Welcome to E-XFL.COM

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	46
Program Memory Size	16KB (16K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	2K x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 3.6V
Data Converters	A/D 12x10b
Oscillator Type	Internal
Operating Temperature	0°C ~ 70°C (TA)
Mounting Type	Surface Mount
Package / Case	68-LCC (J-Lead)
Supplier Device Package	-
Purchase URL	https://www.e-xfl.com/product-detail/zilog/z8f1602vs020sc00tr

Register File Address Map

Table 6 provides the address map for the Register File of the Z8F640x family of products. Not all devices and package styles in the Z8F640x family support Timer 3 and all of the GPIO Ports. Consider registers for unimplemented peripherals as Reserved.

Table 6. Register File Address Map

Address (Hex)	Register Description	Mnemonic	Reset (Hex)	Page #
General Purpose RAM				
000-EFF	General-Purpose Register File RAM	—	XX	
Timer 0				
F00	Timer 0 High Byte	T0H	00	66
F01	Timer 0 Low Byte	T0L	01	66
F02	Timer 0 Reload High Byte	T0RH	FF	67
F03	Timer 0 Reload Low Byte	T0RL	FF	67
F04	Timer 0 PWM High Byte	T0PWMH	00	69
F05	Timer 0 PWM Low Byte	T0PWML	00	69
F06	Reserved	—	XX	
F07	Timer 0 Control	T0CTL	00	70
Timer 1				
F08	Timer 1 High Byte	T1H	00	66
F09	Timer 1 Low Byte	T1L	01	66
F0A	Timer 1 Reload High Byte	T1RH	FF	67
F0B	Timer 1 Reload Low Byte	T1RL	FF	67
F0C	Timer 1 PWM High Byte	T1PWMH	00	69
F0D	Timer 1 PWM Low Byte	T1PWML	00	69
F0E	Reserved	—	XX	
F0F	Timer 1 Control	T1CTL	00	70
Timer 2				
F10	Timer 2 High Byte	T2H	00	66
F11	Timer 2 Low Byte	T2L	01	66
F12	Timer 2 Reload High Byte	T2RH	FF	67
F13	Timer 2 Reload Low Byte	T2RL	FF	67
F14	Timer 2 PWM High Byte	T2PWMH	00	69
F15	Timer 2 PWM Low Byte	T2PWML	00	69
F16	Reserved	—	XX	
F17	Timer 2 Control	T2CTL	00	70
XX=Undefined				

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

Port A-H Output Control Sub-Registers

The Port A-H Output Control sub-register (Table 17) is accessed through the Port A-H Control register by writing 03H to the Port A-H Address register. Setting the bits in the Port A-H 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 17. Port A-H Output Control Sub-Registers

BITS	7	6	5	4	3	2	1	0
FIELD	POC7	POC6	POC5	POC4	POC3	POC2	POC1	POC0
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	If 03H in Port A-H Address Register, accessible via Port A-H Control Register							

POC[7:0]—Port Output Control
These bits function independently of the alternate function bit and disables the drains if set to 1.
0 = The drains are enabled for any output mode.
1 = The drain of the associated pin is disabled (open-drain mode).

Interrupt Port Select register selects between Port A and Port D for the individual interrupts.

Table 35. Interrupt Edge Select Register (IRQES)

BITS	7	6	5	4	3	2	1	0
FIELD	IES7	IES6	IES5	IES4	IES3	IES2	IES1	IES0
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	FCDH							

IES*x*—Interrupt Edge Select *x*
where *x* indicates the specific GPIO Port pin number (0 through 7). The pulse width should be greater than 1 system clock to guarantee capture of the edge triggered interrupt.
0 = An interrupt request is generated on the falling edge of the PA*x*/PD*x* input.
1 = An interrupt request is generated on the rising edge of the PA*x*/PD*x* input.

Interrupt Port Select Register

The Port Select (IRQPS) register (Table 36) determines the port pin that generates the PAx/PDx interrupts. This register allows either Port A or Port D pins to be used as interrupts. The Interrupt Edge Select register controls the active interrupt edge.

Table 36. Interrupt Port Select Register (IRQPS)

BITS	7	6	5	4	3	2	1	0
FIELD	PAD7S	PAD6S	PAD5S	PAD4S	PAD3S	PAD2S	PAD1S	PAD0S
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	FCEH							

PAD*x*S—PA*x*/PD*x* Selection
0 = PA*x* is used for the interrupt for PA*x*/PD*x* interrupt request.
1 = PD*x* is used for the interrupt for PA*x*/PD*x* interrupt request.
where *x* indicates the specific GPIO Port pin number (0 through 7).

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 Output Signal Operation

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

Timer Control Register Definitions

Timers 0–2 are available in all packages. Timer 3 is available only in the 64-, 68- and 80-pin packages.

Timer 0-3 High and Low Byte Registers

The Timer 0-3 High and Low Byte (TxH and TxL) registers (Tables 38 and 39) contain the current 16-bit timer count value. When the timer is enabled, a read from TxH causes the value in TxL to be stored in a temporary holding register. A read from TMRL always returns this temporary register when the timers are enabled. When the timer is disabled, reads from the TMRL reads the register directly.

Writing to the Timer High and Low Byte registers while the timer is enabled is not recommended. There are no temporary holding registers available for write operations, so simultaneous 16-bit writes are not possible. If either the Timer High or Low Byte registers are

CTSE—CTS Enable
0 = The CTS signal has no effect on the transmitter.
1 = The UART recognizes the CTS signal as an enable control from the transmitter.

PEN—Parity Enable
This bit enables or disables parity. Even or odd is determined by the PSEL bit.
0 = Parity is disabled.
1 = The transmitter sends data with an additional parity bit and the receiver receives an additional parity bit.

PSEL—Parity Select
0 = Even parity is transmitted and expected on all received data.
1 = Odd parity is transmitted and expected on all received data.

SBRK—Send Break
This bit pauses or breaks data transmission. Sending a break interrupts any transmission in progress, so insure that the transmitter has finished sending data before setting this bit.
0 = No break is sent.
1 = The output of the transmitter is zero.

STOP—Stop Bit Select
0 = The transmitter sends one stop bit.
1 = The transmitter sends two stop bits.

LBEN—Loop Back Enable
0 = Normal operation.
1 = All transmitted data is looped back to the receiver.

Table 55. UART*x* Control 1 Register (U*x*CTL1)

BITS	7	6	5	4	3	2	1	0
FIELD	BIRQ	MPM	MPE	MPBT	Reserved		RDAIRQ	IREN
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	F43H and F4BH							

BIRQ—Baud Rate Generator Interrupt Request
This bit sets an interrupt request when the Baud Rate Generator times out and is only set if a UART is not enabled. The is bit produces no effect when the UART is enabled.
0 = Interrupts behave as set by UART control.
1 = The Baud Rate Generator generates a receive interrupt when it counts down to zero.

MPM—Multiprocessor (9-bit) mode Select
This bit is used to enable Multiprocessor (9-bit) mode.

0 = Disable Multiprocessor mode.
1 = Enable Multiprocessor mode.

MPE—Multiprocessor Enable
0 = The UART processes all received data bytes.
1 = The UART processes only data bytes in which the multiprocessor data bit (9th bit) is set to 1.

MPBT—Multiprocessor Bit Transmitter
This bit is applicable only when Multiprocessor (9-bit) mode is enabled.
0 = Send a 0 in the multiprocessor bit location of the data stream (9th bit).
1 = Send a 1 in the multiprocessor bit location of the data stream (9th bit).

Reserved
These bits are reserved and must be 0.

$\overline{\text{RDAIRQ}}$—Receive Data Interrupt $\overline{\text{Enable}}$
0 = Received data and receiver errors generates an interrupt request to the Interrupt Controller.
1 = Received data does not generate an interrupt request to the Interrupt Controller. Only receiver errors generate an interrupt request. The associated DMA will still be notified that received data is available.

IREN—Infrared Encoder/Decoder Enable
0 = Infrared Encoder/Decoder is disabled. UART operates normally operation.
1 = Infrared Encoder/Decoder is enabled. The UART transmits and receives data through the Infrared Encoder/Decoder.

UARTx Baud Rate High and Low Byte Registers

The UART*x* Baud Rate High and Low Byte registers (Tables 56 and 57) combine to create a 16-bit baud rate divisor value (BRG[15:0]) that sets the data transmission rate (baud rate) of the UART.

Table 56. UART*x* Baud Rate High Byte Register (U*x*BRH)

BITS	7	6	5	4	3	2	1	0
FIELD	BRH							
RESET	1	1	1	1	1	1	1	1
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
ADDR	F46H and F4EH							

Serial Peripheral Interface

Overview

The Serial Peripheral Interface™ (SPI) is a synchronous interface allowing several SPI-type devices to be interconnected. SPI-compatible devices include EEPROMs, Analog-to-Digital Converters, and ISDN devices. Features of the SPI include:

- Full-duplex, synchronous, character-oriented communication
- Four-wire interface
- Data transfers rates up to a maximum of one-fourth the system clock frequency
- Error detection
- Write and mode collision detection
- Dedicated Baud Rate Generator

Architecture

The SPI may be configured as either a Master (in single or multi-master systems) or a Slave as illustrated in Figures 74 through 76.

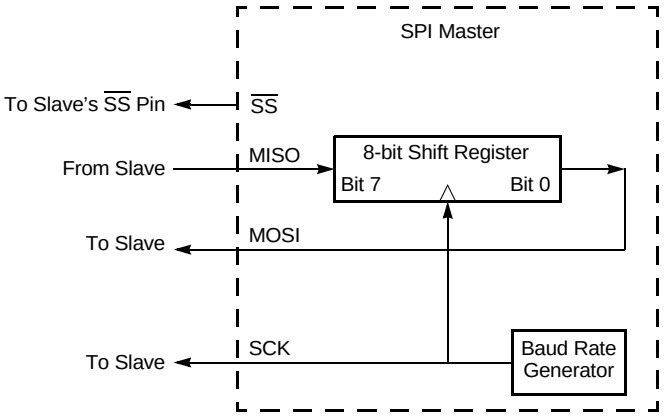

Figure 74. SPI Configured as a Master in a Single Master, Single Slave System

Error Detection

The SPI contains error detection logic to support SPI communication protocols and recognize when communication errors have occurred. The SPI Status register indicates when a data transmission error has been detected.

Overrun (Write Collision)

An overrun error (write collision) indicates a write to the SPI Data register was attempted while a data transfer is in progress. An overrun sets the OVR bit in the SPI Status register to 1. Writing a 1 to OVR clears this error flag.

Mode Fault (Multi-Master Collision)

A mode fault indicates when more than one Master is trying to communicate at the same time (a multi-master collision). The mode fault is detected when the enabled Master's $\overline{SS}$ pin is asserted. A mode fault sets the COL bit in the SPI Status register to 1. Writing a 1 to COL clears this error flag.

SPI Interrupts

When SPI interrupts are enabled, the SPI generates an interrupt after data transmission. The SPI in Master mode generates an interrupt after a character has been sent. A character can be defined to be 1 through 8 bits by the NUMBITS field in the SPI Mode register. The SPI in Slave mode generates an interrupt when the $\overline{SS}$ signal deasserts to indicate completion of the data transfer. Writing a 1 to the IRQ bit in the SPI Status Register clears the pending interrupt request. If the SPI is disabled, an SPI interrupt can be generated by a Baud Rate Generator time-out.

SPI Baud Rate Generator

In SPI Master mode, the Baud Rate Generator creates a lower frequency serial clock (SCK) for data transmission synchronization between the Master and the external Slave. The input to the Baud Rate Generator is the system clock. The SPI Baud Rate High and Low Byte registers combine to form a 16-bit reload value, BRG[15:0], for the SPI Baud Rate Generator. The reload value must be greater than or equal to 0002H for SPI operation (maximum baud rate is system clock frequency divided by 4). The SPI baud rate is calculated using the following equation:

$$\text{SPI Baud Rate (bits/s)} = \frac{\text{System Clock Frequency (Hz)}}{2 \times \text{BRG[15:0]}}$$

When the SPI is disabled, the Baud Rate Generator can function as a basic 16-bit timer with interrupt on time-out. To configure the Baud Rate Generator as a timer with interrupt on time-out, complete the following procedure:

SPI Mode Register

The SPI Mode register configures the character bit width and the direction and value of the $\overline{SS}$ pin.

Table 63. SPI Mode Register (SPIMODE)

BITS	7	6	5	4	3	2	1	0
FIELD	Reserved			NUMBITS[2:0]			SSIO	SSV
RESET	0			0	0	0	0	0
R/W	R			R/W	R/W	R/W	R/W	R/W
ADDR	F63H							

Reserved
These bits are reserved and must be 0.

NUMBITS[2:0]—Number of Data Bits Per Character to Transfer
This field contains the number of bits to shift for each character transfer. Refer to the SPI Data Register description for information on valid bit positions when the character length is less than 8-bits.

000 = 8 bits
001 = 1 bit
010 = 2 bits
011 = 3 bits
100 = 4 bits
101 = 5 bits
110 = 6 bits
111 = 7 bits.

SSIO—Slave Select I/O
0 = $\overline{SS}$ pin configured as an input.
1 = $\overline{SS}$ pin configured as an output (Master mode only).

SSV—Slave Select Value
If SSIO = 1 and SPI configured as a Master:
0 = $\overline{SS}$ pin driven Low (0).
1 = $\overline{SS}$ pin driven High (1).
This bit has no effect if SSIO = 0 or SPI configured as a Slave.

4. The I2C Controller loads the I2C Shift register with the contents of the I2C Data register.
5. After the first bit has been shifted out, a Transmit interrupt is asserted.
6. Software responds by writing eight bits of address to the I2C Data register.
7. The I2C Controller completes shifting of the two address bits and a 0 (write).
8. The I2C slave sends an acknowledge by pulling the SDA signal Low during the next high period of SCL.
9. The I2C Controller loads the I2C Shift register with the contents of the I2C Data register.
10. The I2C Controller shifts out the next eight bits of address. After the first bits are shifted, the I2C Controller generates a Transmit interrupt.
11. Software responds by setting the START bit of the I2C Control register to generate a repeated START.
12. Software responds by writing 11110B followed by the 2-bit slave address and a 1 (read).
13. Software responds by setting the NAK bit of the I2C Control register, so that a Not Acknowledge is sent after the first byte of data has been read. If you want to read only one byte, software responds by setting the NAK bit of the I2C Control register.
14. After the I2C Controller shifts out the address bits mentioned in step 9, the I2C slave sends an acknowledge by pulling the SDA signal Low during the next high period of SCL.
15. The I2C Controller sends the repeated START condition.
16. The I2C Controller loads the I2C Shift register with the contents of the I2C Data register.
17. The I2C Controller sends 11110B followed by the 2-bit slave read and a 1 (read).
18. The I2C slave sends an acknowledge by pulling the SDA signal Low during the next high period of SCL.
19. The I2C slave sends a byte of data.
20. A Receive interrupt is generated.
21. Software responds by reading the I2C Data register.
22. Software responds by setting the STOP bit of the I2C Control register.
23. A NAK condition is sent to the I2C slave.
24. A STOP condition is sent to the I2C slave.

Configuring DMA0 and DMA1 for Data Transfer

Follow these steps to configure and enable DMA0 or DMA1:

1. Write to the DMA*x* I/O Address register to set the Register File address identifying the on-chip peripheral control register. The upper nibble of the 12-bit address for on-chip peripheral control registers is always FH. The full address is {FH, DMA*x*_IO[7:0]}
2. Determine the 12-bit Start and End Register File addresses. The 12-bit Start Address is given by {DMA*x*_H[3:0], DMA_START[7:0]}. The 12-bit End Address is given by {DMA*x*_H[7:4], DMA_END[7:0]}.
3. Write the Start and End Register File address high nibbles to the DMA*x* End/Start Address High Nibble register.
4. Write the lower byte of the Start Address to the DMA*x* Start/Current Address register.
5. Write the lower byte of the End Address to the DMA*x* End Address register.
6. Write to the DMA*x* Control register to complete the following:
   - Select loop or single-pass mode operation
   - Select the data transfer direction (either from the Register File RAM to the on-chip peripheral control register; or from the on-chip peripheral control register to the Register File RAM)
   - Enable the DMA*x* interrupt request, if desired
   - Select Word or Byte mode
   - Select the DMA*x* request trigger
   - Enable the DMA*x* channel

DMA_ADC Operation

DMA_ADC transfers data from the ADC to the Register File. The sequence of operations in a DMA_ADC data transfer is:

1. ADC completes conversion on the current ADC input channel and signals the DMA controller that two-bytes of ADC data are ready for transfer.
2. DMA_ADC requests control of the system bus (address and data) from the eZ8 CPU.
3. After the eZ8 CPU acknowledges the bus request, DMA_ADC transfers the two-byte ADC output value to the Register File and then returns system bus control back to the eZ8 CPU.
4. If the current ADC Analog Input is the highest numbered input to be converted:
   - DMA_ADC resets the ADC Analog Input number to 0 and initiates data conversion on ADC Analog Input 0.
   - If configured to generate an interrupt, DMA_ADC sends an interrupt request to the Interrupt Controller

When the DMA is configured for two-byte word transfers, the DMA*x* I/O Address register must contain an even numbered address.

Table 72. DMA*x* I/O Address Register (DMA*x*IO)

BITS	7	6	5	4	3	2	1	0
FIELD	DMA_IO							
RESET	X	X	X	X	X	X	X	X
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
ADDR	FB1H, FB9H							

DMA_IO—DMA on-chip peripheral control register address
This byte sets the low byte of the on-chip peripheral control register address on Register File Page FH (addresses F00H to FFFH).

DMAx Address High Nibble Register

The DMA*x* Address High register specifies the upper four bits of address for the Start/Current and End Addresses of DMA*x*.

Table 73. DMA*x* Address High Nibble Register (DMA*x*H)

BITS	7	6	5	4	3	2	1	0
FIELD	DMA_END_H				DMA_START_H			
RESET	X	X	X	X	X	X	X	X
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
ADDR	FB2H, FHAH							

DMA_END_H—DMA*x* End Address High Nibble
These bits, used with the DMA*x* End Address Low register, form a 12-bit End Address. The full 12-bit address is given by {DMA_END_H[3:0], DMA_END[7:0]}.

DMA_START_H—DMA*x* Start/Current Address High Nibble
These bits, used with the DMA*x* Start/Current Address Low register, form a 12-bit Start/Current Address. The full 12-bit address is given by {DMA_START_H[3:0], DMA_START[7:0]}.

this bit to 0 when a conversion has been completed.
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.

Reserved
This bit is reserved and must be 0.

$\overline{\text{VREF}}$
0 = Internal voltage reference generator enabled. The VREF pin should be left unconnected (or capacitively coupled to analog ground).
1 = Internal voltage reference generator disabled. An external voltage reference must be provided through the VREF pin.

CONT
0 = Single-shot conversion. ADC data is output once at completion of the 5129 system clock cycles.
1 = Continuous conversion. ADC data updated every 256 system clock cycles.

ANAIN—Analog Input Select
These bits select the analog input for conversion. Not all Port pins in this list are available in all packages for the Z8F640x family of products. Refer to the **Signal and Pin Descriptions** chapter for information regarding the Port pins available with each package style. Do not enable unavailable analog inputs.
0000 = ANA0
0001 = ANA1
0010 = ANA2
0011 = ANA3
0100 = ANA4
0101 = ANA5
0110 = ANA6
0111 = ANA7
1000 = ANA8
1001 = ANA9
1010 = ANA10
1011 = ANA11
11XX = Reserved.

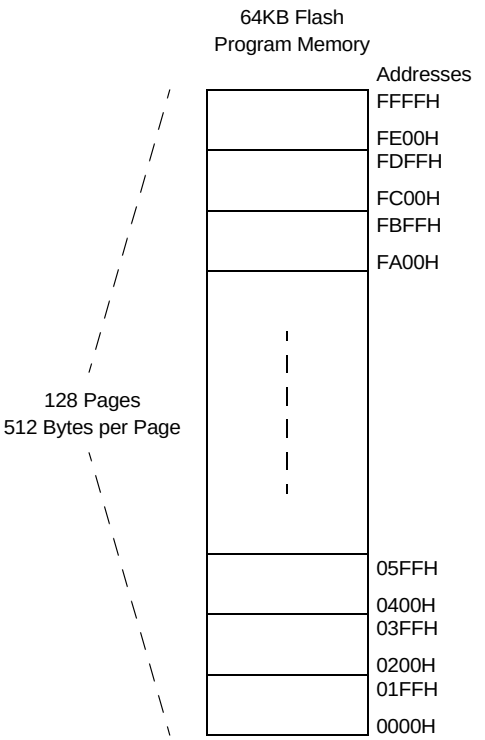

Figure 84. Flash Memory Arrangement

Operation

The Flash Controller programs and erases the Flash memory. The Flash Controller provides the proper Flash controls and timing for byte programming, Page Erase, and Mass Erase of the Flash memory. The Flash Controller contains a protection mechanism, via the Flash Control register (FCTL) to prevent accidental programming or erasure. The Flow Chart in Figure 85 illustrates basic Flash Controller operation. The following subsections provide details on the various operations (Lock, Unlock, Byte Programming, Page Erase, and Mass Erase) listed in Figure 85.

Flash Operation Timing Using the Flash Frequency Registers

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

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 32KHz (32768Hz) or above 20MHz. The Flash Frequency High and Low Byte registers must be loaded with the correct value to insure proper operation of the Z8F640x family device.

Flash Code Protection Against External Access

The user code contained within the Z8F640x family device's Flash memory can be protected against external access via the On-Chip Debugger. Programming the RP Option Bit prevents reading of the user code through the On-Chip Debugger. Refer to the **Option Bits** chapter and the **On-Chip Debugger** chapter for more information.

Flash Code Protection Against Accidental Program and Erasure

The Z8F640x family device provides several levels of protection against accidental program and erasure of the Flash memory contents. This protection is provided by a combination of the Option bits and the locking mechanism of the Flash Controller.

Flash Code Protection Using the Option Bits

The FHSWP and FWP Option Bits combine to provide three levels of Flash Program Memory protection as listed in Table 84. Refer to the **Option Bits** chapter for more information.

Table 84. Flash Code Protection Using the Option Bits

FHSWP	FWP	Flash Code Protection Description
0	0	Programming and erasure disabled for all of Flash Program Memory. In user code programming, Page Erase, and Mass Erase are all disabled. Mass Erase is available through the On-Chip Debugger.
1	0	Programming and Page Erase are enabled for the High Sector of the Flash Program Memory only. The High Sector on the Z8F640x family device contains 1KB to 4KB of Flash with addresses at the top of the available Flash memory. Programming and Page Erase are disabled for the other portions of the Flash Program Memory. Mass erase through user code is disabled. Mass Erase is available through the On-Chip Debugger.
0 or 1	1	Programming, Page Erase, and Mass Erase are enabled for all of Flash Program Memory.

Flash Code Protection Using the Flash Controller

At Reset, the Flash Controller locks to prevent accidental program or erasure of the Flash memory. To program or erase the Flash memory, unlock the Flash Controller by making two consecutive writes to the Flash Control register with the values 73H and 8CH, sequentially. After unlocking the Flash Controller, the Flash can be programmed or erased. When the Flash Controller is unlocked, any value written to the Flash Control register locks the Flash Controller. Writing the Mass Erase or Page Erase commands executes the function before locking the Flash Controller.

Byte Programming

When the Flash Controller is unlocked, all writes to Program Memory program a byte into the Flash. An erased Flash byte contains all 1's (FFH). The programming operation can only be used to change bits from 1 to 0. To change a Flash bit (or multiple bits) from 0 to 1 requires execution of either the Page Erase or Mass Erase commands.

Byte Programming can be accomplished using the On-Chip Debugger's Write Memory command or eZ8 CPU execution of the LDC or LDCI instructions. Refer to the **eZ8 CPU User Manual** for a description of the LDC and LDCI instructions. While the Flash Controller programs the Flash memory, the eZ8 CPU idles but the system clock and on-chip peripherals continue to operate. To exit programming mode and lock the Flash, write any value to the Flash Control register, except the Mass Erase or Page Erase commands.

- Power-on reset
- Voltage Brownout reset
- Asserting the $\overline{\text{RESET}}$ pin Low to initiate a Reset.
- Driving the DBG pin Low while the Z8F640x family device is in Stop mode initiates a System Reset.

OCD Data Format

The OCD interface uses the asynchronous data format defined for RS-232. Each character is transmitted as 1 Start bit, 8 data bits (least-significant bit first), and 1.5 Stop bits (Figure 89)

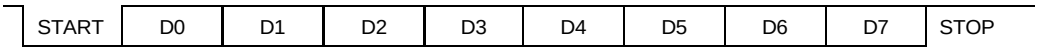

Figure 89. OCD Data Format

OCD Auto-Baud Detector/Generator

To run over a range of baud rates (data bits per second) with various system clock frequencies, the On-Chip Debugger has an Auto-Baud Detector/Generator. After a reset, the OCD is idle until it receives data. The OCD requires that the first character sent from the host is the character 80H. The character 80H has eight continuous bits Low (one Start bit plus 7 data bits). The Auto-Baud Detector measures this period and sets the OCD Baud Rate Generator accordingly.

The Auto-Baud Detector/Generator is clocked by the Z8F640x family device system clock. The minimum baud rate is the system clock frequency divided by 512. For optimal operation, the maximum recommended baud rate is the system clock frequency divided by 8. The theoretical maximum baud rate is the system clock frequency divided by 4. This theoretical maximum is possible for low noise designs with clean signals. Table 92 lists minimum and recommended maximum baud rates for sample crystal frequencies.

Table 92. OCD Baud-Rate Limits

System Clock Frequency (MHz)	Recommended Maximum Baud Rate (kbits/s)	Minimum Baud Rate (kbits/s)
20.0	2500	39.1
1.0	125.0	1.96
0.032768 (32KHz)	4.096	0.064

Table 126. 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
BTJZ bit, src, dst	if src[bit] = 0 PC ← PC + X		r	F6	-	-	-	-	-	-	3	3
			Ir	F7							3	4
CALL dst	SP ← SP -2 @SP ← PC PC ← dst	IRR		D4	-	-	-	-	-	-	2	6
		DA		D6							3	3
CCF	C ← ~C			EF	*	-	-	-	-	-	1	2
CLR dst	dst ← 00H	R		B0	-	-	-	-	-	-	2	2
		IR		B1							2	3
COM dst	dst ← ~dst	R		60	-	*	*	0	-	-	2	2
		IR		61							2	3
CP dst, src	dst - src	r	r	A2	*	*	*	*	-	-	2	3
		r	Ir	A3							2	4
		R	R	A4							3	3
		R	IR	A5							3	4
		R	IM	A6							3	3
		IR	IM	A7							3	4
CPC dst, src	dst - src - C	r	r	1F A2	*	*	*	*	-	-	3	3
		r	Ir	1F A3							3	4
		R	R	1F A4							4	3
		R	IR	1F A5							4	4
		R	IM	1F A6							4	3
		IR	IM	1F A7							4	4
CPCX dst, src	dst - src - C	ER	ER	1F A8	*	*	*	*	-	-	5	3
		ER	IM	1F A9							5	3
CPX dst, src	dst - src	ER	ER	A8	*	*	*	*	-	-	4	3
		ER	IM	A9							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 127. Opcode Map Abbreviations

Abbreviation	Description	Abbreviation	Description
b	Bit position	IRR	Indirect Register Pair
cc	Condition code	p	Polarity (0 or 1)
X	8-bit signed index or displacement	r	4-bit Working Register
DA	Destination address	R	8-bit register
ER	Extended Addressing register	r1, R1, Ir1, Irr1, IR1, rr1, RR1, IRR1, ER1	Destination address
IM	Immediate data value	r2, R2, Ir2, Irr2, IR2, rr2, RR2, IRR2, ER2	Source address
Ir	Indirect Working Register	RA	Relative
IR	Indirect register	rr	Working Register Pair
Irr	Indirect Working Register Pair	RR	Register Pair

controller 111
controller signals 13
interrupts 112
operation 111
SDA and SCL signals 111
stop and start conditions 112
I2CBRH register 121
I2CBRL register 121
I2CCTL register 119
I2CDATA register 118
I2CSTAT register 118
IM 184
immediate data 184
immediate operand prefix 185
INC 187
increment 187
increment word 187
INCW 187
indexed 184
indirect address prefix 185
indirect register 184
indirect register pair 184
indirect working register 184
indirect working register pair 184
infrared encoder/decoder (IrDA) 95
instruction set, ez8 CPU 182
instructions
ADC 187
ADCX 187
ADD 187
ADDX 187
AND 190
ANDX 190
arithmetic 187
BCLR 188
BIT 188
bit manipulation 188
block transfer 188
BRK 190
BSET 188
BSWAP 188, 191
BTJ 190
BTJNZ 190
BTJZ 190
CALL 190
CCF 188, 189
CLR 189
COM 190
CP 187
CPC 187
CPCX 187
CPU control 189
CPX 187
DA 187
DEC 187
DECW 187
DI 189
DJNZ 190
EI 189
HALT 189
INC 187
INCW 187
IRET 190
JP 190
LD 189
LDC 189
LDCI 188, 189
LDE 189
LDEI 188
LDX 189
LEA 189
load 189
logical 190
MULT 187
NOP 189
OR 190
ORX 190
POP 189
POPX 189
program control 190
PUSH 189
PUSHX 189
RCF 188, 189
RET 190
RL 191
RLC 191
rotate and shift 191
RR 191