Universidad de Buenos Aires
Facultad De Ingeniera
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86.07 - Laboratorio de microprocesadores

PROYECTO ESPECIAL
Diseño de dispositivo para control de luces
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1. Introducción

Se diseñó un dispositivo capaz de controlar la intensidad de luz dependiendo de la cantidad de luz y la deteccion de movimiento en el ambiente. Este puede ser utilizado por ejemplo en el control de las luces de un estadio, habitaciones, oficinas,etc. Su principal beneficio es disminuir el consumo de energia, dado que las luces solo consumiran potencia en el momento que sea requerido.

1.1. Diagrama de bloques

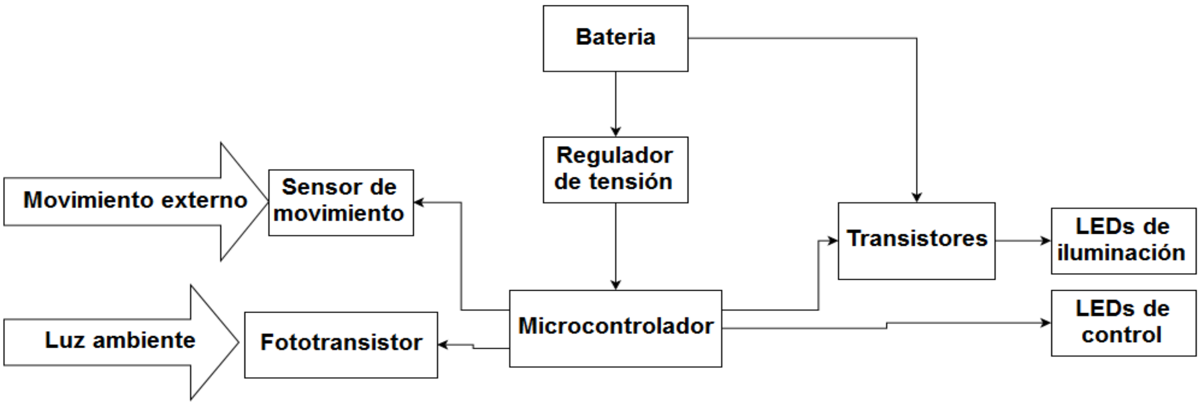


Figura 1: Diagrama de bloques del dispositivo

1.2. Diagrama de flujo

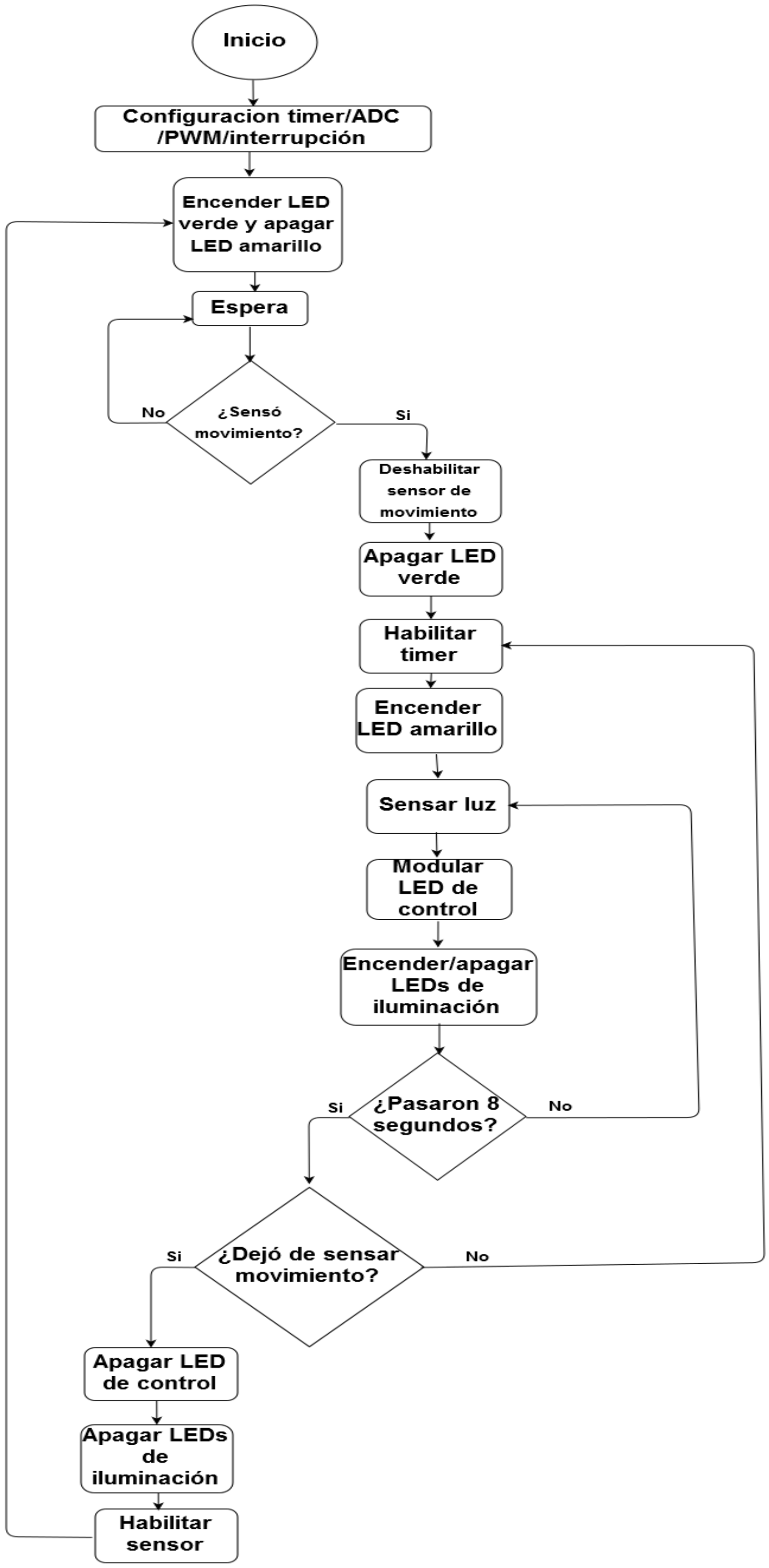


Figura 2: Diagrama de flujo del funcionamiento del dispositivo

1.3. Especificaciones

El dispositivo cuenta con dos mecanismos de control. Para el control de la intensidad de luz utiliza un fototransistor, a traves de este, sensa la cantidad de luz ambiente y en base a esto decide que cantidad de luces encender o apagar. El segundo mecanismo de control es un sensor de movimiento, que en base a detectar o no movimiento durante cierto tiempo encendiende o apaga el dispositivo respectivamente. Ademas posee un LED de control que modula su brillo indicando la intensidad de luz que esta entregando el dispositivo. Tambien posee dos LEDS para indicar su correcto funcionamiento, uno verde que indica que el dispositivo se encuentra encendido esperando sensar movimiento, y uno amarillo que indica que el dispositivo esta trabajando correctamente.

2. Diseño

2.1. Esquematico

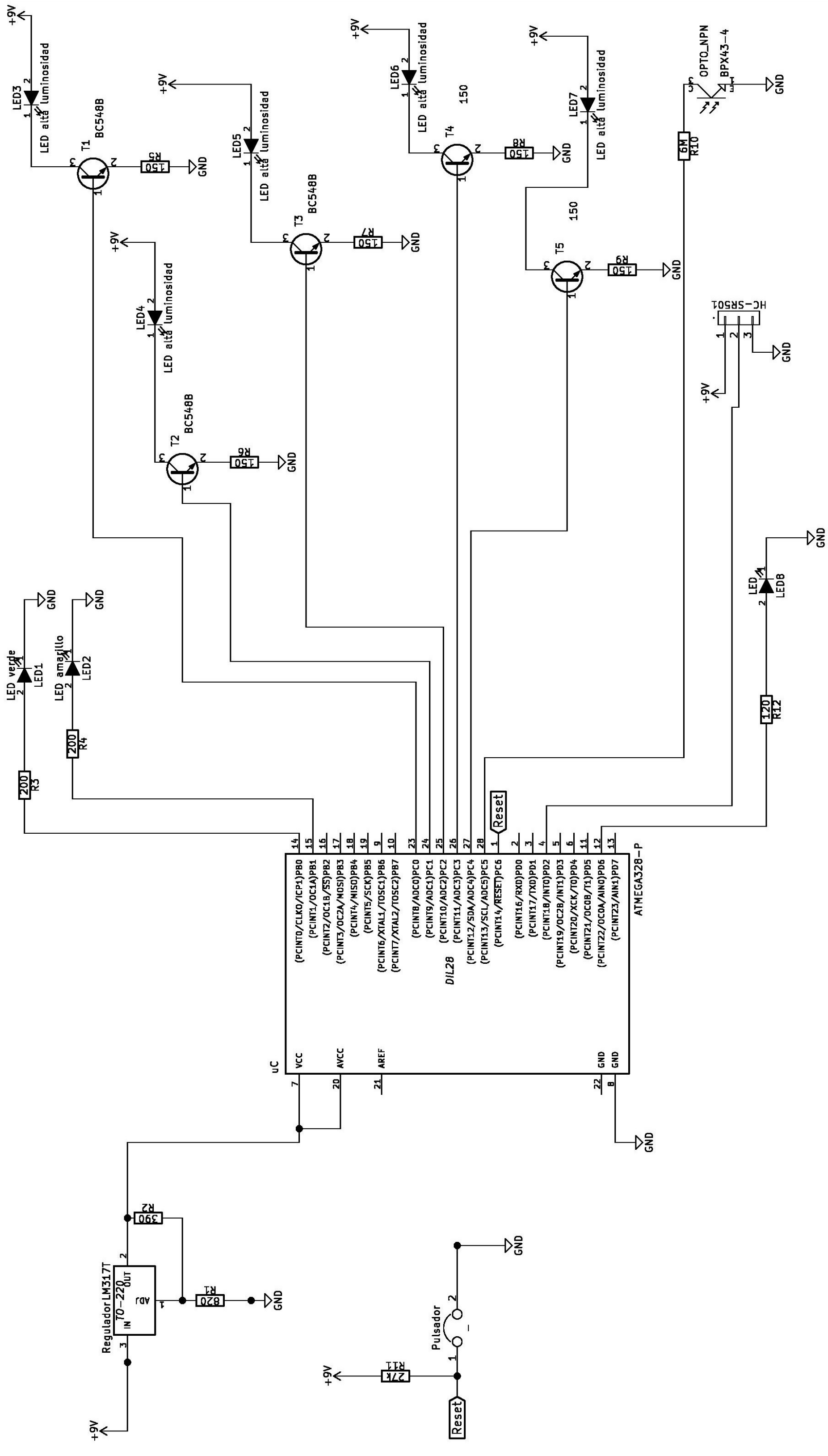


Figura 3: Esquematico del dispositivo

2.2. Hardware

2.2.1. Alimentación

- 1 bateria de 9 V
- 1 regulador de tensión *LM317T* [1]
- 1 resistencia de 820 Ω
- 1 resistencia de 390 Ω

De la hoja de datos del LM317T se obtiene que la tensión de salida será:

$$V_{CC} = 1{,}25.\left(1 + \frac{R_1}{R_2}\right) \tag{1}$$

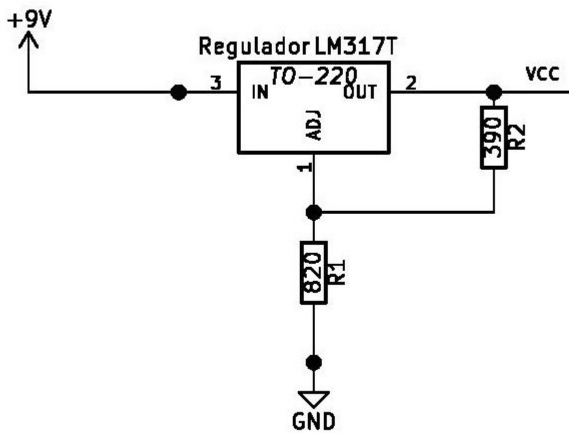


Figura 4: Circuito para el regulador de tensión y su conexión

Por lo tanto se obtiene una tensión de aproximadamente 3,9 V. De la medición del circuito se obtuvo que la tensión entregada por el circuito regulador es de 3,6 V. Se decidió alimentar al microcontrolador con una tensión cercana a 3,3 V debido a que el sensor de movimiento devuelve 3,3 V y se necesita que esta tensión sea interpretada por el microcontrolador como un estado logico alto (se utiliza para habilitar una interrupción por flanco ascendente).

2.2.2. Sensor de movimiento

- *Modulo HC-SR501 PIR infrarrojo de Arduino* [2]

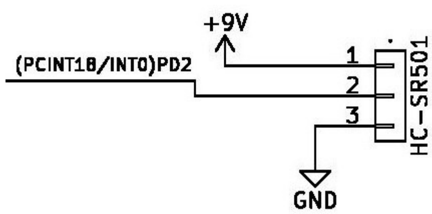


Figura 5: Conexión del sensor de movimiento

Como sensor de movimiento se utilizó el módulo HC-SR501 PIR infrarrojo de Arduino. El mismo se alimenta con 9 V y al sensar movimiento devuelve 3,3 V. Este modulo tarda 1 minuto aproximadamente en estabilizarse, tiempo durante el que devuele tensiones entre 0 y 3,3 V aleatoriamente. Su consumo de corriente es de 50 uA.

2.2.3. Sensor de luz

- 1 *fototransistor BPX43-4* [3]
- 1 resistencia de 6 MΩ

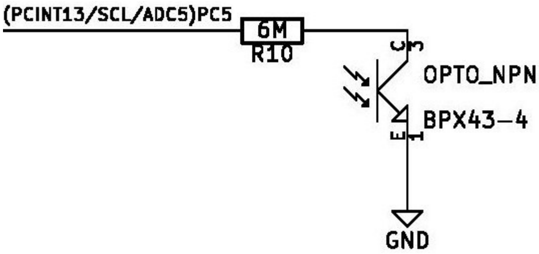


Figura 6: Conexión del sensor de luz

Para sensar la luz ambiente se decidió utilizar un fototransistor BPX43-4. Este posee una corriente de oscuridad del orden de los nanoamperes por lo que es necesaria una intensidad de luz considerable para lograr corrientes tal que su caida en la resistencia genere una tensión suficiente para el ADC (que utiliza como referencia de tension V_{CC} para las aproximaciones sucesivas). Debido a esto al estar frente a luz ambiente, el transistor maneja corrientes del orden de los microampere, por lo tanto se utilizó una resistencia del orden de los megaohms para lograr una mayor sensibilidad frente a condiciones de luz/oscuridad natural.

2.2.4. LEDs de control

- 1 LED verde
- 1 LED amarillo
- 1 LED rojo
- 2 resistencias de 200 Ω
- 1 resistencias de 120 Ω

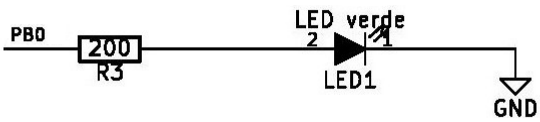


Figura 7: Conexión del LED verde

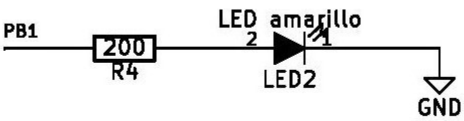


Figura 8: Conexión del LED amarillo

Al tratarse ambos de LEDS standars, se tomó que su caida de tensión es de $1,5\,\mathrm{V}$ y su consumo de corriente de $10\,\mathrm{mA}$ (valores típicos), ademas, cada PIN devuelve una tensión de $3,6\,\mathrm{V}$ por lo tanto las resistencias a conectar se calculan como:

$$R_{LED} = \frac{V_{PIN} - V_{LED}}{I_{LED}} \tag{2}$$

Utilizando la ecuación 2 se obtiene que la resistecia normalizada mas próxima es de 200 Ω.

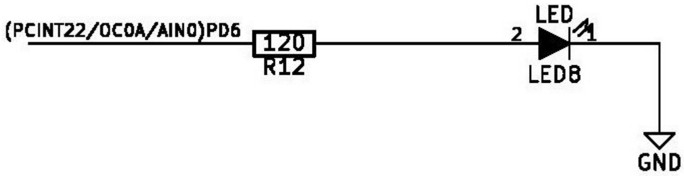


Figura 9: Conexión del LED al pwm

Este LED esta conectado a la salida del PWM, por lo que de acuerdo al ancho de pulso que entregue el micronctrolador, variará su brillo. Debido a que este LED se trata de uno de alto brillo, su caida de tensión es de 2,1 V y su corriente de 20 mA. Utilizando nuevamente la ecuación 2 se obtiene una resistencia de 75 Ω.

2.2.5. LEDs de iluminación

- 5 *LEDs de alta luminosidad* [4]
- 5 transistores BC548B
- 5 resistencias de 50 Ω

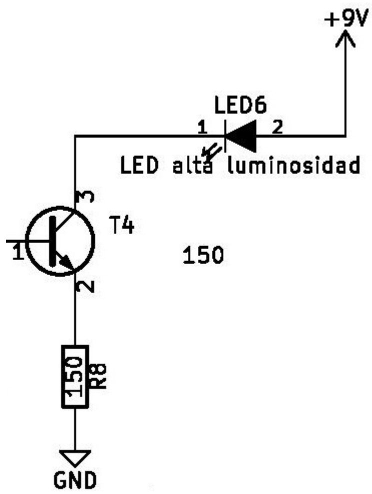


Figura 10: Conexión y circuito de los LEDs de iluminación

La base de los transistores utilizados es conectada a un pin del microcontrolador (ver figura 10). Cada LED de iluminación consume 20 mA, por lo que al tener 5, al estar los 5 encendidos (en condición de penumbra), el micro deberia entregar 100 mA. Para no forzar a que el microcontrolador entregue tanta corriente se decidió utilizar transistores para que cada PIN tenga que entregar una corriente menor. Para calcular la resistencia de emisor, se utilizó la siguiente ecuación:

$$R_E = \frac{V_{PIN} - V_{BE}}{I_E} \tag{3}$$

Considerando despreciable la corriente de base frente a la corriente de colector, se cumple que $I_C = I_E$, por lo que la corriente que se tenga en el emisor, será la misma que se tenga en el colector. Debido a que es necesario que el transistor se encuentre en modo activo directo, la tension base-emisor será de $0,7\,\mathrm{V}$, por lo que utilizando la ecuación 4, se obtiene una resistencia de emisor de 150 Ω. Considerando que en el LED caen entre $3,2\,\mathrm{V}$ y $3,6\,unitV$ recorriendo desde la fuente de tensión a masa se obtiene la siguiente ecuación:

$$V_{CE} = 9 - I_E.R_E - V_{LED} \tag{4}$$

De la misma se obtiene una tensión colector-emisor entre $2,4\,\mathrm{V}$ y $2,8\,\mathrm{V}$, por lo que el transistor no satura.

2.3. Software

Para este proyecto se utilizó un microcontrolador *ATmega328p* [5] a 8 MHz. A continuación se detalla como se modifican los registros para lograr la configuración deseada.

2.3.1. Interrupción

Para que la regulación de la luz comience cuando el sensor detecta movimiento, se implementó una interrupcion por flanco ascendente en el pin INT0, para esto se modificaron los siguientes registros:

7	6	5	4	3	2	1	0
-	-	-	-	ISC11	ISC10	ISC01	ISC00
	0	0	0	0	0	1	1

Tabla 1: Registro EICRA

A traves de esto se configura el pin que posee INT0 como interrupcion por flanco ascendente.

7	6	5	4	3	2	1	0
-	-	-	-	-	-	INT1	INT0
	0	0	0	0	0	0	1

Tabla 2: Registro EIMSK

A traves de esto se habilita la interrupción externa.

2.3.2. Timer/counter

Luego de arrancar el proceso de sensado, es necesario que durante cierta cantidad de tiempo el programa se encuentre sensando y regulando la luz que entrega, para esto, se configuro el timer/counter 1 por overflow.

7	6	5	4	3	2	1	0
ICNC1	ICES1	-	WGM13	WGM12	CS12	CS11	CS10
0	0	0	0	0	1	0	1

Tabla 3: Registro TCCR1B

7	6	5	4	3	2	1	0
COM1A1	COM1A0	COM1B1	COM1B0	-	-	WGM11	WGM10
0	0	0	0	0	0	0	0

Tabla 4: Registro TCCR1A

7	6	5	4	3	2	1	0
-	-	ICIE1	-	-	OCIE1B	OCIE1A	TOEI1
0	0	0	0	0	0	0	1

Tabla 5: Registro TIMSK1

Si bien al inicio los ultimos 3 bits del registro TCCR1B estan en 0 para que no este en funcionamiento, luego se setean de la forma indicada en la tabla 3 para que su frecuencia sea la del clkIO dividido 1024, y se habilita a traves del bit TOIE1 (que inicialmente tambien se encuentra en 0) del registro TIMSK1. Del registro TCCR1A no se modifica ningun bit, ya que inicialmente estan todos en 0, y esto indica modo de funcionamiento normal (es decir cuenta hasta 0xFFFF). Se utilizó este modo ya que se desea que el timer dure lo máximo posible.

2.3.3. PWM

Para configurar el PWM se modifican los siguientes registros:

7	6	5	4	3	2	1	0
COM0A1	COM0A0	COM0B1	COM0B0	-	-	WGM01	WGM00
1	0	0	0	0	0	1	1

Tabla 6: Registro TCCR0A

7	6	5	4	3	2	1	0
FOC0A	FOC0B	-	-	WGM02	CS02	CS01	CS00
0	0	0	0	0	0	1	1

Tabla 7: Registro TCCR0B

Debido a como se setean estos registros, se obtiene fast PWM no inversor. Este PWM se caracteriza por ser de alta frecuenca. Ademas, el pulso que genera vale 1 hasta que el contador llega al valor 0CR0A y 0 hasta que el contador llega al final. Debido a como se setearon los bits del registro TCCR0B, la frecuencia será de clkIO/64.

2.3.4. ADC

Para configurar el conversor analógico digitales se modificcan los siguientes registros:

7	6	5	4	3	2	1	0
REFS1	REFS0	ADLAR	-	MUX3	MUX2	MUX1	MUX0
0	1	0	0	0	1	0	1

Tabla 8: Registro ADMUX

7	6	5	4	3	2	1	0
ADEN	ADSC	ADATE	ADIF	ADIE	ADPS2	ADPS1	ADPS0
1	0	0	0	0	0	1	1

Tabla 9: Registro ADCSRA

Debido a como se setearon estos registros, se utiliza el ADC5 con el valor A_{VCC} como referencia (En este caso este valor es igual a V_{CC}) a una frecuencia igual a la del clock interno dividido 8. Se eligió esta frecuencia debido a que la frecuencia del ADC debe ser bastante menor a la frecuencia del clock interno.

2.3.5. Sleep mode

7	6	5	4	3	2	1	0
-	-	-	-	SM2	SM1	SM0	SE
0	0	0	0	0	1	0	1

Tabla 10: Registro SMCR

Se setean los bits de esta forma para tener sleep mode power down. En este, se duermen todos los clks, y son despertados a traves de la interrupción externa del sensor. Esto se realiza para que, mientras no detecta movimiento, el microcontrolador ahorre energia.

3. Resultados

A continuación se muestran dos mediciones realizadas con el oscilocopio. En rojo puede observarse el pulso que entrega el sensor de movimiento, y en azul la señal que se obtiene sobre el LED amarillo (es decir, cuanto tiempo se encuentra sensando y modulando la luz). De las mismas puede ver que el dispositivo regula durante multiplos de 8 segundos, lo que era esperado de acuerdo al codigo.

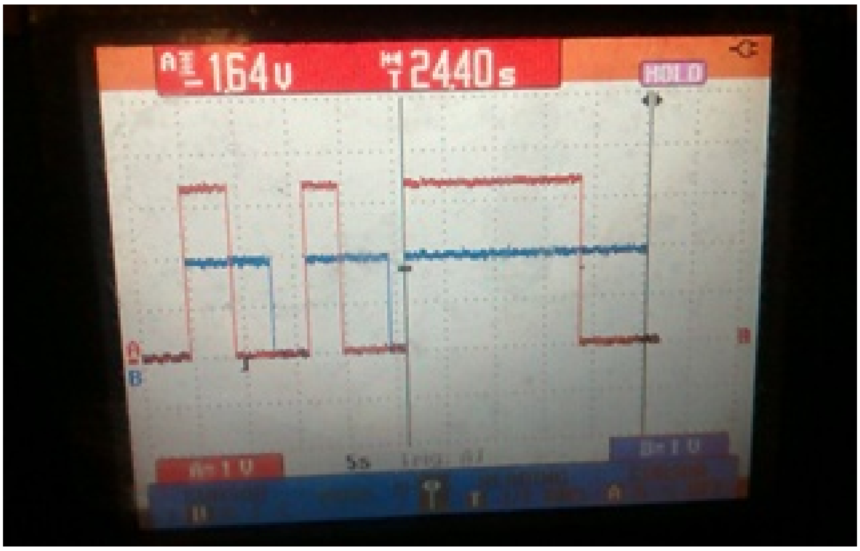


Figura 11: Señal de salida del sensor de movimiento (rojo) y señal sobre el LED de control amarillo (azul)

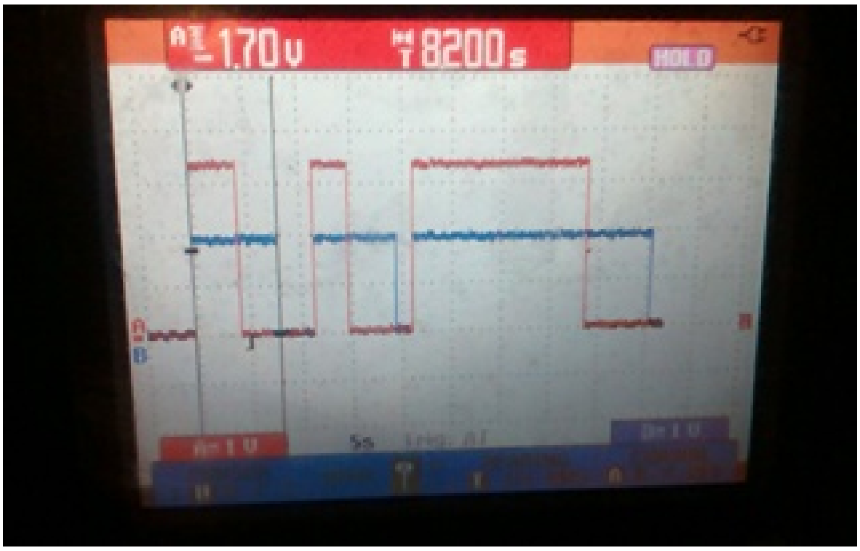


Figura 12: Señal de salida del sensor de movimiento (rojo) y señal sobre el LED de control amarillo (azul)

4. Conclusión

Se logro la implementación de la idea original del trabajo práctico, utilizando los conceptos de programación de los microcontroladores avr. Se utilizaron elementos primordiales como el pwm, conversor a/d, timer, interrupciones para realizar dicho objetivo. Durante la realización del trabajo práctico se encontraron varios inconvenientes, entre estos se destacan la incapacidad de distinguir el espectro luminoso de la manera deseada, esto se debe a que el fototransistor a luz ambiente permite una circulación de corriente relativamente baja, variando levemente ante una variacion de luz moderada. Otro de los problemas encontrados, fue la forma de verificar el correcto funcionamiento del programa, para ello se emplearon los leds de control de manera de verificar el correcto funcionamiento, sin embargo con los leds solo se pudo verificar el estado del programa, por lo que los valores de los registros en cada momento eran desconocidos desde fuera, para solucionar esto podria haberse recurrido a utilizar alguna conexion del tipo puerto serie.

5. Código

```
.include "M328PDEF.INC"
.listmac

.def auxiliar =r22
.def auxiliar_2 =r23
.def auxiliar_adc_1 =r16
.def auxiliar_adc_2 =r17
.def auxiliar_sreg=r18
.def estado_sensor=r19
.def auxiliar_vector=r20
.def auxiliar_comparacion=r21
.cseg
JMP config_init
;Direcciones de los vectores de interrupcion
.ORG 0x001A
JMP TIMER1_OVF
.ORG 0x0002; Dirección del vector INT0
JMP ext_int0;

.ORG 0x0039
config_init:
;Inicializacion del stack
LDI auxiliar,LOW(RAMEND)
OUT SPL,auxiliar
LDI auxiliar,HIGH(RAMEND)
OUT SPH,auxiliar

;*****************************************************
;Configuracion interrupcion del sensor de movimiento
;Se configura INT0 por flanco ascendente
;*****************************************************
LDS auxiliar,EICRA
ORI auxiliar,((1<<ISC01)|(1<<ISC00))
STS EICRA, auxiliar; Registro EICRA
LDS auxiliar,EIMSK
ORI auxiliar,(1<<INT0)
OUT EIMSK,auxiliar

;**********************************************************************************************************
;Configuracion del timer de la interrupcion
;El timer se configura para overflow de manera de habilitar la interrupcion del sensor de movimiento
;**********************************************************************************************************
config_timer:
LDS auxiliar,TCCR1B
ANDI auxiliar,~((0<<ICNC1)|(0<<ICES1)|(0<<WGM13)|(0<<WGM12)|(1<<CS12)|(1<<CS11)|(1<<CS10))
STS TCCR1B,auxiliar
LDI auxiliar_2,0
STS TCNT1H,auxiliar_2
STS TCNT1L,auxiliar_2

;***************************************************************
;Configuracion del pwm en fast mode 8 bits
;***************************************************************
CONFIGURACION_PWM:
LDI auxiliar,0
OUT OCR0A,auxiliar
LDS auxiliar,TCCR0A
ORI auxiliar,((1<<WGM01)|(1<<WGM00)|(1<<COM0A1)|(0<<COM0A0))
```

```
OUT TCCR0A,auxiliar
LDS auxiliar,TCCR0B
ORI auxiliar,((1<<CS00)|(1<<CS01)|(0<<CS02))
OUT TCCR0B,auxiliar

;**************************************************************
;Configuracion del ADC
;**************************************************************
CONFIGURACION_ADC:
LDS auxiliar,ADMUX;
ORI auxiliar,((1<<REFS0)|(1<<MUX2)|(1<<MUX0));
STS ADMUX, auxiliar; Se configura AVcc como la referencia
LDS auxiliar,ADCSRA;
ORI auxiliar,((1<<ADEN)|(1<<ADPS1)|(1<<ADPS0)); Seteo el valor de division del clk 8M/8
STS ADCSRA, auxiliar; Habilito el adc

;************************************************************
;Configuracion de los pines del ADC y PWM
;************************************************************
CONFIGURACION_PINES:
SBI DDRD,6 ;El pin del pwm es (PCINT22/OC0A/AIN0) PD6
CBI DDRC,5;Configuro el pin PC5 (ADC5/SCL/PCINT13) como entrada
SBI DDRB,1;Configuro el led verde para debugear
SBI DDRB,2;Configuro el led amarillo para debugear
SBI DDRC,4;Configuro el pin c4 como salida
SBI DDRC,3;*****************c3************
SBI DDRC,2;*****************c2************
SBI DDRC,1;*****************c1************
SBI DDRC,0;*****************c0************
;**********************
;Programa principal
;**********************
LDI estado_sensor,0;Inicializo el estado del sensor
SBI PORTB,1
RCALL RETARDO_INICIAL
CBI PORTB,1
RCALL RETARDO_INICIAL
SEI;Habilito las interrupciones

HERE:
SBI PORTB,1
CBI PORTB,2
RCALL RETARDO
CBI PORTD,1
RCALL RETARDO
CBI PORTB,1
LDS auxiliar_2,SMCR
ORI auxiliar_2,((0<<SM1)|(1<<SE))
OUT SMCR,auxiliar_2
SLEEP
HERE_IT:
SBRS estado_sensor,0
RJMP HERE
RCALL DESACTIVAR_SENSOR
CBI PORTB,1;
HERE_TIMER:
RCALL HABILITAR_TIMER
ldi estado_sensor,1

SENSAR:
```

```
SBI PORTB,2
SENSAR_IT:
  RCALL SENSAR_LUZ
  RCALL MODULACION_LED
  RCALL CONTROL_LUZ
  SBRC estado_sensor,0
  RJMP SENSAR_IT
  RCALL DESACTIVAR_TIMER
  SBIC PIND,2
  RJMP HERE_TIMER
RCALL APAGAR_LED_CONTROL
RCALL HABILITAR_SENSOR
RCALL APAGAR_LUZ
RJMP HERE

;******************************************************************

SENSAR_LUZ:
LDS auxiliar_adc_1,ADCSRA;
ORI auxiliar_adc_1,(1<<ADSC)
STS ADCSRA,auxiliar_adc_1;
CONVERSION:
LDS auxiliar_adc_1,ADCSRA ;
SBRS auxiliar_adc_1,ADIF;
RJMP CONVERSION;
RET

MODULACION_LED:
LDS auxiliar_adc_1,ADCSRA;
ORI auxiliar_adc_1, (1<<ADIF)
STS ADCSRA,auxiliar_adc_1
LDS auxiliar_adc_1,ADCL;
LDS auxiliar_adc_2,ADCH;
LSR auxiliar_adc_2;%Por relacion llevo el espacios de 1023ptos a 255ptos dividiendo en 4
ROR auxiliar_adc_1;
LSR auxiliar_adc_2
ROR auxiliar_adc_1;
OUT OCR0A,auxiliar_adc_1;
RET

CONTROL_LUZ:
push r30
push r31
push auxiliar_vector
mov auxiliar_comparacion,auxiliar_adc_1
LDI ZL,LOW(VECTOR_LUZ<<1)
LDI ZH,HIGH(VECTOR_LUZ<<1)
LPM auxiliar_vector,Z+
CP auxiliar_comparacion,auxiliar_vector;%Comparo con la maxima intensidad para la que esta todo apaga
BRLO ESTADO1;
LPM auxiliar_vector,Z+
CP auxiliar_comparacion,auxiliar_vector
BRLO ESTADO2;
LPM auxiliar_vector,Z+
CP auxiliar_comparacion,auxiliar_vector
BRLO ESTADO3;
LPM auxiliar_vector,Z+
CP auxiliar_comparacion,auxiliar_vector
BRLO ESTADO4;
LPM auxiliar_vector,Z+
```

```
CP auxiliar_comparacion,auxiliar_vector
BRLO ESTADO5;
LPM auxiliar_vector,Z+
CP auxiliar_comparacion,auxiliar_vector
BRLO ESTADO6;


ESTADO1:
CBI PORTC,0
CBI PORTC,1
CBI PORTC,2
CBI PORTC,3
CBI PORTC,4
RJMP FIN
ESTADO2:
SBI PORTC,0
CBI PORTC,1
CBI PORTC,2
CBI PORTC,3
CBI PORTC,4
RJMP FIN
ESTADO3:
SBI PORTC,0
SBI PORTC,1
CBI PORTC,2
CBI PORTC,3
CBI PORTC,4
RJMP FIN
ESTADO4:
SBI PORTC,0
SBI PORTC,1
SBI PORTC,2
CBI PORTC,3
CBI PORTC,4
RJMP FIN
ESTADO5:
SBI PORTC,0
SBI PORTC,1
SBI PORTC,2
SBI PORTC,3
CBI PORTC,4
RJMP FIN
ESTADO6:
SBI PORTC,0
SBI PORTC,1
SBI PORTC,2
SBI PORTC,3
SBI PORTC,4
RJMP FIN
FIN:
pop auxiliar_vector
pop r31
pop r30
RET

APAGAR_LUZ:
CBI PORTC,0
CBI PORTC,1
CBI PORTC,2
CBI PORTC,3
```

```
CBI PORTC,4
RET

APAGAR_LED_CONTROL:
LDI auxiliar_adc_1,0
OUT OCR0A,auxiliar_adc_1;
RET

DESACTIVAR_SENSOR:
CLI
LDS auxiliar_2,EIMSK
ANDI auxiliar_2,~(1<<INT0)
OUT EIMSK,auxiliar_2
SEI
RET

HABILITAR_SENSOR:
CLI
IN auxiliar_2,EIMSK
ORI auxiliar_2,(1<<INT0)
OUT EIMSK,auxiliar_2
SEI
RET

REACTIVAR_CONTADOR:
LDS auxiliar_2,TCCR1B
ORI auxiliar_2,((1<<CS12)|(0<<CS11)|(1<<CS10))
ANDI auxiliar_2,~((0<<CS12)|(1<<CS11)|(0<<CS10))
RET

DETENER_CONTADOR:
LDS auxiliar_2,TCCR1B
ANDI auxiliar_2,~((0<<ICNC1)|(0<<ICES1)|(0<<WGM13)|(0<<WGM12)|(1<<CS12)|(1<<CS11)|(1<<CS10))
RET

DESACTIVAR_TIMER:
CLI
LDS auxiliar_2,TCCR1B
ANDI auxiliar_2,~((0<<ICNC1)|(0<<ICES1)|(0<<WGM13)|(0<<WGM12)|(1<<CS12)|(1<<CS11)|(1<<CS10))
STS TCCR1B,auxiliar_2
LDI auxiliar_2,0;Desactivo la interrupcion del timer overflow
STS TIMSK1,auxiliar_2;
SEI
RET

HABILITAR_TIMER:
LDI auxiliar_2,0
STS TCNT1H,auxiliar_2
STS TCNT1L,auxiliar_2
LDS auxiliar_2,TCCR1B
ORI auxiliar_2,((1<<CS12)|(0<<CS11)|(1<<CS10))
ANDI auxiliar_2,~((0<<ICNC1)|(0<<ICES1)|(0<<WGM13)|(0<<WGM12)|(0<<CS12)|(1<<CS11)|(0<<CS10))
STS TCCR1B,auxiliar_2
LDI auxiliar_2,1;
STS TIMSK1,auxiliar_2;
RET

dormir_micro:
push auxiliar_2
lds auxiliar_2,SMCR
```

```
ori auxiliar_2,(1<<SM1)
sts SMCR,auxiliar_2
lds auxiliar_2,SMCR
ori auxiliar_2,(1<<SE)
sts SMCR,auxiliar_2
pop auxiliar_2
ret

RETARDO:
LDI R24,33
L1:
LDI R25,200
L2:
LDI R26,250
L3:
DEC R26
BRNE L3
DEC R25
BRNE L2
DEC R24
BRNE L1
RET

RETARDO_INICIAL:
LDI R24,250
L1_INICIO:
LDI R25,250
L2_INICIO:
LDI R26,250
L3_INICIO:
DEC R26
BRNE L3_INICIO
DEC R25
BRNE L2_INICIO
DEC R24
BRNE L1_INICIO
RET

;****************************************************************
;Interrupcion del sensor de movimiento
;****************************************************************
ext_int0:
IN auxiliar_sreg,SREG
PUSH auxiliar_sreg
lds auxiliar_2,SMCR
andi auxiliar_2,~(1<<SE)
out SMCR,auxiliar_2
LDI estado_sensor,1 ;se activo el sensor
POP auxiliar_sreg
OUT SREG,auxiliar_sreg
RETI
;****************************************************************
;Interrupcion del timer overflow
;****************************************************************
TIMER1_OVF:
IN auxiliar_sreg,SREG
PUSH auxiliar_sreg
LDI estado_sensor,0;Dejo de sensar
POP auxiliar_sreg
OUT SREG,auxiliar_sreg
```

```
RETI

VECTOR_LUZ: .db 16,20,32,45,100,255
```

6. Datasheets

ATmega48A/PA/88A/PA/168A/PA/328/P

ATMEL 8-BIT MICROCONTROLLER WITH 4/8/16/32KBYTES IN-SYSTEM PROGRAMMABLE FLASH

DATASHEET

Features

- High Performance, Low Power Atmel®AVR® 8-Bit Microcontroller Family
- Advanced RISC Architecture
  - 131 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 20 MIPS Throughput at 20MHz
  - On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory Segments
  - 4/8/16/32KBytes of In-System Self-Programmable Flash program memory
  - 256/512/512/1KBytes EEPROM
  - 512/1K/1K/2KBytes Internal SRAM
  - Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
  - Data retention: 20 years at 85°C/100 years at 25°C[(1)]
  - Optional Boot Code Section with Independent Lock Bits
    - In-System Programming by On-chip Boot Program
    - True Read-While-Write Operation
  - Programming Lock for Software Security
- Atmel® QTouch® library support
  - Capacitive touch buttons, sliders and wheels
  - QTouch and QMatrix® acquisition
  - Up to 64 sense channels
- Peripheral Features
  - Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
  - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
  - Real Time Counter with Separate Oscillator
  - Six PWM Channels
  - 8-channel 10-bit ADC in TQFP and QFN/MLF package
    - Temperature Measurement
  - 6-channel 10-bit ADC in PDIP Package
    - Temperature Measurement
  - Programmable Serial USART
  - Master/Slave SPI Serial Interface
  - Byte-oriented 2-wire Serial Interface (Philips I^2C compatible)
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-chip Analog Comparator
  - Interrupt and Wake-up on Pin Change

- Special Microcontroller Features
  - Power-on Reset and Programmable Brown-out Detection
  - Internal Calibrated Oscillator
  - External and Internal Interrupt Sources
  - Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby
- I/O and Packages
  - 23 Programmable I/O Lines
  - 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF
- Operating Voltage:
  - 1.8 - 5.5V
- Temperature Range:
  - -40°C to 85°C
- Speed Grade:
  - 0 - 4MHz@1.8 - 5.5V, 0 - 10MHz@2.7 - 5.5.V, 0 - 20MHz @ 4.5 - 5.5V
- Power Consumption at 1MHz, 1.8V, 25°C
  - Active Mode: 0.2mA
  - Power-down Mode: 0.1µA
  - Power-save Mode: 0.75µA (Including 32kHz RTC)

1. Pin Configurations

Figure 1-1. Pinout ATmega48A/PA/88A/PA/168A/PA/328/P

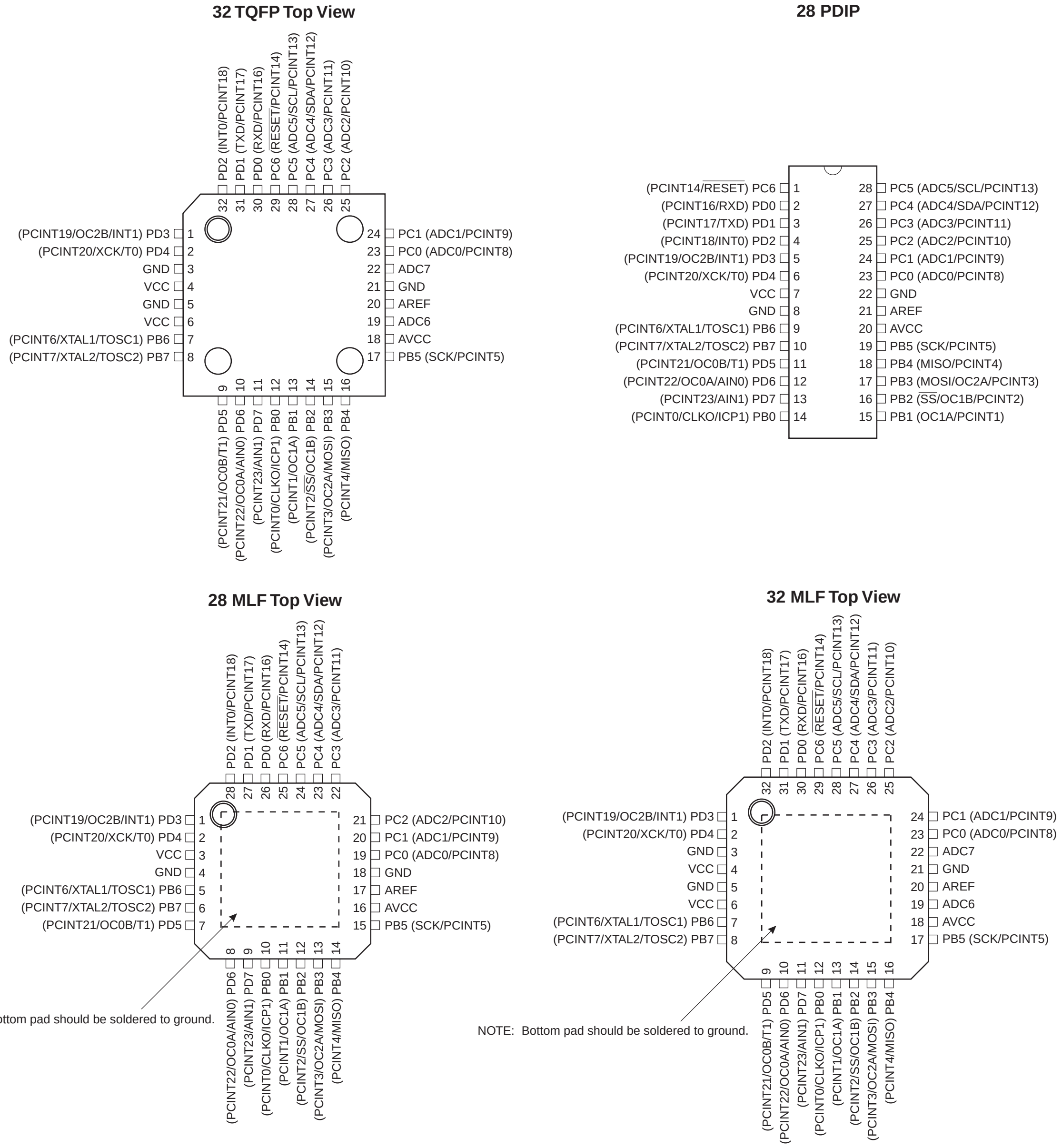


Table 1-1. 32UFBGA - Pinout ATmega48A/48PA/88A/88PA/168A/168PA

	1	2	3	4	5	6
A	PD2	PD1	PC6	PC4	PC2	PC1
B	PD3	PD4	PD0	PC5	PC3	PC0
C	GND	GND			ADC7	GND
D	VDD	VDD			AREF	ADC6
E	PB6	PD6	PB0	PB2	AVDD	PB5
F	PB7	PD5	PD7	PB1	PB3	PB4

HC-SR501 PIR MOTION DETECTOR

Product Discription

HC-SR501 is based on infrared technology, automatic control module, using Germany imported LHI778 probe design, high sensitivity, high reliability, ultra-low-voltage operating mode, widely used in various auto-sensing electrical equipment, especially for battery-powered automatic controlled products.

Specification:

- Voltage: 5V – 20V
- Power Consumption: 65mA
- TTL output: 3.3V, 0V
- Delay time: Adjustable (.3->5min)
- Lock time: 0.2 sec
- Trigger methods: L – disable repeat trigger, H enable repeat trigger
- Sensing range: less than 120 degree, within 7 meters
- Temperature: – 15 ~ +70
- Dimension: 32*24 mm, distance between screw 28mm, M2, Lens dimension in diameter: 23mm

Application:

Automatically sensing light for Floor, bathroom, basement, porch, warehouse, Garage, etc, ventilator, alarm, etc.

Features:

- Automatic induction: to enter the sensing range of the output is high, the person leaves the sensing range of the automatic delay off high, output low.
- Photosensitive control (optional, not factory-set) can be set photosensitive control, day or light intensity without induction.
- Temperature compensation (optional, factory reset): In the summer when the ambient temperature rises to 30 ° C to 32 ° C, the detection distance is slightly shorter, temperature compensation can be used for performance compensation.
- Triggered in two ways: (jumper selectable)
  - non-repeatable trigger: the sensor output high, the delay time is over, the output is automatically changed from high level to low level;
  - repeatable trigger: the sensor output high, the delay period, if there is human activity in its sensing range, the output will always remain high until the people left after the delay will be high level goes low (sensor module detects a time delay period will be automatically extended every human activity, and the starting point for the delay time to the last event of the time).
- With induction blocking time (the default setting: 2.5s blocked time): sensor module after each sensor output (high into low), followed by a blockade set period of time, during this time period sensor does not accept any sensor signal. This feature can be achieved sensor output time “and” blocking time “interval between the work can be applied to interval detection products; This function can inhibit a variety of interference in the process of load switching. (This time can be set at zero seconds – a few tens of seconds).
- Wide operating voltage range: default voltage DC4.5V-20V.
- Micropower consumption: static current <50 microamps, particularly suitable for battery-powered automatic control products.
- Output high signal: easy to achieve docking with the various types of circuit.

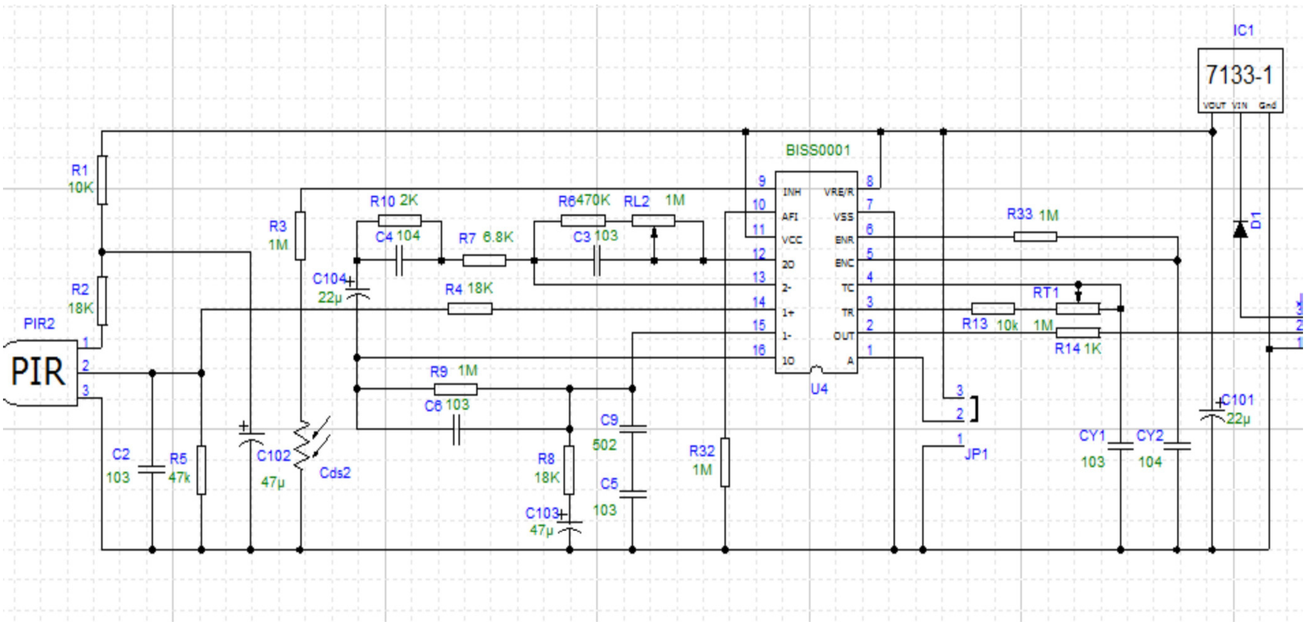
Adjustment:

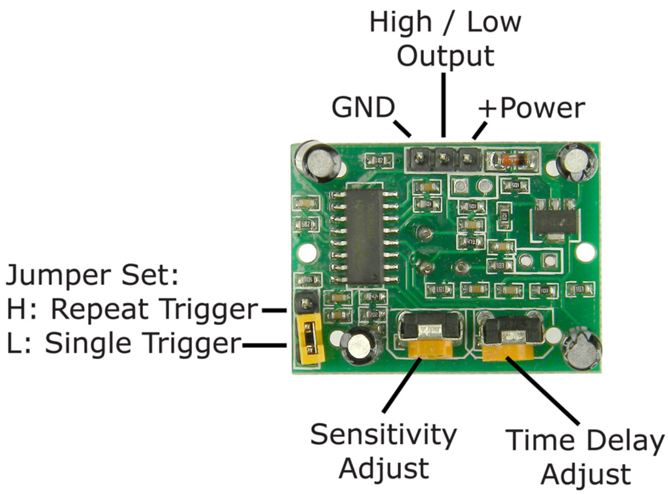
- Adjust the distance potentiometer clockwise rotation, increased sensing distance (about 7 meters), on the contrary, the sensing distance decreases (about 3 meters).
- Adjust the delay potentiometer clockwise rotation sensor the delay lengthened (300S), on the contrary, shorten the induction delay (5S).

Instructions for use:

- Sensor module is powered up after a minute, in this initialization time intervals during this module will output 0-3 times, a minute later enters the standby state.
- Should try to avoid the lights and other sources of interference close direct module surface of the lens, in order to avoid the introduction of interference signal malfunction; environment should avoid the wind flow, the wind will cause interference on the sensor.
- Sensor module with dual probe, the probe window is rectangular, dual (A B) in both ends of the longitudinal direction
  - so when the human body from left to right or right to left through the infrared spectrum to reach dual time, distance difference, the greater the difference, the more sensitive the sensor,
  - when the human body from the front to the probe or from top to bottom or from bottom to top on the direction traveled, double detects changes in the distance of less than infrared spectroscopy, no difference value the sensor insensitive or does not work;
- The dual direction of sensor should be installed parallel as far as possible in inline with human movement. In order to increase the sensor angle range, the module using a circular lens also makes the probe surrounded induction, but the left and right sides still up and down in both directions sensing range, sensitivity, still need to try to install the above requirements.

HC-SR501 PIR MOTION DETECTOR





1 working voltage range :DC 4.5-20V

2 Quiescent Current :50uA

3 high output level 3.3 V / Low 0V

4. Trigger L trigger can not be repeated / H repeated trigger

5. circuit board dimensions :32 * 24 mm

6. maximum 110 ° angle sensor

7. 7 m maximum sensing distance

Product Type	HC--SR501 Body Sensor Module
Operating Voltage Range	5-20VDC
Quiescent Current	<50uA
Level output	High 3.3 V /Low 0V
Trigger	L can not be repeated trigger/H can be repeated trigger(Default repeated trigger)
Delay time	5-300S(adjustable) Range (approximately .3Sec -5Min)
Block time	2.5S(default)Can be made a range(0.xx to tens of seconds
Board Dimensions	32mm*24mm
Angle Sensor	<110 ° cone angle
Operation Temp.	-15-+70 degrees
Lens size sensor	Diameter:23mm(Default)

Application scope
•Security products
•Body induction toys
•Body induction lamps
•Industrial automation control etc

Pyroelectric infrared switch is a passive infrared switch which consists of BISS0001 ,pyroelectric infrared sensors and a few external components. It can au open all kinds of equipments, inculding incandescent lamp, fluorescent lamp, intercom, automatic, electric fan, dryer and automatic washing machine, etc. It is widely used in enterprises, hotels, stores, and corridor and other sensitive area for automatical lamplight, lighting and alarm system.

Instructions

Induction module needs a minute or so to initialize. During initializing time, it will output 0-3 times. One minute later it comes into standby.
Keep the surface of the lens from close lighting source and wind, which will introduce interference.
Induction module has double -probe whose window is rectangle. The two sub-probe (A and B) is located at the two ends of rectangle. When human body r to right, or from right to left, Time for IR to reach to reach the two sub-probes differs.The lager the time diffference is, the more sensitive this module is. Wh body moves face-to probe, or up to down, or down to up, there is no time difference. So it does not work. So instal the module in the direction in which mos activities behaves, to guarantee the induction of human by dual sub-probes. In order to increase the induction range, this module uses round lens which ca from all direction. However, induction from right or left is more sensitivity than from up or down.

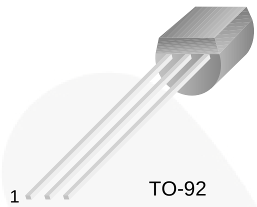
FAIRCHILD

November 2014

BC546 / BC547 / BC548 / BC549 / BC550
NPN Epitaxial Silicon Transistor

Features

- Switching and Amplifier
- High-Voltage: BC546, V_{CEO} = 65 V
- Low-Noise: BC549, BC550
- Complement to BC556, BC557, BC558, BC559, and BC560



TO-92

1. Collector 2. Base 3. Emitter

Ordering Information

Part Number	Marking	Package	Packing Method
BC546ABU	BC546A	TO-92 3L	Bulk
BC546ATA	BC546A	TO-92 3L	Ammo
BC546BTA	BC546B	TO-92 3L	Ammo
BC546BTF	BC546B	TO-92 3L	Tape and Reel
BC546CTA	BC546C	TO-92 3L	Ammo
BC547ATA	BC547A	TO-92 3L	Ammo
BC547B	BC547B	TO-92 3L	Bulk
BC547BBU	BC547B	TO-92 3L	Bulk
BC547BTA	BC547B	TO-92 3L	Ammo
BC547BTF	BC547B	TO-92 3L	Tape and Reel
BC547CBU	BC547C	TO-92 3L	Bulk
BC547CTA	BC547C	TO-92 3L	Ammo
BC547CTFR	BC547C	TO-92 3L	Tape and Reel
BC548BU	BC548	TO-92 3L	Bulk
BC548BTA	BC548B	TO-92 3L	Ammo
BC548CTA	BC548C	TO-92 3L	Ammo
BC549BTA	BC549B	TO-92 3L	Ammo
BC549BTF	BC549B	TO-92 3L	Tape and Reel
BC549CTA	BC549C	TO-92 3L	Ammo
BC550CBU	BC550C	TO-92 3L	Bulk
BC550CTA	BC550C	TO-92 3L	Ammo

Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter		Value	Unit
V_{CBO}	Collector-Base Voltage	BC546	80	V
		BC547 / BC550	50	
		BC548 / BC549	30	
V_{CEO}	Collector-Emitter Voltage	BC546	65	V
		BC547 / BC550	45	
		BC548 / BC549	30	
V_{EBO}	Emitter-Base Voltage	BC546 / BC547	6	V
		BC548 / BC549 / BC550	5	
I_C	Collector Current (DC)		100	mA
P_C	Collector Power Dissipation		500	mW
T_J	Junction Temperature		150	°C
T_{STG}	Storage Temperature Range		-65 to +150	°C

Electrical Characteristics

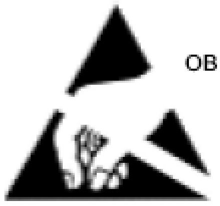
Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter		Conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector Cut-Off Current		V_{CB} = 30 V, I_E = 0			15	nA
h_{FE}	DC Current Gain		V_{CE} = 5 V, I_C = 2 mA	110		800	
V_{CE}(sat)	Collector-Emitter Saturation Voltage		I_C = 10 mA, I_B = 0.5 mA		90	250	mV
			I_C = 100 mA, I_B = 5 mA		250	600	
V_{BE}(sat)	Base-Emitter Saturation Voltage		I_C = 10 mA, I_B = 0.5 mA		700		mV
			I_C = 100 mA, I_B = 5 mA		900		
V_{BE}(on)	Base-Emitter On Voltage		V_{CE} = 5 V, I_C = 2 mA	580	660	700	mV
			V_{CE} = 5 V, I_C = 10 mA			720	
f_T	Current Gain Bandwidth Product		V_{CE} = 5 V, I_C = 10 mA, f = 100 MHz		300		MHz
C_{ob}	Output Capacitance		V_{CB} = 10 V, I_E = 0, f = 1 MHz		3.5	6.0	pF
C_{ib}	Input Capacitance		V_{EB} = 0.5 V, I_C = 0, f = 1 MHz		9		pF
NF	Noise Figure	BC546 / BC547 / BC548	V_{CE} = 5 V, I_C = 200 µA, f = 1 kHz, R_G = 2 kΩ		2.0	10.0	dB
		BC549 / BC550			1.2	4.0	
		BC549	V_{CE} = 5 V, I_C = 200 µA, R_G = 2 kΩ, f = 30 to 15000 MHz		1.4	4.0	
		BC550			1.4	3.0	

h_{FE} Classification

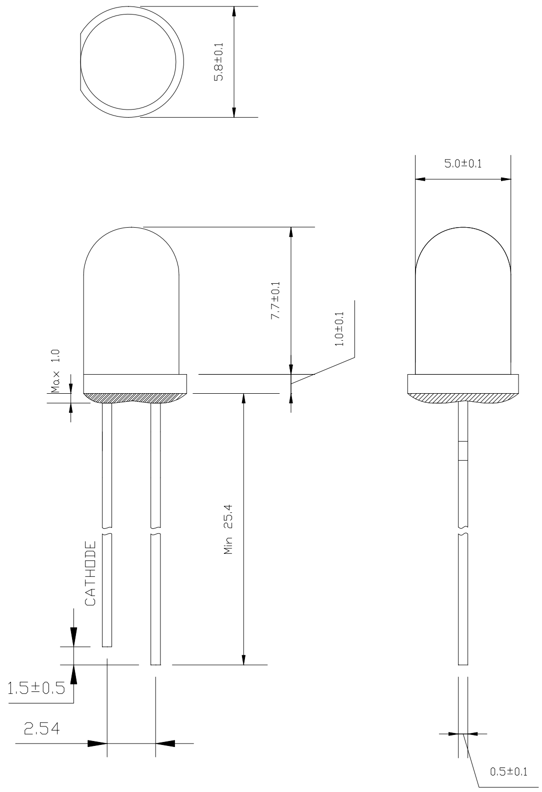
Classification	A	B	C
h_{FE}	110 ~ 220	200 ~ 450	420 ~ 800

LED-010-70042



ATTENTION

OBSERVE PRECAUTIONS FOR HANDLING ELECTROSTATIC DISCHARGE SENSITIVE DEVICES



Features/特征：

- Single color/特征
- High bright output/高亮度输出
- Low power consumption/低功耗
- High reliability and long life/可靠性高、寿命长
- Low brightness declines/低光衰

Descriptions/描述：

- Dice material/芯片材质：GaInN
- Emitting Color/发光颜色：

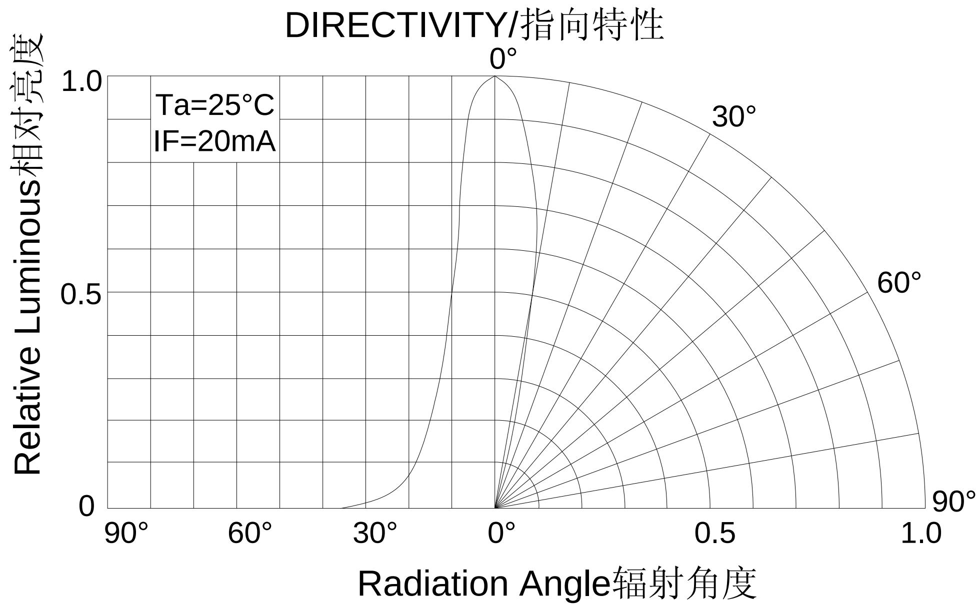
  Super Bright White/高亮度白色
- Device Outline/产品外形：

  ϕ5mm Round Type/5mm 圆形
- Lens Type/胶体颜色：Water Clear/无色透明

NOTE/注意:

- All dimensions are millimeters/单位：mm
- Tolerance is +/-0.25mmunless otherwise noted/没有标注的公差为±0.25mm

Directivity/指向特性：



Absolute maximum ratings/极限参数（Ta = 25℃）

Parameter 参数	Symbol 符号	Test Condition 测试条件	Value 数值		Unit 单位
			Min.	Max.	
Reverse Voltage 反向电压	V_R	I_R = 30μA	5	--	V
Forward Current 正向工作电流	I_F	----	----	25	mA
Power Dissipation 损耗功率	Pd	----	----	108	mW
Pulse Current 正向峰值电流	Ipeak	Duty=0.1mS，1kHz	----	100	mA
Operating Temperature 工作温度范围	Topr	----	-40	+85	℃
Storage Temperature 储存温度范围	Tstr	----	-40	+100	℃

Electrical and optical characteristics /光电参数（Ta = 25℃）

Parameter 参数	Symbol 符号	Test Condition 测试条件	Value 数值			Unit 单位
			Min.	Typ.	Max.	
Forward Voltage 正向电压	V_F	I_F = 20mA	----	3.2	3.6	V
Reverse Current 反向电流	I_R	V_R = 5V	----	----	30	μA
Luminous Intensity 发光强度	I_V	I_F = 20mA	----	8000	----	mcd
Viewing Angle 指向角度	2θ1/2	I_F = 20mA	24		30	Deg.

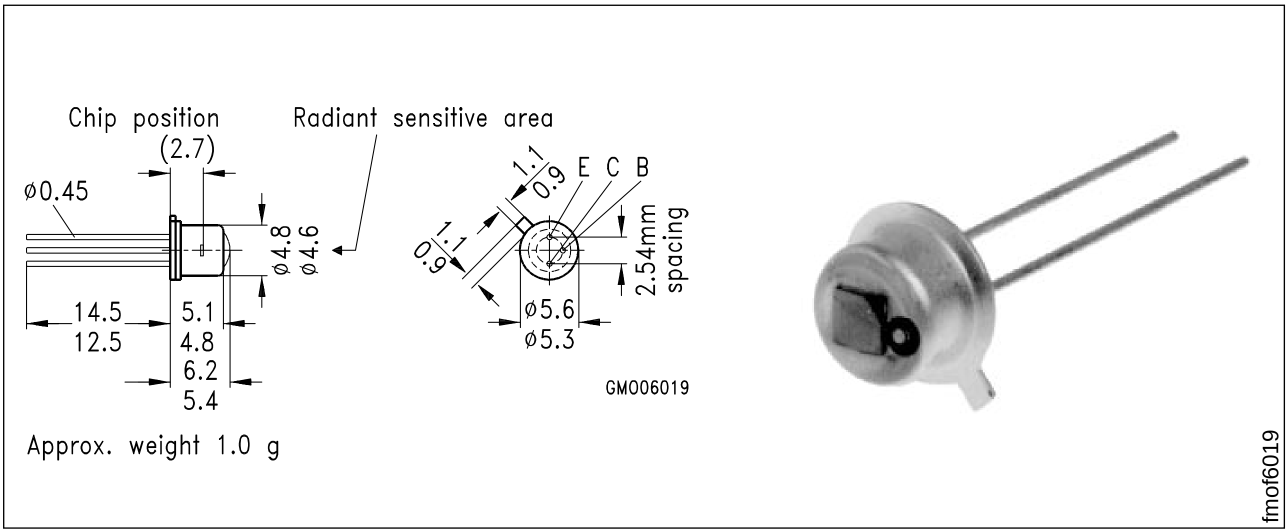
Luminous Intensity Bins Chart/发光强度分档（Ta = 25℃）

Bin	X	Y	Z1		
Min	4000	6000	8000		
Max	6000	8000	10000		

SIEMENS

NPN-Silizium-Fototransistor
Silicon NPN Phototransistor

BPX 43



Maβe in mm, wenn nicht anders angegeben/Dimensions in mm, unless otherwise specified

Wesentliche Merkmale

- Speziell geeignet für Anwendungen im Bereich von 450 nm bis 1100 nm
- Hohe Linearität
- Hermetisch dichte Metallbauform (TO-18) mit Basisanschluβ, geeignet bis 125 °C
- Gruppiert lieferbar

Features

- Especially suitable for applications from 450 nm to 1100 nm
- High linearity
- Hermetically sealed metal package (TO-18) with base connection suitable up to 125 °C
- Available in groups

Anwendungen

- Lichtschranken für Gleich- und Wechsellichtbetrieb
- Industrieelektronik
- “Messen/Steuern/Regeln”

Applications

- Photointerrupters
- Industrial electronics
- For control and drive circuits

Typ Type	Bestellnummer Ordering Code
BPX43	Q62702-P16
BPX 43-2	Q62702-P16-S2
BPX 43-3	Q62702-P16-S3
BPX 43-4	Q62702-P16-S4
BPX 43-5	Q 62702-P16-S5

Grenzwerte
Maximum Ratings

Bezeichnung **Description**	**Symbol** **Symbol**	**Wert** **Value**	**Einheit** **Unit**
Betriebs- und Lagertemperatur Operating and storage temperature range	T_{op}; T_{stg}	– 55 ... + 125	°C
Löttemperatur bei Tauchlötung Lötstelle ≥ 2 mm vom Gehäuse, Lötzeit $t \leq 5$ s Dip soldering temperature ≥ 2 mm distance from case bottom, soldering time $t \leq 5$ s	T_S	260	°C
Löttemperatur bei Kolbenlötung Lötstelle ≥ 2 mm vom Gehäuse, Lötzeit $t \leq 3$ s Iron soldering temperature ≥ 2 mm distance from case bottom, soldering time $t \leq 3$ s	T_S	300	°C
Kollektor-Emitterspannung Collector-emitter voltage	V_{CE}	50	V
Kollektorstrom Collector current	I_C	50	mA
Kollektorspitzenstrom, $\tau < 10$ µs Collector surge current	I_{CS}	200	mA
Emitter-Basisspannung Emitter-base voltage	V_{EB}	7	V
Verlustleistung, $T_A = 25$ °C Total power dissipation	P_{tot}	220	mW
Wärmewiderstand Thermal resistance	R_{thJA}	450	K/W

Kennwerte (T_A = 25 °C, λ = 950 nm)
Characteristics

Bezeichnung **Description**	**Symbol** **Symbol**	**Wert** **Value**	**Einheit** **Unit**
Wellenlänge der max. Fotoempfindlichkeit Wavelength of max. sensitivity	$\lambda_{S\ max}$	880	nm
Spektraler Bereich der Fotoempfindlichkeit S = 10 % von S_{max} Spectral range of sensitivity S = 10 % of S_{max}	λ	450 ... 1100	nm
Bestrahlungsempfindliche Fläche Radiant sensitive area	A	0.675	mm^2
Abmessung der Chipfläche Dimensions of chip area	$L \times B$ $L \times W$	1×1	mm × mm
Abstand Chipoberfläche zu Gehäuseober- fläche Distance chip front to case surface	H	2.4 ... 3.0	mm
Halbwinkel Half angle	φ	± 15	Grad deg.
Fotostrom der Kollektor-Basis-Fotodiode Photocurrent of collector-base photodiode E_e = 0.5 mW/cm^2, V_{CB} = 5 V E_v = 1000 lx, Normlicht/standard light A, V_{CB} = 5 V	 I_{PCB} I_{PCB}	 11 35	 µA µA
Kapazität Capacitance V_{CE} = 0 V, f = 1 MHz, E = 0 V_{CB} = 0 V, f = 1 MHz, E = 0 V_{EB} = 0 V, f = 1 MHz, E = 0	 C_{CE} C_{CB} C_{EB}	 23 39 47	 pF pF pF
Dunkelstrom Dark current V_{CE} = 25 V, E = 0	I_{CEO}	20 (≤ 300)	nA

Die Fototransistoren werden nach ihrer Fotoempfindlichkeit gruppiert und mit arabischen Ziffern gekennzeichnet.
The phototransistors are grouped according to their spectral sensitivity and distinguished by arabian figures.

Bezeichnung Description	Symbol Symbol	Wert Value				Einheit Unit
		-2	-3	-4	-5	
Fotostrom, $\lambda = 950$ nm Photocurrent E_e = 0.5 mW/cm^2, V_{CE} = 5 V E_v = 1000 lx, Normlicht/standard light A, V_{CE} = 5 V	 I_{PCE} I_{PCE}	 0.8 ... 1.6 3.8	 1.25 ... 2.5 6.0	 2.0 ... 4.0 9.5	 ≥ 3.2 15.0	 mA mA
Anstiegszeit/Abfallzeit Rise and fall time I_C = 1 mA, V_{CC} = 5 V, R_L = 1 kΩ	t_r, t_f	9	12	15	18	µs
Kollektor-Emitter-Sättigungsspannung Collector-emitter saturation voltage $I_C = I_{PCEmin}$[1] $\times$ 0.3 E_e = 0.5 mW/cm^2	V_{CEsat}	200	220	240	260	mV
Stromverstärkung Current gain E_e = 0.5 mW/cm^2, V_{CE} = 5 V	$\frac{I_{PCE}}{I_{PCB}}$	110	170	270	430	

[1] I_{PCEmin} ist der minimale Fotostrom der jeweiligen Gruppe
[1] I_{PCEmin} is the min. photocurrent of the specified group

National Semiconductor

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LM117/LM317A/LM317
3-Terminal Adjustable Regulator

General Description

The LM117 series of adjustable 3-terminal positive voltage regulators is capable of supplying in excess of 1.5A over a 1.2V to 37V output range. They are exceptionally easy to use and require only two external resistors to set the output voltage. Further, both line and load regulation are better than standard fixed regulators. Also, the LM117 is packaged in standard transistor packages which are easily mounted and handled.

In addition to higher performance than fixed regulators, the LM117 series offers full overload protection available only in IC's. Included on the chip are current limit, thermal overload protection and safe area protection. All overload protection circuitry remains fully functional even if the adjustment terminal is disconnected.

Normally, no capacitors are needed unless the device is situated more than 6 inches from the input filter capacitors in which case an input bypass is needed. An optional output capacitor can be added to improve transient response. The adjustment terminal can be bypassed to achieve very high ripple rejection ratios which are difficult to achieve with standard 3-terminal regulators.

Besides replacing fixed regulators, the LM117 is useful in a wide variety of other applications. Since the regulator is "floating" and sees only the input-to-output differential voltage, supplies of several hundred volts can be regulated as long as the maximum input to output differential is not exceeded, i.e., avoid short-circuiting the output.

Also, it makes an especially simple adjustable switching regulator, a programmable output regulator, or by connecting a fixed resistor between the adjustment pin and output, the LM117 can be used as a precision current regulator. Supplies with electronic shutdown can be achieved by clamping the adjustment terminal to ground which programs the output to 1.2V where most loads draw little current.

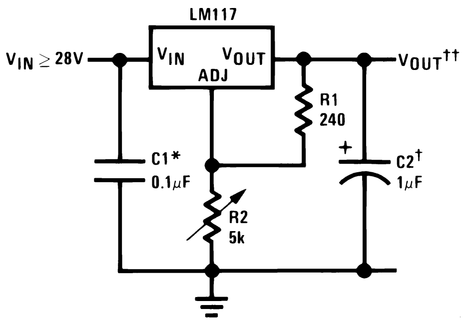
For applications requiring greater output current, see LM150 series (3A) and LM138 series (5A) data sheets. For the negative complement, see LM137 series data sheet.

Features

- Guaranteed 1% output voltage tolerance (LM317A)
- Guaranteed max. 0.01%/V line regulation (LM317A)
- Guaranteed max. 0.3% load regulation (LM117)
- Guaranteed 1.5A output current
- Adjustable output down to 1.2V
- Current limit constant with temperature
- P^+ Product Enhancement tested
- 80 dB ripple rejection
- Output is short-circuit protected

Typical Applications

1.2V–25V Adjustable Regulator



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Full output current not available at high input-output voltages

*Needed if device is more than 6 inches from filter capacitors.

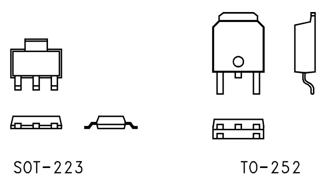
†Optional — improves transient response. Output capacitors in the range of 1µF to 1000µF of aluminum or tantalum electrolytic are commonly used to provide improved output impedance and rejection of transients.

$$††V_{OUT} = 1.25V\left(1 + \frac{R2}{R1}\right) + I_{ADJ}(R_2)$$

LM117 Series Packages

Part Number Suffix	Package	Design Load Current
K	TO-3	1.5A
H	**TO-39**	**0.5A**
T	TO-220	1.5A
E	**LCC**	**0.5A**
S	TO-263	1.5A
EMP	SOT-223	1A
MDT	**TO-252**	**0.5A**

SOT-223 vs. D-Pak (TO-252) Packages



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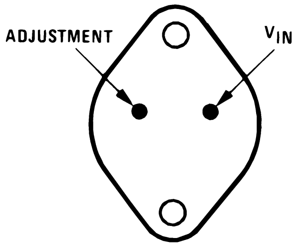
Scale 1:1

Connection Diagrams

(TO-3)
Metal Can Package



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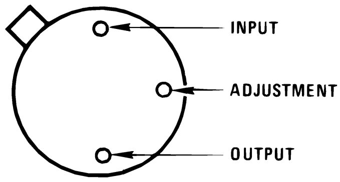
CASE IS OUTPUT

Bottom View
Steel Package
NS Package Number K02A or K02C

(TO-39)
Metal Can Package



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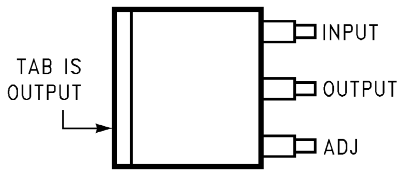
CASE IS OUTPUT

Bottom View
NS Package Number H03A

(TO-263) Surface-Mount Package



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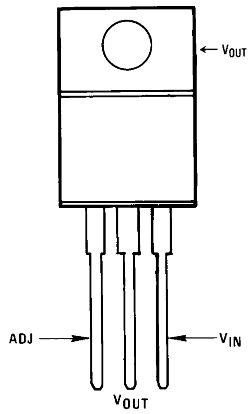
Top View

(TO-220)
Plastic Package



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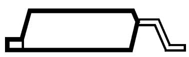
Front View
NS Package Number T03B



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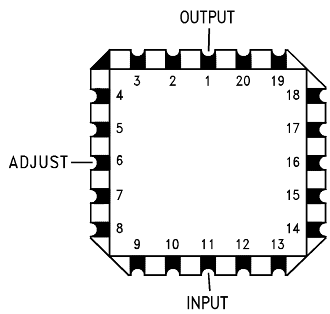
Side View
NS Package Number TS3B

Ceramic Leadless
Chip Carrier



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Top View
NS Package Number E20A

7. Referencias

[1] www.g0kla.com/datasheets/lm317t.pdf

[2] https://www.mpja.com/download/31227sc.pdf

[3] www.osram-os.com/Graphics/XPic3/00101768_0.pdf

[4] www.sycelectronica.com.ar/optoelectronica/LED-010-70042.pdf

[5] http://www.atmel.com/images/atmel-2486-8-bit-avr-microcontroller-atmega8_l_datasheet.pdf