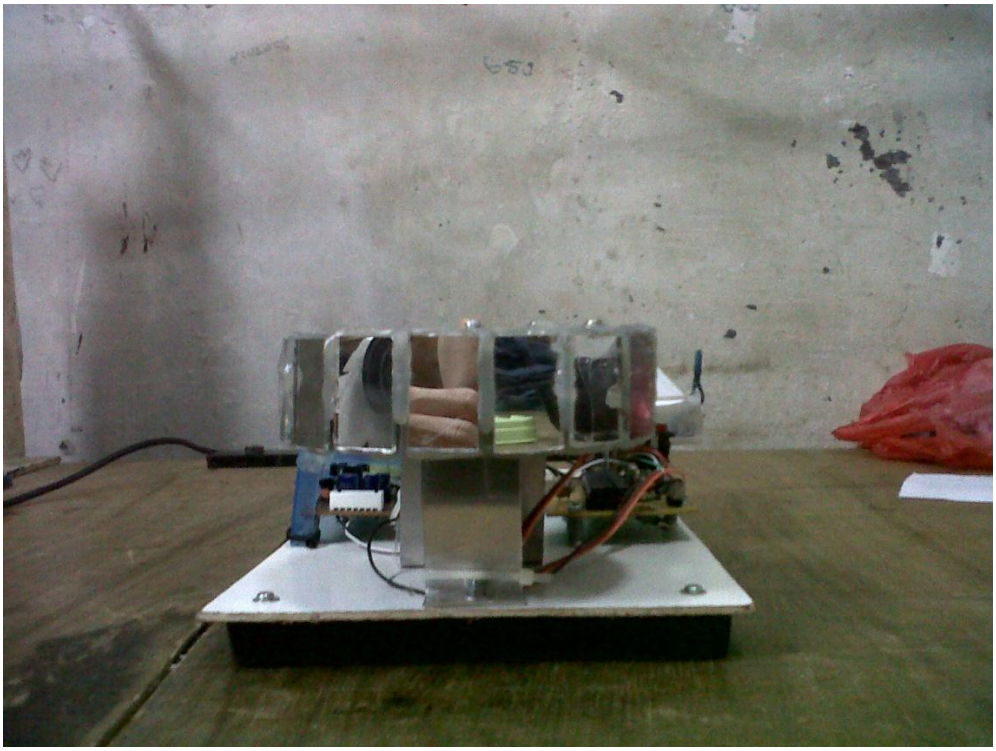
LAMPIRAN A
FOTO ALAT

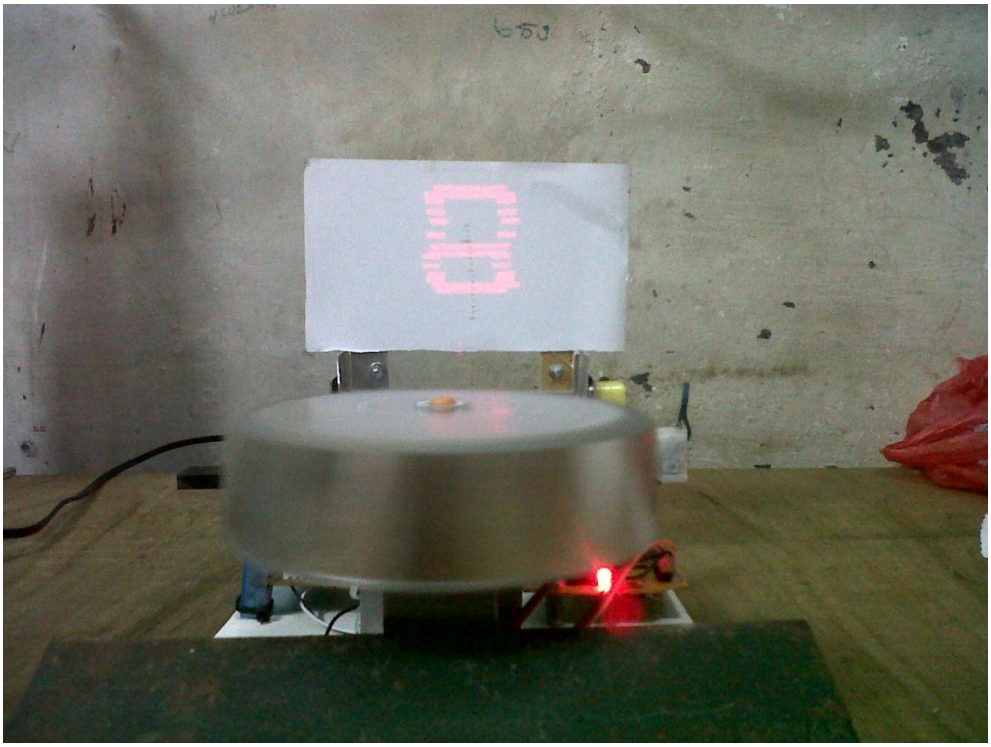


Tampilan Rangkaian Cermin

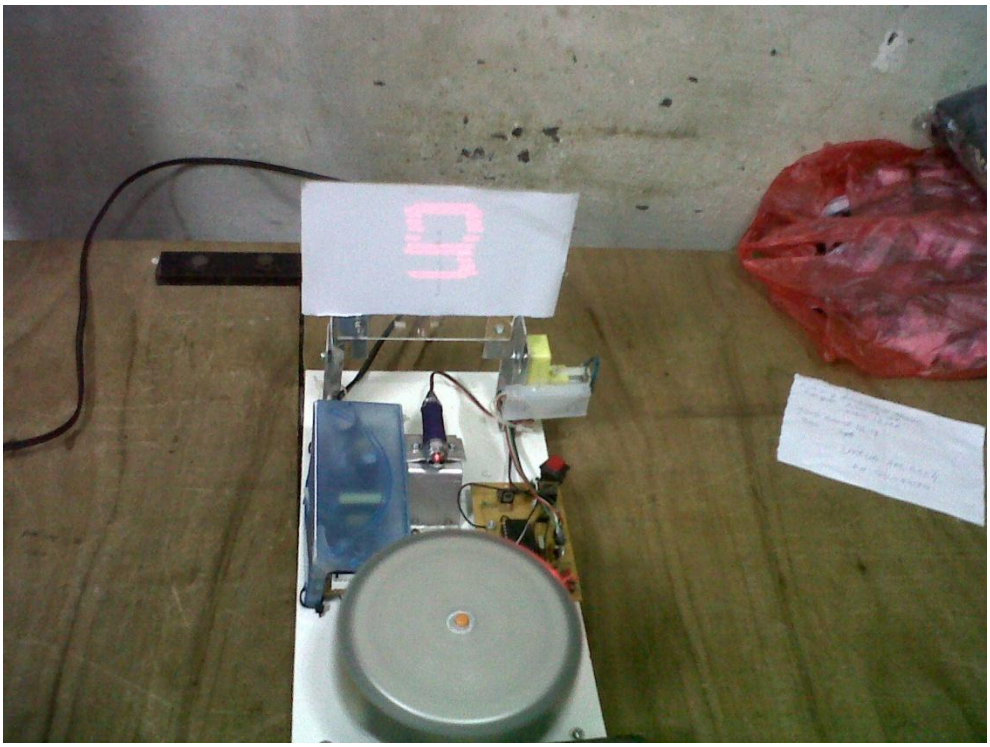
Tampilan Rangkaian Pengendali Laser Pointer

Tampilan Alat

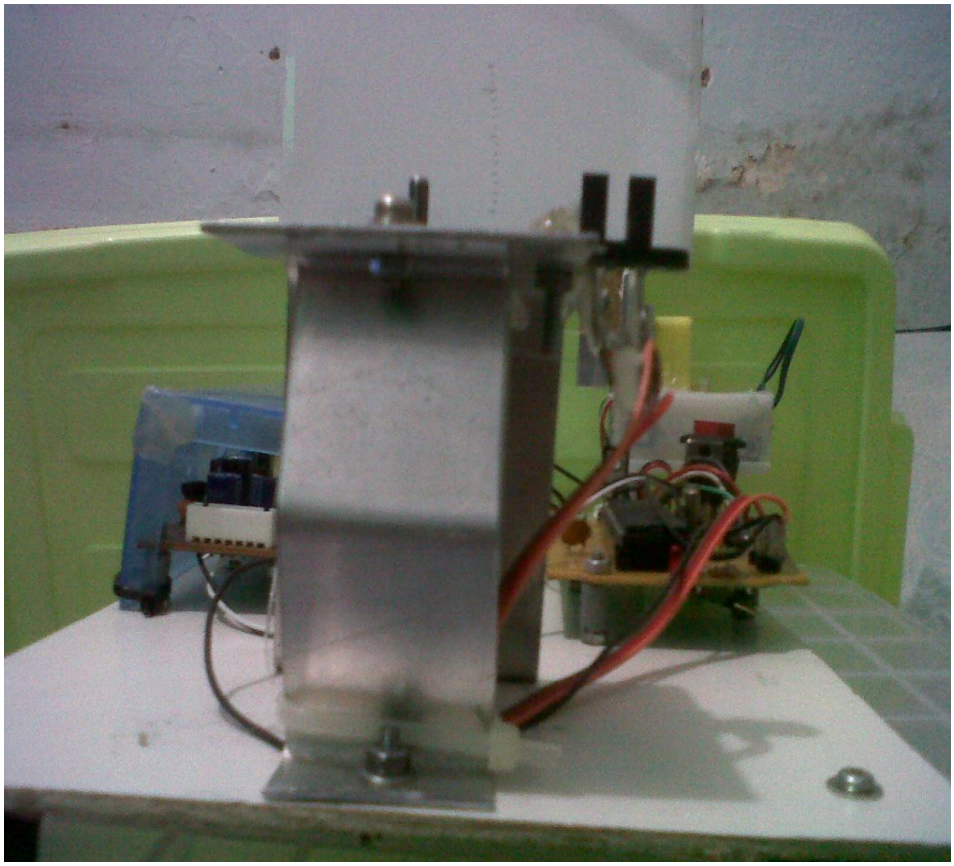
Tampilan Alat



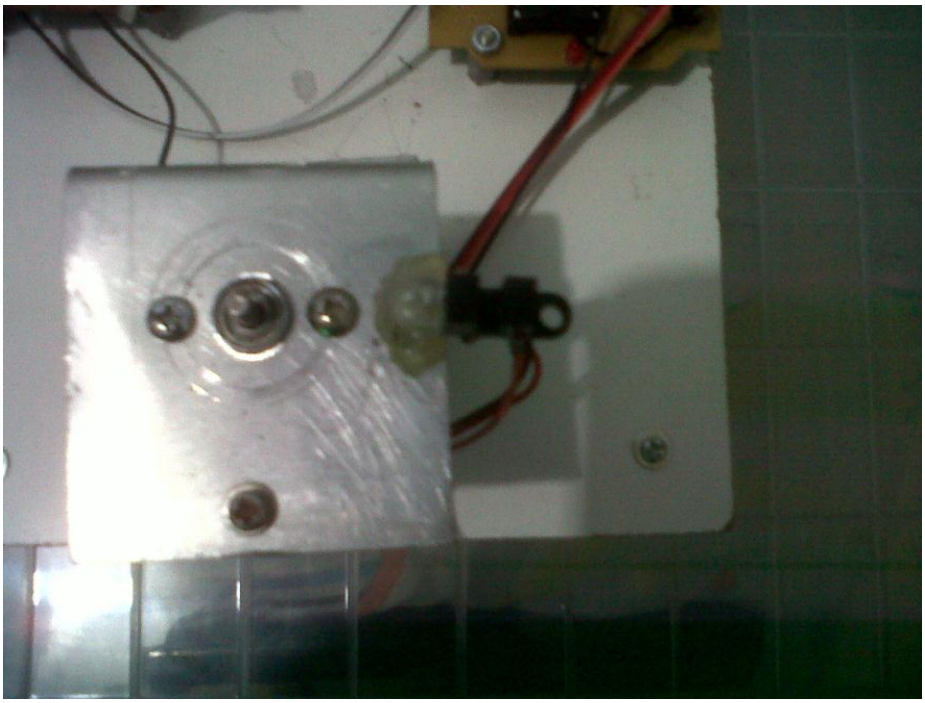
Tampilan Angka di Layar



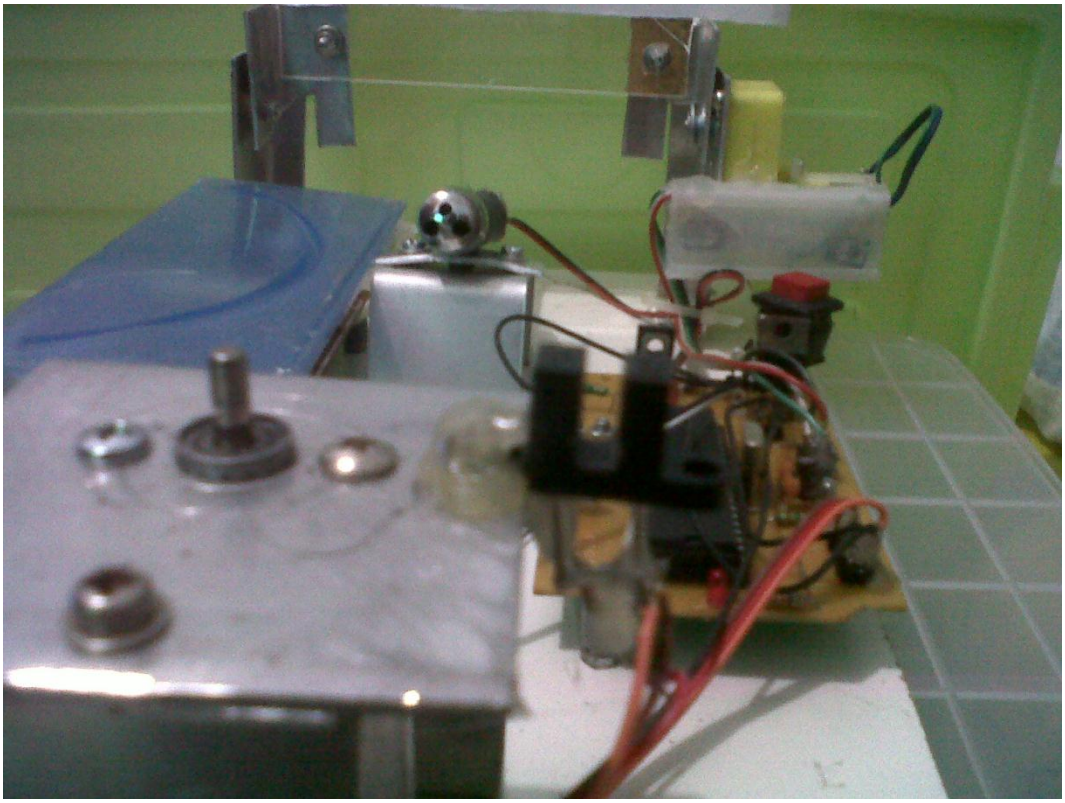
Tampilan Angka di Layar



Tampilan Sensor Optocoupler



Tampilan Sensor Optocoupler



Tampilan Sensor Optocoupler

LAMPIRAN B

PROGRAM PADA PENGENDALI MIKRO AVR ATMEGA16

File **laser.c**

```
#include <avr/io.h>
#include <avr/interrupt.h>
#include <avr/signal.h>
#include <inttypes.h>
#include <stdlib.h>
#include <avr/pgmspace.h>
#include <compat/deprecated.h>
#include <util/delay.h>

/*************************************\
 * Laser projector.
 * 32x16 display. 16x16 active pixels.
 * Use 8MHz clock.
 *
 * Ports:
 * B0: out: Laser
 * B1: out: Motor
 * B2:  in: Fork reader (active low) (B3=INT2)
 * D7: out: Servo control (D7=OC2)
 \*************************************/


//#include "video.h"
#include "angka.h"


/* Calibration */
const char offsetx[16] = {11,10,10,8,10,10,12,11,7,7,8,8,7,8,5,4};
const uint8_t suboffsetx[16] = {5,8,8,8,4,6,8,8,13,8,8,8,8,8,8,8};

/* Variables */
const uint8_t frame_div = 4;                    /* Number of times to show each frame */
volatile uint8_t frame_div_cnt;                 /* Counter for frame slowdown */
volatile uint16_t pixel_pos;                    /* Rotor position in pixels (0 to 511) */
volatile uint16_t rot_ticks;                    /* Number of counter1 ticks per rotation */
volatile uint16_t frame;                                /* Current video frame */
volatile uint16_t frame_inc;                    /* Frames forward per rotation */
volatile uint8_t the_end;                               /* Has the movie reached the end? */
volatile uint8_t pixelclock;                    /* Pixel clock (counter0 ticks per pixel) */
volatile uint8_t pixelclock_frac;               /* 64*(pixelclock fraction) */
volatile uint8_t pixelclock_frac_running;       /* Incremented by pixelclock_frac once per pixel */

#define DDR_Screen DDRD
#define PORT_Screen PORTD
#define PIN_Screen PIND

void Wait()
{
  char i;
  for (i=0;i<25;i++)
    _delay_loop_2(0);
}
```

```
void stop_screen()
{
  PORT_Screen &=~_BV(2);
  PORT_Screen &=~_BV(3);
}

void turn_on_screen()
{
  PORT_Screen &=~_BV(2);
  PORT_Screen |=_BV(3);
}

void turn_off_screen()
{
  PORT_Screen |=_BV(2);
  PORT_Screen &=~_BV(3);
}

void ioinit(void)
{
  /* Set port direction (0=in, 1=out) */
  DDRA = 0x00;
  DDRB = 0x03;
  DDRC = 0x00;
  DDRD = 0xFF;
  /* Set internal pull-up (0=off, 1=on) */
  PORTA = 0xff;
  PORTB = 0xf8;
  PORTC = 0xff;
  PORTD = 0x00;

  /* 8-bit counter (counter0) - Pixel clock */
#define TCCR0_DIV_OFF  (                    0)
#define TCCR0_DIV_1    (              _BV(CS00))
#define TCCR0_DIV_8    (       _BV(CS01)      )
#define TCCR0_DIV_64   (       _BV(CS01)|_BV(CS00))
#define TCCR0_DIV_256  (_BV(CS02)              )
#define TCCR0_DIV_1024 (_BV(CS02)       |_BV(CS00))
  outp(_BV(WGM01)|TCCR0_DIV_8, TCCR0);                          /* Reset counter on compare, set clock
div */


  /* External interrupt INT2 - "Reading fork", triggers once per revolution */
  cbi(MCUCSR, ISC2);                                            /* Trigger on falling edge */
  sbi(GICR, INT2);                                              /* Enable */

  /* Enable interrupts */
  sei();
}

/* 8-bit counter (counter0) - Pixel clock */
SIGNAL(SIG_OUTPUT_COMPARE0)
{
  int8_t x,y,i;
```

```
  pixel_pos++;
  x = pixel_pos & 0x1f;
  y = pixel_pos >> 5;

  /* Sub-x-offset */
  i = 0;
  if (x == 0)
    i = (pixelclock * (uint16_t)suboffsetx[y]) >> 4;
  if (x == 30)
  {
    pixel_pos++;
    i = pixelclock - ((pixelclock * (uint16_t)suboffsetx[y]) >> 4);
  }

  /* Pixel clock fractions / Sub-x-offset */
  pixelclock_frac_running += pixelclock_frac;
  if (pixelclock_frac_running >= 0x40)
  {
    pixelclock_frac_running -= 0x40;
    OCR0 = pixelclock + i + 1;
  }
  else
    OCR0 = pixelclock + i;

  /* Output pixel */
  x = x - offsetx[(int)y];
  if ((x >= 0) && (x < 16))
  {
    if (pgm_read_byte_near(video + (frame<<5) + (y<<1) + (x>>3)) & _BV(7-(x & 0x07)))
      sbi(PORTB,0);
    else
      cbi(PORTB,0);
  }
  else
    cbi(PORTB,0);

  /* Turn off counter0 (this one), so it won't disturb INT2 interrupt */
  if (pixel_pos > 498)
  {
    timer_enable_int(0);
    cbi(PORTB,0);
  }
}

/* External interrupt INT2 */
SIGNAL(SIG_INTERRUPT2)
{
  const uint16_t hysteresis = 1;//4;
  static uint16_t i;

  pixel_pos = 0;


  /* Re-enable 8-bit counter */
  timer_enable_int(_BV(OCIE0));                    /* Output Compare Interrupt Enable */
```

```
  TCNT0 = 0;                            /* Reset counter */
  TIFR = 0xff;                          /* Clear pending counter interrupts. FIXME: Clears all
interrupts! */

  /* Video */
  if (++frame_div_cnt >= frame_div)
  {
    frame_div_cnt = 0;
    frame += frame_inc;
    if (frame >= video_frames)
    {
      frame = video_frames-1;
      the_end = 1;
    }
  }
}

int main(void)
{
  uint8_t i;
  uint32_t j;

  frame = 0;
  frame_inc = 0;
  ioinit();

  /* Startup */
  turn_on_screen();                     /* Raise screen */
              Wait();
              stop_screen();            /* Stop motor screen */
              Wait();
  sbi(PORTB, 1);                        /* Turn on motor */
              _delay_ms(30000);

  /* Play video */
  for (j=0; j < 16000000; j++);
  for (i=0; i<2; i++)
  {
    frame = 0;
    frame_div_cnt = 0;
    the_end = 0;
    for (j=0; j < 16000000; j++);
    frame_inc = 1;
    while (!the_end);
    frame_inc = 0;
    for (j=0; j < 16000000; j++);
  }

  /* Shutdown */
  cli();                                /* Disable interrupts */
  cbi(PORTB, 0);                        /* Turn off laser */
  cbi(PORTB, 1);                        /* Turn off motor */
  for (j=0; j < 64000000; j++);
  turn_off_screen();                    /* Lower screen */
              Wait();
```

```
        stop_screen();                  /* Stop motor screen */
  for(;;);

  return 0;
}
```

File **angka.h**

```
const uint16_t video_frames = 81;
static uint8_t video[] PROGMEM = {
0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x80, 0x00, 0x00, 0x00, 0x00, 0x00,
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```

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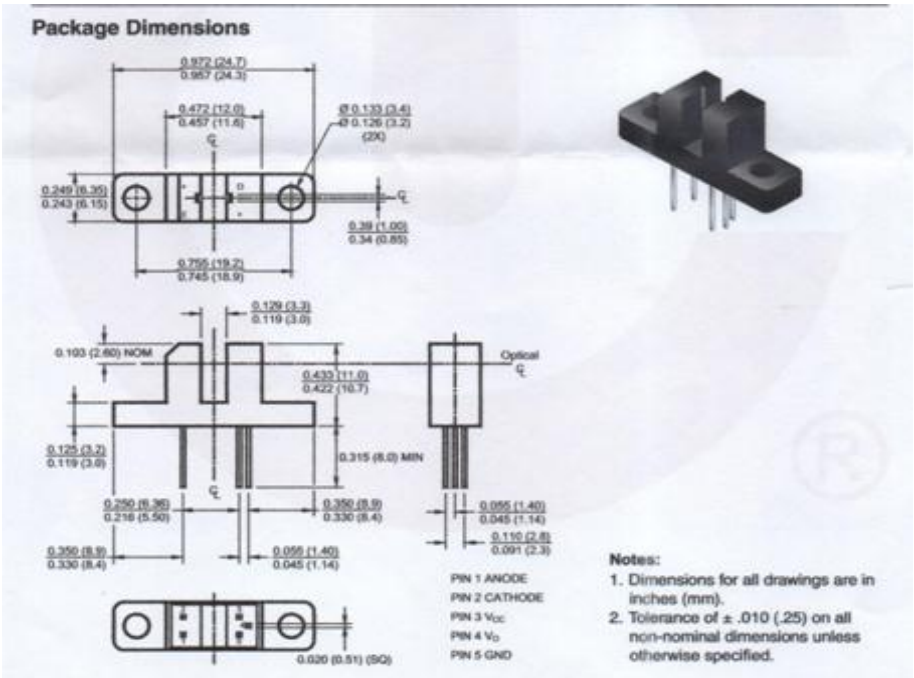
LAMPIRAN D

DATASHEET

Sensor Optocoupler H21LOB

Package Dimensions



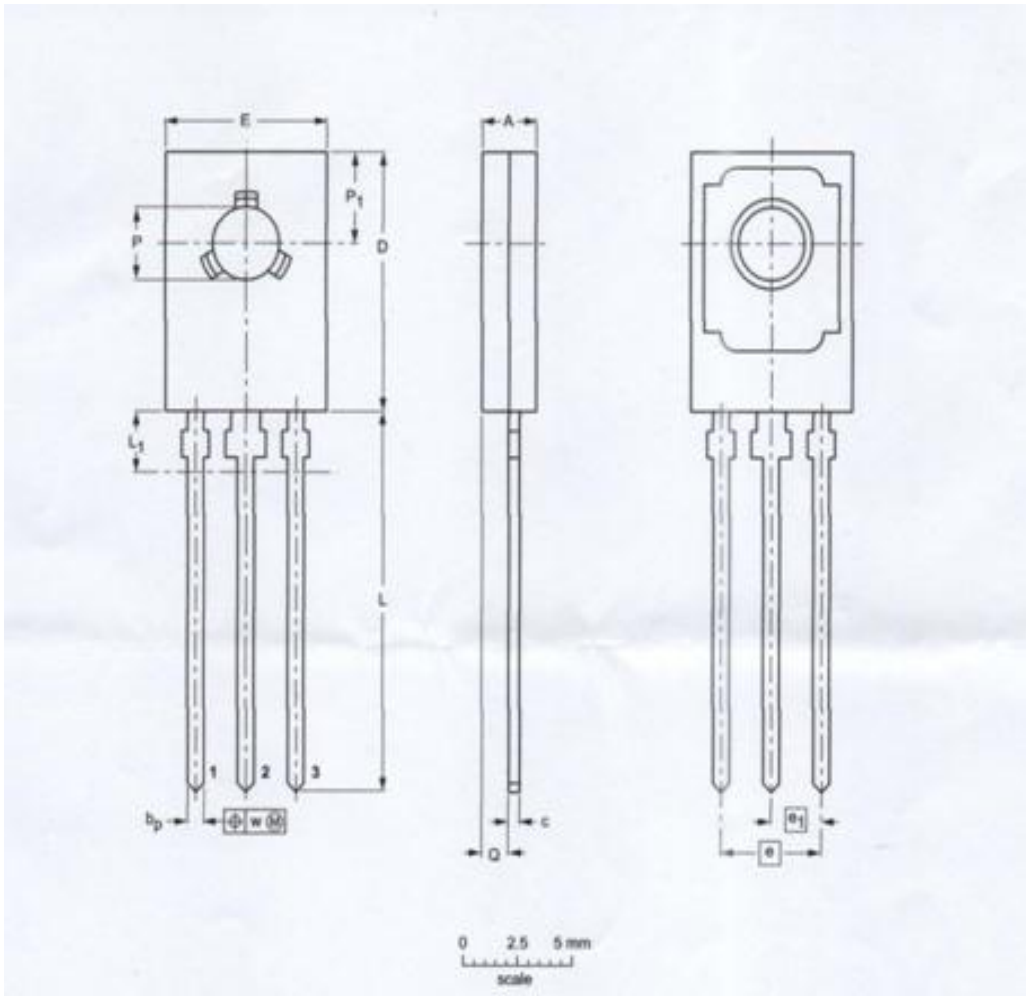
Notes:
1. Dimensions for all drawings are in inches (mm).
2. Tolerance of ± .010 (.25) on all non-nominal dimensions unless otherwise specified.

Absolute Maximum Ratings (T_A = 25°C Unless otherwise specified)

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.

Symbol	Parameter	Rating	Units
T_{OPR}	Operating Temperature	-40 to +85	°C
T_{STG}	Storage Temperature	-40 to +85	°C
T_{SOL-I}	Soldering Temperature (Iron)[3][6][7][8]	240 for 5 sec	°C
T_{SOL-F}	Soldering Temperature (Flow)[5][6][8]	260 for 10 sec	°C
INPUT (Emitter)			
I_F	Continuous Forward Current	50	mA
V_R	Reverse Voltage	6	V
P_D	Power Dissipation[3]	100	mW
OUTPUT (Sensor)			
I_O	Output Current	50	mA
V_{CC}	Supply Voltage	4.0 to 16	V
V_O	Output Voltage	30	V
P_D	Power Dissipation[4]	150	mW

Notes:
3. Derate power dissipation linearly 1.67mW/°C above 25°C.
4. Derate power dissipation linearly 2.50mW/°C above 25°C.
5. RMA flux is recommended.
6. Methanol or isopropyl alcohols are recommended as cleaning agents.
7. Soldering iron 1/16" (1.6mm) from housing.
8. As long as leads are not under any stress or spring tension.



DIMENSIONS (mm are the original dimensions)

UNIT	A	b_p	c	D	E	e	e_1	L	$L_1^{(1)}$ max	Q	P	P_1	w
mm	2.7 2.3	0.88 0.65	0.60 0.45	11.1 10.5	7.8 7.2	4.58	2.29	16.5 15.3	2.54	1.5 0.9	3.2 3.0	3.9 3.6	0.254

Note

1. Terminal dimensions within this zone are uncontrolled to allow for flow of plastic and terminal irregularities.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT32		TO-126				97-03-04

Electrical/Optical Characteristics (T_A = 25°C)

Symbol	Parameter	Test Conditions	Min.	Typ	Max.	Units
INPUT (Emitter)						
V_F	Forward Voltage	I_F = 20mA			1.5	V
I_R	Reverse Leakage Current	V_R = 5 V			10	µA
OUTPUT (Sensor)						
I_{CC}	Supply Current	V_{CC} = 5 V			5	mA
COUPLED						
V_{OL}	Low Level Output Voltage H21LTB, H21LOB	I_F = 0mA, V_{CC} = 5V, I_{OL} = 16mA			0.4	V
	Low Level Output Voltage H21LTI, H21LOI	I_F = 15mA, V_{CC} = 5V, I_{OL} = 16mA			0.4	
V_{OH}	High Level Output Voltage H21LTB	I_F = 15mA, V_{CC} = 5V, I_{OH} = -1mA	2.4			V
	High Level Output Voltage H21LTI	I_F = 0mA, V_{CC} = 5V, I_{OH} = -1mA	2.4			
I_{OH}	High Level Output Current H21LOB	I_F = 15mA, V_{CC} = 5 V, V_{OH} = 30V			100	µA
	High Level Output Current H21LOI	I_F = 0 mA, V_{CC} = 5 V, V_{OH} = 30 V			100	
$I_F(+)$	Turn on Threshold Current	V_{CC} = 5V			15	mA
$I_F(-)$	Turn off Threshold Current	V_{CC} = 5V	0.50			mA
$I_F(+) / I_F(-)$	Hysteresis Ratio			1.2		
t_{PLH}, t_{PHL}	Propagation Delay, H21LOI, H21LOB	V_{CC} = 5V, R_L = 300Ω (Fig. 9)		6		µs
	Propagation Delay, H21LTI, H21LTB	V_{CC} = 5V, R_L = 300Ω (Fig. 9)		6		
t_r, t_f	Output Rise and Fall Time, H21LOI, H21LOB	V_{CC} = 5V, R_L = 300Ω (Fig. 9)		100		ns
	Output Rise and Fall Time, H21LTI, H21LTB	V_{CC} = 5V, R_L = 300Ω (Fig. 9)		70		

Input/Output Table

Part Number	LED	Output
H21LTB	On	High
H21LTB	Off	Low
H21LTI	On	Low
H21LTI	Off	High
H21LOB	On	High
H21LOB	Off	Low
H21LOI	On	Low
H21LOI	Off	High

Transistor BD139

FEATURES

- High current (max. 1.5 A)
- Low voltage (max. 80 V).

APPLICATIONS

- Driver stages in hi-fi amplifiers and television circuits.

DESCRIPTION

NPN power transistor in a TO-126; SOT32 plastic package. PNP complements: BD136, BD138 and BD140.

PINNING

PIN	DESCRIPTION
1	emitter
2	collector, connected to metal part of mounting surface
3	base

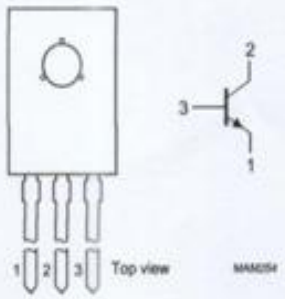


Fig.1 Simplified outline (TO-126; SOT32) and symbol.

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter			
	BD135		–	45	V
	BD137		–	60	V
	BD139		–	100	V
V_{CEO}	collector-emitter voltage	open base			
	BD135		–	45	V
	BD137		–	60	V
	BD139		–	80	V
V_{EBO}	emitter-base voltage	open collector	–	5	V
I_C	collector current (DC)		–	1.5	A
I_{CM}	peak collector current		–	2	A
I_{BM}	peak base current		–	1	A
P_{tot}	total power dissipation	$T_{mb} \leq 70$ °C	–	8	W
T_{stg}	storage temperature		–65	+150	°C
T_j	junction temperature		–	150	°C
T_{amb}	operating ambient temperature		–65	+150	°C

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient	note 1	100	K/W
$R_{th\ j\text{-}mb}$	thermal resistance from junction to mounting base		10	K/W

Note

1. Refer to TO-126; SOT32 standard mounting conditions.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CBO}	collector cut-off current	I_E = 0; V_{CB} = 30 V	–	–	100	nA
		I_E = 0; V_{CB} = 30 V; T_j = 125 °C	–	–	10	µA
I_{EBO}	emitter cut-off current	I_C = 0; V_{EB} = 5 V	–	–	100	nA
h_{FE}	DC current gain	V_{CE} = 2 V; (see Fig.2)				
		I_C = 5 mA	40	–	–	
		I_C = 150 mA	63	–	250	
		I_C = 500 mA	25	–	–	
	DC current gain BD135-10; BD137-10; BD139-10 BD135-16; BD137-16; BD139-16	I_C = 150 mA; V_{CE} = 2 V; (see Fig.2)	 63 100	 – –	 160 250	
V_{CEsat}	collector-emitter saturation voltage	I_C = 500 mA; I_B = 50 mA	–	–	0.5	V
V_{BE}	base-emitter voltage	I_C = 500 mA; V_{CE} = 2 V	–	–	1	V
f_T	transition frequency	I_C = 50 mA; V_{CE} = 5 V; f = 100 MHz	–	190	–	MHz
$\frac{h_{FE1}}{h_{FE2}}$	DC current gain ratio of the complementary pairs	$\lvert I_C \rvert$ = 150 mA; $\lvert V_{CE} \rvert$ = 2 V	–	1.3	1.6	

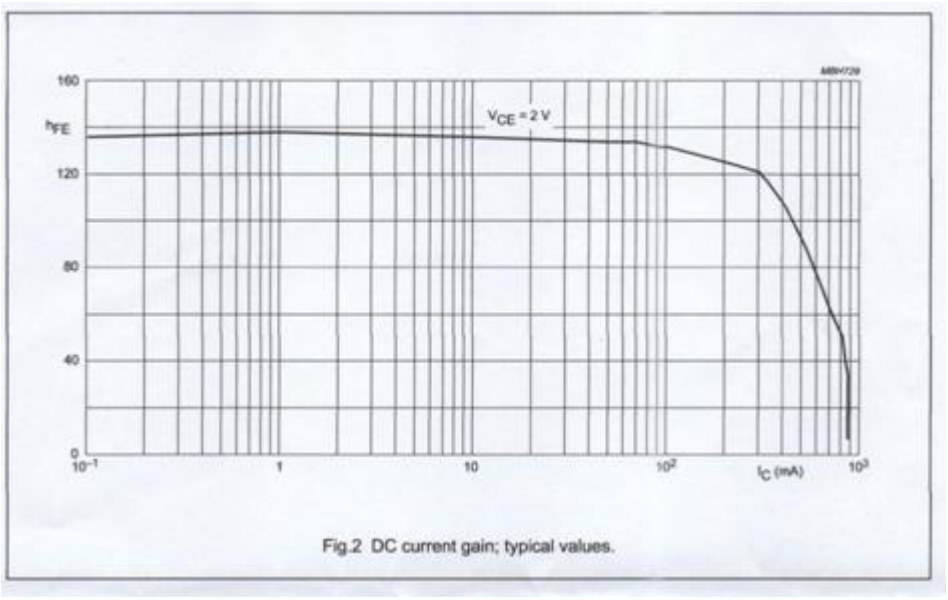


Fig.2 DC current gain; typical values.