Application Note

Controlling Power with the ZMOTION Detection Module and Clare Solid State Relays

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Abstract

This Application Note describes how to activate electrical appliances and commercial lighting devices using Zilog's ZMOTION Detection Module and a Clare Solid State Relay (SSR). In this document, we will use a DC-driven device to determine how it will function as a motion-detection switching system in combination with the Clare CPC1017N SSR (though a number of other Clare SSRs can be used in the application). This same concept can be used to control power in many other indoor lighting applications such as those employed in vending machines, kiosks and inventory display systems.

Indoor kiosk systems are typically always ON or always OFF. However, there is a more intelligent way of controlling the switching of a kiosk or similar system by employing motion detection. Incorporating a ZMOTION Detection Module with a Clare Solid State Relay into the system allows you to provide an automated switching system on different appliances. For this application, ZMOTION Hardware Interface Mode is used to control the switching mechanism.

ZMOTION technology relies on bodies in motion to trigger a set of desired reactions. This technology can be used to implement power management in lighting fixtures, electrical appliances and other applicable indoor devices.

ZMOTION Detection Module Overview

Zilog's ZMOTION Detection Module is a complete and fully functional motion detection solution, ideal for lighting control and other occupancy and proximity detection applications. It is a board-level module that combines the unique features of Zilog's Z8FS040 Motion Detection Microcontroller with a pyroelectric sensor and a low profile Fresnel lens.

Parameters for sensitivity and output timing are provided in a simple hardware interface mode; more advanced settings and status are available in serial interface mode. Whether you employ hardware or serial interface modes, sensitivity and delay time can be controlled to match application requirements.

The ZMOTION Detection Module enhances the reduction of design efforts and eliminates development risk for any device that requires motion detection capability. It is a solid choice for lighting controls, access control, display systems and general-purpose proximity sensing. It is also an easy way to add energy management capabilities to a number of applications, such as vending machines, appliances and even security systems.

ZMOTION Features

The main features of the ZMOTION Detection Module are:

- Complete, fully functional motion detection single-board computer, including a Fresnel lens
- Preprogrammed with motion detection software
- Small form factor: 25.5mm x 16.7mm
- Wide 5m x 5m, 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

Clare Solid State Relays Overview

Clare's line of solid state relays uses discrete semiconductor components and the patented OptoMOS architecture to deliver fast, reliable, bounce-free switching in a compact design. From one of the world's smallest single-pole, 4-pin relays to multi-pole and multi-function devices, OptoMOS products are ideal solid state replacements for larger reed and electromechanical relays. Compared to previous relay technologies, Clare relays offer significantly lower drive current, a small package type for simpler circuit design, no susceptibility to magnetic interaction, and solid state reliability.

Unlike other 4-pin products, Clare's small 4-pin SOP relays combine state-of-the-art double-molded, vertical-construction packaging with high performance to offer a reliable product with a savings of up to 20% in board space design. The dual-pole OptoMOS relays combine two independent relays into a single 8-pin package, paving the way for designers to condense more functionality into a single chip. Additionally, common-input OptoMOS relays provide a design alternative where two independent outputs are driven by the same input signal.

Clare Solid State Relays Features

Clare Solid State Relays offer the following features:

- Low drive current
- High reliability

- Optically isolated input and output
- No EMI/RFI generation
- Arc-free with no snubbing circuits
- Machine insertable, wave solderable
- AC/DC switching
- Current limiting (parts with an *L* suffix)
- FCC compatible

Applications

Clare Solid State Relays are ideal for the following types of applications:

- Telecommunications/data communications
- Multiplexers
- Data acquisition
- Electronic switching
- I/O subsystems
- Meters (Watt-hour, water, gas, etc.)
- Medical (patient/equipment isolation)
- Industrial applications (critical systems)

Table 1 lists the primary specifications of a number of Clare relays. This application employs the CPC1017N part.

Table 1. List of Available Clare Solid State Relays

Part Number	Blocking Voltage (Vp)	Current Handling (mA)	On-Resistance (Ω)	Isolation Voltage (Vrms)	Input control current (mA)	Off-State Leakage (µA)	Turn-On Time (ms)	Turn-Off Time (ms)
CPC1017N	60	100	16	1500	1	1	10	10
CPC1016N	100	100	16	1500	2	1	2	0.5
CPC1510	250	200	10	3750	5	1	2	2

Table 1. List of Available Clare Solid State Relays (Continued)

Part Number	Blocking Voltage (Vp)	Current Handling (mA)	On-Resistance (Ω)	Isolation Voltage (Vrms)	Input control current (mA)	Off-State Leakage (µA)	Turn-On Time (ms)	Turn-Off Time (ms)
LCA715	60	1800	0.25	3750	10	1	2.5	0.25
LCA717	30	2000	0.15	3750	2	1	3	3

Additional relays are available from Clare. Visit www.clare.com for detailed solid state relay specifications.

Discussion

This application note used a light bulb (example for a high DC load), ZMOTION Detection Module in Hardware Interface Mode and the Clare CPC1017N Solid State Relay to illustrate how a motion-detection switching system can be incorporated into simple household devices. This section describes the hardware connections of the ZMOTION Detection Module and any type of indoor device.

Hardware Architecture

Figure 1 shows the hardware interface between the ZMOTION Detection Module, Clare SSR and to any indoor peripheral. The ZMOTION Detection Module continuously monitors for motion within its detection area. When motion is detected, this will turn ON the Clare SSR and load. The module will turn OFF the Clare SSR and load when there is no motion for a predefined period of time.

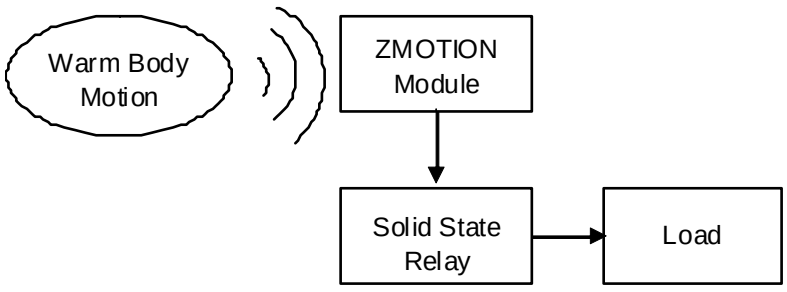

Figure 1. Hardware Setup for Load

Figure 2 and Table 2 illustrate and describe the pin functionality of the ZMOTION Detection Module. The module is capable of operating in Hardware and Serial interface modes. This application note uses the Hardware Interface Mode to demonstrate the capabilities of ZMOTION technology.

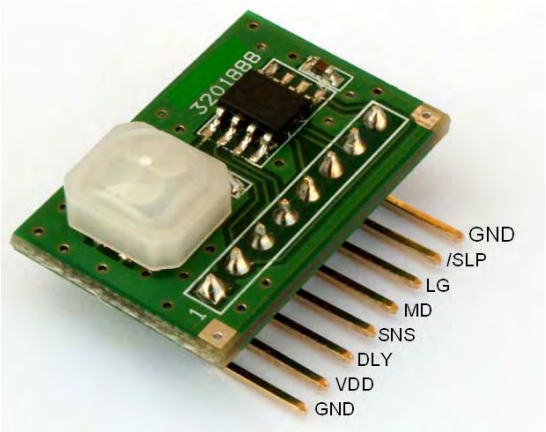

Figure 2. ZMOTION Detection Module Pin-Outs

Table 2. ZMOTION Detection Module 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 input)	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 VDD.
7	/SLP/DBG	/SLP Sleep (digital input)	/SLP Sleep (digital input)	DBG is used for programming and debug.
8	GND	Ground	Ground	—

Circuit Description

Figure 3 illustrates the connection of ZMOTION Detection Module to the Clare CPC1017N solid-state relay for DC operations. The voltage divider circuits created by R1/R_DLY and R4/R_SENS are used to control delay time and sensitivity.

All Ground (GND) signals are connected to form a common GND reference. Pin 2 is the VDD supply voltage, which is set to 3.3V.

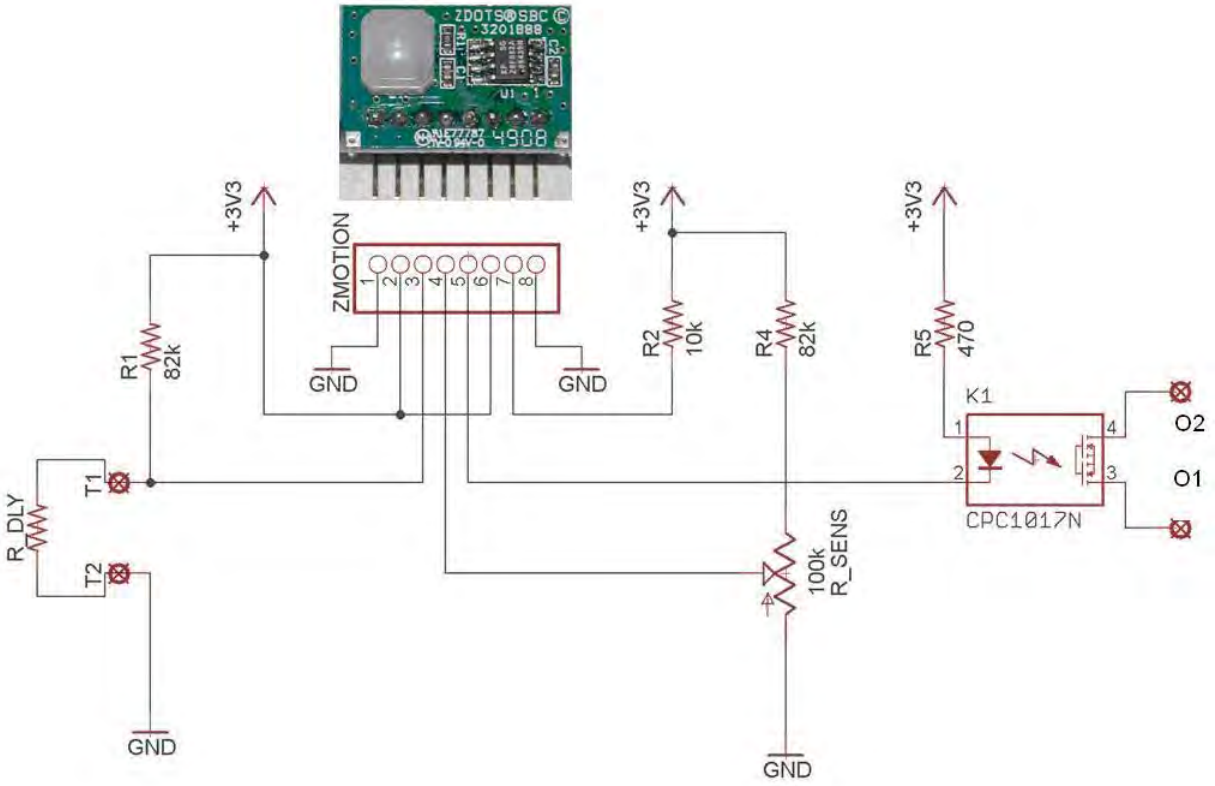

Figure 3. Schematic Diagram for DC Operation

Power Control

The solid state relay controls power to the trigger on the peripheral. Power lines to the peripheral (see Figure 3) are connected to the O1 and O2 terminals on the solid-state relay. When the module detects motion, it will send logic 0 to pin 5 (/MD), activating the solid-state relay. If no motion is detected for the specified delay time, the module will send logic 1 to pin 5, deactivating the solid-state relay and turning the peripheral off.

Power-On Time

Changing the R_DLY resistor value changes the duration in which the power stays on after motion is detected, as listed in Table 2 on page 5. The voltage created by the R1/R_DLY divider is connected to the DLY input pin on the module (pin 3).

From Figures 3 and 4 (see page 8), the R_DLY resistor value is determined by the voltage divider formula (R1=82kΩ):

$$R\_DLYVoltage = Vdd * \frac{R\_DLYResistorValue}{82k + R\ \ DLYResistorValue}$$

Thus,

$$R\_DLY\ \mathrm{Re}\ sistorValue = \frac{X * 82k}{1 - X}$$

where:

$$X = \frac{R\_DLYVoltage}{Vdd}$$

Table 2 shows standard resistor values calculated for R_DLY based on the above equation.

Table 3. Delay Time Resistor Values (R1 = 82kΩ)

Delay Time	R_DLY Voltage	R_DLY Standard Resistor Value
2 sec	0 V	0Ω
5 sec	0.2 V	5.1kΩ
10 sec	0.4 V	11kΩ
30 sec	0.6 V	18kΩ
1 min	0.8 V	24kΩ
2 min	1.0 V	33.2kΩ
3 min	1.2 V	43kΩ
5 min	1.4 V	56kΩ
10 min	1.6 V	68kΩ
15 min	1.8 V	91kΩ

Sensitivity Control

The R_SENS potentiometer is used to adjust sensitivity. Fine-tuning sensitivity to the environment minimizes false triggers. A lower voltage value from R_SENS increases the sensitivity of the ZMOTION Detection module to target motion, while a higher value decreases sensitivity.

Pin 4 is the SNS input signal on the Module; it is a high-impedance analog input that receives the voltage created by the R4/R_SENS voltage divider to control sensitivity. A lower input voltage to this pin provides higher sensitivity; a higher input voltage provides lower sensitivity.

This pin also governs the selection of the Interface Mode during Reset. A voltage on this pin between GND and 2.0V during Reset causes the system to enter Hardware Interface Mode. A voltage above 2.4V causes the module to enter Serial Interface Mode. Assuming a worst-case scenario of 5% resistors and a 5% power supply tolerance, the following equation can yield a voltage under two volts:

$$SNS\_Input\_Voltage = 3.3V * 1.05 * \frac{100k * 1.05}{(100K * 1.05) + (82k * 0.95)} = 1.989V$$

Unused Signals

Pin 6 (LG) is the Light Gate input and is not used in this application. It is connected to VDD.

Pin 7 (/SLP/DBG) is the Sleep mode input. When this pin is active Low, the ZMOTION Detection Module enters a low-power Sleep mode. It is not used in this application; therefore it is tied to VDD. This pin is also used as the debug input for custom software development and device programming.

As Figure 4 shows, the DC load has two wires that carry power to the DC source. The red line is cut and connected to the load output signals of the solid-state relay for ON and OFF control.

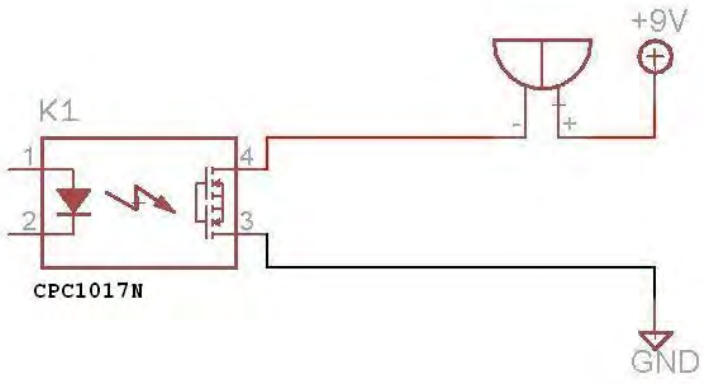

Figure 4. DC Power Line

Summary

Using the flexible controls offered by the ZMOTION Detection Module, power management can be incorporated in a number of electrical appliances and commercial lighting related fixtures. With ZMOTION technology, appliances and security systems can be turned ON or OFF depending on detected human motion. For this application note, indoor peripherals were able to control power by turning ON only when motion is detected. Also, any indoor peripherals in DC or AC operation shall be fully operable within the context of this application.

References

The following documents associated with the ZMOTION Detection Module are available on www.zilog.com. The documents associated with the Clare solid state relays are available on www.clare.com.

- ZMOTION Detection Module Product Brief (PB0223)
- ZMOTION Detection Module Product Specification (PS0284)
- ZMOTION Detection Module Development Kit User Manual (UM0223)
- Clare DC Solid State Relay Datasheet (CPC1017N)

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