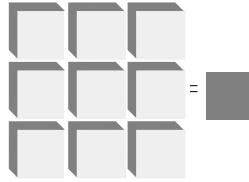




# LSI/CSI



# LS6506R LS6507R

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## PIR SENSOR INTERFACE

June 2009

### FEATURES:

- Latching relay drive (**LS6506R**)
- **LS6506R** is suitable for incandescent and fluorescent lights, electronic and magnetic ballasts, motors and heaters, etc.
- Triac drive (**LS6507R**)
- Sensitivity adjustment
- Push-button for manual on/off control
- Ambient light override adjustment
- Selectable time-out adjustments
- **3 Operating Modes:**
  1. Manual On or Auto On / (Manual Off and Delayed Auto On) or (Manual Off and Manual On) or Auto Off
  2. Manual On / Manual Off or Auto Off
  3. Manual On or Auto On / Manual Off or Auto Off
- LED indicator light for motion detection
- Controls 115VAC and 220VAC applications
- **LS6506R** (DIP), **LS6506R-S** (SOIC);  
**LS6507R** (DIP), **LS6507R-S** (SOIC) - See Figures 1A & 1B

### DESCRIPTION

The **LS6506R** is a CMOS integrated circuit designed for room occupancy detection and can be used for switching power on to all types of AC loads. The circuit drives a two-coil latching relay (Figure 2). When the latching relay is engaged, full AC power is connected to the load. The **LS6506R** draws its power from the AC hot line and the house-ground connection that is located in a standard wall box. The maximum current draw from the ground line is 500 $\mu$ A RMS. The **LS6507R** draws its power from the AC HOT and AC NEUTRAL lines. All timing is generated from the AC input.

The circuit contains a two stage PIR amplifier. The sensitivity can be adjusted by replacing R5 in **Figure 2** with a potentiometer. Upon power up all inputs are disabled for a period of 56 seconds (60Hz operation) or 67 seconds (50Hz operation) in order for the PIR amplifier to reach its quiescent operating state. The circuit contains two operating modes. Refer to **Figure 5** for State Diagrams.

### Operation for Mode 1 is as follows:

Refer to **Figure 2**. The IC will power up in the **Off-State, S0**. A momentary pressing of the pushbutton switch SW1, or occupancy detection, will cause a negative-going output pulse, LR1, to occur and turn on the light and place the IC in the **On-State, S1**. If occupancy is not detected, a negative-going output pulse, LR2, will cause the lights to turn off after a time-out of 5, 10, 20 or 30 minutes, or 30 seconds, as selected by a potentiometer control at the Timer Control input. If occupancy is detected before time-out occurs, the selected time-out begins again. If time-out occurs and the lights switch off, then occupancy detection, or pressing the pushbutton switch, will switch the lights back on again. Once the unit is in **S1**, pressing the On/Off push-button switch places the unit in the **Off-State, S2**, and turns the lights off and keeps them off as long as motion is detected, or if motion is not detected the lights will stay off for the time-out period. At the end of the time-out period, the unit will revert to **S0**. Whether the lights are on or off, detected motion will cause the LED indicator light to blink.

### Operation for Mode 2 is as follows:

In this mode, lights can only be turned on by pressing the On/Off push-button. Lights will remain on if occupancy is detected. Lights will turn off automatically when occupancy no longer exists and the time-out occurs. Lights can also be turned off by pressing the On/Off push-button.

### Operation for Mode 3 is as follows:

In this mode, Pins 10 and 12 are connected together. One momentary switch is used instead of the two as shown in Figures 2 and 3. Lights can be turned on by pressing the momentary pushbutton or by occupancy detection. Lights will remain on if occupancy is detected. Lights will turn off automatically when occupancy no longer exists and the time-out occurs. Lights can also be turned off by pressing the momentary pushbutton.

Refer to the application schematic of **Figure 2**: Whenever the momentary switch SW1 is pressed, a 7 second delay period (60Hz operation) or an 8.4 second delay period (50Hz operation) occurs in which the momentary switch operation is disabled. This enables capacitor C9 to be recharged so that the next operation of SW1 will be properly recognized.

An additional control potentiometer at the LDR input is used to adjust the amount of ambient light required to prevent occupancy detection from turning the lights on (Mode 1 only) and from resetting the time-out counter. The occurrence of an ambient light condition will not affect a timeout already in progress.

The **LS6506R** can operate using a 12V latching relay. **Figure 2** shows typical resistor and capacitor values for a 12V relay. Z1 is specified as a 15V zener diode. The chip generates its own 5V regulator to power its internal circuits and a separate 5V regulator to power the two stage PIR amplifier and external PIR. The **LS6506R** generates 16ms pulses on two outputs for setting/resetting the latching relay. Upon power up, the **LS6506R** generates a reset pulse as soon as its supply voltage reaches the relay coil's set/reset voltage. This ensures that the relay comes up in the off position and occurs 20 seconds (60Hz operation) or 24 seconds (50Hz operation) after power is applied.

For triac operation, the **LS6507R** is shown in the **Figure 3** application schematic. The **LS6507R** has the same features as the **LS6506R**. This circuit is intended for driving lamps, motors and heaters. The **LS6507R** has a single output that generates a 50 $\mu$ s negative pulse to drive the gate of a triac. The pulse output is delayed from the AC zero-crossover point by 1.2ms. This delay still enables 99% power to be delivered to the load while allowing circuit power to be derived from the connection to the load. The **LS6507R** application schematic does not require connection to the house-ground.

For calibration purposes in either mode, connecting the Timer Control to VREG will set the time-out to be 30 seconds allowing for walking test to set the desired sensitivity. Note also that a two-position switch may be used instead of a potentiometer for time-out control. In that case, either 5 minutes or 30 seconds is available for time-out. The circuit also has a built-in 2 second dead time at the end of the time-out to prevent false turn-ons from occurring.

## INPUT / OUTPUT DESCRIPTION

### PIR AMPLIFIER

This is a two stage amplifier. Each stage can be set to have its own amplification and bandwidth. **Pins 15 and 16** make up the positive and negative inputs for Stage 1 and **Pin 1** is the output. The two inputs allow for single-ended or differential connection to PIR Sensors. **Pin 2** is the negative input for Stage 2. The output of Stage 2 is applied to an internal comparator. The positive input of Stage 2 is internally biased so that the comparator's lower and higher threshold can be fixed relative to this bias. Only those signals greater than a fixed threshold appear at the output of the window comparator. Refer to Figure 4.

### LR1 / LR2 OUTPUT (LS6506R, Pin 6 / Pin7)

For the **LS6506R**, a 16.66ms negative going pulse appears on the LR1 output whenever conditions call for the latching relay to turn on. When conditions call for the latching relay to turn off, a 16.66ms negative going pulse appears on the LR2 output. Each output is capable of sinking 50mA. The outputs are generated in synchronism with the AC voltage input such that the leading edge of these outputs always occur when the AC voltage input switches low. Refer to Figure 6. Potentiometers R2 and R5 are adjusted so that the relay contacts always close and open at the AC zero-crossover at the load.

### TRIAC OUTPUT (LS6507R, Pin7)

With the output duration timer on and a 2.7V P-P 60Hz Signal applied to the AC input, the output produces a negative going 32us wide pulse in each half-cycle delayed a nominal 1.2ms from the zero-crossing. Refer to Figure 3. Resistors R9 and R10 are used to generate the input which is then AC-coupled into the chip through C9.

### AC INPUT (Pin 5)

This input is derived from the AC hot line input. For the **LS6506R** it is used for synchronizing the relay drive outputs. For the **LS6507R** it is used for generating the triac output. It is also the source for all timing in the **LS6506R** and **LS6507R**.

### ON/OFF INPUT (Pin 12)

The On/Off input is a momentary input used to turn the latching relay on or off (**LS6506R**) or to enable or disable output pulses to a triac (**LS6507R**). Refer to the state diagrams of Figure 5. This input has a pull-up resistor which allows the use of a SPST momentary switch.

### LDR INPUT (Pin 11)

The Light Determining Resistor (LDR) input is used to inhibit motion from turning on the load during daylight hours. Referring to Figure 2, the ambient level for inhibiting turn-on can be adjusted. There is also approximately 10% hysteresis between inhibiting and enabling at the LDR input. Under certain conditions the LDR input is also used to keep the load off when motion is detected. Refer to Figure 5, Mode 1.

### TIME CONTROL INPUT (Pin 13)

The voltage level at the time out control input selects 5 different timeouts and the Walking Test as shown in Table 1. A potentiometer can be used for these selections as shown in Figure 2.

### MODE INPUT (Pin 10)

This input has a pull-up resistor. When this input is left floating, Mode 1 is selected. When this input is tied to ground, Mode 2 is selected.

### LED OUTPUT (Pin 9)

This is an open drain output which generates negative-going pulses whenever motion is detected. The output is not affected by the LDR input. It is used to sink current from a series Resistor – LED network as shown in Figure 3.

### 5V REGULATOR OUTPUT (Pin 14)

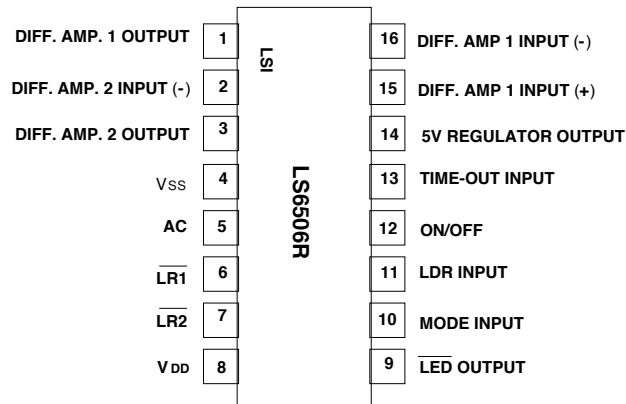
This regulator is used to provide power to the PIR sensor and the internal PIR amplifiers as well as the external timeout and LDR networks.

**TABLE 1**  
**Output Operation Time as a Function of Time Out Input Control Voltage**

Input Voltage	60Hz Operation	50Hz Operation	Units
$V_{IN} = 0$	5	6	Minutes
$V_{IN} = 0.25V_{REG}$	10	12	Minutes
$V_{IN} = 0.5V_{REG}$	20	24	Minutes
$V_{IN} = 0.75V_{REG}$	30	36	Minutes
<b>*<math>V_{IN} = V_{REG}</math></b>	<b>30</b>	<b>36</b>	<b>Seconds</b>

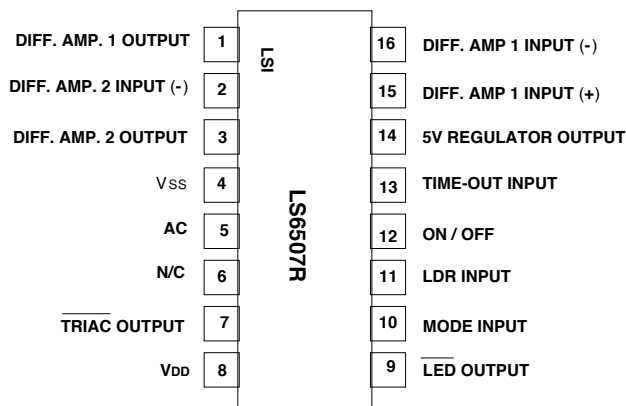
**\*Walking Test:** Ambient light will not prevent motion from turning the lights on or resetting the time-out counter

**PIN ASSIGNMENT - TOP VIEW**



**FIGURE 1A**

**PIN ASSIGNMENT - TOP VIEW**



**FIGURE 1B**

**ABSOLUTE MAXIMUM RATINGS:**

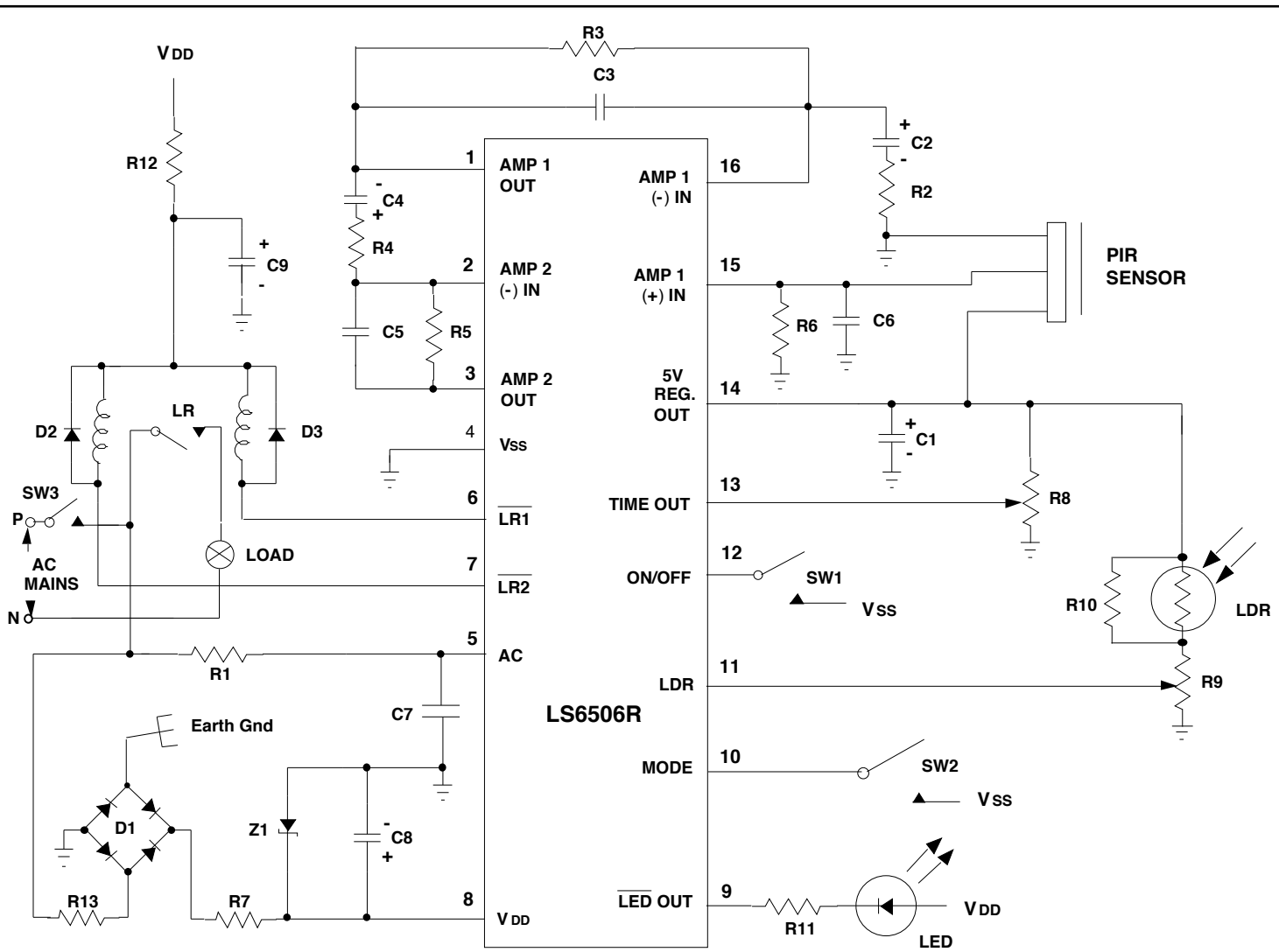
PARAMETER	SYMBOL	VALUE	UNIT
DC supply voltage	$V_{DD} - V_{SS}$	+17	V
Any input voltage (Except AC)	$V_{IN}$	$V_{SS} - 0.3$ to $V_R + 0.3$	V
AC input voltage	$V_{AC}$	$V_{SS} - 0.3$ to $V_{DD} + 0.3$	V
Operating temperature	$T_A$	-40 to +70	°C
Storage temperature	$T_{STG}$	-65 to +150	°C

**ELECTRICAL CHARACTERISTICS:**(All voltages referenced to  $V_{SS}$ ,  $T_A = -40^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$ ,  $V_{DD} = 15\text{V}$ , unless otherwise specified.)

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	CONDITIONS
<b>SUPPLY CURRENT:</b>						
$V_{DD} = 15\text{V}$	$I_{DD}$	-	250	350	$\mu\text{A}$	Figure 2 configuration
<b>REGULATOR:</b>						
Voltage	$V_R$	4.0	-	6	V	-
Current	$I_R$	-	100	150	$\mu\text{A}$	-
<b>DIFFERENTIAL AMPLIFIERS:</b>						
Open Loop Gain, Each Stage	G	70	-	-	dB	-
Common Mode Rejection Ratio	CMRR	-	60	-	dB	-
Power Supply Rejection Ratio	PSRR	-	60	-	dB	-
Input Sensitivity (Minimum Detectable Voltage to first amplifier when both amplifiers are cascaded for a net gain of 5,000)	$V_S$	100	-	-	$\mu\text{V}$	$T_A = 25^{\circ}\text{C}$ , with Amplifier Bandpass configuration as shown in Figure 2
Input Dynamic Range	-	0	-	2.0	V	-
Diff. Amp 2 Internal Reference	$V_{IR}$	-	$0.3V_R$	-	V	-
<b>COMPARATOR:</b>						
Lower Reference	$V_{THL}$	-	$V_{IR} - 0.5$	-	V	-
Higher Reference	$V_{THH}$	-	$V_{IR} + 0.5$	-	V	-
<b>DIGITAL FILTER:</b>						
Input Pulse Width (for recognition)	$TPW$	66.6	-	-	ms	60Hz operation
	$TPW$	80.0	-	-	ms	50Hz operation
<b>LDR INPUT:</b>						
Inhibit Threshold	$V_{THI}$	-	$\geq 0.5V_R$	-	V	-
Enable Threshold	$V_{THE}$	-	$\leq 0.45V_R$	-	V	-
<b>LATCHING RELAY:</b>						
Output Sink Current LR1 / LR2	$I_{LO}$	50	-	-	mA	$V_{OUT} \leq 1.75\text{V}$
Drive Output Pulse Width	$LPW$	-	16.66	-	ms	60Hz operation
	$LPW$	-	20.0	-	ms	50Hz operation
<b>ON / OFF &amp; MODE INPUTS:</b>						
Input Current Source	$I_{DS}$	1	-	4	$\mu\text{A}$	-
On Threshold Voltage ] Mode 1 Selection ]	$V_{THN}$	-	-	$\geq 0.5V_R$	V	-
On Threshold Voltage ] Mode 2 Selection ]	$V_{THF}$	$\leq 0.25V_R$	-	-	V	-

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	CONDITIONS
<b>TRIAC:</b>						
Output Drive Current	I <sub>TO</sub>	-75	-	-	mA	V <sub>O</sub> = V <sub>DD</sub> - 3V 3V Triac Gate Drive
<b>Output Timing:</b>						
Pulse Width	T <sub>PW</sub>	20	30	45	us	-
Delay From Zero-Crossover	T <sub>OD</sub>	1.00	1.20	1.32	ms	Freq = 60Hz, and 2.7V P-P AC Input
Delay Difference Between Zero-Crossovers	T <sub>ODD</sub>	-	-	150	us	-
AC Input Impedance	Z <sub>AC</sub>	-	2.9	-	MΩ	LS6507R
<b>LED OUTPUT:</b>						
Sink Current	I <sub>LS</sub>	2	-	-	mA	V <sub>DD</sub> = 15V, V <sub>O</sub> = 0.5V
Pulse Width	D <sub>PW</sub>	-	32	-	ms	
Minimum Repetition Rate	D <sub>PS</sub>	-	-	2	sec	

The information included herein is believed to be accurate and reliable. However, LSI Computer Systems, Inc. assumes no responsibilities for inaccuracies, nor for any infringements of patent rights of others which may result from its use.



- R1 = 1.5MΩ
- R2 = 33kΩ
- R3 = 1.5MΩ
- R4 = 33kΩ
- R5 = 1.5MΩ
- R6 = 36kΩ
- R7 = 220kΩ
- \* R7 = 390kΩ
- R8 = 1MΩ
- R9 = 1MΩ
- R10 = 910kΩ
- R11 = 12kΩ
- R12 = 12kΩ
- R13 = 56kΩ, 1/2W
- \* R13 = 120kΩ, 1/2W

- C1 = 100μF
- C2 = 10μF
- C3 = 0.01μF
- C4 = 10μF
- C5 = 0.01μF
- C6 = 0.1uF
- C7 = 100pF, 25V
- C8 = 50μF, 25V
- C9 = 100uF, 25V
- D2, D3 = 1N4148
- LDR = SILONEX NSL-19M51 (Typical)
- Z1 = 15V, 1/2W, 5%
- SW1 = SPST Momentary
- SW2 = SPST
- SW3 = SPST

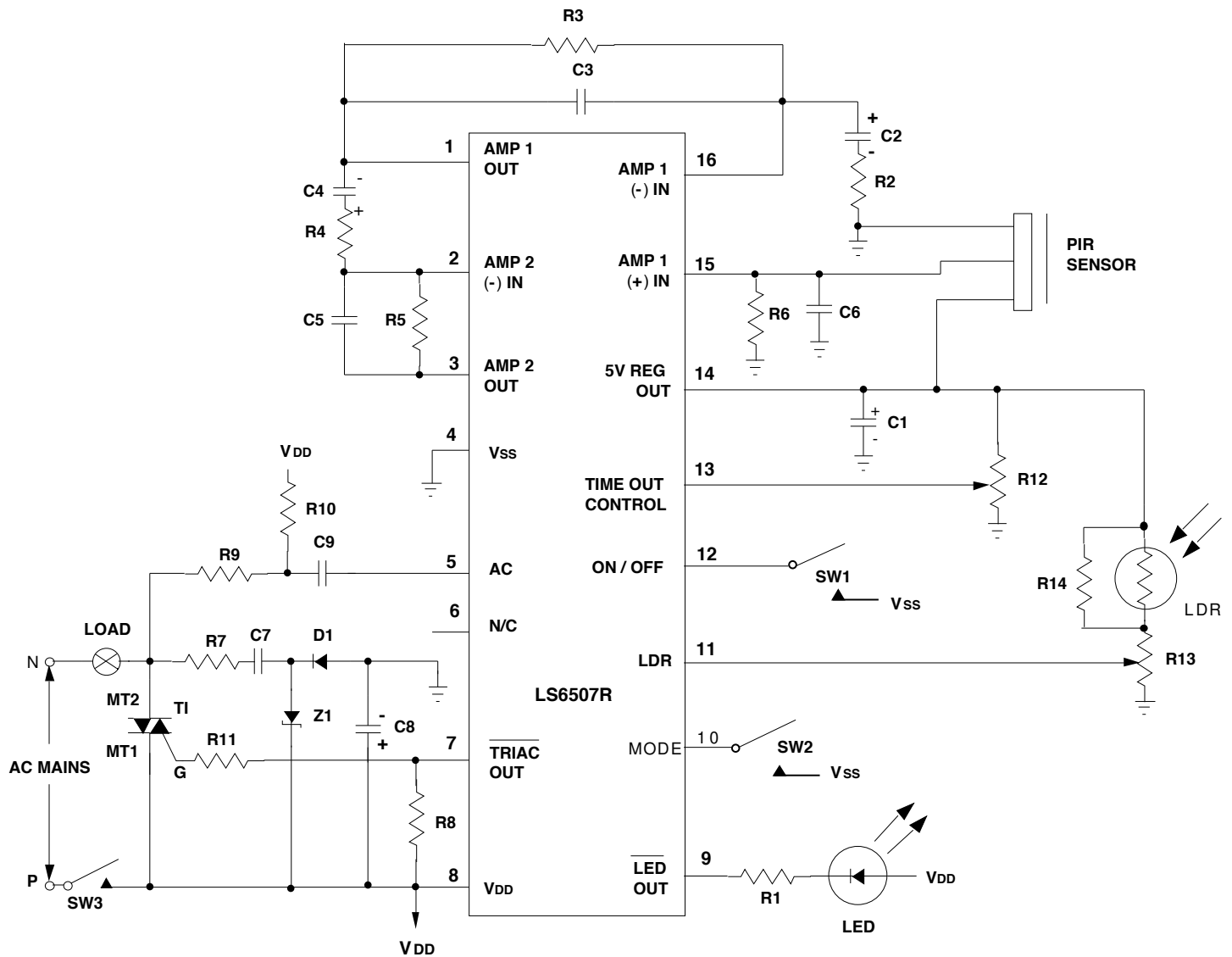
All Rs 1/4W, all Cs 10V unless otherwise specified.

\* = Component change for 220VAC

D1 = DF02 Bridge Rectifier  
 \* D1 = DF04 Bridge Rectifier  
 LR = Two-Coil Latching Relay (Typical):  
**Schrack RT314F12, Matsushita NAiS DSPIA-L2-DC12V**  
**Panasonic ADJ23012**  
 PIR = **Perkin-Elmer** LHi 958 or 878, **Nicera** RE200B, SDA02-54 (Typical)

- NOTES:**
1. The C8, D1, Z1, R7 components generate the DC Supply Voltage for the LS6506R.
  2. The R2, C2, R3, C3, R4, C4, R5, C5, R6, C6 components and the two on-chip Differential Amplifiers set a nominal gain of 2,000 with bandpass filtering of 0.5Hz to 10Hz.
  3. R5 may be replaced with a potentiometer in order to adjust the Sensitivity.
  4. The value of R6 may have to be adjusted if the selected PIR Sensor causes the input static voltage at Pin 15 to be out of the Input Dynamic Range.
  5. LR1 output closes contacts of Relay LR. LR2 output opens contacts of Relay LR.
  6. Total Earth Ground current is typically 450uA RMS.

**FIGURE 2. Typical Two-Coil Latching Relay Wall Switch Application**



- |                 |               |                     |                          |                                   |
|-----------------|---------------|---------------------|--------------------------|-----------------------------------|
| R1 = 12kΩ       | R8 = 1kΩ      | C1 = 100μF          | C8 = 1000μF, 25V         | SW1 = SPST Momentary              |
| R2 = 33kΩ       | R9 = 910kΩ    | C2 = 10μF           | C9 = 0.1μF, 25V          | SW2 = SPST                        |
| R3 = 1.5MΩ      | R10 = 7.5kΩ   | C3 = 0.01μF         |                          | SW3 = SPST                        |
| R4 = 33kΩ       | * R10 = 3.6kΩ | C4 = 10μF           |                          |                                   |
| R5 = 1.5MΩ      | R11 = 100Ω    | C5 = 0.01μF         | D1 = 1N4004              | LDR = Silonex NSL-19M51 (Typical) |
| R6 = 36kΩ       | R12 = 1.0MΩ   | C6 = 0.1μF          | Z1 = 15V, 1/2W, 5%       | T1 = Q4008L4 (Typical)            |
| R7 = 270Ω, 1/2W | R13 = 1.0MΩ   | C7 = 0.47μF, 250V   | * T1 = Q5004L4 (Typical) |                                   |
| * R7 = 1kΩ, 1W  | R14 = 910kΩ   | * C7 = 0.33μF, 400V |                          |                                   |

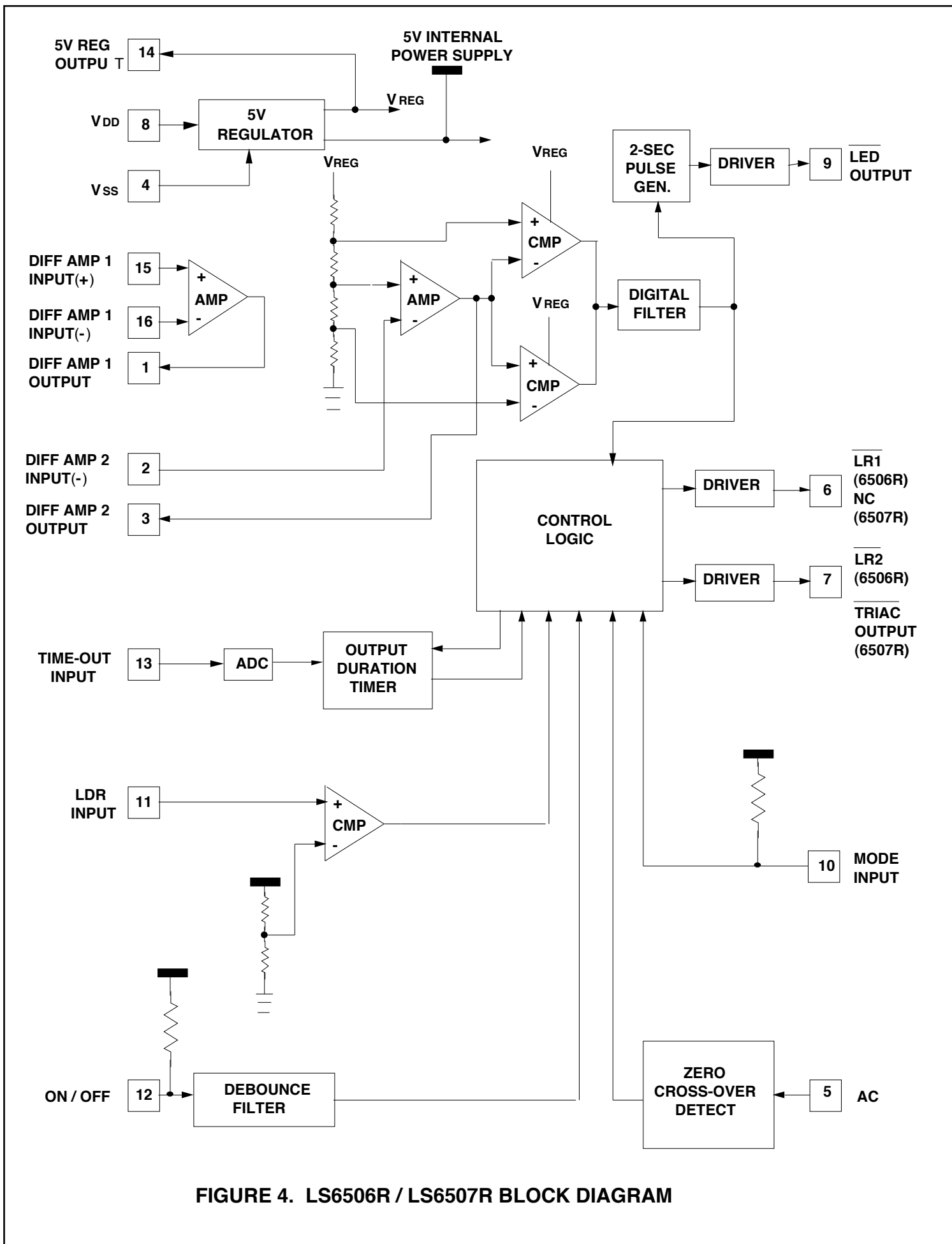
PIR = Perkin-Elmer LHi 958 or 878 (Typical)  
 Nicera RE200B, SDA02-54 (Typical)

All Resistors 1/4W, all Capacitors 10V unless otherwise specified.

\* = Component change for 220VAC

**NOTE:** The R9, R10, C9 network provides a 2.7V P-P AC signal input to Pin 5.

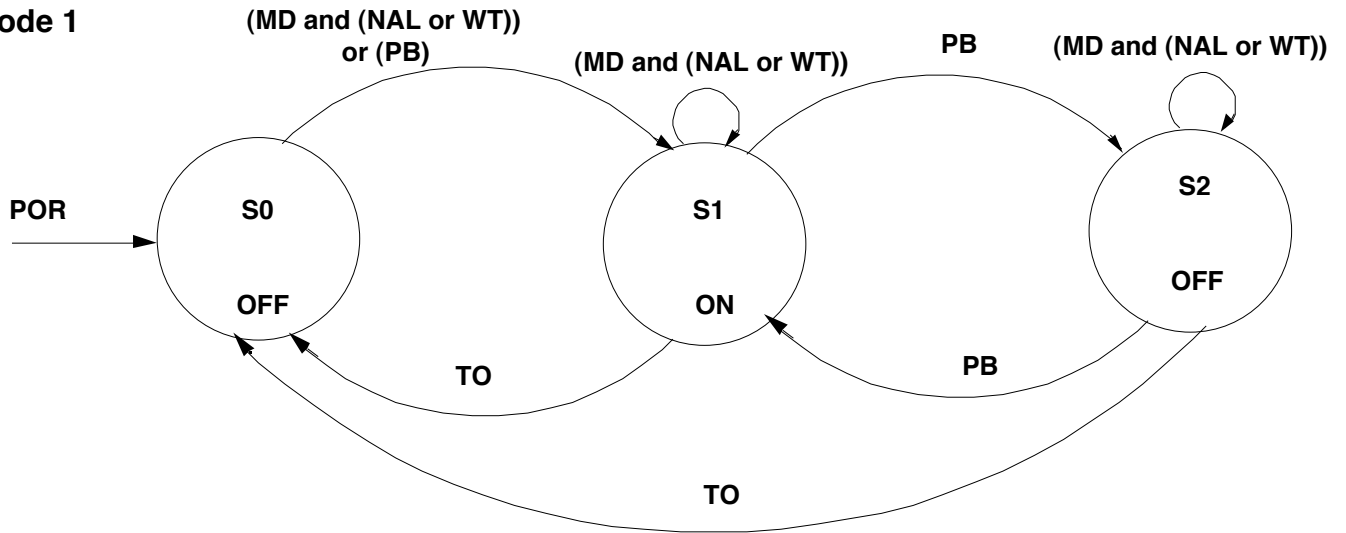
**FIGURE 3. Typical Triac Wall Switch Application**



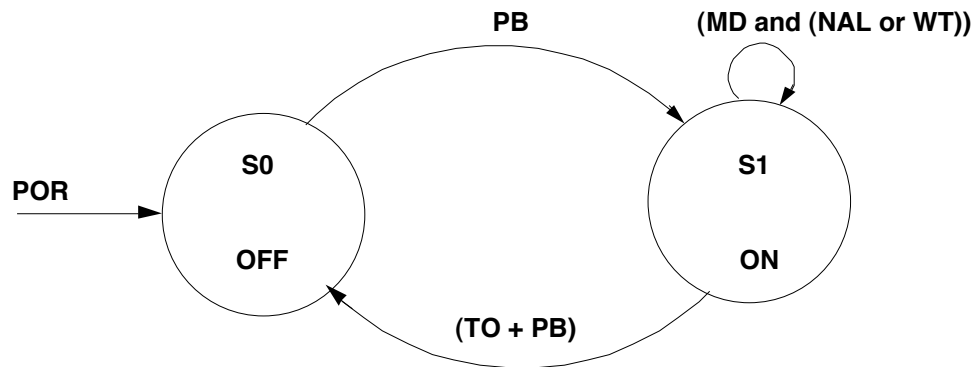
**FIGURE 4. LS6506R / LS6507R BLOCK DIAGRAM**



### Mode 1



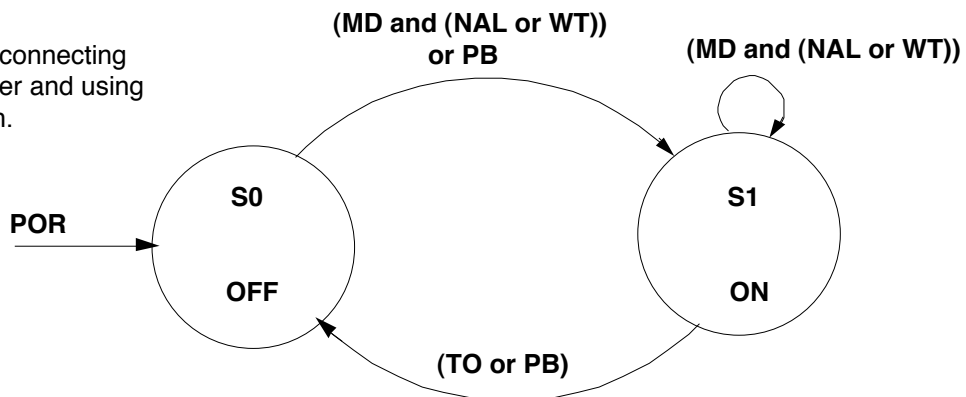
### Mode 2



### Mode 3

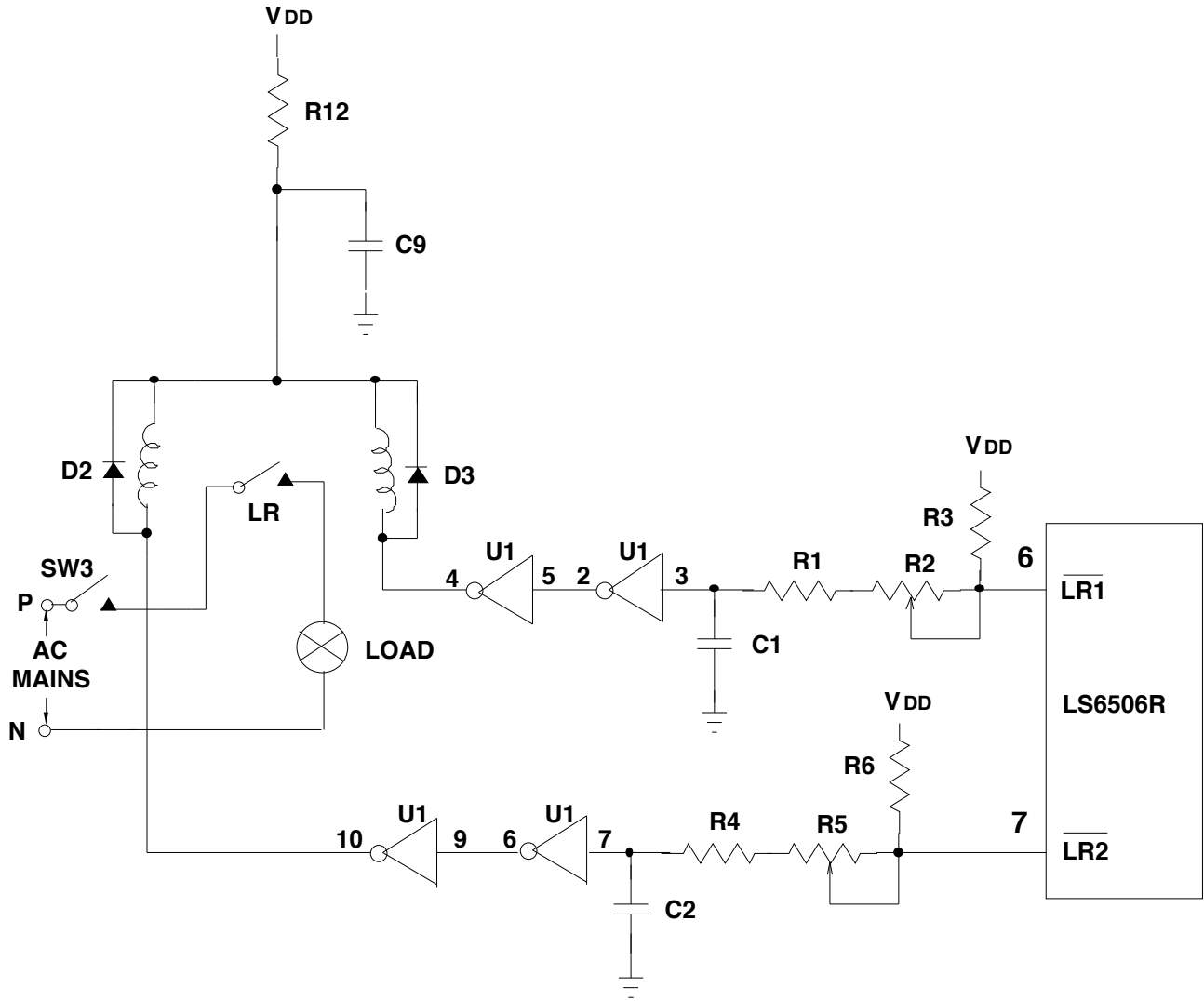
**Note:**

Mode 3 is entered by connecting Pins 10 and 12 together and using one momentary switch.



MD = Motion Detect  
 NAL = No Ambient Light  
 TO = Time-Out  
 PB = Push-Button pressed  
 WT = Walking Test

**FIGURE 5. STATE DIAGRAMS**

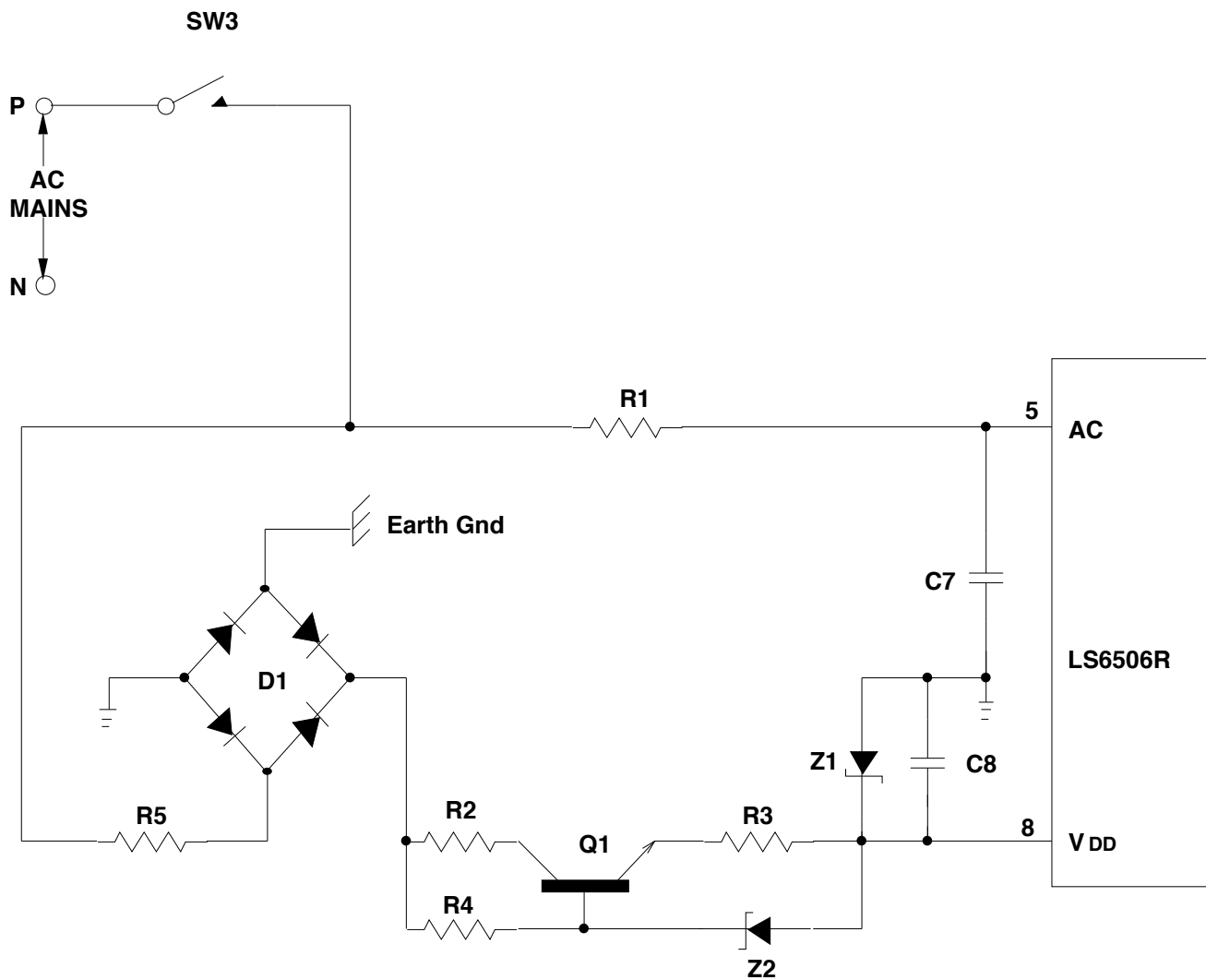


U1 = CD4049UB/CD4050B  
 R1, R4 = 51k $\Omega$ , 1/4W  
 R2, R5 = 2M $\Omega$  Potentiometer, 1/4W  
 R3, R6 = 100k $\Omega$ , 1/4W  
 C1, C2 = 0.01 $\mu$ F, 25V

**Note:** Connect U1 Pins 11 and 14 to Gnd.

Outputs  $\overline{LR1}$  and  $\overline{LR2}$  occur on the negative edge of the AC input at Pin 5 of the LS6506R.  
 Variable resistors R2 and R5 are adjusted so the relay contact closes and opens at the  
 at the AC zero-crossover at the Load.

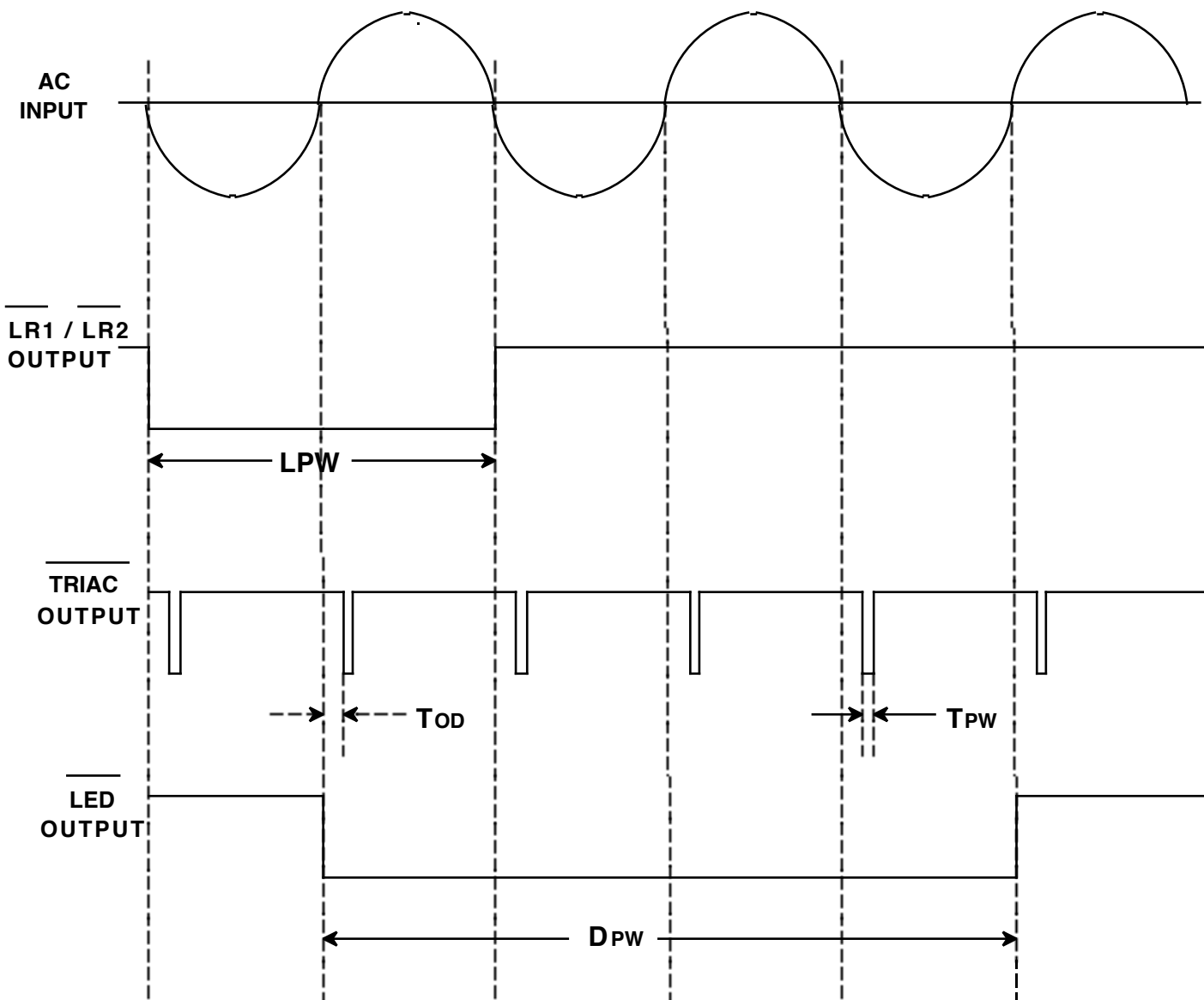
**FIGURE 6. Zero-Crossing Adjustment**



- Q1 = MPSA42 or equivalent
- R1 = 1.5M $\Omega$ , 1/4W (Reference Figure 2)
- R2 = 180k $\Omega$ , 1/4W
- R3 = 12k $\Omega$ , 1/4W
- R4 = 4.7M $\Omega$ , 1/4W
- R5 = 91k $\Omega$ , 1W
- C7 = 0.001 $\mu$ F, 25V (Reference Figure 2)
- C8 = 50 $\mu$ F, 25V (Reference Figure 2)
- Z1 = 15V, 5%, 1/2W (Reference Figure 2)
- Z2 = 5.6V, 10%, 1/4W

The AC current drawn from Earth Ground is regulated to remain virtually constant as the AC Mains Voltage varies from 120VRMS to 277VRMS

**FIGURE 7. Earth Ground Current Regulator**



**FIGURE 8. OUTPUT TIMING**