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ZEPIR0BxS02MODG

ZMOTION® Detection Module II

Product Specification

PS030504-0917

Warning: DO NOT USE THIS PRODUCT IN LIFE SUPPORT SYSTEMS.

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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
Sep 2017	04	Corrected ZMOTION Engine revision.	65
Sep 2014	03	Updated Table 10 to include PS0336 and change title of PS0286	58
May 2013	02	Updated mechanical drawings, Figures 9 and 10.	56, 57
Mar 2013	01	Original issue.	All

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Architectural Overview

Zilog's ZMOTION® Detection Module II (ZDMII) is a complete motion detection solution ideally suited for applications that must detect a human presence. It is an excellent solution for detecting people as they approach entrances, kiosks, product displays, vending machines, appliances and advertising displays.

ZDMII is a board-level module that combines the unique features of Zilog's ZMOTION® (Z8FS040) microcontroller with a pyroelectric sensor and a clip-on lens. The pyroelectric sensor and clip-on Fresnel lens combine to provide a compact solution without sacrificing performance, plus the ability to change lenses provides the flexibility to suit a variety of applications. The module is only 25.5mm x 16.7mm (and only 11mm thick), so it can easily fit into many size-constrained applications.

ZDMII is simple to use. It can operate in Hardware Mode – which simply activates an output signal when motion is detected – or in Serial Mode, allowing it to communicate with another processor in your system when greater control over motion detection performance is required. In both modes, sensitivity and output activation time can be controlled to match application requirements. For applications that require ambient light sensing, an input supporting an external light sensor is provided for gating motion detection output.

ZDMII provides an easy, low-risk solution for your motion detection requirements.

Features

Key features of the ZDMII include:

- Complete low-profile motion detection solution
- Small form factor: 25.5mm x 16.7mm
- Ranges up to 7m with a 95-degree detection pattern
- Simple-to-use Hardware Mode or advanced Serial Mode (UART)
- Flexible control over sensitivity and output activation time
- Sleep Mode for low-power applications
- Support for Ambient Light Sensor input
- Unique Hyper Sense feature automatically increases sensitivity after motion is detected
- Minimal components ensure high reliability
- Application code can be modified to support custom solutions
- Complete evaluation system available

- 8-pin interface connector with two orientations available (right-angle and straight)
- Operates from a 2.8 V to 3.6 V power supply
- Standard operating temperature range: 0°C to 70°C

ZEPIR0BxS02MODG Block Diagram

Figure 1 shows a block diagram of the ZMOTION® Detection Module II.

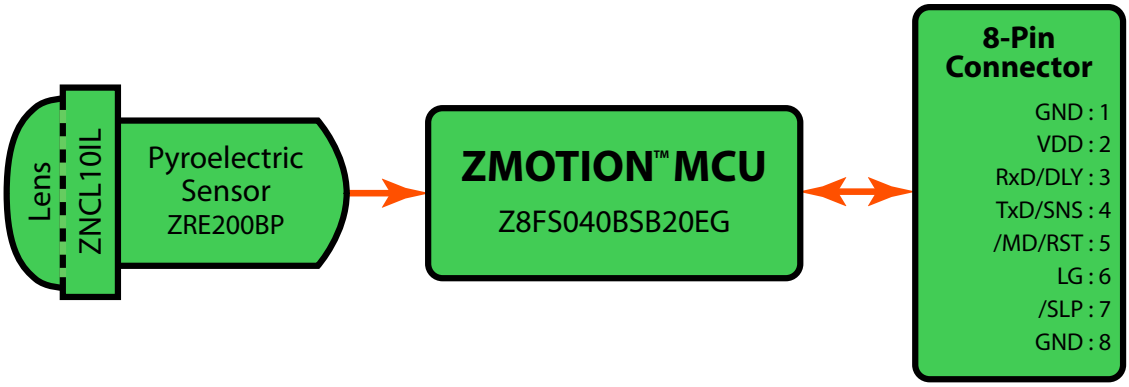


Figure 1. ZDMII Block Diagram (ZEPIR0BxS02MODG)

Figure 2 shows the right-angle version of the ZDMII Module.

Figure 2. The ZMOTION Detection Module II, Right-Angle Version (ZEPIR0BAS02MODG)

Pin Description

Table 1 lists the pin and signal descriptions per mode for ZDMII.

Table 1. Pin Description

Pin#	Signal Name	Hardware Interface Mode	Serial Interface Mode	Comments
1	GND	Ground	Ground	—
2	V_{DD}	Supply Voltage	Supply Voltage	—
3	RXD/DLY	Delay (DLY; analog input)	RXD — Receive Data (digital input)	—
4	TXD/SNS	─Sensitivity (SNS; analog input)	TXD — Transmit Data (digital output)	Mode Select during reset
5	$\overline{MD}$/$\overline{RST}$	Motion Detect (digital output)	Configurable: Reset ($\overline{RST}$; digital input); Motion Detect ($\overline{MD}$; digital input)	Default is Reset ($\overline{RST}$) in Serial Interface Mode.
6	LG	Light Gate (analog input)	Light Gate (analog input)	If unused, connect to V_{DD}.
7	$\overline{SLP}$/DBG	Sleep ($\overline{SLP}$; digital input)	Sleep ($\overline{SLP}$; digital input)	DBG is used for programming and debug.
8	GND	Ground	Ground	—

Operational Modes

ZDMII operates in both Hardware Interface and Software Interface modes; each is described in this section.

Hardware Interface Mode

- Provides basic configuration via the hardware interface pins
- Allows you to adjust sensitivity and delay
- Offers optional ambient light input
- Includes a Sleep Mode to reduce power consumption

Serial Interface Mode

- Provides advanced configuration and status via a serial interface
- $\overline{MD}$, LG and $\overline{SLP}$ remain functional
- The serial interface runs at: 9600 bps, no parity, 8 data bits, 1 stop bit and no flow control

Setting Operation Mode

This section briefly outlines how to set Module operation in either Serial Interface or Hardware Interface modes.

Serial Interface Mode Selection

To select Serial Interface Mode, provide a pull up resistor from TXD/SNS to V_{DD} during power ON or when exiting Sleep Mode (typically 100KΩ). The device detects that the voltage on the pin is greater than 2.5V and enables the TXD and RXD signals. $\overline{MD}$, LG and $\overline{SLP}$ remain active also. This resistor will have no effect on the transmitted data.

Hardware Interface Mode Selection

The Hardware Interface Mode is selected when TXD/SNS is between 0V and 1.8V during power ON or when exiting Sleep Mode.

For examples of using ZDMII in Hardware and Serial Interface Modes, see Appendix B. Hardware Interface Mode on page 63 and Appendix C. Serial Interface Mode on page 64.

Signal Descriptions, Hardware Interface Mode

This section describes the signals for operating in Hardware Interface Mode.

Ground

Both Pin 1 and the Pin 8 ground (GND) signals are tied together on the ZMOTION® Detection Module II and are connected to power ground.

Supply Voltage

The supply voltage (V_{DD}) provides power to ZDMII via Pin 2. For power consumption details, see the Electrical Characteristics chapter on page 59.

Delay

A high-impedance analog input, Pin 3 (RXD/DLY), sets the duration for the Motion Detect ($\overline{MD}$) pin to remain active when motion has been detected. Provide a voltage between 0V and 2V to select a delay of 2 seconds to 15 minutes (see Table 2). Typically, a simple resistor divider or trim pot is used to set the voltage.

Table 2. Delay Time and Voltage on DLY

Delay Time	Voltage on DLY
2 sec	0V
5 sec	0.2V
10 sec	0.4V
30 sec	0.6V
1 min	0.8V
2 min	1.0V
3 min	1.2V
5 min	1.4V
10 min	1.6V
15 min	1.8V

Sensitivity

A high-impedance analog input, Pin 4 (TXD/SNS) sets the Module's sensitivity to motion. Provide a voltage between 0V and 1.8V to adjust the sensitivity to meet the application requirements. A lower voltage means higher sensitivity. Typically, a simple resistor divider or trim pot is used to set the voltage.

- 1.8V = lowest sensitivity
- 0V = highest sensitivity

This signal also determines the interface mode of the Module. At power ON, and when exiting Sleep Mode, the signal is sampled; if it is greater than 2.5V (for example, pulled to V_{DD} via resistor), then the system enters Serial Interface Mode and the pin is converted to TXD. If the signal is between 0V and 1.8V, Hardware Interface Mode is selected.

Motion Detect

An active Low output, Pin 5 ($\overline{MD}$) is activated when motion is detected. The duration in which this signal remains active is set by the DLY signal. This signal is actively driven High.

- 0 = motion detected
- 1 = no motion detected

Light Gate

A high-impedance analog input, Pin 6 (LG), should be provided with a voltage that is proportional to the amount of ambient light in the environment (typically provided via a CDS photocell or similar circuit). The signal is used internally to gate the $\overline{MD}$ output signal such that it does not activate in the presence of daytime ambient light. When the voltage on this pin is lower than 1.0V, the $\overline{MD}$ signal will not activate even when motion is detected. If $\overline{MD}$ is in an active state when LG transitions below 1.0V, the current DLY duration is completed before $\overline{MD}$ is deactivated. If LG is unused, connect to V_{DD}.

- GND to 1.0V = $\overline{MD}$ does not activate when motion is detected
- 1.0V to V_{DD} = $\overline{MD}$ is activated when motion is detected

Sleep Mode

Pin 7 ($\overline{SLP}$) is an active Low digital input. When at logic 0, the Module enters low-power Sleep Mode. The Module does not detect any motion and $\overline{MD}$ is driven inactive. When SLP is at logic 1, the Module exits Sleep Mode and begins detecting motion. This signal must be held at logic 1 during power ON.

- 0 = module disabled; low-power Sleep Mode is active
- 1 = normal operation

Signal Descriptions, Serial Interface Mode

This section describes the signals for operating in Serial Interface Mode.

Ground

Both Pin 1 and Pin 8 ground (GND) signals are tied together on the ZDMII Module and are connected to power ground.

Supply Voltage

The supply voltage (V_{DD}) provides power to the Module via Pin 2. For power consumption details, see the Electrical Characteristics chapter on page 59.

Receive Data

This Pin 3 (RXD/DLY) input is the asynchronous serial input used for sending commands and configuration to the Module. It operates at 9600 bps, no parity, 8 data bits, 1 stop bit and no flow control. For a list and description of the commands supported, see Table 3 on page 14.

Transmit Data

This Pin 4 (TXD/SNS) output is the asynchronous serial data output from the Module in response to commands and configuration supplied on the RXD line. It operates at 9600 bps, no parity, 8 data bits and 1 stop bit. For more information about the serial command interface, see the Serial Interface Commands and Description section on page 12.

This signal also determines the interface mode of the Module. At power ON, and when exiting Sleep Mode, the signal is sampled; if it is higher than 2.5 V (for example, pulled to V_{DD} via resistor), then the system enters Serial Interface Mode. If the signal is at a value between 0 V and 1.8 V, Hardware Interface Mode is selected.

Motion Detect and Reset

An active Low output, Pin 5 ($\overline{MD}/\overline{RST}$), is activated when motion is detected. The duration in which this signal remains active is set by the DLY signal. This signal is actively driven High.

- 0 = motion detected
- 1 = no motion detected

As $\overline{RST}$, this pin provides an active Low hardware reset signal for the Module. The function of this pin is selected by the C serial command. The default value for this pin is $\overline{RST}$.

Light Gate

A high-impedance analog input, Pin 6 (LG), is used internally to gate the $\overline{MD}$ signal such that it does not activate in the presence of daytime ambient light. The voltage applied to this pin should be proportional to the amount of ambient light in the environment (typically provided via a CDS photocell or similar circuit).

- LG > Light Gate Threshold Register — $\overline{MD}$ is activated when motion is detected
- LG < Light Gate Threshold Register — $\overline{MD}$ does not activate when motion is detected

If $\overline{MD}$ is in an active state when LG transitions above the programmed value, the current DLY time is completed before $\overline{MD}$ is deactivated.

If LG is unused, connect to V_{DD}.

Sleep Mode

Pin 7 ($\overline{SLP}$) is an active Low digital input. When at logic 0, the Module enters low-power Sleep Mode. The Module does not detect any motion and $\overline{MD}$ is driven inactive. When SLP is at logic 1, the Module exits Sleep Mode and begins detecting motion. This signal must be held at logic 1 during power ON.

- 0 = module disabled; low-power Sleep Mode is active
- 1 = normal operation

Voltage Brown-Out Protection and Power-On Reset

ZDMII contains an internal Reset Controller with a Power-On Reset (POR) circuit and Voltage Brown-Out (VBO) protection to ensure proper operation. When power is first applied, the POR circuit monitors the supply voltage and holds the Module's MCU in the Reset state until the supply voltage reaches a safe operating level. After the supply voltage exceeds the POR voltage threshold (V_{POR}), the MCU is released and the Module begins operating. A further delay of typically 20 seconds is included to allow the pyroelectric sensor to stabilize. This value varies depending on environmental conditions. After this delay, the system begins to look for motion. Prior to this delay, the $\overline{MD}$ signal remains inactive.

Figure 3 shows Power-on Reset operation. See the Electrical Characteristics chapter on page 59 for the POR voltage threshold (V_{POR}).

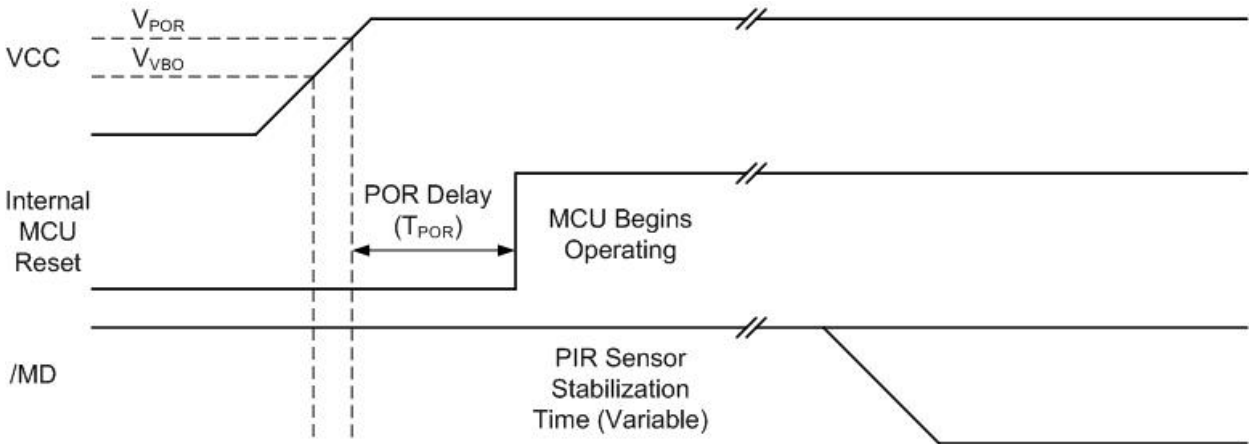


Figure 3. Power-On Reset Operation

ZDMII provides low Voltage Brown-Out protection to ensure proper operation when the supply voltage drops below an unsafe level – below the VBO voltage threshold. The VBO circuit senses this condition and forces the Module into the Reset state. While the supply voltage remains below the POR voltage threshold (V_{POR}), the VBO block holds the Module in the Reset.

After the supply voltage again exceeds the Power-On Reset voltage threshold, the Module progresses through a full Power-On Reset sequence, as described in the Power-On Reset section. Figure 4 shows the Voltage Brown-Out operation. See the Electrical Characteristics chapter on page 59 for the VBO voltage threshold (V_{VBO}).

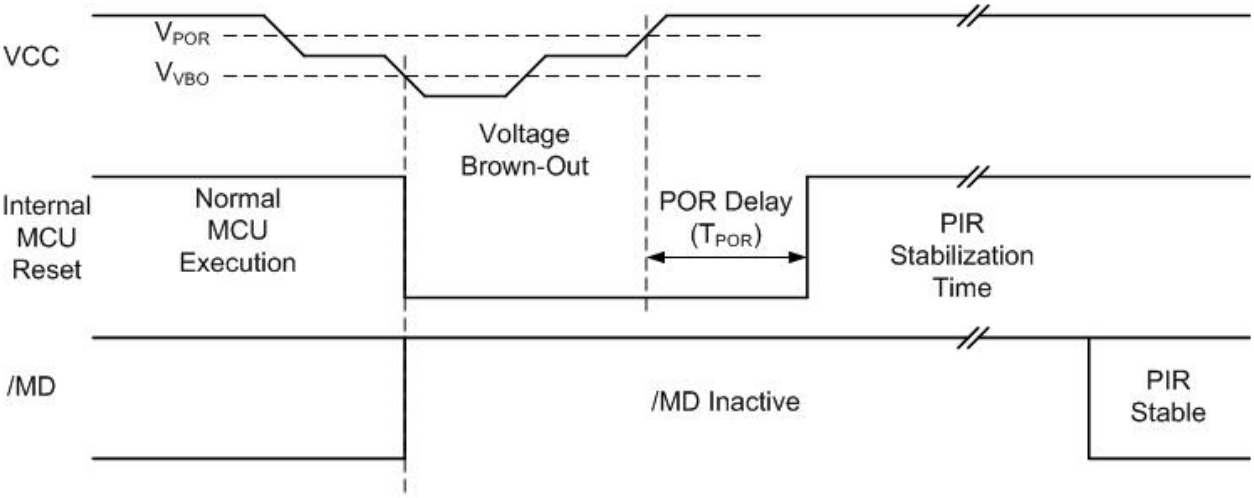


Figure 4. Voltage Brown-Out Reset Operation

Operation

When power is applied, the TXD/SNS pin is sampled to determine the mode of operation. If the signal is above 2.5V, Serial Interface Mode is entered. If the signal is between 0V and 1.8V Hardware Interface Mode is entered. During this time, the pyroelectric sensor is monitored, and the device waits for it to stabilize. After this stabilization period is complete, the device starts normal operation in the selected mode. In Hardware Interface Mode, the DLY, SNS, LG and $\overline{SLP}$ signals are sampled regularly. In Serial Interface Mode, TXD/RXD are used to communicate with the device and LG, $\overline{SLP}$ and $\overline{MD}$ also provide their defined functions.

Hardware Interface Mode

This mode of operation is selected when the SNS pin is at a value between 0V and 1.8V during power ON (or after a reset caused by V_{BO}). After Hardware Interface Mode has been established, this pin becomes the sensitivity input and accepts a voltage between 0V and 1.8V to set the motion detection sensitivity level.

- 0V = highest sensitivity
- 1.8V = lowest sensitivity

These sensitivity levels are normally achieved with a simple resistor divider or potentiometer resistor divider.

After application of power, the PIR sensor is allowed to stabilize. At this point, the MCU waits for the PIR sensor to stabilize; this period is typically 20 seconds but varies depending on environmental conditions. The software dynamically monitors the pyroelectric sensor during power up and begins detecting motion as soon as the sensor is stable.

The $\overline{MD}$ (Motion Detect) pin is driven active (Low) when motion is detected. The duration in which the signal remains active is determined by the voltage on the delay pin and can be set to a value between 2 seconds and 15 minutes. See Table 2 on page 5.

The Light Gate signal acts as a disable (gate) for the $\overline{MD}$ signal. In a typical application, this signal is a representation of the ambient light in the environment. If there is light detected, the $\overline{MD}$ signal does not activate, even in the presence of motion. For an example showing how to use ZDMII in Hardware Interface Mode, see Appendix B. Hardware Interface Mode on page 63.

Sleep Mode in Hardware Interface Mode

For applications in which motion detection is not always required, the Sleep signal can be used to put the device into a low-power mode. The advantage of this feature vs. removing power from the Module is that the PIR stabilization time is much shorter.

If the Sleep ($\overline{SLP}$) input signal is driven Low, the device enters a low-power Sleep Mode and is awakened by deactivating the signal (driving the signal High).

Serial Interface Mode

Serial Interface Mode is implemented as a superset of the features available in Hardware Interface Mode. The interfacing device (Host) has an expanded feature set and more flexibility with many of those features. The interface is designed to be simple to implement on the host processor and use as few resources as possible.

This mode of operation is selected when the SNS pin is above 2.5 V during power ON (or after a reset caused by V_{BO}). Typically this signal is tied to V_{DD} through a pull-up resistor. After Serial Interface Mode has been established, this pin becomes the Transmit Data (TXD) output and is used to send responses to commands given to the device.

The serial interface is asynchronous and is set to:

- 9600 baud
- No parity
- 8 data bits
- 1 stop bit
- No flow control

In Serial Interface Mode, commands are sent to the device over the RXD input pin and responses are sent from the device over the TXD output pin. The other signals on the device ($\overline{MD}$, LG, $\overline{SLP}$) remain active in Serial Interface Mode.

Motion Detect ($\overline{MD}$) output is driven active for the time set by the Output Activation Time command when motion is detected. The signal is also gated by the Light Gate (LG) input. For an example of how to use ZDMII in Serial Interface Mode, see Appendix B. Hardware Interface Mode on page 63.

Sleep Mode in Serial Interface Mode

For applications in which motion detection is not always required, the Sleep signal can be used to put the device into a low-power mode. The advantage of this feature vs. removing power from the Module is that the PIR stabilization time is much shorter.

If the Sleep ($\overline{SLP}$) input signal is driven Low, the device enters a low-power Sleep Mode and is awakened by either deactivating the signal (driving the signal High) or sending a character over the serial interface; the character is received and processed.

Serial Interface Commands and Description

The Serial Interface operates as a Host/Client relationship in which the Module is the client. Commands are sent from the Host and the Module responds with the requested information or confirmation. The only exception is when the Module is configured for *MD Unsolicited* operation. In this mode, the Module will send *Motion Detected* information without first receiving a command from the host. All commands sent to ZDMII are in ASCII character format; however, the data sent to and from the Module may be in ASCII or decimal formats.

There are three types of command structures accepted by ZDMII; each is described in this section.

- Read commands
- Write commands
- Confirmation commands

Read Command Structure

Read commands are used to request information from ZDMII, and are sent from the Host. The Module responds with the requested data.

- All Read commands are initiated by single lower-case letters.
- When a Read command is received, the Module returns the applicable value, as described in the Serial Commands chapter on page 15. See the example in Figure 5.

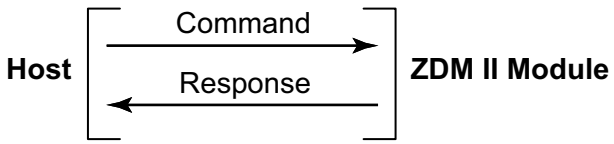


Figure 5. Read Command Structure

Write Command Structure

Write commands are used to update the configuration of ZDMII, and are sent from the Host. The Module responds with the current value as an acknowledgment. The Host then sends the new data and the Module responds with an ACK.

- All write commands are initiated by single upper-case letters.
- After a write command is received, the device returns the current value and expects an appropriate single-byte data value.
- When the data value is received, the device returns an ACK. If no data is received after the inactivity time-out period of 2.5 seconds, the device returns a NACK. See the example in Figure 6.

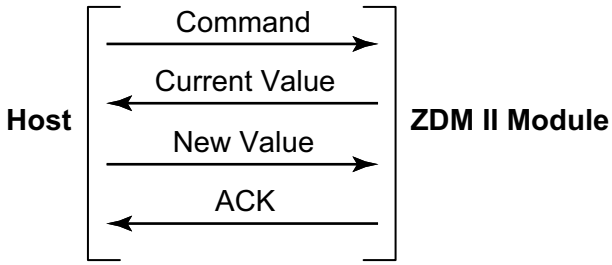


Figure 6. Write Command Structure

Confirmed Command Structure

Certain commands require a specific sequence of characters to be sent to prevent accidental initiation. These commands require a 4-character confirmation sequence. After a command requiring confirmation is received, the device returns an ACK.

- If the sequence is correct, the device returns an ACK and executes the command.
- If the sequence is incorrect, or if there is an inactivity delay of more than 2.5 seconds between any characters of the sequence, the device immediately sends a NACK and does not execute the command. See the example in Figure 7.

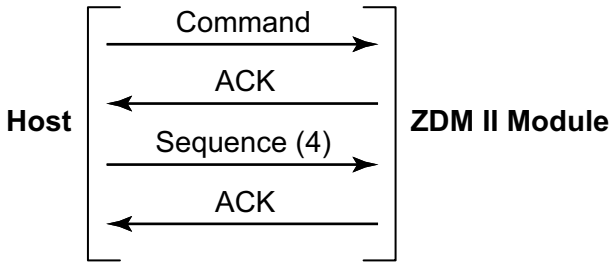


Figure 7. Confirmed Command Structure

Note: ACK = `0x06` (ASCII ACK character).

NACK = `0x15` (ASCII NACK character). The Module will respond with a NACK on all unrecognized commands, and when commands requiring data (that is, Write, Clear, and Confirmation types) do not receive the required data within the inactivity time-out period.

Serial Commands

The Serial Interface commands are summarized in Table 3, and are each described in this section.

Table 3. Summary of Serial Interface Commands

Command	Name	Value [Default]	Command	Name	Value [Default]
0x43–'C'	Write $\overline{MD}$/$\overline{RST}$ Pin Configuration	'M', 'R'	0x64–'d'	Read $\overline{MD}$ Activation Time	0–255 [2]
0x44–'D'	Write $\overline{MD}$ Activation Time	0–255	0x65–'e'	Read Hyper Sense Setting	'Y', 'N' [N]
0x45–'E'	Write Hyper Sense Setting	'Y', 'N'	0x66–'f'	Read Frequency Response Setting	'H', 'L' [L]
0x46–'F'	Write Frequency Response Setting	'H', 'L'	0x67–'g'	Read Hyper Sense Level	0–3 [1]
0x47–'G'	Write Hyper Sense Level	0–3	0x68–'h'	Read Motion Detection Suspend Setting	'Y', 'N' [N]
0x48–'H'	Write Motion Detection Suspend Setting	'Y', 'N'	0x69–'i'	Read Module Software Revision	0–255, 0–255 [6,4]
0x4B–'K'	Write Serial Interface Command Mode	'D', 'A'	0x6B–'k'	Read Serial Interface Command Mode	'D', 'A' [D]
0x4C–'L'	Write Light Gate Threshold	0–255	0x6C–'l'	Read Light Gate Threshold	0–255 [100]
0x4F–'O'	Write $\overline{MD}$ Output State	0–255	0x6D–'m'	Read Motion Detected Unsolicited Mode	'Y','N' [N]
0x50–'P'	Write Ping Value	0–255	0x4D–'M'	Write Motion Detected Unsolicited Mode	'Y','N'
0x52–'R'	Write Range Setting	0–7	0x6F–'o'	Read $\overline{MD}$ Current Output Active Time	0–255 [0]
0x53–'S'	Write Sensitivity	0–255	0x70–'p'	Read Ping Value	0–255 [1]
0x55–'U'	Write Dual Directional Mode	'Y', 'N'	0x72–'r'	Read Range Setting	0–7 [2]
0x58–'X'	Module Reset	'1', '2', '3', '4'	0x73–'s'	Read Sensitivity	0–255 [16]
0x59–'Y'	Write Sleep Time	0–255	0x75–'u'	Read Dual Directional Mode	'Y', 'N' [N]

Table 3. Summary of Serial Interface Commands (Continued)

Command	Name	Value [Default]	Command	Name	Value [Default]
0x5A–'Z'	Sleep Mode	'1', '2', '3', '4'	0x76–'v'	Read Single Directional Mode	'A', '+', '–' [A]
0x61–'a'	Read Motion Status	'Y', 'N', 'U'	0x56–'V'	Write Single Directional Mode	'A', '+', '–'
0x62–'b'	Read Current Light Gate Input Level	0–255	0x79–'y'	Read Sleep Time	0–255 [0]
0x63–'c'	Read $\overline{MD}$/$\overline{RST}$ Pin Configuration	'M', 'R' [R]			

Motion Status Command

The current status of detected motion can be read and cleared through this command. When motion has been detected the value is set to 'Y' and latched until read with the 'a' command. Once cleared, the status remains at 'N' until motion is again detected.

Read Motion Status

Command

`'a' (0x61)`

Description

The Read Motion Status command returns the current status of detected motion. The current status is set to 'N' when read.

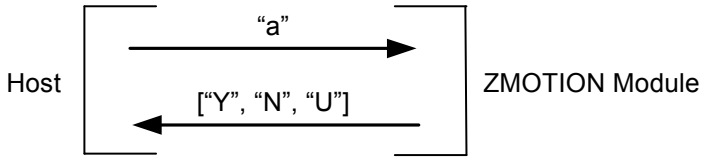
Return Values

'Y' = Motion detected

'N' = No motion detected

'U' = PIR Sensor has not stabilized after power-up

Normal Command Sequence



Note: The returned value ('Y', 'N', 'U') is independent of the $\overline{MD}$ output state or the $\overline{MD}$ Activation Time (see commands 'o'/'O' and 'd'/'D').