Zilog - Z8FS021AHH20EG Datasheet

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What Are Embedded - Microcontrollers - Application Specific?

Details	
Product Status	Active
Applications	Infrared Motion Detection
Core Processor	eZ8®
Program Memory Type	FLASH (2KB)
Controller Series	Z8 Encore! XP®
RAM Size	256 x 8
Interface	UART/USART
Number of I/O	16
Voltage - Supply	2.7V ~ 3.6V
Operating Temperature	-40°C ~ 105°C
Mounting Type	Surface Mount
Package / Case	20-SSOP (0.209", 5.30mm Width)
Supplier Device Package	-
Purchase URL	https://www.e-xfl.com/product-detail/zilog/z8fs021ahh20eg

Revision History

Each instance in the following revision history table reflects a change to this document from its previous version. For more details, refer to the corresponding pages or appropriate links provided in the table.

Date	Revision Level	Description	Page Number
Oct 2011	04	Corrected error in ePIR_SC1 description, Table 9; modified Packaging section.	29, 46
Jul 2011	03	Corrections to ePIR_SC1, ePIR_Process_Rate and ePIR_Signal_DC registers	29, 40, 44
Apr 2011	02	Corrections to PIR Noise Sensitivity Level Register and PIR Transient Sensitivity Level Register.	42
Feb 2011	01	Original issue.	All

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- Programmable transient and noise detection

Z8FS021 MCU Features

- High-performance eZ8® CPU core
- 2KB in-circuit programmable Flash available for application code
- Single-pin debug with unlimited breakpoints
- Flexible clocking scheme
- Internal precision oscillator running at 5.53MHz
- External oscillator operating up to 20MHz
- Sigma Delta ADC
- Up to 6 single-ended channels or 3 differential channels available
- On-chip analog comparator with independent programmable reference voltage
- Full-duplex UART with dedicated BRG
- Two 16-bit timers with input capture, output compare and PWM capability (11 modes total)
- Watchdog timer (WDT) with dedicated internal oscillator
- Up to 20 vectored interrupts
- 6 to 25 I/O pins depending upon package
- 2.7V to 3.6V operating voltage with extended operating temperature range –40°C to +105°C
- Low power modes

Signal Descriptions

Table 2 describes the Z8FS021 MCU signals. Signal availability is package dependent. See the Pin Configuration section on page 5 for signal availability multiplexing.

Table 2. Z8FS021 MCU Signal Descriptions

Signal Mnemonic	I/O	Description
General-Purpose I/O Ports A–D		
PA[7:0]	I/O	Port A. These pins are used for general-purpose I/O.
PB[5:0]	I/O	Port B. These pins are used for general-purpose I/O.
PC[7:0]	I/O	Port C. These pins are used for general-purpose I/O.
PD[0]	O	Port D. This pin is used for general-purpose output only.
UART Controllers		
TXD0	O	Transmit Data. This signal is the transmit output from the UART and IrDA.
RXD0	I	Receive Data. This signal is the receive input for the UART and IrDA.
CTS0	I	Clear To Send. This signal is the flow control input for the UART.
DE	O	Driver Enable. This signal allows automatic control of external RS-485 drivers. It is approximately the inverse of the Transmit Empty (TXE) bit in the UART Status 0 Register. The DE signal can be used to ensure that the external RS-485 driver is enabled when data is transmitted by the UART.
Timers		
T0OUT/T1OUT	O	Timer Output 0–1. These signals are outputs from the timers.
T0OUT/T1OUT	O	Timer Complement Output 0–1. These signals are output from the timers in PWM Dual Output mode.
T0IN/T1IN	I	Timer Input 0–1. These signals are used as the capture, gating and counter inputs.
Comparator		
CINP/CINN	I	Comparator Inputs. These signals are the positive and negative inputs to the comparator.
COUT	O	Comparator Output.
Analog		
ANA[7:0]	I	Analog Port. These signals are used as inputs to the analog-to-digital converter (ADC).
V_{REF}	I/O	Analog-to-digital converter reference voltage input, or buffered output for internal reference.

UART

8-Pin Device	/CTS0 is configured as ANA2 to support the signal input from the Pyroelectric sensor. It is therefore not available to the user application. The UART is still able to function correctly without /CTS when CTSE in the U0CTL0 Register is set to 0.
20-Pin Device	All external UART functions are available for the user application.
28-Pin Device	All external UART functions are available for the user application.

Oscillator Control

All devices can be operated with the internal 5.54 MHz IPO. For applications that require more processing power or a more accurate time base, an external crystal oscillator or ceramic resonator can be used.

When using the 8-pin device, external oscillator support is limited to Single Pyro Mode only, because ANA3 (the ADC input for a second pyro sensor) is multiplexed with X_{OUT}. The 20- and 28-pin devices can be operated with an external oscillator in both Single and Dual Pyro modes.

! **Caution:** Do not operate at frequencies lower than the IPO frequency while the PIR Engine is enabled or motion detection performance will be degraded.

No other changes or limitations are placed on oscillator control functions by the PIR Engine.

Flash Memory

The control registers associated with Flash memory are all available to the application. The PIR Engine uses the value programmed into the Flash Frequency registers (FFREQ) to determine the required sample rate of the ADC and other functions. The Flash Frequency High (FFREQH) and Flash Frequency Low Byte (FFREQL) registers must be programmed prior to initializing the PIR Engine. These two registers combine to form a 16-bit value, FFREQ. This value is the System Clock Frequency in KHz and is calculated using the following equation.

```
FFREQ[15:0] = {FFREQH[7:0],FFREQL[7:0]} = (System Clock
Frequency)/1000
```

PIR Engine and API

The ZMOTION MCU Series is developed upon the Z8 Encore! XP-based Z8F082A MCU with the added functionality of a motion detection (PIR) Engine. The PIR Engine is located in the upper 4KB area of the 8KB device, leaving 4KB of code space to the user application. The PIR Engine operates in the background and is controlled and monitored via an Application Programmer Interface (API). The API is a series of reserved registers in memory.

There are two sections to the API: Standard API Registers and Advanced API Registers, as described below.

Standard API Registers. These registers include all of the status and control functions required by most applications. These include sensitivity control, motion detection/direction status and operational modes.

Advanced API Registers. These registers provide additional control over the PIR Engine operation and allows it to be configured to support the pyroelectric sensor and lens being used in the application.

PIR Engine Timer Tick

Bit 7 of PIR Status/Control Register 1 provides a one-second time base for the PIR Engine to perform housekeeping operations. This bit must be set to 1, once per second by the user application. The bit is checked and cleared during the EPIR_ADC_ISR routine.

PIR Engine Entry Points

There are two entry points to the PIR Engine that are accessed via two predefined macros – one is an initialization macro that is used to start the Engine and the other is executed upon every ADC interrupt. Both macros save and initialize the Register Pointer, perform a call to the PIR Engine entry point and then restore the Register Pointer before returning control to the application. It is the responsibility of the application software to execute these macros at the appropriate time.

ePIR_INIT Macro. This macro is executed to initialize the PIR Engine after reset. It is normally only executed once and is used in conjunction with the PIR Engine Enable Register in the Standard API section. The application should initialize all API registers, write the PIR Enable Pattern to the PIR Engine Enable Register, then execute this macro. ADC conversions are started by this macro.

```
EPIR_INIT Macro:
PUSHX                       RP
LDX                         RP, #%E0
CALL                        %1FFD
POPX                        RP
```

Dual Pyro Mode (Bit 0)

Dual Pyroelectric Sensor Signaling Mode; controlled by the application.

- This bit determines if the PIR Engine should accept signals from one or two pyroelectric sensors.
- When configured for single pyro operation, only one sensor is used (connected to ANA2). When configured for dual pyro operation, the Engine will scan two sensors simultaneously. Dual pyro mode is typically used to provide a larger area of coverage. The second pyroelectric sensor is connected to input ANA3. In Dual Pyro Mode, motion on either sensor will generate a motion detected event.

  0 = Single pyroelectric sensor mode.

  1 = Dual pyroelectric sensor mode.

Table 10. PIR Status/Control Register 2 (ePIR_SC2)

Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Field	White Light Threshold					Range Control		
Control	Read/Write					Read/Write		
Address	104H							

Bits 7–3 reserved
White Light Detection Threshold*
Controlled by application

- These bits determine how sensitive the White light detector is to changes in detected white light. Larger values cause the white light detector to be less sensitive. A value of 00000 disables White Light Detection. The light is sensed via the LED connected to the ANA1 pin. Light shining on the LED creates a small current that can generate enough voltage on the pin to measure changes accurately. The PIR Engine automatically configures the ADC to single-ended buffered mode and performs the necessary conversions and processing. See the White Light Detection section on page 19 for a description of White Light operation.

Note: *This register is ignored in Low Power Mode; White Light Detection is disabled by Lower Power Mode.

Range Control (Bits 2–0)

Motion Detection Range Control; controlled by the application.

- These bits determine the relative range of motion detection. Larger values decrease the range of detection.
- Typical values used for range control are dependent on the lens and pyroelectric sensor being used. Range is also dependent on target size, speed and relative temperature. For example, a range control setting that rejects one target of a particular size at a given distance does not guarantee that a larger target will be rejected at the same distance.

Table 14. PIR ADC Result Value (ePIR_ADC_Result)

Bit	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Field	ADC Result Value															
Control	Read															
Address	10AH								10BH							

PIR ADC Result Value (Bits 0–15)

ADC Scan Request Result Value

Controlled by PIR Engine

The PIR ADC Result Value contains the result of the last application requested ADC conversion.

The data format is identical to that discussed in the Z8 Encore! XP Product Specification (PS0228) for registers ADCD_H and ADCD_L.

Example for requesting an ANA0 Conversion:

- Set bit 0 (ANA0 Scan Request) in PIR Status/Control Register 3 (ePIR_SC3).
- Wait until the ANA0 Scan Request bit is cleared by the Engine.
- Read the ADC conversion result from the PIR ADC Result Value register.

Note: Even though the ADC Result Value is a 16 bit register, atomic operations are not required since the value is only updated at the request of the application.

Table 15. PIR Version (ePIR_Version)

Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Field	Version							
Control	Read							
Address	10CH							

Version (Bits 0–7)

PIR Engine software version; controlled by the PIR Engine.

- The value stored in this register indicates the software version of the PIR Engine.

Value	PIR Engine Software Version
11h	2.00

Table 19. PIR Advanced Status/Control Register 2 (ePIR_ASC2)

Bit	7	6	5	4	3	2	1	0
Field	Lock Level			Window Size		Window Update Rate		
Control	R/W			R/W		R/W		
Address	F2H							

Lock Level (Bits 7–5)

Controlled by the application.

- This parameter sets the minimum slope change in the signal that can be considered valid motion. This prevents small signal changes caused by environmental or V_{CC} shifts from causing a false detection. Use this value in combination with PIR Sensitivity and Range Control settings to balance sensitivity and stability to the particular lens and pyroelectric sensor being used.
  - Smaller values allow subtle signals with lower slopes to be considered motion events at the expense of potential false motion events.
  - Larger values allow the system to ignore smaller signal slope changes at the expense of potentially missing smaller motion events.

Window Size (Bits 4–3)

Controlled by the application.

- This register determines the size of the control limit window. A larger window size produces more stable control limits at the cost of additional CPU usage. If a smaller window size is used, the more frequently the window can be calculated which allows it to track the signal better.

  00 = Reserved.

  01 = Small window.

  02 = Medium window.

  03 = Large window.

Window Update Rate (Bits 2–0)

Controlled by the application.

- This register determines how frequently the control limits are calculated. It is measured in PIR samples. A smaller number produces more frequent calculations which allow the control limits to track the signal better, at the cost of increased CPU usage. The valid range is 0 to 7.
- The window is updated every 4 + (Window Update Rate * 2) PIR samples.

Table 20. PIR Process Rate (ePIR_Process_Rate)

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Field	PIR Process Rate															
Control	Read															
Address	F3H								F4H							

ePIR Process Rate (Bits 15–0)

Controlled by the PIR Engine.

- The PIR Process Rate Indicator is provided by the Engine to determine if the user application process and interrupts overhead is impacting the performance of the Engine. If the Engine process rate drops significantly, its ability to detect motion can be significantly reduced. This value is typically used at the application development stage. This number gives an indication of how much CPU time the Engine is receiving. Higher numbers are better. Generally, if the process rate drops below 0080h, the ability to detect motion could be compromised.

Note: The 16-bit value provided by these two 8-bit registers must be read as an atomic operation by the application. This read can be ensured by using either the CPU's ATM instruction or by disabling interrupts while reading the two 8-bit registers.

Table 21. PIR Sample Size Register (ePIR_Sample_Size)

Bit	7	6	5	4	3	2	1	0
Field	PIR Sample Size							
Control	Read/Write							
Address	F5H							

PIR Sample Size (Bits 7–0)

Controlled by the application.

- This register controls the amount of averaging that the Engine performs on the incoming PIR signal ADC samples. More averaging improves signal noise immunity at the cost of a slower sample rate.

Table 24. PIR Transient Sensitivity Level Register (ePIR_Transient_Sense)

Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Field	Reserved	PIR Transient Sensitivity						
Control	0	Read/Write						
Address	F8H							

Reserved (Bit 7)

This bit is reserved and must be 0.

Transient Sensitivity (Bits 6–0)

Controlled by the application.

- This register determines how sensitive the transient detection part of the engine is to sudden changes in the PIR signal. A lower number makes the engine more sensitive at the cost of potential rejection of large signal motion (for example, a warm target very close to the detector). The valid range is 0 (disabled) to 64h.

Table 25. PIR Noise Sensitivity Level Register (ePIR_Noise_Sense)

Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Field	Reserved	PIR Noise Sensitivity						
Control	0	Read/Write						
Address	F9H							

Reserved (Bit 7)

This bit is reserved and must be 0.

Noise Sensitivity (Bits 6–0)

Controlled by the application – see Table 26 for values.

- This register determines how sensitive the noise detection part of the Engine is to random noise in the PIR signal. A lower number makes the noise detector more sensitive at the cost of potential rejection of small-signal motion (for example, a small delta between the ambient and target temperatures, or a distant target). The valid range is 0 (disabled) to a maximum value determined by the Window Size selected in the PIR Advanced Status/Control Register 2.

Table 30. PIR Extended Detection Debounce Timeout (ePIR_Extended_Timeout)

Bit	7	6	5	4	3	2	1	0
Field	PIR Extended Detection Debounce Timeout							
Control	Read/Write							
Address	FEH							

Extended Detection Debounce Timeout (Bits 7–0)
Controlled by the application. • This register determines how long the Extended Detection part of the Engine waits for a motion event to be confirmed. A higher number makes the extended detector wait longer, at the cost of potential false motion events. The valid range is 1 (short debounce) to 255 (long debounce) with typical values between 3 and 30. Related control features include the PIR Extended Detection Level (PIR_SC0) and the PIR Extended Detection Sensitivity Level.

Packaging

Zilog's Intrusion Detection Solution takes advantage of the Z8FS021 MCU, which is available in the following three packages:

- 8-Pin Small Outline Integrated Circuit Package (SOIC)
- 20-Pin Small Shrink Outline Package (SSOP)
- 28-Pin Small Shrink Outline Package (SSOP)

Current diagrams for each of these packages are published in Zilog's Packaging Product Specification (PS0072), which is available free for download from the Zilog website.

MCU, lens and pyroelectric sensor you wish to order. There are four fields in the part number that determine this combination. See Appendix D. Lens Specifications on page 63 for a lens selection guide and the ZMOTION Lens and Pyroelectric Sensor Product Specification (PS0286) for details about each lens type.

Order the ZMOTION Intrusion Detection device from Zilog using the fields denoted in Table 33. To better understand the position and field elements noted in this table – and therefore to build the appropriate part number – please refer to Selector Tables 34 through 37, and see the Ordering Example shown in Table 38 on page 49.

Table 33. ZMOTION Intrusion Detection Device Number Schema

Position:	1	2	3	4	5	6	7	8	9	10	11	12	13
Field	Z	M	O	T	MCU		MCU Package		Lens		PIR		G
					User-Defined Options								

Table 34. Device Number Description, Positions 1–4: Product Family Selector

ZMOT	ZMOTION Product Family

Table 35. Device Number Description, Positions 5–8: MCU and Package Selector

MCU Part Number	Description	PIR Software Revision	MCU (Positions 5 & 6)	Package (Positions 7 & 8)
Z8FS021xSB20EG	Intrusion, 8-pin SOIC	2.00	1A	SB
Z8FS021xHH20EG	Intrusion, 20-pin SSOP	2.00	1A	HH
Z8FS021xHJ20EG	Intrusion, 28-pin SSOP	2.00	1A	HJ

Note: The second character in the MCU field refers to the PIR Software Engine revision; see Table 4 on page 23.

Table 36. Device Number Description, Positions 9–12: Lens and PIR Sensor Selector

Manufacturer	Part Number	Description	Lens Field (Pos. 9 & 10)	PIR Sensor	PIR Field (Pos. 11 & 12)
Fresnel Technologies	WA 1.2 GI 12 V4	Wide Angle Array (88°); 18m range	0E	RE200B	0A

Table 36. Device Number Description, Positions 9–12: Lens and PIR Sensor Selector

Manufacturer	Part Number	Description	Lens Field (Pos. 9 & 10)	PIR Sensor	PIR Field (Pos. 11 & 12)
Fresnel Technologies	VB 1.2 GI V1	Vertical Barrier Array; 10m range	0F	RE200B	0A
Fresnel Technologies	LR 1.2 GI 12 V3	Long Range Array; 30.5m range	0G	RE200B	0A

Table 37. Device Number Description, Position 13: Environmental Flow Selector

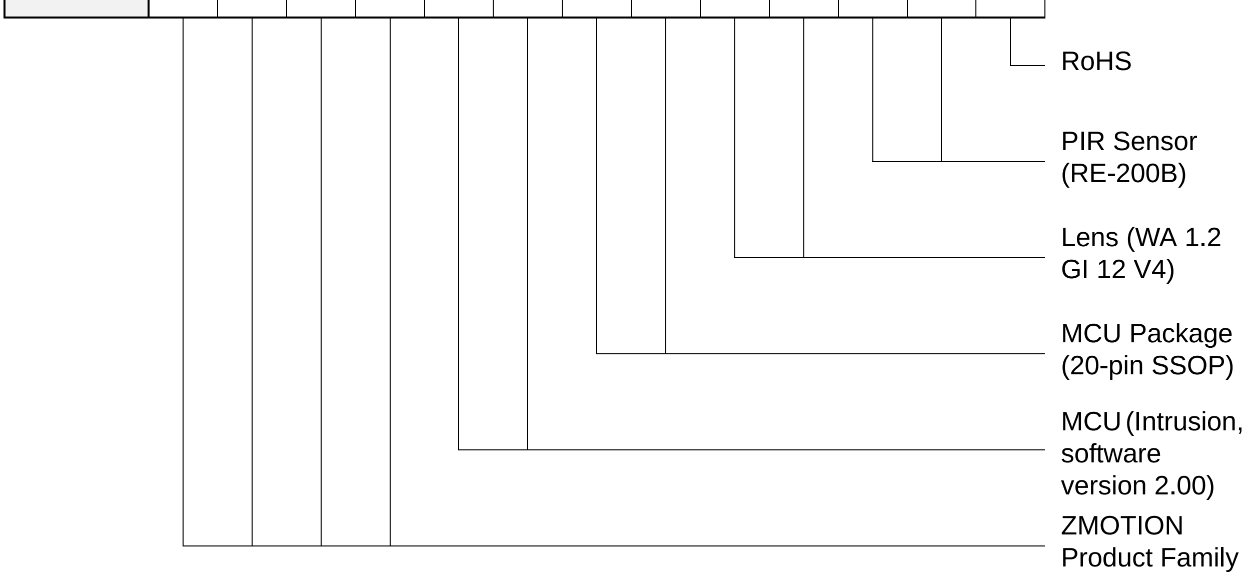
G	Lead-Free, RoHS-Compliant

Intrusion Detection Bundle Ordering Example

As an example of Zilog's part numbering schema, Part Number ZMOT1AHH0E0AG breaks out into the field components indicated in Table 38.

Table 38. ZMOTION Intrusion Detection Device Number Example

Position	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Field	Z	M	O	T	MCU		MCU Package		Lens		PIR		G
Example	Z	M	O	T	1	A	H	H	0	E	0	A	G



Appendix A. Example Application Schematics

Whether you choose to employ single or dual pyro modes using 8-pin, 20-pin or 28-pin ZMOTION Intrusion Detection packages, this appendix offers assistance toward creating your circuit design.

Z8FS021xSB20EG (8-Pin Device)

Figure 7 shows an example circuit for the 8-pin version of the ZMOTION Intrusion Detection MCU. The interface to the pyroelectric sensor is via the dedicated input ANA2 (Pin 5).

The status LED is driven by Pin 6, which is normally configured as a GPIO by the application to control the state of the LED. When White Light Detection is enabled, the PIR Engine automatically reconfigures this pin to an ADC input to perform the necessary ADC conversion and returns it to a GPIO when conversion is complete.

Pin 2 is used as the debug input to the chip, but can be used for other functions as required. Pin 4 is set up for the Reset function, but can also be used for other functions as the application requires. Pull-up resistors (10KΩ) are provided on the Debug and Reset signals as required for the Debug interface.

The signals on pins 3 and 7 can be used as required by the application. The power supply design remains available to application requirements.

In Dual Pyro mode, the second Pyroelectric sensor is connected to Pin 3 (ANA3). All other connections remain the same.

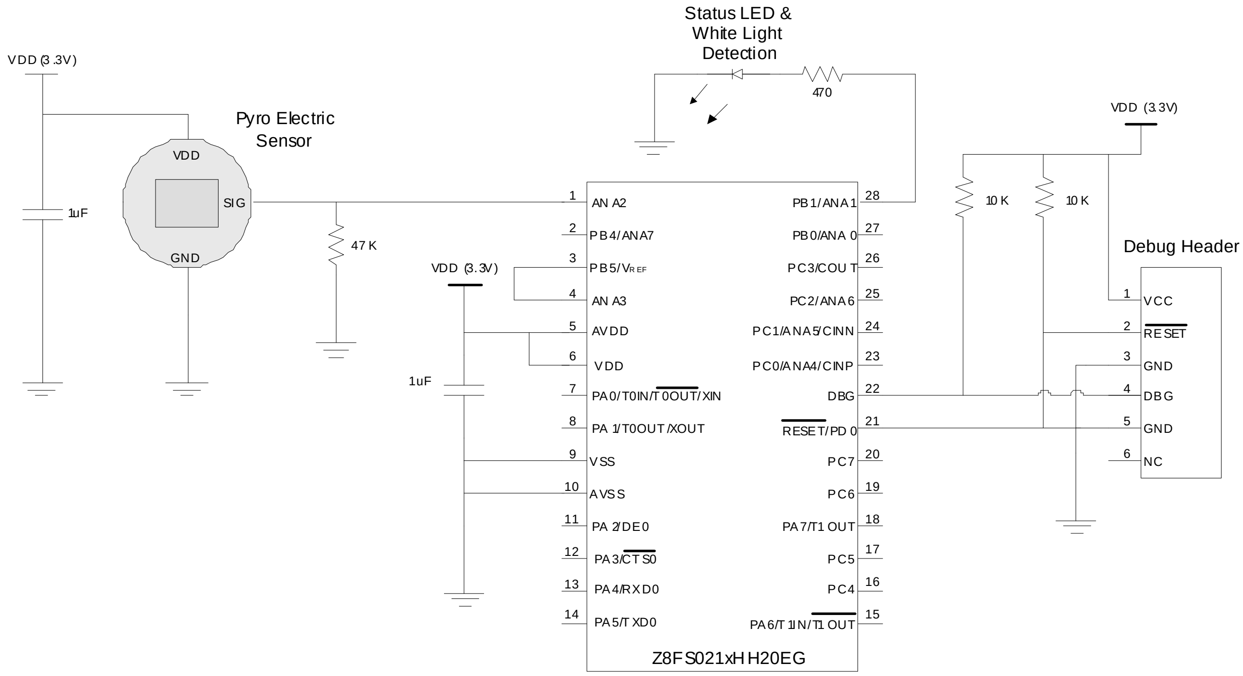


Figure 10. Example Circuit with the Z8FS021xHJ20EG (28-Pin) ZMOTION Intrusion Detection MCU, Single Pyro Mode

The flow diagram shown in Figure 12 displays the general software operation for Normal Scan Rate mode.

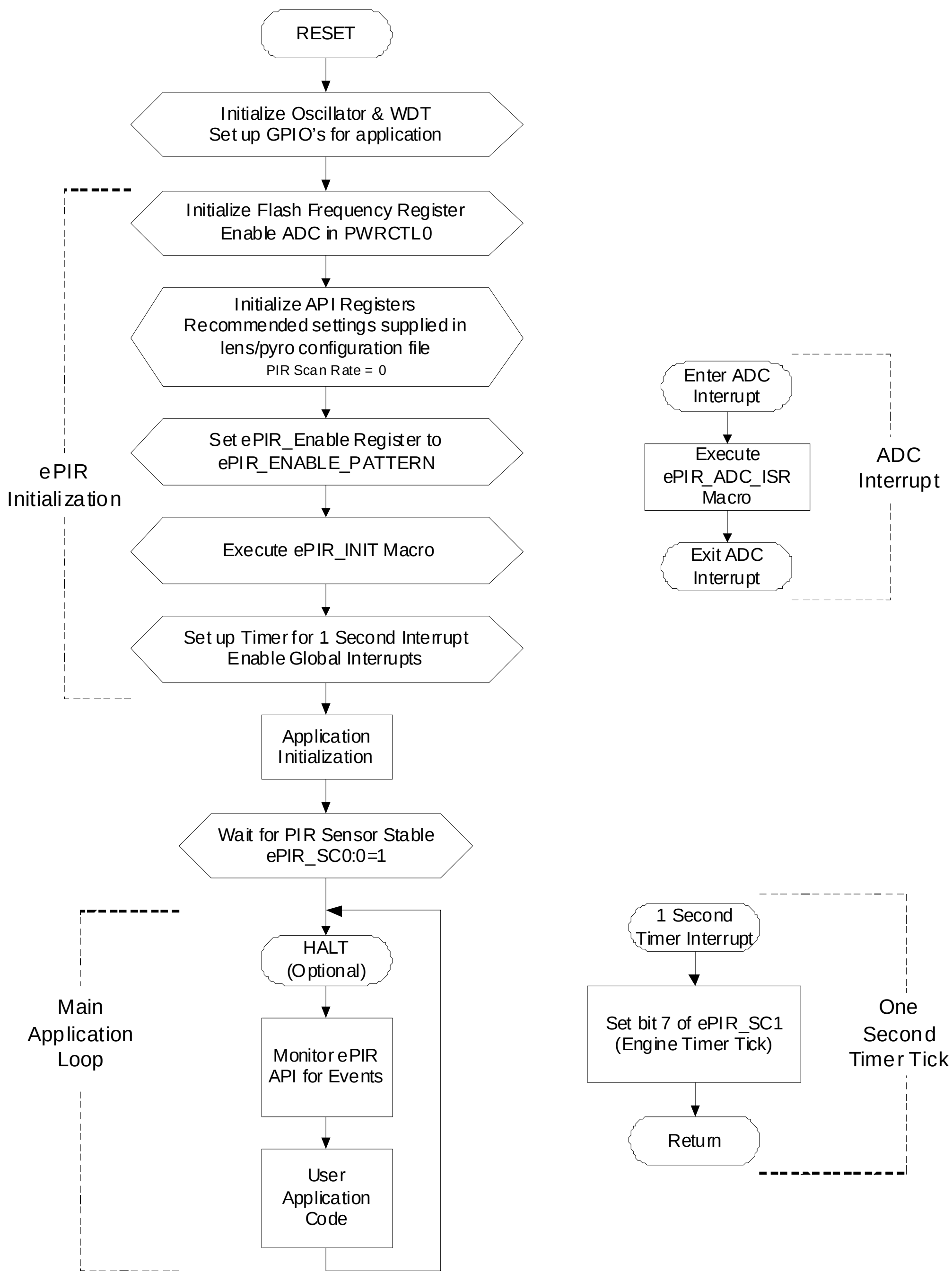


Figure 12. Application Flow Diagram, Normal Scan Rate

The flow diagram shown in Figure 13 displays the general software operation for Low Scan Rate mode.

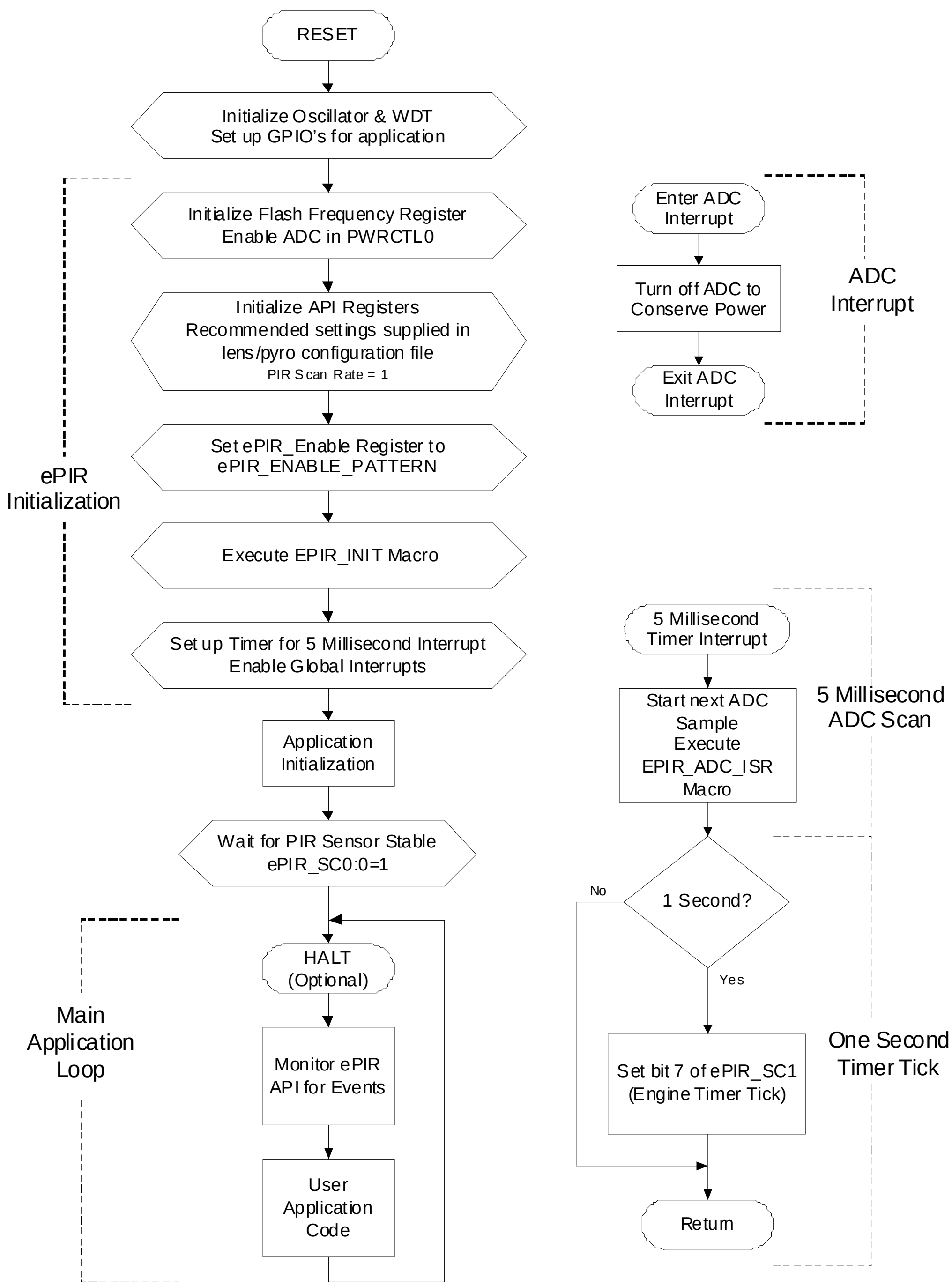


Figure 13. Application Flow Diagram, Normal Scan Rate

Appendix D. Lens Specifications

Use Table 39 to select the appropriate lens for your specific application. The configuration header file should be included with your ZMOTION project. Refer to the ZMOTION Lens and Pyroelectric Sensor Product Specification (PS0286) for detailed lens specifications. Contact Zilog for additional lens and PIR Sensor options.

Table 39. Lens Selection Guide

Manufacturer	Part Number	Description	Typical Applications	Configuration Header File
Fresnel Technologies	WA 1.2 GI 12 V4	Wide Angle Array (88.2°) Flat lens: 42.6mm x 61mm 18 meter range 1.2 inch focal length	• Intrusion Detection • 18m corner mount	API_INIT_09.h
Fresnel Technologies	VB 0.9 GI T1	Vertical Barrier Array Flat lens: 35.6mm x 49.9mm 2 beams (7.5°) 10 meter range 0.9 inch focal length	• Curtain Style Intrusion Motion Detector • Access Control	API_INIT_11.h
Fresnel Technologies	LR 1.2 GI 12 V3	Long Range Array Flat lens: 42.6mm x 61mm 30.5 meter range 1.2 inch focal length	• Corridor Detector • Combined Intrusion + Hallway Lighting Control	API_INIT_10.h