Features

- Stand-by current: 100μA (Typ.)
- On-chip regulator
- Adjustable output duration
- CDS input
- 40 second warm-up
- ON/AUTO/OFF selectable by MODE pin
- Override function
- Auto-reset if the ZC signal disappears over 3 seconds
- Operating voltage: 5V~12V
- 16 pin DIP or SOP packaging

Applications

- PIR light controllers
- Motion detectors
- Alarm systems
- Auto door bells

General Description

The HT761X is a CMOS LSI chip designed for use in automatic PIR lamp control. It can operate with a 2-wire configuration for triac applications or with a 3-wire configuration for relay applications. The chip is equipped with operational amplifiers, a comparator, timer, a zero crossing detector, control circuit, a voltage regulator, a system oscillator, and an output timing oscillator.

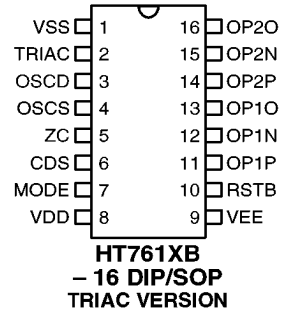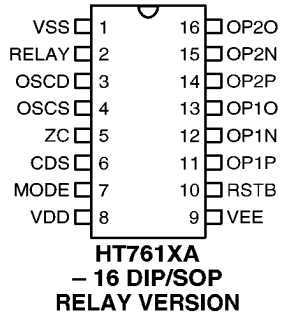Its PIR sensor detects infrared power variations induced by the motion of a human body and transforms it to a voltage variation. If the PIR output voltage variation conforms to the criteria (refer to the functional description), the lamp is turned on with an adjustable duration.

The HT761X offers three operating modes (ON, AUTO, OFF) which can be set through the MODE pin. While the chip is working in the AUTO mode the user can override it and switch to the TEST mode, or manual ON mode, or return to the AUTO mode by switching the power switch. The chip is enclosed in a 16 pin DIP/SOP.
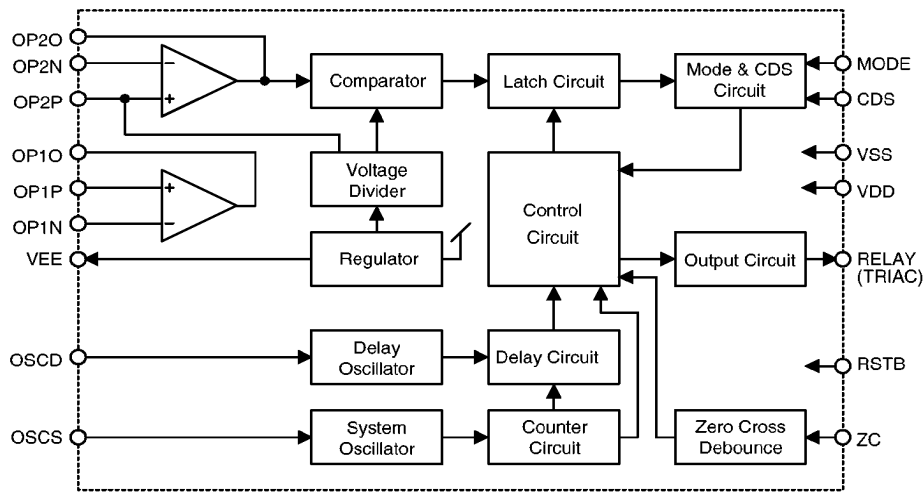
Selection Table

Part Number	ZC off/on for override	Flash on mode auto-change	Override ON duration	Comparator window	Effective trigger width
HT7610	2 times	Flash	8 hrs	$\frac{1}{16}(V_{DD}-V_{EE})$	>24ms
HT7611	1 time	No flash	8 hrs	$\frac{1}{16}(V_{DD}-V_{EE})$	>24ms

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Pin Assignment

```
        VSS ▢ 1    16 ▢ OP2O
      RELAY ▢ 2    15 ▢ OP2N
       OSCD ▢ 3    14 ▢ OP2P
       OSCS ▢ 4    13 ▢ OP1O
         ZC ▢ 5    12 ▢ OP1N
        CDS ▢ 6    11 ▢ OP1P
       MODE ▢ 7    10 ▢ RSTB
        VDD ▢ 8     9 ▢ VEE
```

**HT761XA
– 16 DIP/SOP
RELAY VERSION**

```
        VSS ▢ 1    16 ▢ OP2O
      TRIAC ▢ 2    15 ▢ OP2N
       OSCD ▢ 3    14 ▢ OP2P
       OSCS ▢ 4    13 ▢ OP1O
         ZC ▢ 5    12 ▢ OP1N
        CDS ▢ 6    11 ▢ OP1P
       MODE ▢ 7    10 ▢ RSTB
        VDD ▢ 8     9 ▢ VEE
```

**HT761XB
– 16 DIP/SOP
TRIAC VERSION**

Block Diagram

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Pin Description

Pin No.		Pin Name	I/O	Internal Connection	Description
A	B				
1	1	VSS	I	—	Negative power supply
2		RELAY	O	CMOS	RELAY drive output through an external NPN transistor, active high
	2	TRIAC	O	CMOS	TRIAC drive output The output is a pulse output when active.
3	3	OSCD	I/O	PMOS IN NMOS OUT	Output timing oscillator I/O It is connected to an external RC to adjust output duration.
4	4	OSCS	I/O	PMOS IN NMOS OUT	System oscillator I/O OSCS is connected to an external RC to set the system frequency. The system frequency $\cong$ 16KHz for normal application.
5	5	ZC	I	CMOS	Input for AC zero crossing detection
6	6	CDS	I	CMOS	CDS is connected to a CDS voltage divider for daytime/night auto-detection. Low input to this pin can disable the PIR input. CDS a schmitt trigger input with 5-second input debounce time.
7	7	MODE	I	CMOS	Operating mode selection input: VDD: Output is always ON VSS: Output is always OFF Open: Auto detection
8	8	VDD	I	—	Positive power supply
9	9	VEE	O	NMOS	Regulated voltage output The output voltage is about –4V with respect to VDD.
10	10	RSTB	I	Pull-High	Chip reset input, active low
11	11	OP1P	I	PMOS	Noninverting input of OP1
12	12	OP1N	I	PMOS	Inverting input of OP1
13	13	OP1O	O	NMOS	Output of OP1
14	14	OP2P	I	PMOS	Noninverting input of OP2
15	15	OP2N	I	PMOS	Inverting input of OP2
16	16	OP2O	O	NMOS	Output of OP2

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Absolute Maximum Ratings

Supply Voltage .... −0.3V to 13V

Input Voltage .... V_{SS}−0.3V to V_{DD}+0.3V

Storage Temperature .... −50°C to 125°C

Operating Temperature .... −25°C to 75°C

Zero Crossing Current .... max. 300μA

Electrical Characteristics

Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
		V_{DD}	Condition				
V_{DD}	Operating Voltage	—	—	5	9	12	V
V_{EE}	Regulator Output Voltage	12V	V_{DD}−V_{EE}	3.5	4	4.5	V
I_{DD}	Operating Current	12V	No load, OSC on	—	100	350	μA
V_{TH1}	CDS "H" Transfer Voltage	12V	—	6.4	8	9.6	V
V_{TL1}	CDS "L" Transfer Voltage	12V	—	3.7	4.7	5.6	V
I_{OH1}	OUTPUT Source Current (RELAY, TRIAC)	12V	V_{OH}=10.8V	−6	−12	—	mA
I_{OL1}	OUTPUT Sink Current (RELAY, TRIAC)	12V	V_{OL}=1.2V	40	80	—	mA
I_{OL2}	VEE Sink Current	12V	V_{DD}−V_{EE}=4V	—	1	—	mA
V_{IH}	"H" Input Voltage	—	—	0.8V_{DD}	—	—	V
V_{IL}	"L" Input Voltage	—	—	—	—	0.2V_{DD}	V
V_{TH2}	ZC "H" Transfer Voltage	12V	—	4.7	6.7	8.7	V
V_{TL2}	ZC "L" Transfer Voltage	12V	—	1.3	1.8	2.3	V
F_{SYS}	System Oscillator Frequency	12V	R_{OSCS}=560K C_{OSCS}=100P	12.8	16	19.2	KHz
F_d	Delay Oscillator Frequency	12V	R_{OSCD}=560K C_{OSCD}=100P	12.8	16	19.2	KHz
A_{VO}	OP Amp Open Loop Gain	12V	No load	60	80	—	dB
V_{OS}	OP Amp Input Offset Voltage	12V	No load	—	10	35	mV

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Trigger Timing
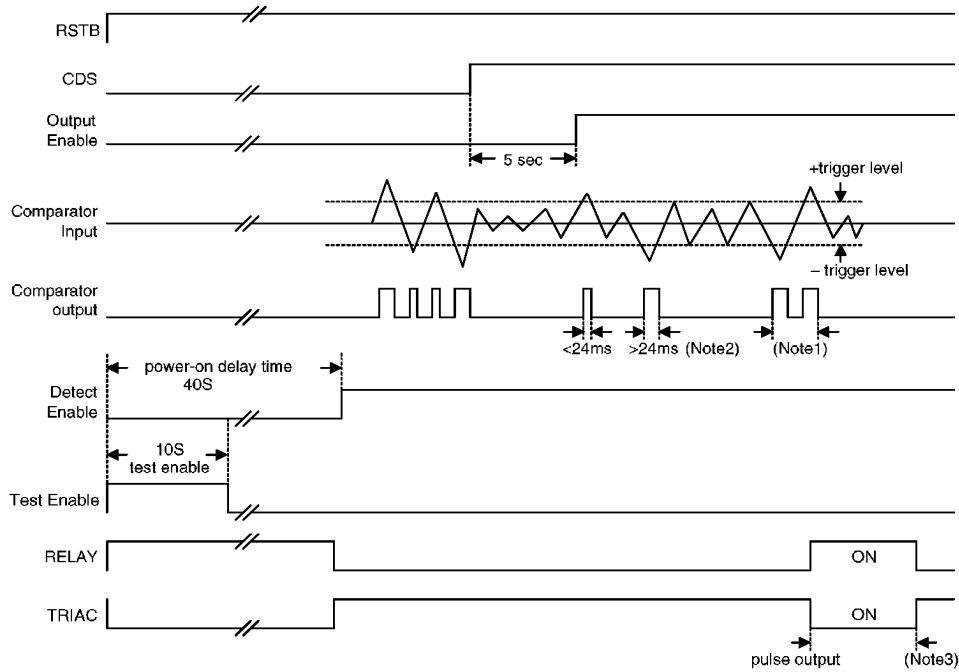
Note: 1. The output is activated if the trigger signal conforms to the following criteria:
  • More then 3 triggers within 2 seconds.
  • A trigger signal sustain duration ≥ 0.34 secs.
  • 2 trigger signals within 2 secs with one of the trigger signal sustain ≥ 0.16 secs.

  2. The effective comparator output width can be selected to be 24ms or 32ms or 48ms by mask option. The default is 24ms (system frequency=16KHz).

  3. The output duration is set by an external RC that is connected to the OSCD pin.

Functional Description

VEE

VEE supplies power to the analog front end circuit with a stabilized voltage which is –4V with respect to VDD normally.

OSCS

OSCS is a system oscillator input pin. When it is connected to an external RC a system frequency of 16KHz can be generated.
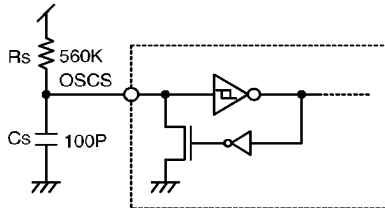
Fig.1 System oscillator

OSCD

OSCD is an output timing oscillator input pin. It's connected to an external RC to obtain the desired output turn-on duration. Variable output turn-on durations can be achieved by selecting various values of RC or using a variable resistor.

$$T_D = \frac{1}{f} \times 21504$$
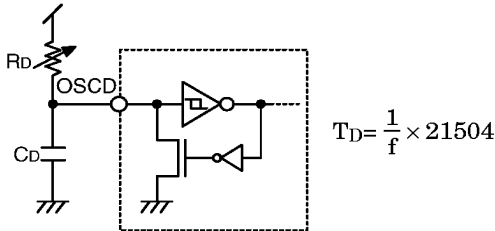
Fig.2 Output timing oscillator

RELAY (TRIAC)

RELAY is an output pin set as a RELAY driving (active high) output for the HT761XA, or as a TRIAC driving (active low) output for the HT761XB.

The output active duration is controlled by the OSCD oscillating period.

	HT761XA	**HT761XB**
OUTPUT	RELAY	TRIAC

CDS

CDS is a CMOS schmitt trigger input structure. It is used to distinguish between day time and night time. When the input voltage of CDS is high the PIR input is enabled. On the other hand, when CDS is low the PIR input is disabled. The input disable to enable debounce time is 5 seconds. Connect this pin to VDD when not using this function. The CDS input is ignored when the output is active.

CDS	**Status**	**PIR**
LOW	Day Time	Disabled
HIGH	Night	Enabled

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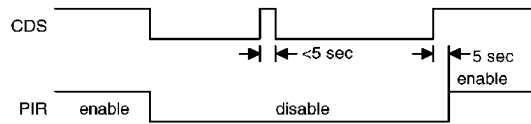
MODE

MODE is a tri-state input pin used to select the operating mode.

MODE Status	Operating Mode	Description
VDD	ON	Output is always ON: RELAY outputs high for relay driving. TRIAC pulse train output is synchronized by ZC for triac driving.
VSS	OFF	Output is always OFF: RELAY outputs low for relay driving. TRIAC outputs high for triac driving.
Open	AUTO	Outputs remain in the off state until activated by a valid PIR input trigger signal. When working in the AUTO mode, the chip allows override control by switching the ZC signal.

ZC

ZC is a CMOS input structure. It receives AC line frequency and generates zero crossing pulses to synchronize the triac driver. By effective ZC signal switching (switch OFF/ON 1 or 2 times within 3 seconds by mask option), the chip provides the following additional functions:

• Test mode control

Within 10 seconds after power-on, effective ZC switching will force the chip to enter the test mode. During the test mode, the outputs will be active for a duration of 2 seconds each time a valid PIR trigger signal is received. If a time interval exceeds 32 seconds without a valid trigger input, the chip will enter the AUTO mode automatically.

* : flash 3 times at 1Hz rate
    flash or not is a mask option
: flash 3 times at 2Hz rate
    flash or not is a mask option
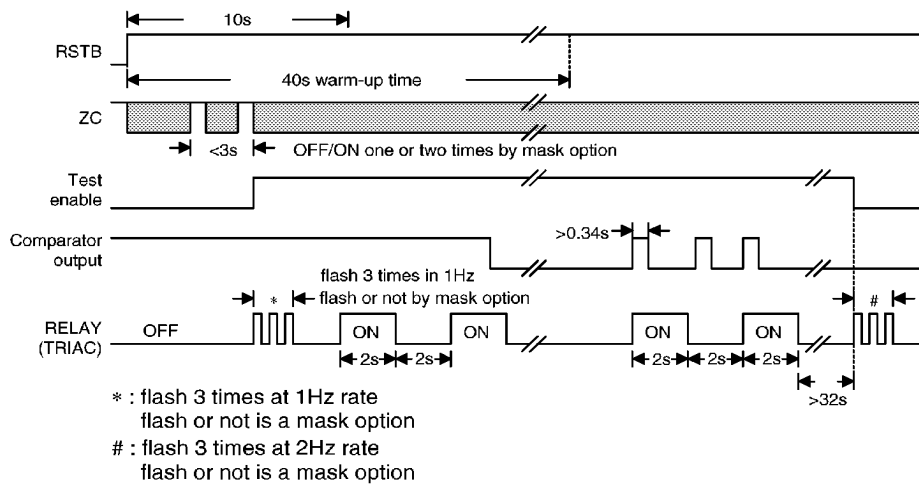
• Override control

When the chip is working in the AUTO mode (MODE=open), the output is activated by a valid PIR trigger signal and the output active duration is controlled by the OSCD oscillating period. The lamp can be switched always to "ON" from the AUTO mode by either switching the MODE pin to VDD or switching the ZC signal by an OFF/ON operation of the power switch (OFF/ON once or twice within 3 seconds by mask option). The term "override" refers to the change of operating mode by switching the power switch. The chip can be toggled from ON to AUTO by an override operation. If the chip is overridden to ON and there is no further override operation, it will return to AUTO automatically after an internal preset ON time duration has elapsed. This override ON time duration can be set to 4 or 6 or 8 hours by mask option. The default is 8 hours.

The chip provides a mask option to decide the output flash times (3 times) when changing the operating mode. It will flash 3 times at a 1Hz rate each time the chip changes from the AUTO mode to another mode or flash 3 times at a 2Hz rate when returning to the AUTO mode. But if the AUTO mode is changed by switching the MODE switch it will not flash.
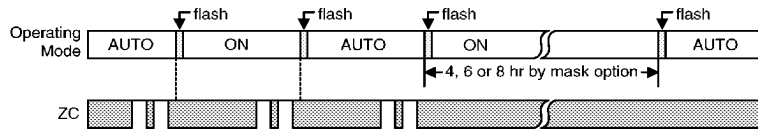

Fig.3 ZC override timing

RSTB

RSTB is used to reset the chip. It is internal pull-high and active low.

The use of C_{RST} can extend the power-on initial time. If the RSTB pin is an open circuit (without C_{RST}), the initial time is the default (40 secs).
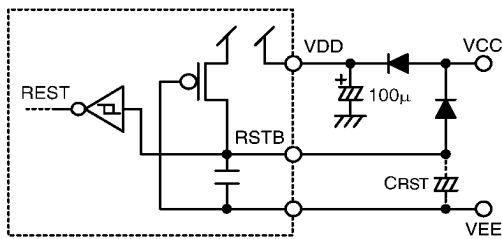

Fig.4 RSTB application example

Power on initial

The PIR signal amplifier requires a warm up period after power-on. The input should be disabled during this period.

In the AUTO mode within the first 10 seconds of power-on initialization, the chip allows override control to enter the test mode. After 40 seconds of the initial time the chip allows override control between ON and AUTO. It will remain in the warm up period if the total initial time has not elapsed after returning to AUTO.

In case that the ZC signal disappears more than 3 seconds, the chip will restart the initialization operation. However, the restart initial time is always 40 seconds and cannot be extended by adding C_{RST} to the RSTB pin as shown in Fig.4.

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Mask options

The HT761X offers mask options to select the output flash (3 times) when changing the operating mode. The chip will flash 3 times at a 1Hz rate each time it changes from AUTO to another mode and flash 3 times at a 2Hz rate when it returns to the AUTO mode. However the chip will not flash if the mode is changed by switching the MODE switch.

- 4, 6, or 8 hour options to return to AUTO from override ON. The default is 8 hours.

- Options for effective override: Once or twice OFF/ON operation of power switch within 3 seconds. The default is OFF/ON twice.

- Options for output flash to indicate effective override operation. The default is to flash.

- Options for effective PIR trigger pulse width: >24mS, >32mS or >48mS. The default is 24ms.

- Options for setting comparator window to be $\frac{1}{16}$, $\frac{1}{11.3}$ or $\frac{1}{9}$ (VDD–VEE). The default is $\frac{1}{16}$ (VDD–VEE).

PIR amplifier

Consult the diagram below for details on the PIR front end amplifier.

In Fig.5 there are 2 op-amps with different applications. OP1 can be used independently as a first stage inverting or non-inverting amplifier for the PIR.

As the output of OP2 is directly connected to the input of the comparator, it is used as a second
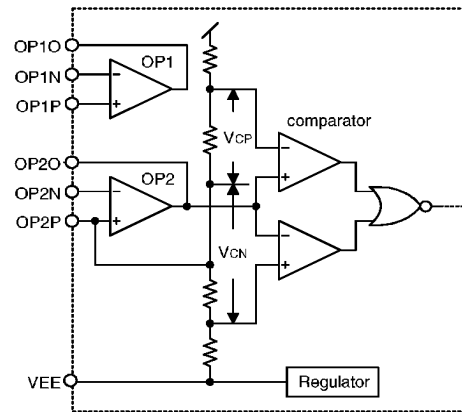

Fig. 5 PIR amplifier

stage amplifying device. The non-inverting input of OP2 is connected to the comparator's window centerpoint and can be used to check this voltage and to provide a bias voltage that is equal to the centerpoint voltage of the comparator. In Fig.5 the comparator can have 3 window levels set by mask option. 1. $\frac{1}{16}$ (VDD–VEE), 2. $\frac{1}{11.3}$ (VDD–VEE), 3. $\frac{1}{9}$ (VDD–VEE). If the window level fails to be specified the default window is set to $\frac{1}{16}$ (VDD–VEE). The preset voltage of VDD–VEE is 4V. The default values of V_{CP} and V_{CN} are therefore 0.25V, ($\frac{4}{16}$ V).
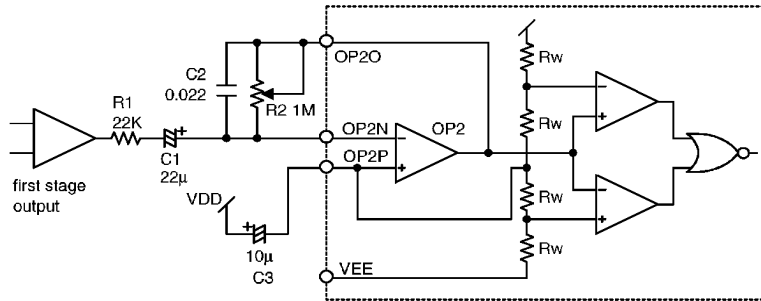
Second stage amplifier

Fig.6 Typical second stage amplifier

Usually the second stage PIR amplifier is a simple capacitively coupled inverting amplifier with a low pass configuration. The noninverting input terminal is biased to the center point of the comparator window and the output of the second stage amplifier is directly coupled to the comparator center point.

In Fig.6 OP2P is directly connected to the comparator window center, and with the C3 filter it can act as the bias for OP2. For this configuration $A_V = \dfrac{R2}{R1}$, low cutoff frequency $f_L = \dfrac{1}{2\pi R1 C1}$, high cutoff frequency $f_H = \dfrac{1}{2\pi R2 C2}$. By changing the value of R2 the sensitivity can be varied. C1 and C3 should be of low leakage types to prevent the DC operating point from change due to current leakage.

Each op-amp current consumption is approximately 5μA with the op-amps and comparator's working voltage all provided by the regulator.

Consult the following diagrams for typical PIR front end circuit.

First stage of PIR amplifier

Fig.7 shows a typical first stage amplifier. C2 and R2 form a simple low pass filter with cut off frequency at 7Hz. The low frequency response is governed by R1 and C1 with cut-off frequency at 0.33Hz.

$$A_V = \frac{(R1 + R2)}{R1}$$

Fig.7 and Fig.8 are similar but in Fig.8 the input signal of amplifier is taken from the drain of the PIR. This has higher gain than that in Fig.7. Since OP1 is a PMOS input V_D has to be greater than 1.2V for adequate operation.
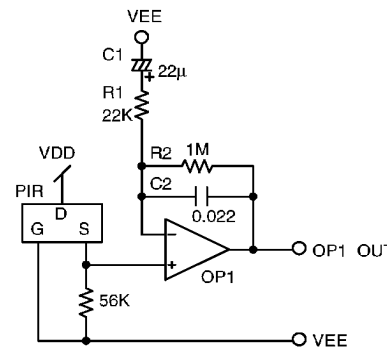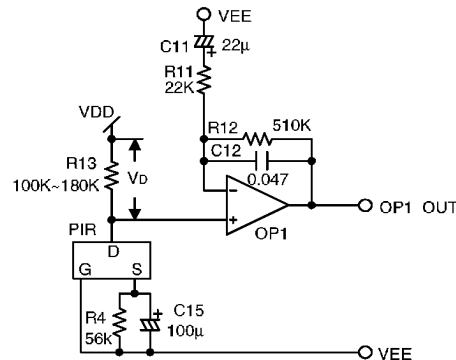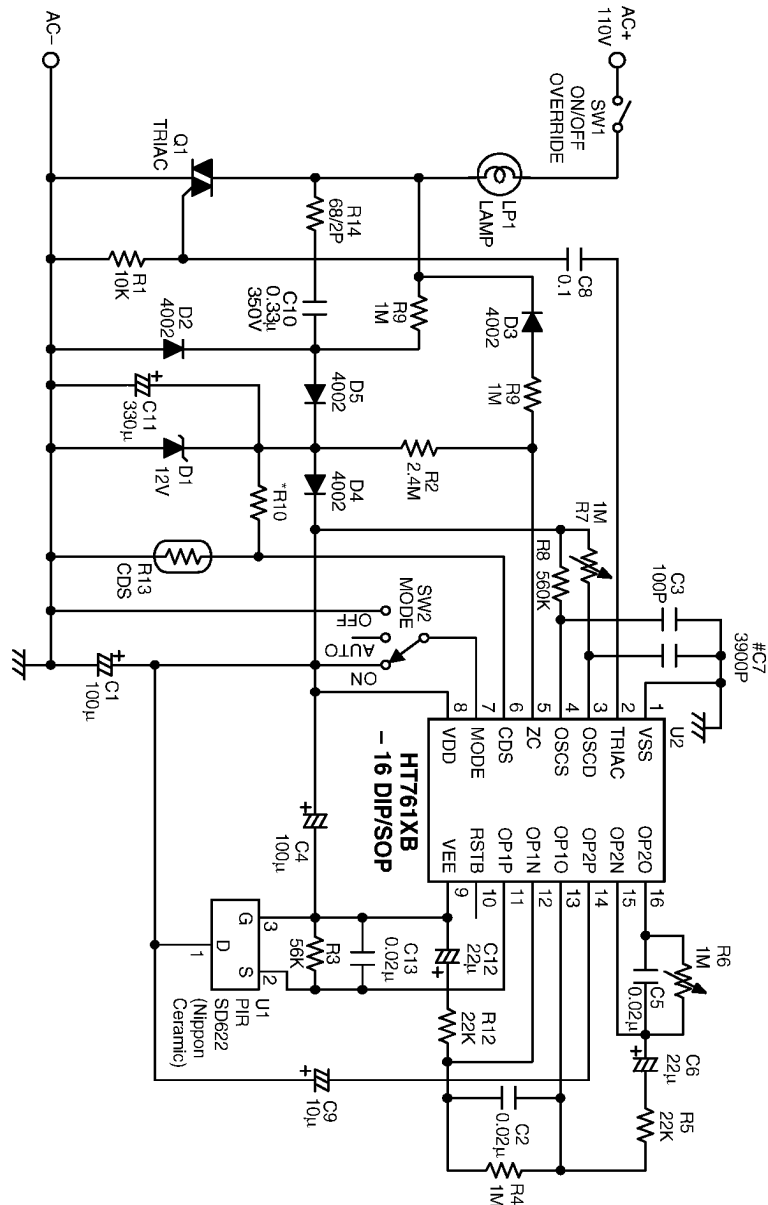

Fig. 7 Typical first-stage PIR

Fig.8 High gain first stage

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Application Circuit

HT761XA relay application

Note: 1. Adjust R13 to fit various CDS.
2. Change C6 to obtain the desired adjusting range of output duration.
3. Change the value of C11 to 0.33μF/600V for AC 220V application.

HT761XB triac application

Note: 1. Adjust R10 to fit various CDS.
2. Change C7 to obtain the desired adjusting range of output duration.
3. Change the value of C10 to 0.15μF/600V for AC 220V application.