Application Note

ePIR™ and Z8 Encore! XP® in Serial Interface with Digital Picture Frame

AN029701-1108

Abstract

This Application Note describes how Zilog's Enhanced Passive Infrared (ePIR™) can be used to detect motion and identify the hand wave direction (left-to-right or right-to-left). Zilog's Z8 Encore! XP® F1680 MCU is used to turn ON/OFF and control the movement in the Digital Picture Frame (DPF).

Note: *The source code file associated with this application note,* `AN0297-SC01.zip` *is available for download at* www.zilog.com.

ePIR™ Overview

ePIR Motion Detection Zdots® Single Board Computer (SBC) is a complete, compact, and high-performance product specifically designed for the rapid development and deployment of products requiring control based on infrared motion detection. It combines the unique features of the Z8 Encore! XP® MCU with powerful new software detection algorithms and delivers a significant performance improvement over traditional passive infrared (PIR) based solutions. Based on PIR sensor technology, it is a complete motion detector solution including *PIR sensor* and *Fresnel lens*. Parameters for sensitivity and output timing are provided through a simple hardware interface or more advanced settings and status are available through a serial interface. The ePIR Motion Detection Zdots SBC provides a dramatic improvement in both sensitivity and stability and is scalable to various market segments including Lighting Control, Access Control, Vending, Display, Proximity, and Power Management.

Features

The key features of ePIR include:

- Complete, fully functional motion detection SBC including Fresnel lens
  - Comes pre-programmed with motion detection software
- Small form factor—25.5 mm x 16.7 mm
- Wide 5 m x 5 m, 60 degree detection pattern
- Sensitivity control via simple hardware configuration
- Advanced serial (UART) based configuration and interface
- SLEEP mode for low-power applications
- No temperature compensation required
- Input to support CDS photocell input for ambient light detection
- Minimal components ensure highest possible Mean Time Between Failures (MTBF)
- Application code can also be modified to support custom solutions
- Complete development system available

Discussion

This section describes ePIR, F1680 MCU and DPF connections, and state diagram.

Hardware Architecture

Figure 1 on page 2 displays the data flow between ePIR™, F1680 MCU, and the Digital Picture Frame (DPF). ePIR continuously sends the status signals to the F1680 MCU, whether the (left-to-right, right-to-left) motion is detected or there is no

motion. Information is transferred between ePIR and F1680 MCU through UART communication. The F1680 MCU interprets the information from the ePIR and responds according to its state diagram (see Figure 7 on page 6). It powers ON the LCD if a motion is detected by sending logic 1 to the relay (see Figure 2 on page 3). The relay closes the power line of the DPF's LCD to turn it ON. The LCD is turned OFF by sending logic 0 to the relay by the F1680 MCU. This occurs after 4 sec (approximately) if the motion is not detected within the ePIR range (3 m x 3 m with a 60 degree angle).

In this hardware setup, logic 0 is required to activate NEXT and PREV of the DPF. These are connected to PB0 and PB1 of the F1680 MCU, respectively. PB0 and PB1 are configured as open-drain requiring pull-up resistor.

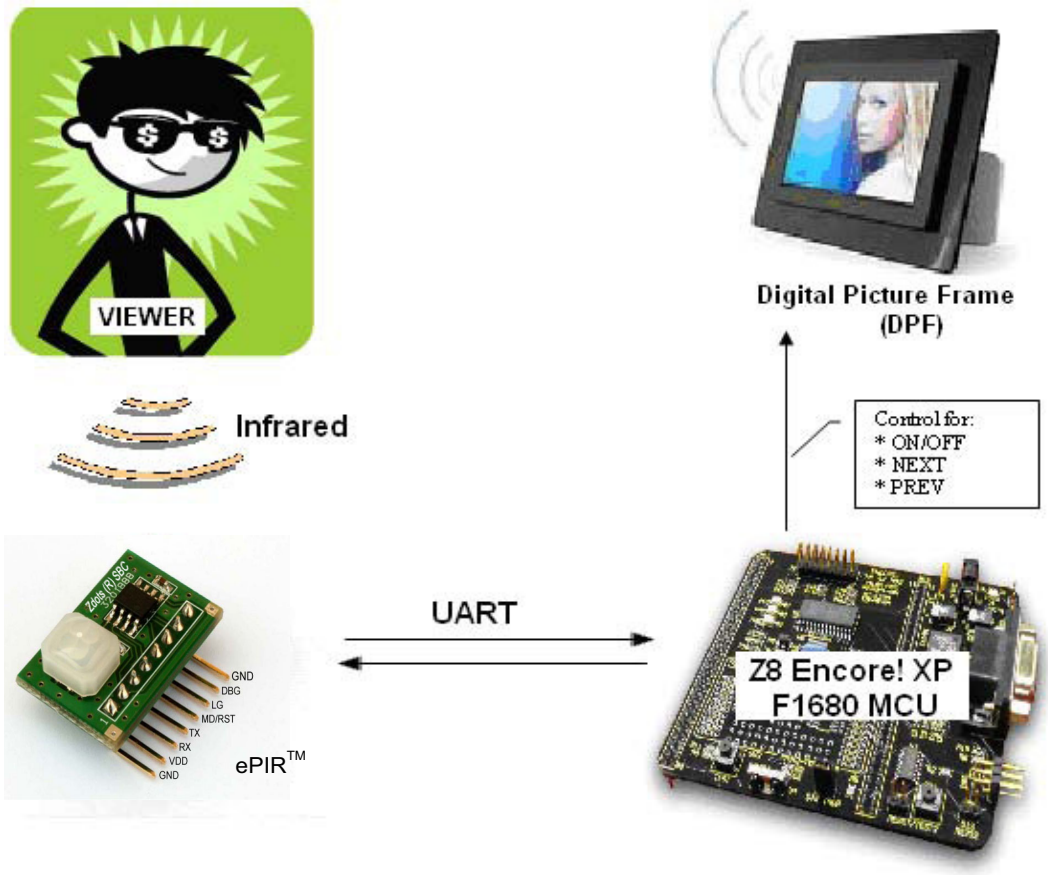

Figure 1. Hardware Setup

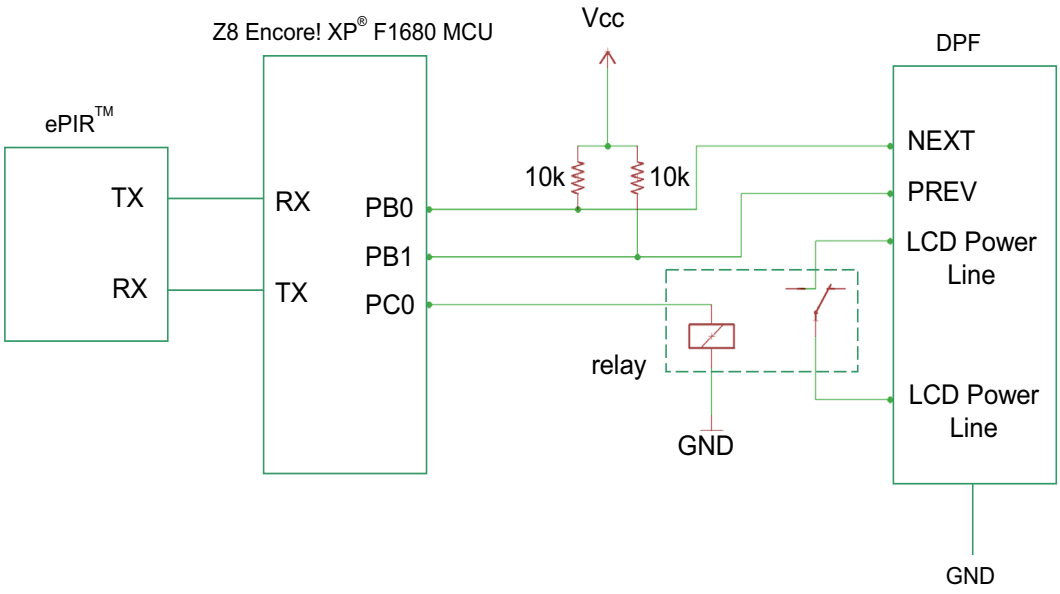

Figure 2. Schematic of Energy Saver Controller for DPF using ePIR™

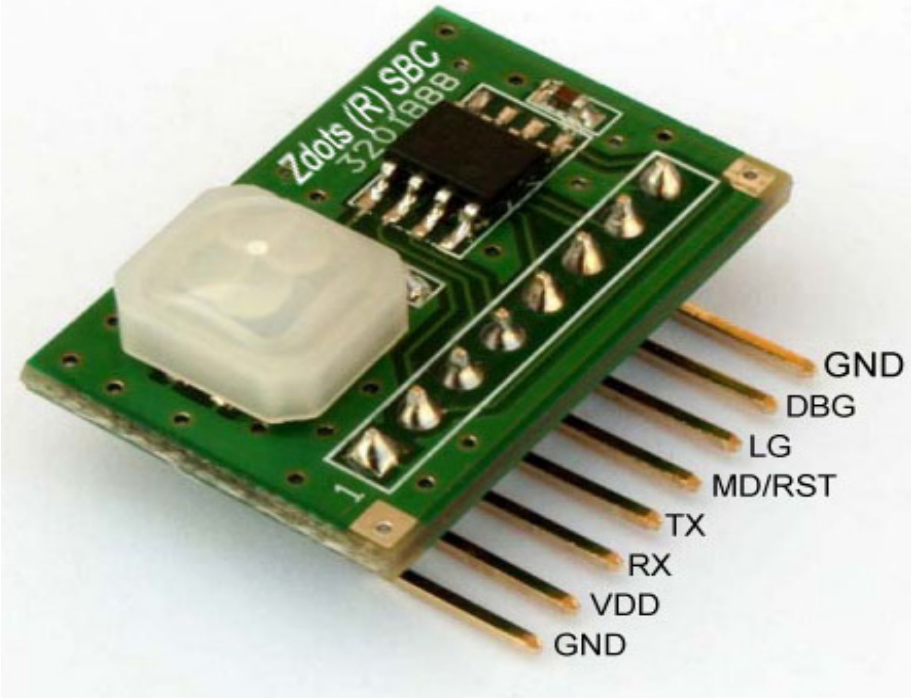

Figure 3. ePIR™ Pin Diagram

Table 1. ePIR™ Pin Description

Pin No.	Signal Name	Hardware Interface Mode	Serial Interface Mode	Description
1	GND	Ground	Ground	-
2	VDD	Supply Voltage	Supply Voltage	-
3	RXD/DLY	DLY-Delay (analog input)	RXD-Receive Data (digital input)	-
4	TXD/SNS	SNS-Sensitivity (analog input)	TXD-Transmit Data (digital output)	Mode select during Reset
5	/MD/RST	Motion Detect (digital output)	Configurable: /RST-Reset (digital input) /MD-Motion Detect (digital input)	Default is /RST (Reset) in Serial Interface Mode
6	LG	Light Gate (analog input)	Light Gate (analog input)	If unused, connect to V_{dd}
7	/SLP/DBG	/SLP-Sleep (digital input)	/SLP-Sleep (digital input)	DBG is used for programming and debug
8	GND	Ground	Ground	-

Controlling DPF with ePIR™

Between the LCD and main board of the DPF (see Figure 4) are two wires (black is GND and orange is VCC) for LCD power. The VCC wire is connected to a relay. This is used to turn ON/OFF the LCD.

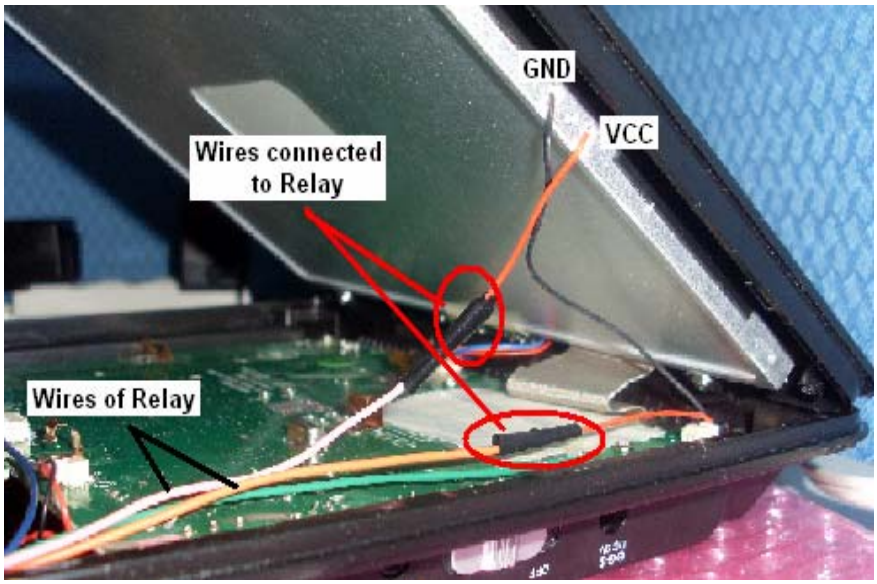

Figure 4. DPF LCD Power Line

Figure 5 displays the wire connection to control NEXT and PREV. These wires are connected to the F1680 MCU (see Figure 2 on page 3). Figure 6 displays the wire connections inside the DPF including GND.

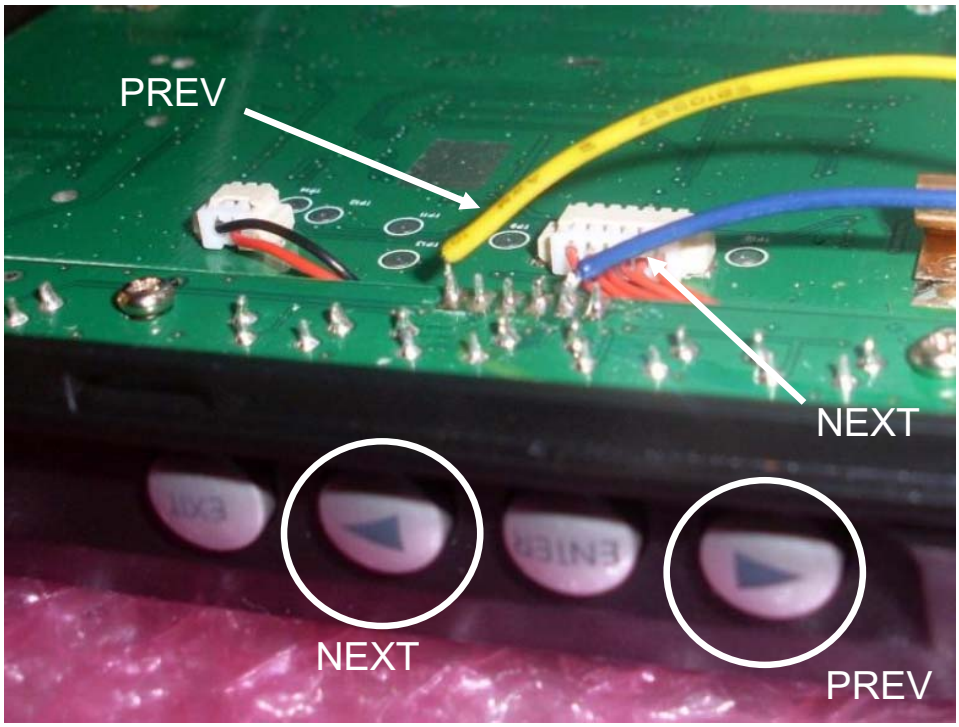

Figure 5. NEXT and PREV Wire Connection

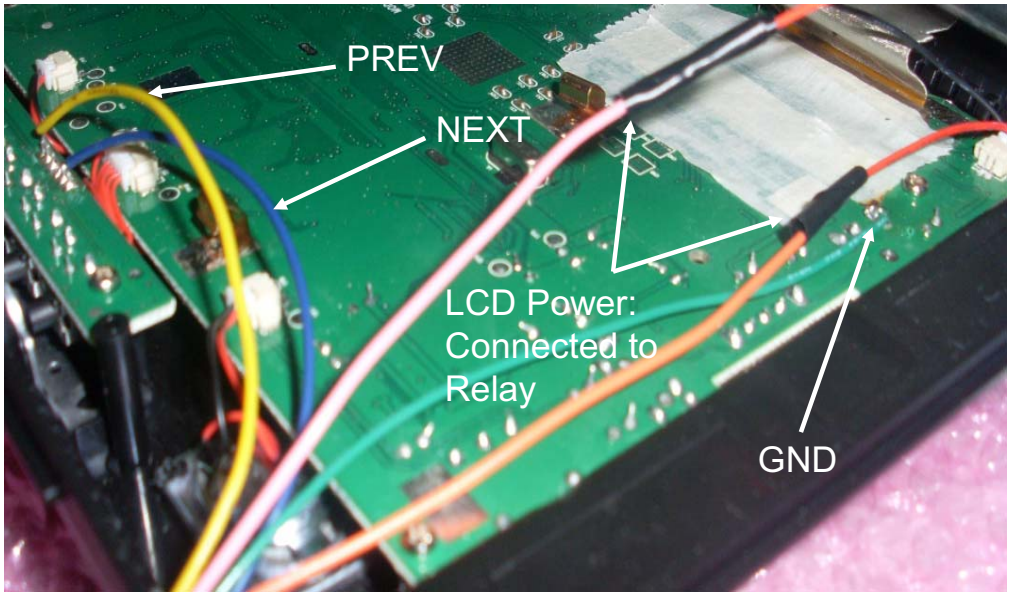

Figure 6. Wire Connections Inside the DPF

Software Implementation

Two firmware developed are:

1. For Z8FS040A (based on the Z8F082A device) of the ePIR
2. For Z8 Encore! XP® F1680 MCU

The firmware on the ePIR™ Zdots® SBC sends 'R' and 'L' to its UART when left-to-right motion and right-to-left motion is detected, respectively. When there is no motion, it sends `'_' (off1)`.

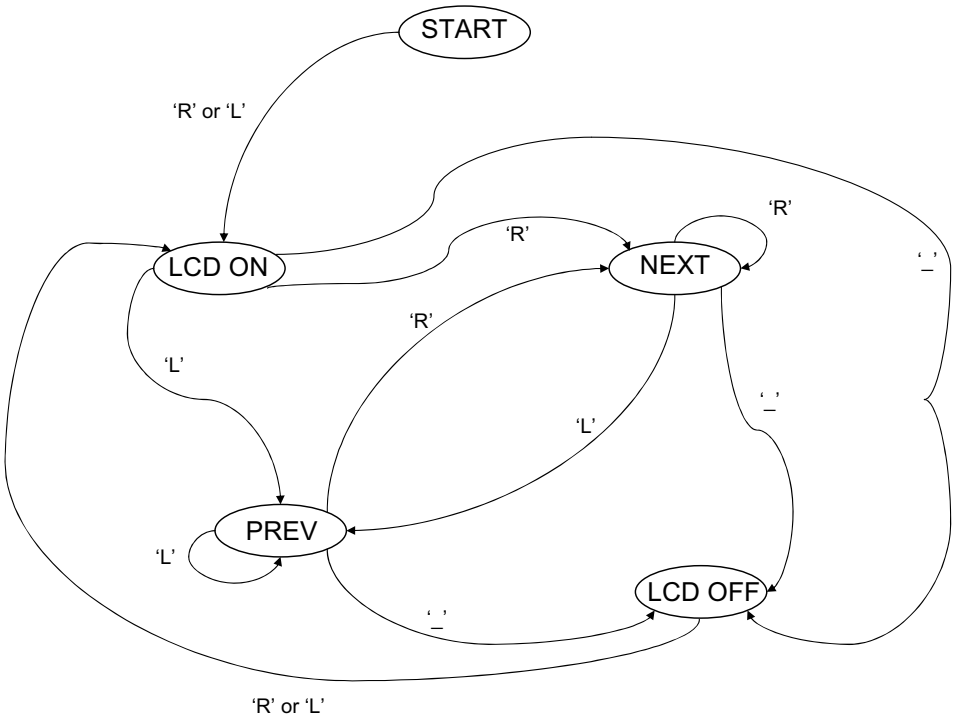

Figure 7. State Diagram

The state diagram in Figure 7 displays how the code on F1680 MCU flows. In the **START** state, the DPF is OFF and the initializations are completed.

Note: *In the DPF, only the LCD is OFF, and it is possible that pictures are running in slide show.*

Once the motion is detected, the state changes to **LCD ON**, turning ON the DPF's LCD and displays the picture. In the code, the F1680 MCU continuously monitors the data on the UART. If either 'L' or 'R' is received, logic 1 is send to the relay to turn ON the LCD. Also, the `STATUS` is changed to 1. It is used in the program to monitor if the LCD is ON (`STATUS = 1`) or OFF (`STATUS = 0`).

```
data=getchar();
if ((data =='L') || (data=='R'))
{
    lcd_on;
    STATUS = 1;
}
```

As the viewer waves the hand from left-to-right ('R'), `NEXT` state occurs which displays the next picture and for right-to-left ('L'), `PREV` state occurs which returns to the previous picture.

The following code snippet displays that the F1680 MCU continuously counts the number of 'R' (NEXT), 'L' (PREV), and '_' (off1) received from ePIR. Everytime it increments the number NEXT and PREV, counter for off1 that is used to trigger LCD OFF, is Reset.

```
for (i=0;i<7;i++)
    {
    data = getchar();
    if((data =='L') || (data=='R'))
      {
      if(data=='R')
         {
         next++;
         off1=0;
         }
      else if(data=='L')
         {
        prev++;
        off1=0;
        }
      }
    else if(data=='_')
        {
       off1++;
        }
    }
```

If NEXT is greater than PREV, next picture on DPF is displayed. Otherwise, the previous picture is displayed. On executing the lines to display next picture and previous picture, NEXT, PREV, and off1 are Reset.

```
else if(next>prev)
{
    disp_next;
    delay(1);
    disp_idle;
    delay(4);
    next=0;
    prev=0;
    off1 =0;

}
else if(prev>next)
{
    disp_prev;
    delay(1);
    disp_idle;
    delay(4);
    next=0;
    prev=0;
    off1 =0;
}
```

If there is no motion, the F1680 MCU receives '_'. **LCD OFF** state occurs after 4 sec (approximately). In this state, the F1680 MCU sends logic 0 to relay and turns OFF the LCD. When LCD turns OFF, the LCD, off1, and STATUS are Reset.

```
else if(off1 >= 50)
{
    lcd_off;
    delay(10);
    off1=0;
    STATUS = 0;
}
```

Theory of Operation

The ePIR™ controller on DPF demonstration performs the following:

1. If a viewer is within the range of the ePIR, DPF turns ON.
2. Once the DPF is ON, the viewer can control the slide show by waving the hand either left-to-right for next picture or right-to-left for previous picture.
3. If the viewer exits the range of the ePIR, the DPF turns OFF after 4 sec (approximately).

Summary

Using ePIR and Z8 Encore! XP® F1680, you can save power and control the DPF slide show with simple hand gestures. This setup turns the DPF ON/OFF by sensing the presence of human movement. Simple hand gestures left-to-right (NEXT) and right-to-left (PREV) controls the DPF's slide-show function. The life of the LCD is also more as power is turned OFF when not in use.

References

The documents associated with ePIR™ and Z8 Encore! XP® F1680 available on www.zilog.com are provided below:

- ePIR™ Motion Detection Zdots® SBC Development Kit Quick Start Guide (QS0073)
- ePIR™ Motion Detection Zdots® SBC Product Specification (PS0284)
- ePIR™ Motion Detection Zdots® Single Board Computer Product Brief (PB0223)
- ePIR™ Motion Detection Zdots® SBC Development Kit User Manual (UM0223)
- Z8 Encore! XP® F1680 Series Product Specification (PS0250)

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