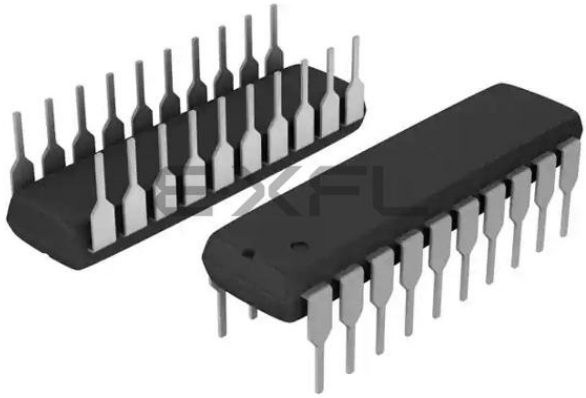

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What is "Embedded - Microcontrollers"?

"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	17
Program Memory Size	2KB (2K x 8)
Program Memory Type	FLASH
EEPROM Size	64 x 8
RAM Size	512 x 8
Voltage - Supply (Vcc/Vdd)	2.7V ~ 3.6V
Data Converters	-
Oscillator Type	Internal
Operating Temperature	-40°C ~ 105°C (TA)
Mounting Type	Through Hole
Package / Case	20-DIP (0.300", 7.62mm)
Supplier Device Package	-
Purchase URL	https://www.e-xfl.com/product-detail/zilog/z8f021aph020ec

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- Up to thirteen 5 V-tolerant input pins
- Up to 8 ports capable of direct LED drive with no current limit resistor required
- On-Chip Debugger (OCD)
- Voltage Brownout (VBO) protection
- Programmable low battery detection (LVD) (8-pin devices only)
- Bandgap generated precision voltage references available for the ADC, comparator, VBO, and LVD
- Power-On Reset (POR)
- 2.7 V to 3.6 V operating voltage
- 8-, 20-, and 28-pin packages
- 0 °C to +70 °C and -40 °C to +105 °C for operating temperature ranges

Part Selection Guide

Table 1 on page 3 identifies the basic features and package styles available for each device within the Z8 Encore! XP® F082A Series product line.

initiate Stop Mode Recovery without being written to the Port Input Data register or without initiating an interrupt (if enabled for that pin).

Stop Mode Recovery Using the External $\overline{\text{RESET}}$ Pin

When the Z8 Encore! XP F082A Series device is in STOP mode and the external $\overline{\text{RESET}}$ pin is driven Low, a system reset occurs. Because of a glitch filter operating on the $\overline{\text{RESET}}$ pin, the Low pulse must be greater than the minimum width specified, or it is ignored. See Electrical Characteristics on page 221 for details.

Low Voltage Detection

In addition to the Voltage Brownout (VBO) Reset described above, it is also possible to generate an interrupt when the supply voltage drops below a user-selected value. For details about configuring the Low Voltage Detection (LVD) and the threshold levels available, see Trim Bit Address 0003H on page 159. The LVD function is available on the 8-pin product versions only.

When the supply voltage drops below the LVD threshold, the LVD bit of the Reset Status (RSTSTAT) register is set to one. This bit remains one until the low-voltage condition goes away. Reading or writing this bit does not clear it. The LVD circuit can also generate an interrupt when so enabled, see Interrupt Vectors and Priority on page 58. The LVD bit is NOT latched, so enabling the interrupt is the only way to guarantee detection of a transient low voltage event.

The LVD functionality depends on circuitry shared with the VBO block; therefore, disabling the VBO also disables the LVD.

Reset Register Definitions

The following sections define the Reset registers.

Reset Status Register

The Reset Status (RSTSTAT) register is a read-only register that indicates the source of the most recent Reset event, indicates a Stop Mode Recovery event, and indicates a Watchdog Timer time-out. Reading this register resets the upper four bits to 0.

This register shares its address with the Watchdog Timer control register, which is write-only (see Table 11 on page 31).

Table 15. Port Alternate Function Mapping (8-Pin Parts)

Port	Pin	Mnemonic	Alternate Function Description	Alternate Function Select Register AFS1	Alternate Function Select Register AFS2
Port A	PA0	T0IN	Timer 0 Input	AFS1[0]: 0	AFS2[0]: 0
		Reserved		AFS1[0]: 0	AFS2[0]: 1
		Reserved		AFS1[0]: 1	AFS2[0]: 0
		$\overline{\text{T0OUT}}$	Timer 0 Output Complement	AFS1[0]: 1	AFS2[0]: 1
	PA1	T0OUT	Timer 0 Output	AFS1[1]: 0	AFS2[1]: 0
		Reserved		AFS1[1]: 0	AFS2[1]: 1
		CLKIN	External Clock Input	AFS1[1]: 1	AFS2[1]: 0
		Analog Functions*	ADC Analog Input/VREF	AFS1[1]: 1	AFS2[1]: 1
	PA2	DE0	UART 0 Driver Enable	AFS1[2]: 0	AFS2[2]: 0
		$\overline{\text{RESET}}$	External Reset	AFS1[2]: 0	AFS2[2]: 1
		T1OUT	Timer 1 Output	AFS1[2]: 1	AFS2[2]: 0
		Reserved		AFS1[2]: 1	AFS2[2]: 1
	PA3	$\overline{\text{CTS0}}$	UART 0 Clear to Send	AFS1[3]: 0	AFS2[3]: 0
		COUT	Comparator Output	AFS1[3]: 0	AFS2[3]: 1
		T1IN	Timer 1 Input	AFS1[3]: 1	AFS2[3]: 0
		Analog Functions*	ADC Analog Input/LPO Input (P)	AFS1[3]: 1	AFS2[3]: 1
	PA4	RXD0	UART 0 Receive Data	AFS1[4]: 0	AFS2[4]: 0
		Reserved		AFS1[4]: 0	AFS2[4]: 1
		Reserved		AFS1[4]: 1	AFS2[4]: 0
		Analog Functions*	ADC/Comparator Input (N)/LPO Input (N)	AFS1[4]: 1	AFS2[4]: 1
	PA5	TXD0	UART 0 Transmit Data	AFS1[5]: 0	AFS2[5]: 0
		$\overline{\text{T1OUT}}$	Timer 1 Output Complement	AFS1[5]: 0	AFS2[5]: 1
		Reserved		AFS1[5]: 1	AFS2[5]: 0
		Analog Functions*	ADC/Comparator Input (P) LPO Output	AFS1[5]: 1	AFS2[5]: 1

*Analog Functions include ADC inputs, ADC reference, comparator inputs and LPO ports.

Note: Also, alternate function selection as described in Port A–D Alternate Function Sub-Registers on page 47 must be enabled.

Table 31. LED Drive Level Low Register (LEDLVLL)

BITS	7	6	5	4	3	2	1	0
FIELD	LEDLVLL[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	F84H							

LEDLVLL[7:0]—LED Level Low 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

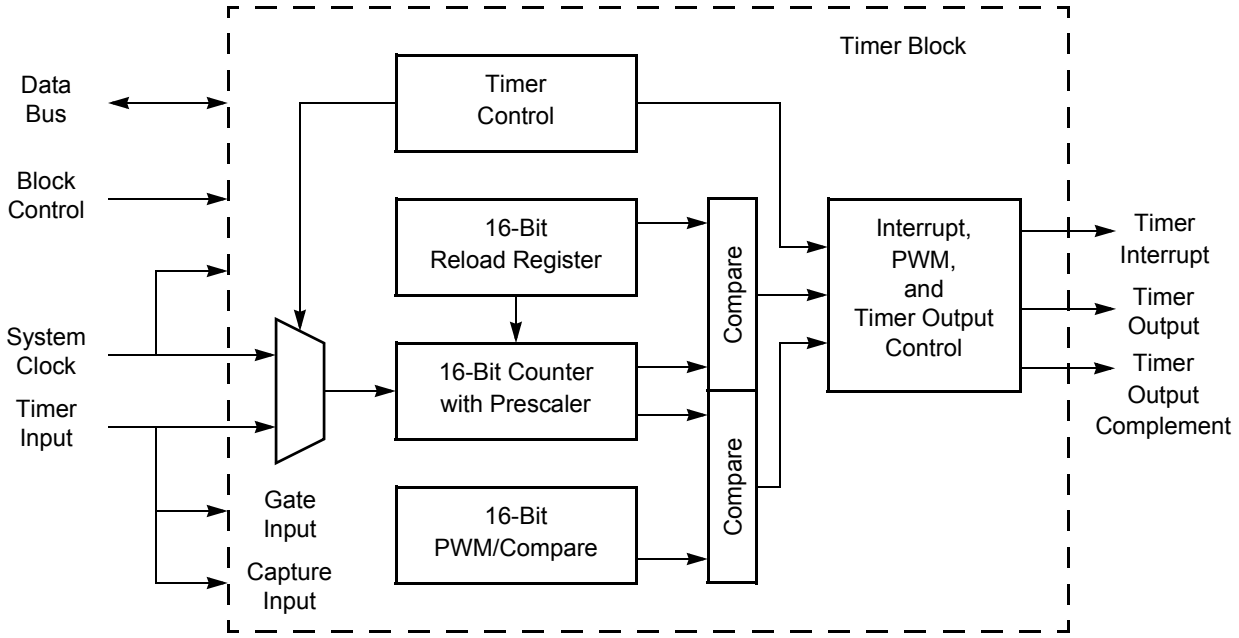

Figure 9. Timer Block Diagram

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. The timer is automatically disabled and stops counting.

Follow the steps below for configuring a timer for COUNTER mode and initiating the count:

1. Write to the Timer Control register to:
   - Disable the timer.
   - Configure the timer for COUNTER mode.
   - Select either the rising edge or falling edge of the Timer Input signal for the count. This selection also sets the initial logic level (High or Low) for the Timer Output alternate function. However, the Timer Output function is not required to be enabled.
2. Write to the Timer High and Low Byte registers to set the starting count value. This only affects the first pass in COUNTER mode. After the first timer Reload in COUNTER mode, counting always begins at the reset value of 0001H. In COUNTER mode the Timer High and Low Byte registers must be written with the value 0001H.
3. Write to the Timer Reload High and Low Byte registers to set the Reload value.
4. If appropriate, enable the timer interrupt and set the timer interrupt priority by writing to the relevant interrupt registers.
5. Configure the associated GPIO port pin for the Timer Input alternate function.
6. If using the Timer Output function, configure the associated GPIO port pin for the Timer Output alternate function.
7. Write to the Timer Control register to enable the timer.

In COUNTER mode, the number of Timer Input transitions since the timer start is given by the following equation:

COUNTER Mode Timer Input Transitions = Current Count Value-Start Value

COMPARATOR COUNTER Mode

In COMPARATOR COUNTER mode, the timer counts input transitions from the analog comparator output. The TPOLbit in the Timer Control Register selects whether the count occurs on the rising edge or the falling edge of the comparator output signal. In COMPARATOR COUNTER mode, the prescaler is disabled.

Caution: *The frequency of the comparator output signal must not exceed one-fourth the system clock frequency. Further, the high or low state of the comparator output signal pulse must be no less than twice the system clock period. A shorter pulse may not be captured.*

After reaching the Reload value stored in the Timer Reload High and Low Byte registers, the timer generates an interrupt, the count value in the Timer High and Low Byte registers is reset to 0001H and counting resumes. Also, if the Timer Output alternate function is enabled, the Timer Output pin changes state (from Low to High or from High to Low) at timer Reload.

4. Enable the timer interrupt, if appropriate, and set the timer interrupt priority by writing to the relevant interrupt registers.By default, the timer interrupt are generated for both input capture and reload events. If appropriate, configure the timer interrupt to be generated only at the input capture event or the reload event by setting TICONFIG field of the TxCTL0 register.
5. Configure the associated GPIO port pin for the Timer Input alternate function.
6. Write to the Timer Control register to enable the timer.
7. Counting begins on the first appropriate transition of the Timer Input signal. No interrupt is generated by this first edge.

In CAPTURE/COMPARE mode, the elapsed time from timer start to Capture event can be calculated using the following equation:

$$\text{Capture Elapsed Time (s)} = \frac{(\text{Capture Value} - \text{Start Value}) \times \text{Prescale}}{\text{System Clock Frequency (Hz)}}$$

Reading the Timer Count Values

The current count value in the timers can be read while counting (enabled). This capability has no effect on timer operation. When the timer is enabled and the Timer High Byte register is read, the contents of the Timer Low Byte register are placed in a holding register. A subsequent read from the Timer Low Byte register returns the value in the holding register. This operation allows accurate reads of the full 16-bit timer count value while enabled. When the timers are not enabled, a read from the Timer Low Byte register returns the actual value in the counter.

Timer Pin Signal Operation

Timer Output is a GPIO Port pin alternate function. The Timer Output is toggled every time the counter is reloaded.

The Timer Input can be used as a selectable counting source. It shares the same pin as the complementary timer output. When selected by the GPIO Alternate Function Registers, this pin functions as a timer input in all modes except for the DUAL PWM OUTPUT mode. For this mode, there is no timer input available.

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.

Compensation Steps:

1. Correct for Offset

ADC MSB	ADC LSB

-

Offset MSB	Offset LSB

=

#1 MSB	#1 LSB

2. Take absolute value of the offset corrected ADC value *if negative*—the gain correction factor is computed assuming positive numbers, with sign restoration afterward.

#2 MSB	#2 LSB

Also take absolute value of the gain correction word *if negative*.

AGain MSB	AGain LSB

3. Multiply by Gain Correction Word. If in DIFFERENTIAL mode, there are two gain correction values: one for positive ADC values, another for negative ADC values. Based on the sign of #2, use the appropriate Gain Correction Word.

#2 MSB	#2 LSB

*

AGain MSB	AGain LSB

=

#3	#3	#3	#3

4. Round the result and discard the least significant two bytes (this is equivalent to dividing by 2^{16}).

#3	#3	#3	#3

-

0x00	0x00	0x80	0x00

=

#4 MSB	#4 LSB

5. Determine sign of the gain correction factor using the sign bits from Step 2. If the offset corrected ADC value AND the gain correction word have the same sign, then the factor is positive and is left unchanged. If they have differing signs, then the factor is negative and must be multiplied by -1.

SPROT7-SPROT0—Sector Protection
Each bit corresponds to a 512 byte Flash sector. For the Z8F08xx devices, the upper 3 bits must be zero. For the Z8F04xx devices all bits are used. For the Z8F02xx devices, the upper 4 bits are unused. For the Z8F01xx devices, the upper 6 bits are unused.

Flash Frequency High and Low Byte Registers

The Flash Frequency High (FFREQH) and Low Byte (FFREQL) 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) and is calculated using the following equation:

$$FFREQ[15:0] = \{FFREQH[7:0],FFREQL[7:0]\} = \frac{\text{System Clock Frequency}}{1000}$$

Caution: *The Flash Frequency High and Low Byte registers must be loaded with the correct value to ensure proper operation of the device. Also, Flash programming and erasure is not supported for system clock frequencies below 20 kHz or above 20 MHz.*

Table 82. Flash Frequency High Byte Register (FFREQH)

BITS	7	6	5	4	3	2	1	0
FIELD	FFREQH							
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	FFAH							

FFREQH—Flash Frequency High Byte
High byte of the 16-bit Flash Frequency value.

Table 83. Flash Frequency Low Byte Register (FFREQL)

BITS	7	6	5	4	3	2	1	0
FIELD	FFREQL							
RESET	0							
R/W	R/W							
ADDR	FFBH							

FFREQL—Flash Frequency Low Byte
Low byte of the 16-bit Flash Frequency value.

Write Memory, Read Memory, Write Register, Read Register, Read Memory CRC, Step Instruction, Stuff Instruction, and Execute Instruction commands.

DBG 03H
DBG RuntimeCounter[15:8]
DBG RuntimeCounter[7:0]

- **Write OCD Control Register (04H)**—The Write OCD Control Register command writes the data that follows to the OCDCTL register. When the Flash Read Protect Option Bit is enabled, the DBGMODE bit (OCDCTL[7]) can only be set to 1, it cannot be cleared to 0 and the only method of returning the device to normal operating mode is to reset the device.

DBG 04H
DBG OCDCTL[7:0]

- **Read OCD Control Register (05H)**—The Read OCD Control Register command reads the value of the OCDCTL register.

DBG 05H
DBG OCDCTL[7:0]

- **Write Program Counter (06H)**—The Write Program Counter command writes the data that follows to the eZ8 CPU's Program Counter (PC). If the device is not in DEBUG mode or if the Flash Read Protect Option bit is enabled, the Program Counter (PC) values are discarded.

DBG 06H
DBG ProgramCounter[15:8]
DBG ProgramCounter[7:0]

- **Read Program Counter (07H)**—The Read Program Counter command reads the value in the eZ8 CPU's Program Counter (PC). If the device is not in DEBUG mode or if the Flash Read Protect Option bit is enabled, this command returns FFFFH.

DBG 07H
DBG ProgramCounter[15:8]
DBG ProgramCounter[7:0]

- **Write Register (08H)**—The Write Register command writes data to the Register File. Data can be written 1–256 bytes at a time (256 bytes can be written by setting size to 0). If the device is not in DEBUG mode, the address and data values are discarded. If the Flash Read Protect Option bit is enabled, only writes to the Flash Control Registers are allowed and all other register write data values are discarded.

DBG 08H
DBG {4'h0,Register Address[11:8]}
DBG Register Address[7:0]
DBG Size[7:0]
DBG 1-256 data bytes

Table 123. Rotate and Shift Instructions (Continued)

Mnemonic	Operands	Instruction
SRA	dst	Shift Right Arithmetic
SRL	dst	Shift Right Logical
SWAP	dst	Swap Nibbles

eZ8 CPU Instruction Summary

Table 124 summarizes the eZ8 CPU instructions. The table identifies the addressing modes employed by the instruction, the effect upon the Flags register, the number of CPU clock cycles required for the instruction fetch, and the number of CPU clock cycles required for the instruction execution.

Table 124. eZ8 CPU Instruction Summary

Assembly Mnemonic	Symbolic Operation		Address Mode		Opcode(s) (Hex)	Flags						Fetch Cycles	Instr. Cycles
			dst	src		C	Z	S	V	D	H		
ADC dst, src	dst	dst + src + C	r	r	12	*	*	*	*	0	*	2	3
			r	Ir	13							2	4
			R	R	14							3	3
			R	IR	15							3	4
			R	IM	16							3	3
			IR	IM	17							3	4
ADCX dst, src	dst	dst + src + C	ER	ER	18	*	*	*	*	0	*	4	3
			ER	IM	19							4	3
ADD dst, src	dst	dst + src	r	r	02	*	*	*	*	0	*	2	3
			r	Ir	03							2	4
			R	R	04							3	3
			R	IR	05							3	4
			R	IM	06							3	3
			IR	IM	07							3	4
ADDX dst, src	dst	dst + src	ER	ER	08	*	*	*	*	0	*	4	3
			ER	IM	09							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							

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 with 2 KB Flash											
Standard Temperature: 0 °C to 70 °C											
Z8F021APB020SC	2 KB	512 B	64 B	6	13	2	0	1	1	0	PDIP 8-pin package
Z8F021AQB020SC	2 KB	512 B	64 B	6	13	2	0	1	1	0	QFN 8-pin package
Z8F021ASB020SC	2 KB	512 B	64 B	6	13	2	0	1	1	0	SOIC 8-pin package
Z8F021ASH020SC	2 KB	512 B	64 B	17	19	2	0	1	1	0	SOIC 20-pin package
Z8F021AHH020SC	2 KB	512 B	64 B	17	19	2	0	1	1	0	SSOP 20-pin package
Z8F021APH020SC	2 KB	512 B	64 B	17	19	2	0	1	1	0	PDIP 20-pin package
Z8F021ASJ020SC	2 KB	512 B	64 B	25	19	2	0	1	1	0	SOIC 28-pin package
Z8F021AHJ020SC	2 KB	512 B	64 B	25	19	2	0	1	1	0	SSOP 28-pin package
Z8F021APJ020SC	2 KB	512 B	64 B	25	19	2	0	1	1	0	PDIP 28-pin package
Extended Temperature: -40 °C to 105 °C											
Z8F021APB020EC	2 KB	512 B	64 B	6	13	2	0	1	1	0	PDIP 8-pin package
Z8F021AQB020EC	2 KB	512 B	64 B	6	13	2	0	1	1	0	QFN 8-pin package
Z8F021ASB020EC	2 KB	512 B	64 B	6	13	2	0	1	1	0	SOIC 8-pin package
Z8F021ASH020EC	2 KB	512 B	64 B	17	19	2	0	1	1	0	SOIC 20-pin package
Z8F021AHH020EC	2 KB	512 B	64 B	17	19	2	0	1	1	0	SSOP 20-pin package
Z8F021APH020EC	2 KB	512 B	64 B	17	19	2	0	1	1	0	PDIP 20-pin package
Z8F021ASJ020EC	2 KB	512 B	64 B	25	19	2	0	1	1	0	SOIC 28-pin package
Z8F021AHJ020EC	2 KB	512 B	64 B	25	19	2	0	1	1	0	SSOP 28-pin package
Z8F021APJ020EC	2 KB	512 B	64 B	25	19	2	0	1	1	0	PDIP 28-pin package
Replace C with G for Lead-Free Packaging											

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