STOP instruction by the eZ8 CPU. See Low-Power Modes on page 33 for detailed STOP mode information. During Stop Mode Recovery (SMR), the CPU is held in reset for 66 IPO cycles if the crystal oscillator is disabled or 5000 cycles if it is enabled. The SMR delay (see Table 131 on page 229) T_{SMR}, also includes the time required to start up the IPO.

Stop Mode Recovery does not affect on-chip registers other than the Watchdog Timer Control register (WDTCTL) and the Oscillator Control register (OSCCTL). After any Stop Mode Recovery, the IPO is enabled and selected as the system clock. If another system clock source is required, the Stop Mode Recovery code must reconfigure the oscillator control block such that the correct system clock source is enabled and selected.

The eZ8 CPU fetches the Reset vector at Program Memory addresses 0002H and 0003H and loads that value into the Program Counter. Program execution begins at the Reset

LEDEN[7:0]—LED Drive Enable
These bits determine which Port C pins are connected to an internal current sink.
0 = Tristate the Port C pin.
1= Enable controlled current sink on the Port C pin.

LED Drive Level High Register

The LED Drive Level registers contain two control bits for each Port C pin (Table 30). These two bits select between four programmable drive levels. Each pin is individually programmable.

Table 30. LED Drive Level High Register (LEDLVLH)

BITS	7	6	5	4	3	2	1	0
FIELD	LEDLVLH[7:0]							
RESET	0	0	0	0	0	0	0	0
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
ADDR	F83H							

LEDLVLH[7:0]—LED Level High Bit
{LEDLVLH, LEDLVLL} select one of four programmable current drive levels for each Port C pin.
00 = 3 mA
01= 7 mA
10= 13 mA
11= 20 mA

LED Drive Level Low Register

The LED Drive Level registers contain two control bits for each Port C pin (Table 31). These two bits select between four programmable drive levels. Each pin is individually programmable.

Caution: *The following coding style that clears bits in the Interrupt Request registers is not recommended. All incoming interrupts received between execution of the first* LDX *command and the final LDX command are lost.*

Poor coding style that can result in lost interrupt requests:
```
LDX r0, IRQ0
AND r0, MASK
LDX IRQ0, r0
```

Caution: *To avoid missing interrupts, use the following coding style to clear bits in the Interrupt Request 0 register:*

Good coding style that avoids lost interrupt requests:
```
ANDX IRQ0, MASK
```

Software Interrupt Assertion

Program code can generate interrupts directly. Writing a 1 to the correct bit in the Interrupt Request register triggers an interrupt (assuming that interrupt is enabled). When the interrupt request is acknowledged by the eZ8 CPU, the bit in the Interrupt Request register is automatically cleared to 0.

Caution: *The following coding style used to generate software interrupts by setting bits in the Interrupt Request registers is not recommended. All incoming interrupts received between execution of the first LDX command and the final LDX command are lost.*

Poor coding style that can result in lost interrupt requests:
```
LDX r0, IRQ0
OR r0, MASK
LDX IRQ0, r0
```

Caution: *To avoid missing interrupts, use the following coding style to set bits in the Interrupt Request registers:*

Good coding style that avoids lost interrupt requests:
```
ORX IRQ0, MASK
```

Watchdog Timer Interrupt Assertion

The Watchdog Timer interrupt behavior is different from interrupts generated by other sources. The Watchdog Timer continues to assert an interrupt as long as the timeout condition continues. As it operates on a different (and usually slower) clock domain than the rest of the device, the Watchdog Timer continues to assert this interrupt for many system clocks until the counter rolls over.

U0RXI—UART 0 Receiver Interrupt Request
0 = No interrupt request is pending for the UART 0 receiver.
1 = An interrupt request from the UART 0 receiver is awaiting service.

U0TXI—UART 0 Transmitter Interrupt Request
0 = No interrupt request is pending for the UART 0 transmitter.
1 = An interrupt request from the UART 0 transmitter is awaiting service.

ADCI—ADC Interrupt Request
0 = No interrupt request is pending for the analog-to-digital Converter.
1 = An interrupt request from the Analog-to-Digital Converter is awaiting service.

Interrupt Request 1 Register

The Interrupt Request 1 (IRQ1) register (Table 34) stores interrupt requests for both vectored and polled interrupts. When a request is presented to the interrupt controller, the corresponding bit in the IRQ1 register becomes 1. If interrupts are globally enabled (vectored interrupts), the interrupt controller passes an interrupt request to the eZ8 CPU. If interrupts are globally disabled (polled interrupts), the eZ8 CPU can read the Interrupt Request 1 register to determine if any interrupt requests are pending.

Table 34. Interrupt Request 1 Register (IRQ1)

BITS	7	6	5	4	3	2	1	0
FIELD	PA7VI	PA6CI	PA5I	PA4I	PA3I	PA2I	PA1I	PA0I
RESET	0	0	0	0	0	0	0	0
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
ADDR	FC3H							

PA7VI—Port A Pin 7 or LVD Interrupt Request
0 = No interrupt request is pending for GPIO Port A or LVD.
1 = An interrupt request from GPIO Port A or LVD.

PA6CI—Port A Pin 6 or Comparator Interrupt Request
0 = No interrupt request is pending for GPIO Port A or Comparator.
1 = An interrupt request from GPIO Port A or Comparator.

PA*x*I—Port A Pin *x* Interrupt Request
0 = No interrupt request is pending for GPIO Port A pin *x*.
1 = An interrupt request from GPIO Port A pin *x* is awaiting service.

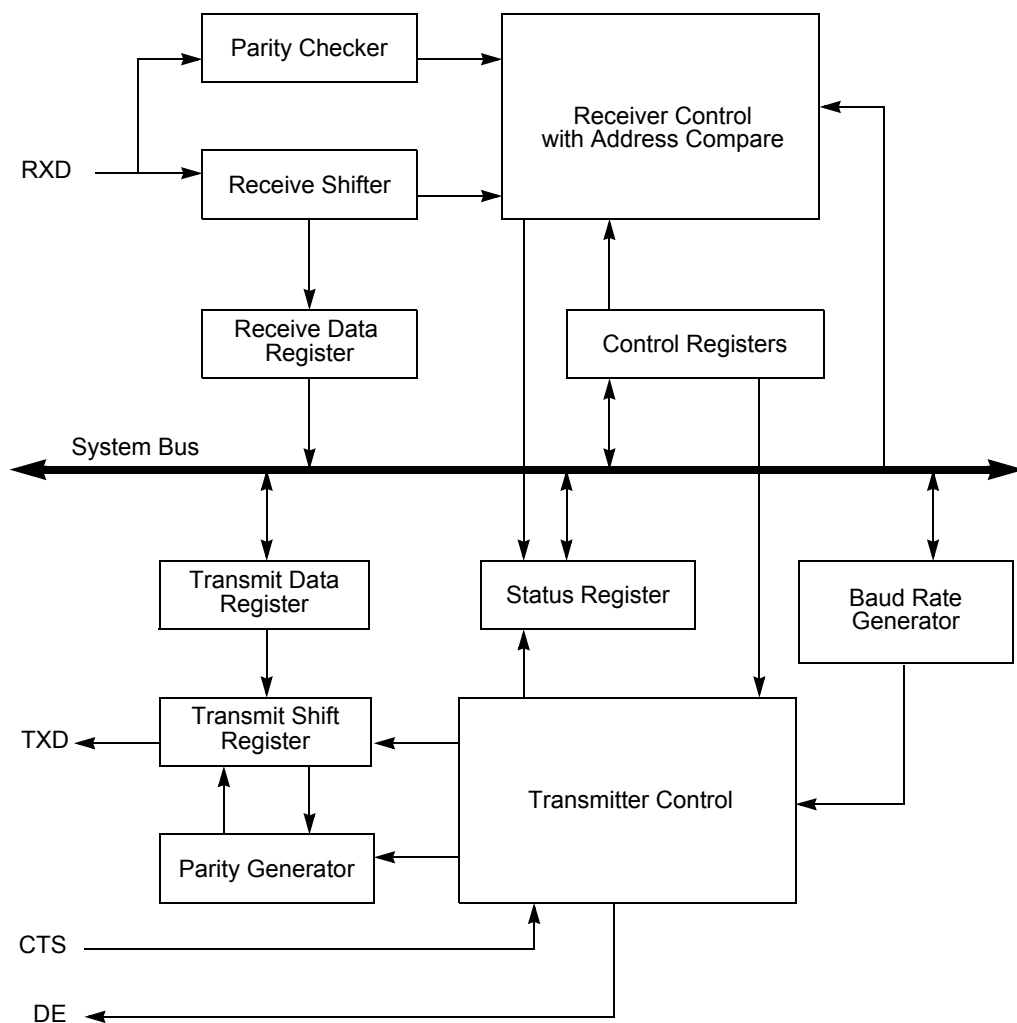where *x* indicates the specific GPIO Port pin number (0–5).

Figure 10. UART Block Diagram

Operation

Data Format

The UART always transmits and receives data in an 8-bit data format, least-significant bit first. An even or odd parity bit can be added to the data stream. Each character begins with an active Low START bit and ends with either 1 or 2 active High STOP bits. Figure 11 and Figure 12 display the asynchronous data format employed by the UART without parity and with parity, respectively.
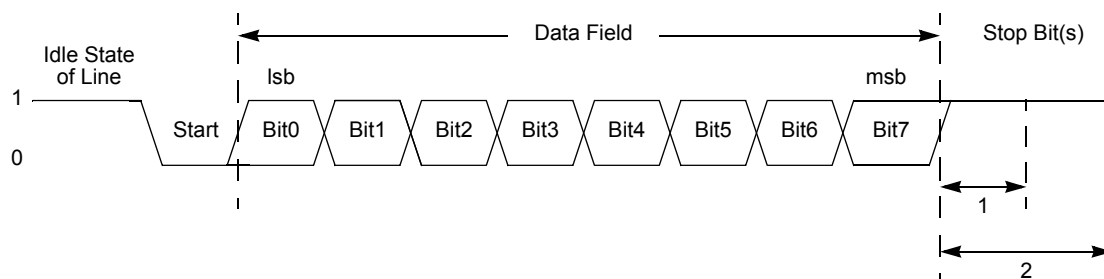
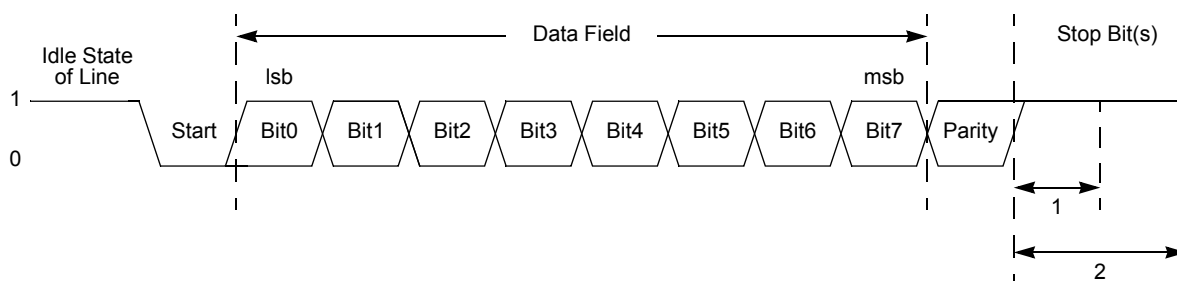**Figure 11. UART Asynchronous Data Format without Parity**

Figure 12. UART Asynchronous Data Format with Parity

Transmitting Data using the Polled Method

Follow the steps below to transmit data using the polled method of operation:

1. Write to the UART Baud Rate High and Low Byte registers to set the required baud rate.

2. Enable the UART pin functions by configuring the associated GPIO Port pins for alternate function operation.

3. Write to the UART Control 1 register, if MULTIPROCESSOR mode is appropriate, to enable MULTIPROCESSOR (9-bit) mode functions.

4. Set the Multiprocessor Mode Select (MPEN) bit to enable MULTIPROCESSOR mode.

5. Write to the UART Control 0 register to:
   – Set the transmit enable bit (TEN) to enable the UART for data transmission.
   – Set the parity enable bit (PEN), if parity is appropriate and MULTIPROCESSOR mode is not enabled, and select either even or odd parity (PSEL).
   – Set or clear the CTSE bit to enable or disable control from the remote receiver using the $\overline{\text{CTS}}$ pin.

baud rate clocks to plus eight baud rate clocks around the expected time of an incoming pulse. If an incoming pulse is detected inside this window this process is repeated. If the incoming data is a logical 1 (no pulse), the Endec returns to the initial state and waits for the next falling edge. As each falling edge is detected, the Endec clock counter is reset, resynchronizing the Endec to the incoming signal, allowing the Endec to tolerate jitter and baud rate errors in the incoming datastream. Resynchronizing the Endec does not alter the operation of the UART, which ultimately receives the data. The UART is only synchronized to the incoming data stream when a Start bit is received.

Infrared Encoder/Decoder Control Register Definitions

All Infrared Endec configuration and status information is set by the UART control registers as defined in Universal Asynchronous Receiver/Transmitter on page 97.

⚠️ **Caution:** *To prevent spurious signals during IrDA data transmission, set the IREN bit in the UART Control 1 register to 1 to enable the Infrared Encoder/Decoder before enabling the GPIO Port alternate function for the corresponding pin.*

Trim Bit Data Register

The Trim Bid Data (TRMDR) register contains the read or write data for access to the trim option bits (Table 85).

Table 85. Trim Bit Data Register (TRMDR)

BITS	7	6	5	4	3	2	1	0
FIELD	TRMDR - Trim Bit Data							
RESET	0	0	0	0	0	0	0	0
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
ADDR	FF7H							

Flash Option Bit Address Space

The first two bytes of Flash program memory at addresses `0000H` and `0001H` are reserved for the user-programmable Flash option bits.

Flash Program Memory Address 0000H

Table 86. Flash Option Bits at Program Memory Address 0000H

BITS	7	6	5	4	3	2	1	0
FIELD	WDT_RES	WDT_AO	OSC_SEL[1:0]		VBO_AO	FRP	Reserved	FWP
RESET	U	U	U	U	U	U	U	U
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
ADDR	Program Memory 0000H							
Note: U = Unchanged by Reset. R/W = Read/Write.								

WDT_RES—Watchdog Timer Reset
0 = Watchdog Timer time-out generates an interrupt request. Interrupts must be globally enabled for the eZ8 CPU to acknowledge the interrupt request.
1 = Watchdog Timer time-out causes a system reset. This setting is the default for unprogrammed (erased) Flash.

WDT_AO—Watchdog Timer Always On
0 = Watchdog Timer is automatically enabled upon application of system power. Watchdog Timer can not be disabled.

Temperature Sensor Calibration Data

Table 95. Temperature Sensor Calibration High Byte at 003A (TSCALH)

BITS	7	6	5	4	3	2	1	0
FIELD	TSCALH							
RESET	U	U	U	U	U	U	U	U
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
ADDR	Information Page Memory 003A							
Note: U = Unchanged by Reset. R/W = Read/Write.								

TSCALH – Temperature Sensor Calibration High Byte

The TSCALH and TSCALL bytes combine to form the 12-bit temperature sensor offset calibration value. For more details, see Temperature Sensor Operation on page 139.

Table 96. Temperature Sensor Calibration Low Byte at 003B (TSCALL)

BITS	7	6	5	4	3	2	1	0
FIELD	TSCALL							
RESET	U	U	U	U	U	U	U	U
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
ADDR	Information Page Memory 003B							
Note: U = Unchanged by Reset. R/W = Read/Write.								

TSCALL – Temperature Sensor Calibration Low Byte

The TSCALH and TSCALL bytes combine to form the 12-bit temperature sensor offset calibration value. For usage details, see Temperature Sensor Operation on page 139.

Watchdog Timer Calibration Data

Table 97. Watchdog Calibration High Byte at 007EH (WDTCALH)

BITS	7	6	5	4	3	2	1	0
FIELD	WDTCALH							
RESET	U	U	U	U	U	U	U	U
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
ADDR	Information Page Memory 007EH							
Note: U = Unchanged by Reset. R/W = Read/Write.								

read operations to illegal addresses. Also, the user code must pop the address byte off the stack.

The read routine uses 9 bytes of stack space in addition to the one byte of address pushed by the user. Sufficient memory must be available for this stack usage.

Because of the Flash memory architecture, NVDS reads exhibit a non-uniform execution time. A read operation takes between 44 µs and 489 µs (assuming a 20 MHz system clock). Slower system clock speeds result in proportionally higher execution times.

NVDS byte reads from invalid addresses (those exceeding the NVDS array size) return 0xff. Illegal read operations have a 2 µs execution time.

The status byte returned by the NVDS read routine is zero for successful read, as determined by a CRC check. If the status byte is non-zero, there was a corrupted value in the NVDS array at the location being read. In this case, the value returned in R0 is the byte most recently written to the array that does not have a CRC error.

Power Failure Protection

The NVDS routines employ error checking mechanisms to ensure a power failure endangers only the most recently written byte. Bytes previously written to the array are not perturbed.

A system reset (such as a pin reset or Watchdog Timer reset) that occurs during a write operation also perturbs the byte currently being written. All other bytes in the array are unperturbed.

Optimizing NVDS Memory Usage for Execution Speed

The NVDS read time varies drastically, this discrepancy being a trade-off for minimizing the frequency of writes that require post-write page erases (see Table 104). The NVDS read time of address N is a function of the number of writes to addresses other than N since the most recent write to address N, as well as the number of writes since the most recent page erase. Neglecting effects caused by page erases and results caused by the initial condition in which the NVDS is blank, a rule of thumb is that every write since the most recent page erase causes read times of unwritten addresses to increase by 1 µs, up to a maximum of (511-NVDS_SIZE) µs.

Table 104. NVDS Read Time

Operation	Minimum Latency	Maximum Latency
Read (16 byte array)	875	9961
Read (64 byte array)	876	8952

Figure 27 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 110. 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 C_1 and C_2 to decrease loading.
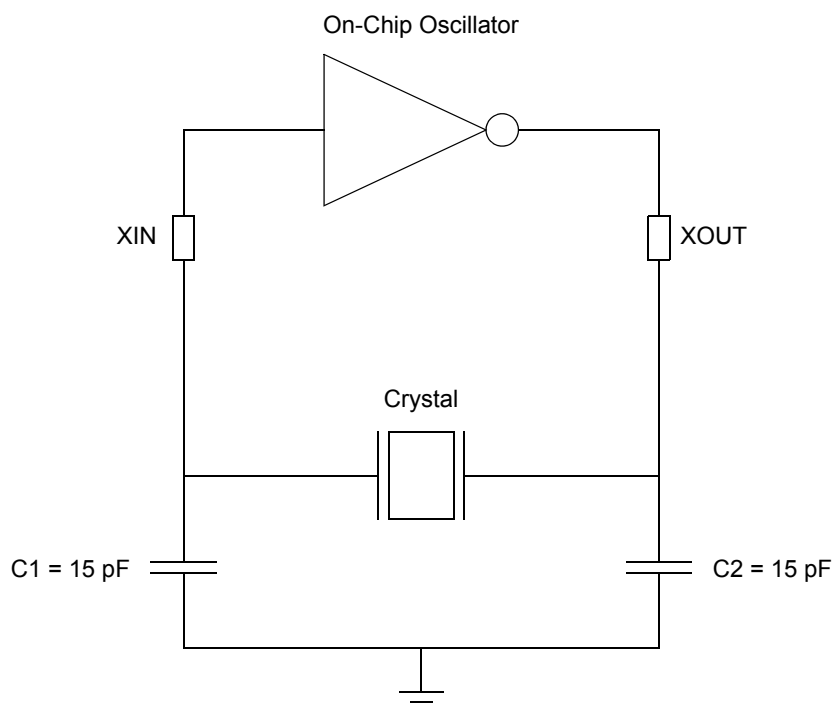
Figure 27. Recommended 20 MHz Crystal Oscillator Configuration

Table 110. Recommended Crystal Oscillator Specifications

Parameter	Value	Units	Comments
Frequency	20	MHz	
Resonance	Parallel		
Mode	Fundamental		
Series Resistance (R_S)	60	Ω	Maximum
Load Capacitance (C_L)	30	pF	Maximum
Shunt Capacitance (C_0)	7	pF	Maximum
Drive Level	1	mW	Maximum

Figure 29 displays the typical (3.3 V and 25 °C) oscillator frequency as a function of the capacitor (C in pF) employed in the RC network assuming a 45 KΩ external resistor. For very small values of C, the parasitic capacitance of the oscillator XIN pin and the printed circuit board must be included in the estimation of the oscillator frequency.

It is possible to operate the RC oscillator using only the parasitic capacitance of the package and printed circuit board. To minimize sensitivity to external parasitics, external capacitance values in excess of 20 pF are recommended.
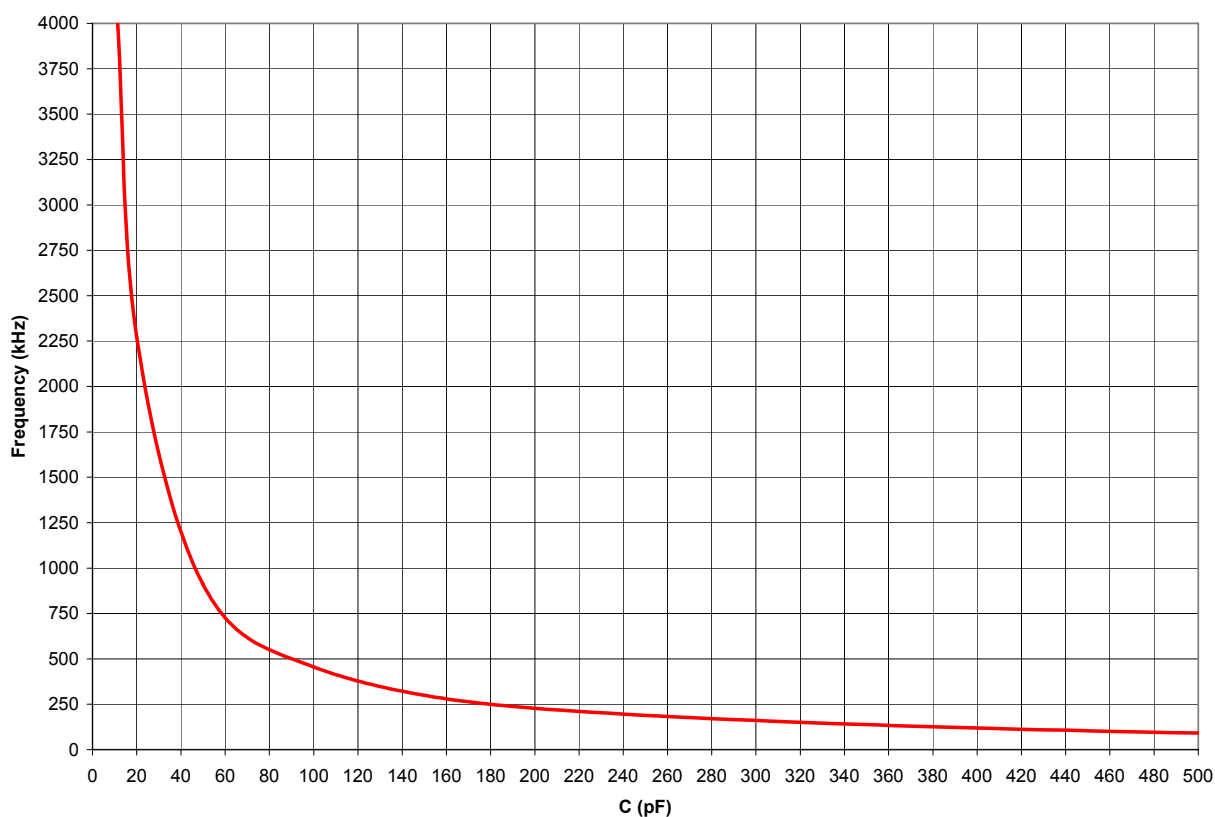
Figure 29. Typical RC Oscillator Frequency as a Function of the External Capacitance with a 45 kΩ Resistor

⚠️ **Caution:** *When using the external RC oscillator mode, the oscillator can stop oscillating if the power supply drops below 2.7 V, but before the power supply drops to the Voltage Brownout threshold. The oscillator resumes oscillation when the supply voltage exceeds 2.7 V.*

Figure 41 displays the 8-pin Quad Flat No-Lead package (QFN)/MLF-S available for the Z8 Encore! XP F082A Series devices. This package has a footprint identical to that of the 8-pin SOIC, but with a lower profile.
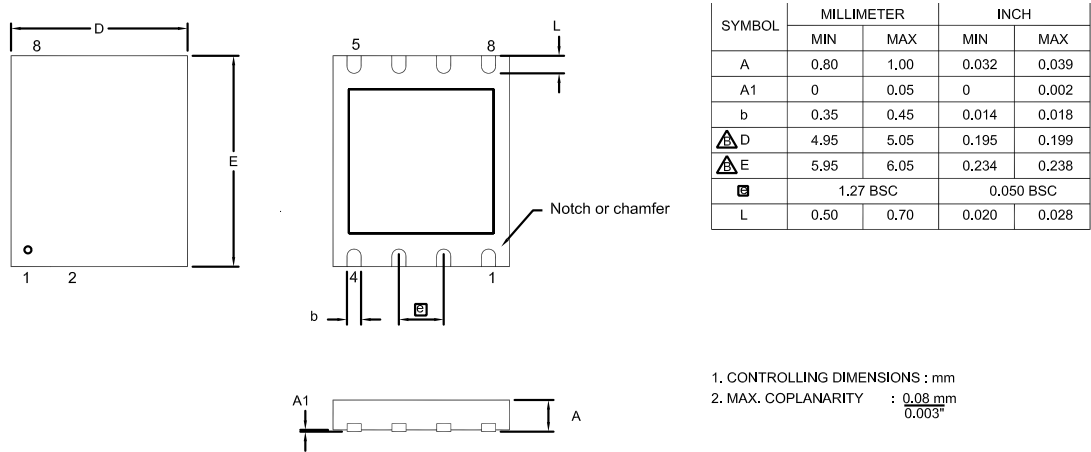

SYMBOL	MILLIMETER		INCH	
	MIN	MAX	MIN	MAX
A	0.80	1.00	0.032	0.039
A1	0	0.05	0	0.002
b	0.35	0.45	0.014	0.018
D	4.95	5.05	0.195	0.199
E	5.95	6.05	0.234	0.238
e	1.27 BSC		0.050 BSC	
L	0.50	0.70	0.020	0.028

1. CONTROLLING DIMENSIONS : mm
2. MAX. COPLANARITY : 0.08 mm
0.003"

Figure 41. 8-Pin Quad Flat No-Lead Package (QFN)/MLF-S

Part Number	Flash	RAM	NVDS	I/O Lines	Interrupts	16-Bit Timers w/PWM	10-Bit A/D Channels	UART with IrDA	Comparator	Temperature Sensor	Description
Z8 Encore! XP® F082A Series Development Kit											
Z8F08A28100KITG											**Z8 Encore! XP F082A Series 28-Pin Development Kit**
Z8F04A28100KITG											**Z8 Encore! XP F042A Series 28-Pin Development Kit**
Z8F04A08100KITG											**Z8 Encore! XP F042A Series 8-Pin Development Kit**
ZUSBSC00100ZACG											**USB Smart Cable Accessory Kit**
ZUSBOPTSC01ZACG											**USB Opto-Isolated Smart Cable Accessory Kit**
ZENETSC0100ZACG											**Ethernet Smart Cable Accessory Kit**