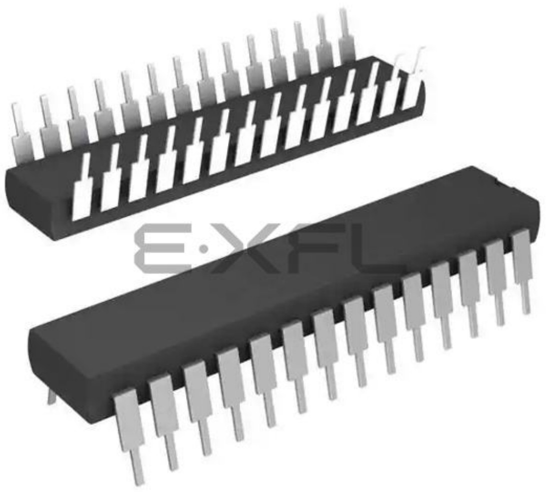

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What is "Embedded - Microcontrollers"?

"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, Temp Sensor, WDT
Number of I/O	23
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	A/D 8x10b
Oscillator Type	Internal
Operating Temperature	0°C ~ 70°C (TA)
Mounting Type	Through Hole
Package / Case	28-DIP (0.600", 15.24mm)
Supplier Device Package	-
Purchase URL	https://www.e-xfl.com/product-detail/zilog/z8f012apj020sc

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

Set 1 Sub-Registers on page 50, GPIO Alternate Functions on page 38, and Port A–D Alternate Function Set 2 Sub-Registers on page 51. See GPIO Alternate Functions on page 38 to determine the alternate function associated with each port pin.

Caution: *Do not enable alternate functions for GPIO port pins for which there is no associated alternate function. Failure to follow this guideline can result in unpredictable operation.*

Table 20. Port A–D Alternate Function Sub-Registers (PxAF)

BITS	7	6	5	4	3	2	1	0
FIELD	AF7	AF6	AF5	AF4	AF3	AF2	AF1	AF0
RESET	00H (Ports A–C); 01H (Port D); 04H (Port A of 8-pin device)							
R/W	R/W							
ADDR	If 02H in Port A–D Address Register, accessible through the Port A–D Control Register							

AF[7:0]—Port Alternate Function enabled
0 = The port pin is in normal mode and the `DDx` bit in the Port A–D Data Direction sub-register determines the direction of the pin.
1 = The alternate function selected through Alternate Function Set sub-registers is enabled. Port pin operation is controlled by the alternate function.

Port A–D Output Control Sub-Registers

The Port A–D Output Control sub-register (Table 21) is accessed through the Port A–D Control register by writing `03H` to the Port A–D Address register. Setting the bits in the Port A–D Output Control sub-registers to 1 configures the specified port pins for open-drain operation. These sub-registers affect the pins directly and, as a result, alternate functions are also affected.

Table 21. Port A–D Output Control Sub-Registers (PxOC)

BITS	7	6	5	4	3	2	1	0
FIELD	POC7	POC6	POC5	POC4	POC3	POC2	POC1	POC0
RESET	00H (Ports A-C); 01H (Port D)							
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
ADDR	If 03H in Port A–D Address Register, accessible through the Port A–D Control Register							

POC[7:0]—Port Output Control
These bits function independently of the alternate function bit and always disable the drains if set to 1.
0 = The source current is enabled for any output mode (unless overridden by the alternate

CAPTURE RESTART mode
0 = Count is captured on the rising edge of the Timer Input signal.
1 = Count is captured on the falling edge of the Timer Input signal.

COMPARATOR COUNTER mode
When the timer is disabled, the Timer Output signal is set to the value of this bit. When the timer is enabled, the Timer Output signal is complemented upon timer Reload. Also:

0 = Count is captured on the rising edge of the comparator output.
1 = Count is captured on the falling edge of the comparator output.

Caution: *When the Timer Output alternate function TxOUT on a GPIO port pin is enabled, TxOUT changes to whatever state the TPOL bit is in.The timer does not need to be enabled for that to happen. Also, the Port data direction sub register is not needed to be set to output on TxOUT. Changing the TPOL bit with the timer enabled and running does not immediately change the TxOUT.*

PRES—Prescale value
The timer input clock is divided by 2^{PRES}, where PRES can be set from 0 to 7. The prescaler is reset each time the Timer is disabled. This reset ensures proper clock division each time the Timer is restarted.

000 = Divide by 1
001 = Divide by 2
010 = Divide by 4
011 = Divide by 8
100 = Divide by 16
101 = Divide by 32
110 = Divide by 64
111 = Divide by 128

TMODE—Timer mode
This field along with the TMODEHI bit in TxCTL0 register determines the operating mode of the timer. TMODEHI is the most significant bit of the Timer mode selection value. The entire operating mode bits are expressed as {TMODEHI, TMODE[2:0]}. The TMODEHI is bit 7 of the TxCTL0 register while TMODE[2:0] is the lower 3 bits of the TxCTL1 register.

0000 = ONE-SHOT mode
0001 = CONTINUOUS mode
0010 = COUNTER mode
0011 = PWM SINGLE OUTPUT mode
0100 = CAPTURE mode
0101 = COMPARE mode
0110 = GATED mode
0111 = CAPTURE/COMPARE mode

Table 55. Timer 0–1 PWM Low Byte Register (TxPWML)

BITS	7	6	5	4	3	2	1	0
FIELD	PWML							
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	F05H, F0DH							

PWMH and PWML—Pulse-Width Modulator High and Low Bytes
These two bytes, {PWMH[7:0], PWML[7:0]}, form a 16-bit value that is compared to the current 16-bit timer count. When a match occurs, the PWM output changes state. The PWM output value is set by the `TPOL` bit in the Timer Control Register (TxCTL1) register.

The TxPWMH and TxPWML registers also store the 16-bit captured timer value when operating in CAPTURE or CAPTURE/COMPARE modes.

Universal Asynchronous Receiver/Transmitter

The universal asynchronous receiver/transmitter (UART) is a full-duplex communication channel capable of handling asynchronous data transfers. The UART uses a single 8-bit data mode with selectable parity. Features of the UART include:

- 8-bit asynchronous data transfer.
- Selectable even- and odd-parity generation and checking.
- Option of one or two STOP bits.
- Separate transmit and receive interrupts.
- Framing, parity, overrun and break detection.
- Separate transmit and receive enables.
- 16-bit baud rate generator (BRG).
- Selectable MULTIPROCESSOR (9-bit) mode with three configurable interrupt schemes.
- Baud rate generator (BRG) can be configured and used as a basic 16-bit timer.
- Driver enable (DE) output for external bus transceivers.

Architecture

The UART consists of three primary functional blocks: transmitter, receiver, and baud rate generator. The UART's transmitter and receiver function independently, but employ the same baud rate and data format. Figure 10 on page 98 displays the UART architecture.

ADC Control Register Definitions

ADC Control Register 0

The ADC Control Register 0 (ADCCTL0) selects the analog input channel and initiates the analog-to-digital conversion. It also selects the voltage reference configuration.

Table 71. ADC Control Register 0 (ADCCTL0)

BITS	7	6	5	4	3	2	1	0
FIELD	CEN	REFSELL	REFOUT	CONT	ANAIN[3:0]			
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	F70H							

CEN—Conversion Enable
0 = Conversion is complete. Writing a 0 produces no effect. The ADC automatically clears this bit to 0 when a conversion is complete.
1 = Begin conversion. Writing a 1 to this bit starts a conversion. If a conversion is already in progress, the conversion restarts. This bit remains 1 until the conversion is complete.

REFSELL—Voltage Reference Level Select Low Bit; in conjunction with the High bit (REFSELH) in ADC Control/Status Register 1, this determines the level of the internal voltage reference; the following details the effects of {REFSELH, REFSELL}; note that this reference is independent of the Comparator reference.
00= Internal Reference Disabled, reference comes from external pin
01= Internal Reference set to 1.0 V
10= Internal Reference set to 2.0 V (default)
11= Reserved

REFOUT—Internal Reference Output Enable
0 = Reference buffer is disabled; Vref pin is available for GPIO or analog functions
1 = The internal ADC reference is buffered and driven out to the Vref pin

Warning: *When the ADC is used with an external reference ({REFSELH,REFSELL}=00), the REFOUT bit must be set to 0.*

CONT
0 = Single-shot conversion. ADC data is output once at completion of the 5129 system clock cycles (measurements of the internal temperature sensor take twice as long)
1 = Continuous conversion. ADC data updated every 256 system clock cycles after an initial 5129 clock conversion (measurements of the internal temperature sensor take twice as long)

Flash Operation Timing Using the Flash Frequency Registers

Before performing either a program or erase operation on Flash memory, you must first configure the Flash Frequency High and Low Byte registers. The Flash Frequency registers allow programming and erasing of the Flash with system clock frequencies ranging from 32 kHz (32768 Hz) through 20 MHz.

The Flash Frequency High and Low Byte registers combine to form a 16-bit value, `FFREQ`, to control timing for Flash program and erase operations. The 16-bit binary Flash Frequency value must contain the system clock frequency (in kHz). This value is calculated using the following equation:

$$\text{FFREQ[15:0]} = \frac{\text{System Clock Frequency (Hz)}}{1000}$$

Caution: *Flash programming and erasure are not supported for system clock frequencies below 32 kHz (32768 Hz) or above 20 MHz. The Flash Frequency High and Low Byte registers must be loaded with the correct value to ensure operation of the Z8 Encore! XP® F082A Series devices.*

Flash Code Protection Against External Access

The user code contained within the Flash memory can be protected against external access by the on-chip debugger. Programming the `FRP` Flash Option Bit prevents reading of the user code with the On-Chip Debugger. See Flash Option Bits on page 153 and On-Chip Debugger on page 173 for more information.

Flash Code Protection Against Accidental Program and Erasure

The Z8 Encore! XP F082A Series provides several levels of protection against accidental program and erasure of the Flash memory contents. This protection is provided by a combination of the Flash Option bits, the register locking mechanism, the page select redundancy and the sector level protection control of the Flash Controller.

Flash Code Protection Using the Flash Option Bits

The `FRP` and `FWP` Flash Option Bits combine to provide three levels of Flash Program Memory protection as listed in Table 77. See Flash Option Bits on page 153 for more information.

Table 102. Randomized Lot ID Locations (Continued)

Info Page Address	Memory Address	Usage
5C	FE5C	Randomized Lot ID Byte 23
5D	FE5D	Randomized Lot ID Byte 22
5E	FE5E	Randomized Lot ID Byte 21
5F	FE5F	Randomized Lot ID Byte 20
61	FE61	Randomized Lot ID Byte 19
62	FE62	Randomized Lot ID Byte 18
64	FE64	Randomized Lot ID Byte 17
65	FE65	Randomized Lot ID Byte 16
67	FE67	Randomized Lot ID Byte 15
68	FE68	Randomized Lot ID Byte 14
6A	FE6A	Randomized Lot ID Byte 13
6B	FE6B	Randomized Lot ID Byte 12
6D	FE6D	Randomized Lot ID Byte 11
6E	FE6E	Randomized Lot ID Byte 10
70	FE70	Randomized Lot ID Byte 9
71	FE71	Randomized Lot ID Byte 8
73	FE73	Randomized Lot ID Byte 7
74	FE74	Randomized Lot ID Byte 6
76	FE76	Randomized Lot ID Byte 5
77	FE77	Randomized Lot ID Byte 4
79	FE79	Randomized Lot ID Byte 3
7A	FE7A	Randomized Lot ID Byte 2
7C	FE7C	Randomized Lot ID Byte 1
7D	FE7D	Randomized Lot ID Byte 0 (least significant)

If the device is not in DEBUG mode or the Flash Read Protect Option bit is enabled, this command reads and discards one byte.

```
DBG ← 12H
DBG ← 1-5 byte opcode
```

On-Chip Debugger Control Register Definitions

OCD Control Register

The OCD Control register controls the state of the On-Chip Debugger. This register is used to enter or exit DEBUG mode and to enable the BRK instruction. It can also reset the Z8 Encore! XP® F082A Series device.

A reset and stop function can be achieved by writing 81H to this register. A reset and go function can be achieved by writing 41H to this register. If the device is in DEBUG mode, a run function can be implemented by writing 40H to this register.

.

Table 106. OCD Control Register (OCDCTL)

BITS	7	6	5	4	3	2	1	0
FIELD	DBGMODE	BRKEN	DBGACK	Reserved				RST
RESET	0	0	0	0	0	0	0	0
R/W	R/W	R/W	R/W	R	R	R	R	R/W

DBGMODE—DEBUG Mode
The device enters DEBUG mode when this bit is 1. When in DEBUG mode, the eZ8 CPU stops fetching new instructions. Clearing this bit causes the eZ8 CPU to restart. This bit is automatically set when a BRK instruction is decoded and Breakpoints are enabled. If the Flash Read Protect Option Bit is enabled, this bit can only be cleared by resetting the device. It cannot be written to 0.
0 = The Z8 Encore! XP F082A Series device is operating in NORMAL mode.
1 = The Z8 Encore! XP F082A Series device is in DEBUG mode.

BRKEN—Breakpoint Enable
This bit controls the behavior of the BRK instruction (opcode 00H). By default, Breakpoints are disabled and the BRK instruction behaves similar to an NOP instruction. If this bit is 1, when a BRK instruction is decoded, the DBGMODE bit of the OCDCTL register is automatically set to 1.
0 = Breakpoints are disabled.
1 = Breakpoints are enabled.

DBGACK—Debug Acknowledge
This bit enables the debug acknowledge feature. If this bit is set to 1, the OCD sends a Debug Acknowledge character (`FFH`) to the host when a Breakpoint occurs.
0 = Debug Acknowledge is disabled.
1 = Debug Acknowledge is enabled.

Reserved—Must be 0.

RST—Reset
Setting this bit to 1 resets the Z8F04xA family device. The device goes through a normal Power-On Reset sequence with the exception that the On-Chip Debugger is not reset. This bit is automatically cleared to 0 at the end of reset.
0 = No effect.
1 = Reset the Flash Read Protect Option Bit device.

OCD Status Register

The OCD Status register reports status information about the current state of the debugger and the system.

Table 107. OCD Status Register (OCDSTAT)

BITS	7	6	5	4	3	2	1	0
FIELD	DBG	HALT	FRPENB	Reserved				
RESET	0	0	0	0	0	0	0	0
R/W	R	R	R	R	R	R	R	R

DBG—Debug Status
0 = NORMAL mode
1 = DEBUG mode

HALT—HALT Mode
0 = Not in HALT mode
1 = In HALT mode

FRPENB—Flash Read Protect Option Bit Enable
0 = FRP bit enabled, that allows disabling of many OCD commands
1 = FRP bit has no effect

Reserved—Must be 0

Internal Precision Oscillator

The internal precision oscillator (IPO) is designed for use without external components. You can either manually trim the oscillator for a non-standard frequency or use the automatic factory-trimmed version to achieve a 5.53 MHz frequency. IPO features include:

- On-chip RC oscillator that does not require external components
- Output frequency of either 5.53 MHz or 32.8 kHz (contains both a fast and a slow mode)
- Trimmed through Flash option bits with user override
- Elimination of crystals or ceramic resonators in applications where very high timing accuracy is not required

Operation

An 8-bit trimming register, incorporated into the design, compensates for absolute variation of oscillator frequency. Once trimmed the oscillator frequency is stable and does not require subsequent calibration. Trimming is performed during manufacturing and is not necessary for you to repeat unless a frequency other than 5.53 MHz (fast mode) or 32.8 kHz (slow mode) is required. This trimming is done at +30 ºC and a supply voltage of 3.3 V, so accuracy of this operating point is optimal.

If not used, the IPO can be disabled by the Oscillator Control register (see Oscillator Control Register Definitions on page 190).

By default, the oscillator frequency is set by the factory trim value stored in the write-protected Flash information page. However, the user code can override these trim values as described in Trim Bit Address Space on page 158.

Select one of two frequencies for the oscillator: 5.53 MHz and 32.8 kHz, using the OSCSEL bits in the Oscillator Control on page 187.

Table 124. eZ8 CPU Instruction Summary (Continued)

Assembly Mnemonic	Symbolic Operation	Address Mode dst	Address Mode src	Opcode(s) (Hex)	Flags C	Z	S	V	D	H	Fetch Cycles	Instr. Cycles
XOR dst, src	dst ← dst XOR src	r	r	B2	–	*	*	0	–	–	2	3
		r	Ir	B3							2	4
		R	R	B4							3	3
		R	IR	B5							3	4
		R	IM	B6							3	3
		IR	IM	B7							3	4
XORX dst, src	dst ← dst XOR src	ER	ER	B8	–	*	*	0	–	–	4	3
		ER	IM	B9							4	3

Flags Notation: * = Value is a function of the result of the operation.
– = Unaffected
X = Undefined
0 = Reset to 0
1 = Set to 1

Table 128. Power Consumption

Symbol	Parameter	V_{DD} = 2.7 V to 3.6 V Typical[1]	Maximum[2] Std Temp	Maximum[3] Ext Temp	Units	Conditions
I_{DD} Stop	Supply Current in STOP Mode	0.1			µA	No peripherals enabled. All pins driven to V_{DD} or V_{SS}.
I_{DD} Halt	Supply Current in HALT Mode (with all peripherals disabled)	35	55	65	µA	32 kHz
		520			µA	5.5 MHz
		2.1	2.85	2.85	mA	20 MHz
I_{DD}	Supply Current in ACTIVE Mode (with all peripherals disabled)	2.8			mA	32 kHz
		4.5	5.2	5.2	mA	5.5 MHz
		5.5	6.5	6.5	mA	10 MHz
		7.9	11.5	11.5	mA	20 MHz
I_{DD} WDT	Watchdog Timer Supply Current	0.9	1.0	1.1	µA	
I_{DD} XTAL	Crystal Oscillator Supply Current	40			µA	32 kHz
		230			µA	4 MHz
		760			µA	20 MHz
I_{DD} IPO	Internal Precision Oscillator Supply Current	350	500	550	µA	
I_{DD} VBO	Voltage Brownout and Low-Voltage Detect Supply Current	50			µA	For 20-/28-pin devices (VBO only); See Notes 4
						For 8-pin devices; See Notes 4
I_{DD} ADC	Analog to Digital Converter Supply Current (with External Reference)	2.8	3.1	3.2	mA	32 kHz
		3.1	3.6	3.7	mA	5.5 MHz
		3.3	3.7	3.8	mA	10 MHz
		3.7	4.2	4.3	mA	20 MHz
I_{DD} ADCRef	ADC Internal Reference Supply Current	0			µA	See Notes 4
I_{DD} CMP	Comparator supply Current	150	180	190	µA	See Notes 4

General Purpose I/O Port Output Timing

Figure 35 and Table 140 provide timing information for GPIO Port pins.

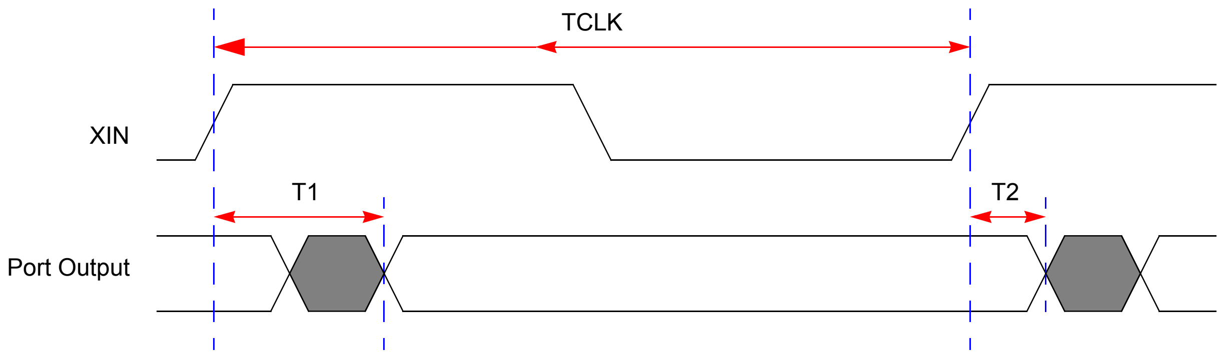


Figure 35. GPIO Port Output Timing

Table 140. GPIO Port Output Timing

Parameter	Abbreviation	Delay (ns)	
		Minimum	**Maximum**
GPIO Port pins			
T_1	XIN Rise to Port Output Valid Delay	–	15
T_2	XIN Rise to Port Output Hold Time	2	–

Figure 38 and Table 143 provide timing information for UART pins for the case where CTS is not used for flow control. DE asserts after the transmit data register has been written. DE remains asserted for multiple characters as long as the transmit data register is written with the next character before the current character has completed.

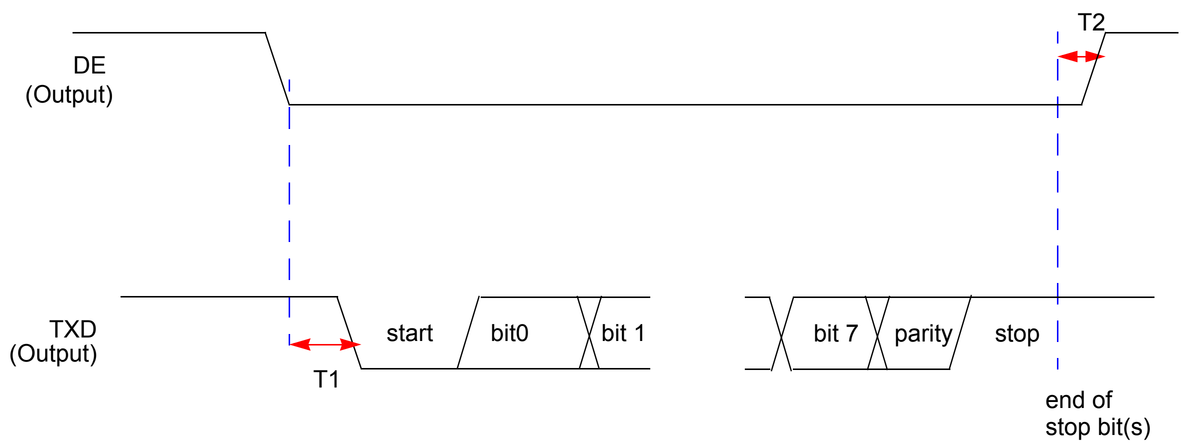
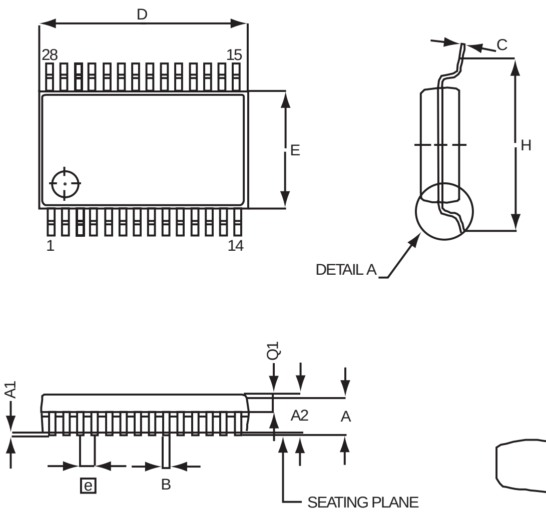


Figure 38. UART Timing Without CTS

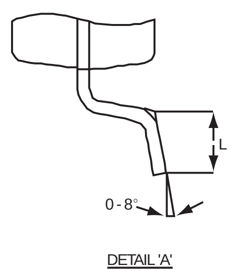
Table 143. UART Timing Without CTS

		Delay (ns)	
Parameter	**Abbreviation**	**Minimum**	**Maximum**
UART			
T_1	DE assertion to TXD falling edge (start bit) delay	1 * XIN period	1 bit time
T_2	End of Stop Bit(s) to DE deassertion delay (Tx data register is empty)	± 5	

Figure 47 displays the 28-pin Small Shrink Outline Package (SSOP) available for the Z8 Encore! XP F082A Series devices.



SYMBOL	MILLIMETER			INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.73	1.86	1.99	0.068	0.073	0.078
A1	0.05	0.13	0.21	0.002	0.005	0.008
A2	1.68	1.73	1.78	0.066	0.068	0.070
B	0.25		0.38	0.010		0.015
C	0.09	–	0.20	0.004	0.006	0.008
D	10.07	10.20	10.33	0.397	0.402	0.407
E	5.20	5.30	5.38	0.205	0.209	0.212
e	0.65 TYP			0.0256 TYP		
H	7.65	7.80	7.90	0.301	0.307	0.311
L	0.63	0.75	0.95	0.025	0.030	0.037



CONTROLLING DIMENSIONS: MM
LEADS ARE COPLANAR WITHIN .004 INCHES.

Figure 47. 28-Pin Small Shrink Outline Package (SSOP)

Index

Symbols

Numerics

A

B

C