LAMPIRAN A

Foto Alat
Tampak Depan

Tampak Atas
Rangkaian Pengontrol Mikro
LAMPIRAN B

Program pada Pengontrol Mikro.................................................................B-1
Program pada Microsoft Visual Basic 6.0....................................................B-9
PROGRAM UTAMA

MIKROKONTROLER ATMega16
/*******************************************************************************
This program was produced by the
CodeWizardAVR V1.25.3 Professional
Automatic Program Generator
© Copyright 1998-2007 Pavel Haiduc, HP InfoTech s.r.l.
http://www.hpinfotech.com
Project :
Version :
Date : 8/20/2009
Author : Yogi Agus
Company : UKM
Comments:

Chip type : ATMega16
Program type : Application
Clock frequency : 11.052900 MHz
Memory model : Small
External SRAM size : 0
Data Stack size : 256
*******************************************************************************/
#include <mega16.h>
#include <delay.h>

#define RXB8 1
#define TXB8 0
#define UPE 2
#define OVR 3
#define FE 4
#define UDRE 5
#define RXC 7
#define FRAMING_ERROR (1<<FE)
#define PARITY_ERROR (1<<UPE)
#define DATA_OVERRUN (1<<OVR)
#define DATA_REGISTER_EMPTY (1<<UDRE)
#define RX_COMPLETE (1<<RXC)

void geser_kanan(void);  // gerak sumbu x positif
void geser_kiri(void);   // gerak sumbu x negatif
void geser_turun(void);  // gerak sumbu z negatif

B-6
void geser_naik(void); // gerak sumbu z positif
void geser_maju(void); // gerak sumbu y negatif
void geser_mundur(void); // gerak sumbu y negatif
void stop(void);
unsigned char a,b,c,d,e,f,g,h,x;

// USART Receiver buffer
#define RX_BUFFER_SIZE 8
char rx_buffer[RX_BUFFER_SIZE];

#if RX_BUFFER_SIZE<256
unsigned char rx_wr_index,rx_rd_index,rx_counter;
#else
unsigned int rx_wr_index,rx_rd_index,rx_counter;
#endif

// This flag is set on USART Receiver buffer overflow
bit rx_buffer_overflow;

// USART Receiver interrupt service routine
interrupt [USART_RXC] void usart_rx_isr(void)
{
char status,data;
status=UCSRA;
data=UDR;
if ((status & (FRAMING_ERROR | PARITY_ERROR | DATA_OVERRUN))==0)
{
    rx_buffer[rx_wr_index]=data;
    if (++rx_wr_index == RX_BUFFER_SIZE) rx_wr_index=0;
    if (++rx_counter == RX_BUFFER_SIZE)
    {
        rx_counter=0;
        rx_buffer_overflow=1;
    }
}
#endif

#ifndef _DEBUG_TERMINAL_IO_
#define _ALTERNATE_GETCHAR_
#define _ALTERNATE_putstr_
#pragma used+
char getchar(void)
{
char data;

while (rx_counter==0);
data=rx_buffer[rx_rd_index];
if (++rx_rd_index == RX_BUFFER_SIZE) rx_rd_index=0;
#asm("cli")
--rx_counter;
#asm("sei")
return data;
}
#pragma used-
#endif

// Standard Input/Output functions
#include <stdio.h>
#include <delay.h>

// Declare your global variables here
char var_terima_data[32] ;       //Variabel array yang berfungsi untuk menyimpan data dari komputer
int count_terima_serial;        //Variabel yang berfungsi untuk mengcounter jumlah data yang masuk ke mikro
int i;

void main(void)
{
// Declare your local variables here

PORTA=0x00;  //Port A di set output buat motor DC
DDRA=0xFF;
PORTB=0x00;  //Port B di set output buat motor DC
DDRB=0xFF;
PORTC=0x01;
DDRC=0x00;
PORTD=0x01; //Port D.0 di set input pull-up buat receive UART, Port D.1 di set output low buat transmit UART
DDRD=0x02;

// USART initialization
// Communication Parameters: 8 Data, 1 Stop, No Parity
// USART Receiver: On
// USART Transmitter: On

B-8
// USART Mode: Asynchronous
// USART Baud rate: 9600
UCSRA=0x00;
UCSRB=0x98;
UCSRC=0x86;
UBRRH=0x00;
UBRRL=0x47;
/*Inisialisasi Variabel*/
count_terima_serial = 0;
x=0;

// Global enable interrupts
#asm("sei")
while (1) {
    for(i=1;i<=13;i++)
    {
        var_terima_data[i] = getchar();
        a = var_terima_data[i] & (0x80);
        if(a == 0x80)
        {
            geser_turun ();
            geser_naik ();
            geser_kanan();
            stop();
        }
        if(a == 0x00)
        {
            Geser_kanan ();
            stop();
        }
        b = var_terima_data[i] & (0x40);
        if(b == 0x40)
        {
            geser_turun ();
            geser_naik ();
            geser_kanan();
            stop();
        }
        if(b == 0x00)
        {
            Geser_kanan ();
            stop();
        }
}

b = var_terima_data[i] & (0x20);
if(b == 0x20)
{
    geser_turun ();
    geser_naik ();
    geser_kanan();
    stop();
}
if(b == 0x00)
{
    Geser_kanan ();
    stop();
}
c = var_terima_data[i] & (0x20);
if(c == 0x20)
{
  geser_turun ();
  geser_naik ();
  geser_kanan();
  stop();
}
if(c == 0x00)
{
  Geser_kanan ();
  stop();
}

d = var_terima_data[i] & (0x10);
if(d == 0x10)
{
  geser_turun ();
  geser_naik ();
  geser_kanan();
  stop();
}
if(d == 0x00)
{
  Geser_kanan ();
  stop();
}

e = var_terima_data[i] & (0x08);
if(e == 0x08)
{
  geser_turun ();
  geser_naik ();
  geser_kanan();
  stop();
}
if(a == 0x00)
{
  Geser_kanan ();
  stop();
}

f = var_terima_data[i] & (0x04);
if(f == 0x04)
    {
        geser_turun ();
        geser_naik ();
        geser_kanan();
        stop();
    }
if(f == 0x00)
    {
        Geser_kanan ();
        stop();
    }

    
g = var_terima_data[i] & (0x02);
    if(g == 0x02)
        {
            geser_turun ();
            geser_naik ();
            geser_kanan();
            stop();
        }
    if(g == 0x00)
        {
            Geser_kanan ();
            stop();
        }

    
h = var_terima_data[i] & (0x01);
    if(h == 0x01)
        {
            geser_turun ();
            geser_naik ();
            geser_kanan();
            stop();
        }
    if(h == 0x00)
        {
            Geser_kanan ();
            stop();
        }

    
putchar('1');
{  
gesar_kiri();  
}  
gesar_maju();  
stop();  
putchar('2');  
x++;  

if(x>=100)  
{  
gesar_mundur();  
x=0;  
}  

}  

void geser_kanan(void);  
{  
PORTA.0=1;  
PORTA.1=0;  
PORTA.2=1;  
delay_ms(150);  
PORTA.2=0;  
delay_ms(500);  
}  

void geser_kiri(void);  
{  
PORTA.0=0;  
PORTA.1=1;  
PORTA.2=1;  
delay_ms(15600);  
}  

void geser_maju(void);  
{  
PORTB.3=1;  
PORTB.4=0;  
PORTB.5=1;  
delay_ms(150);  
}
PORTB.5=0;
}
void geser_mundur(void);
{
    PORTB.3=0;
    PORTB.4=1;
    PORTB.5=1;
    delay_ms(15000);
    PORTB.5=0;
}

void geser_naik(void);
{
    PORTB.0=0;
    PORTB.1=1;
    PORTB.2=1;
    delay_ms(1000);
    PORTB.2=0;
}

void geser_turun(void);
{
    PORTB.0=1;
    PORTB.1=0;
    PORTB.2=1;
    delay_ms(1000);
    PORTB.2=0;
}

void stop(void)
{
    PORTA.2=0;
    PORTB.5=0;
    PORTB.2=0;
    delay_ms(500);
}
LISTING PROGRAM Visual Basic 6.0

Private Sub Control_Enable()
    cmd_CLEAR.Enabled = True
    sldr_LEVEL.Enabled = True
    cmd_EXECUTE.Enabled = True
    cmd_LOAD.Enabled = False
End Sub

Private Sub Control_Disable()
    cmd_CLEAR.Enabled = False
    sldr_LEVEL.Enabled = False
    cmd_EXECUTE.Enabled = False
    cmd_LOAD.Enabled = True
End Sub

Private Sub Control_Disable_Full()
    cmd_CLEAR.Enabled = False
    sldr_LEVEL.Enabled = False
    cmd_EXECUTE.Enabled = False
    cmd_LOAD.Enabled = False
    sldr_LEVEL.Enabled = False
    cmd_EXECUTE.Enabled = False
End Sub

Private Sub Control_Enable_Full()
    cmd_CLEAR.Enabled = True
    sldr_LEVEL.Enabled = True
    cmd_EXECUTE.Enabled = True
    cmd_LOAD.Enabled = True
    sldr_LEVEL.Enabled = True
    cmd_EXECUTE.Enabled = True
End Sub

Private Sub cmd_CLEAR_Click()
    Call Control_Disable_Full

    STRIKE = 0

    For y = 1 To pic_PROCESSOR.ScaleHeight
        For x = 1 To pic_PROCESSOR.ScaleWidth
            pic_PROCESSOR.PSet (x, y), RGB(255, 255, 255)
            STRIKE = STRIKE + 1
            bar_PROCESS.Value = (STRIKE / (pic_PROCESSOR.ScaleWidth * pic_PROCESSOR.ScaleHeight)) * 100
        Next x
    Next y
Next x
Next y

With img_PROCESSOR
    .Picture = pic_PROCESSOR.Image
    .Refresh
    rtb_MATRIX.Text = Empty

End With

bar_PROCESS.Value = 0
Call Control_Disable
End Sub

Private Sub cmd_EXECUTE_Click()
    com_TxRx.PortOpen = True
    pic_PROCESSOR.AutoRedraw = True

    Call Control_Disable_Full

    STRIKE = 0
    FIRE = False
    For y = 1 To pic_PROCESSOR.ScaleHeight
        For x = 1 To pic_PROCESSOR.ScaleWidth
            TMP = pic_PROCESSOR.Point(x, y)
            RED = TMP And RGB(255, 0, 0)
            GREEN = Int((TMP And RGB(0, 255, 0)) / 256)
            BLUE = Int(((TMP And RGB(0, 0, 255)) / 256) / 256)
            GREY = (RED + GREEN + BLUE) / 3

            If GREY >= sldr_LEVEL.Value Then
                BIN = 255
                MATRIX(x, y) = 0
            Else
                BIN = 0
                MATRIX(x, y) = 1
            End If

            pic_PROCESSOR.PSet (x, y), RGB(BIN, BIN, BIN)
            MATRIKS = MATRIKS & MATRIX(x, y)
            STRIKE = STRIKE + 1

End Sub
bar_PROCESS.Value = (STRIKE / (pic_PROCESSOR.ScaleWidth * pic_PROCESSOR.ScaleHeight)) * 100
Next x
FIRE = False
MATRIKS = MATRIKS & Chr(10)
Next y

With img_PROCESSOR
  .Picture = pic_PROCESSOR.Image
  .Refresh
End With

rtb_MATRIX.Text = MATRIKS
Call TRANSLATE_PACKET
Call SEND_PACKET

bar_PROCESS.Value = 0
Call Control_Enable_Full

End Sub

Private Sub cmd_EXIT_Click()
  Unload Me
End Sub

Private Sub cmd_LOAD_Click()
  With dlg_OPEN
    .DialogTitle = "Select Source Picture"
    .Filter = "Image Files (JPEG)|*.jpg|All Files | *.*
    .ShowOpen
  End With
  If dlg_OPEN.FileName <> "" Then
    With pic_PROCESSOR
      .ScaleMode = 3
      .AutoRedraw = True
      .Picture = LoadPicture(dlg_OPEN.FileName)
    End With
    If (pic_PROCESSOR.ScaleHeight = 100) And (pic_PROCESSOR.ScaleWidth = 104) Then
      With img_PROCESSOR
        .Picture = pic_PROCESSOR.Image
      End With
    End If
  End If
End Sub
Private Sub com_TxRx_OnComm()
    Dim bfrINPUT As Variant
    bfrINPUT = com_TxRx.Input
    If (bfrINPUT = "1") Then
        kirim:
            Call SEND_PACKET
        ElseIf (bfrINPUT = "2") Then
            If Baris <= 104 Then
                Baris = Baris + 1
                GoTo kirim
            Else
                com_TxRx.PortOpen = False
            End If
        End If
    End If
End Sub

Private Sub Form_Load()
    Call Control_Disable
    sldr_LEVEL.Value = 128
    lbl_LEVEL.Caption = sldr_LEVEL.Value
    com_TxRx.InputLen = 0
    com_TxRx.RThreshold = 1
    com_TxRx.SThreshold = 1
    com_TxRx.DTREnable = True
End Sub

Private Sub sldr_LEVEL_Scroll()
    lbl_LEVEL.Caption = sldr_LEVEL.Value
End Sub

Public MATRIX(104, 100) As Byte
Public COUNTER As Integer
Dim TRANSLATOR(10400) As String
Public Sub TRANSLATE_PACKET()
    Dim i As Integer
    For LINKIN = 1 To 100
        For PARK = 1 To 104
            TRANSLATOR(i) = MATRIX(PARK, LINKIN)
            i = i + 1
        Next PARK
    Next LINKIN
End Sub

Public Function Str2Hex(aHEX As String) As Variant
    Dim b(8) As Integer
    Dim c(8) As Integer
    Dim d As Integer
    b(0) = Mid(aHEX, 1, 1)
    b(1) = Mid(aHEX, 2, 1)
    b(2) = Mid(aHEX, 3, 1)
    b(3) = Mid(aHEX, 4, 1)
    b(4) = Mid(aHEX, 5, 1)
    b(5) = Mid(aHEX, 6, 1)
    b(6) = Mid(aHEX, 7, 1)
    b(7) = Mid(aHEX, 8, 1)
    d = 0
    For i = 0 To 7
        If b(7 - i) = 1 Then
            c(i) = i
            d = d + 2 ^ (c(i))
        End If
    Next i
    Str2Hex = Chr$(d)
End Function
Public Sub SEND_PACKET()
    Dim a As String
    Dim b(8) As Integer
    Dim c(8) As Integer
    Dim d As Integer
    Dim YELLOW As Integer
    Dim TRANSFORMER As String

    YELLOW = 0
    For i = 0 To 10400
        If (i > COUNTER) Then
            If (YELLOW = 8) Then
                YELLOW = 0
                frmMAIN.com_TxRx.Output = Str2Hex(TRANSFORMER)
                TRANSFORMER = ""
                Exit Sub
            Else
                TRANSFORMER = TRANSFORMER & TRANSLATOR(i)
                YELLOW = YELLOW + 1
                COUNTER = COUNTER + 1
            End If
        End If
    Next i
End Sub
LAMPIRAN C
DATASHEET

IC MAX 232..................................................................................................................C-1
IC L298.......................................................................................................................C-7
MAX232, MAX233
DUAL EIA-232 DRIVERS/RECEIVERS

Function Tables

- Meets or Exceeds TIA/EIA-232-F and ITU Recommendation V.28
- Operates from a Single 5-V Power Supply
- With ±10-V Charge-Pump Capacitors
- Operates Up To 10k ohms
- Two Drivers and Two Receivers
- 3.3-V Input Levels
- Low Supply Current . . . 9 mA Typical
- ESD Protection Exceeds JEIDA J22
- 200-V Human-Body Model (A144-A)
- Upgrade With Improved ESD TINY-HEM
- and 8-V P Charge-Pump Capacitors In Available With the MAX232
- Applications
  - TIA/EIA-232-F, Battery-Powered Systems
  - Terminals, Modems, and Computers

description/ordering information

The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply TIA/EIA-232-F voltage levels from a single 5-V supply. Each receiver converts TIA/EIA-232-F inputs to ±10-V TTL/CMOS levels. These receivers have a typical threshold of 1-V, a typical hysteresis of 0.5-V, and can accept ±15-V inputs. Each driver converts TTL/CMOS input levels into TIA/EIA-232-F levels. The driver, receiver, and voltage-generator functions are available as cells in the Texas Instruments LVDS™ library.

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Temp Range</th>
<th>Pack/Item</th>
<th>Orderable Part Number</th>
<th>Ordering Marking</th>
</tr>
</thead>
<tbody>
<tr>
<td>C to 0°C</td>
<td>4 TOP (0)</td>
<td>MAX232</td>
<td>MAX232</td>
</tr>
<tr>
<td>0°C to 70°C</td>
<td>8 TOP (0)</td>
<td>MAX232</td>
<td>MAX232</td>
</tr>
<tr>
<td>70°C to 85°C</td>
<td>4 TOP (0)</td>
<td>MAX232</td>
<td>MAX232</td>
</tr>
<tr>
<td>85°C to 0°C</td>
<td>8 TOP (0)</td>
<td>MAX232</td>
<td>MAX232</td>
</tr>
</tbody>
</table>

Package drawings, standard packing quantities, thermal data, schematics, and PCB design guidelines are available at www.ti.com/packaging.

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereof appear at the end of this data sheet.
MAX209, MAX209
DUAL EIA-232 DRIVERS/RECEIVERS

DRIVER SECTION

Electrical characteristics over recommended ranges of supply voltage and operating free-air temperature range (see Note 4)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCC</td>
<td>5</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>ISO</td>
<td>1.5</td>
<td>3</td>
<td>mA</td>
</tr>
<tr>
<td>ISOUT</td>
<td>1.5</td>
<td>3</td>
<td>mA</td>
</tr>
<tr>
<td>VOUT</td>
<td>3</td>
<td>3</td>
<td>V</td>
</tr>
</tbody>
</table>

Switching characteristics, VCC = 5 V, Ta = 25°C (see Note 4)

RECEIVER SECTION

Electrical characteristics over recommended ranges of supply voltage and operating free-air temperature range (see Note 4)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCC</td>
<td>3</td>
<td>3.6</td>
<td>V</td>
</tr>
<tr>
<td>VISO</td>
<td>1.5</td>
<td>3</td>
<td>mA</td>
</tr>
<tr>
<td>VT</td>
<td>2</td>
<td>3</td>
<td>V</td>
</tr>
</tbody>
</table>

Switching characteristics, VCC = 5 V, Ta = 25°C (see Note 4 and Figure 1)

NOTES:
1. All tests are done at VCC = 5 V, Ta = 25°C.
2. The data in this table are for reference only and do not imply unconditional operational limits.
3. | VCC | 4 | 5 | V |
4. | VISO | 1 | 3 | mA |
| VT | 2 | 3 | V |

Texas Instruments
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265
L298

DUAL FULL-BRIDGE DRIVER

- Operating supply voltage up to 46 V
- Total DC current up to 4 A
- Low saturation voltage
- Overtemperature protection
- Logical '0' input voltage up to 1.5 V (high-noise immunity)

**DESCRIPTION**

The L298 is an integrated monolithic circuit in a 15-lead Multiwatt and PowerSO20 packages. It is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors. Two enable inputs are provided to enable or disable the device independently of the input signals. The emitters of the lower transistors of each bridge are connected together and the corresponding external terminal can be used for the connection of an external sensing resistor. An additional supply input is provided so that the logic works at a lower voltage.

**ORDERING NUMBERS**

- L298N (Multiwatt Vert.)
- L298HN (Multiwatt Horiz.)
- L298P (PowerSO20)

**BLOCK DIAGRAM**

[Diagram of the L298 circuit]

January 2000
**ABSORBE MAXIMUM RATINGS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{SS}$</td>
<td>Logic Supply Voltage</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>$V_{DD}$</td>
<td>Power Supply</td>
<td>50</td>
<td>V</td>
</tr>
<tr>
<td>$V_{IN}$</td>
<td>Input and Enable Voltage</td>
<td>0.3 to 7</td>
<td>V</td>
</tr>
<tr>
<td>$I_{O}$</td>
<td>Peak Output Current (each Channel)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non Repetitive ($t = 100\mu s$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Repetitive ($80%$ on $22%$ off; $t_{ON} = 10\mu s$)</td>
<td>2.5</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>DC-Operator</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>$V_{Sens}$</td>
<td>Sensing Voltage</td>
<td>-1 to 2.3</td>
<td>V</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>Total Power Dissipation ($T_{case} = 75^\circ C$)</td>
<td>25</td>
<td>W</td>
</tr>
<tr>
<td>$T_{cd}$</td>
<td>Junction Operating Temperature</td>
<td>-25 to 130</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{oper}, T_{j}$</td>
<td>Storage and Junction Temperature</td>
<td>-40 to 150</td>
<td>°C</td>
</tr>
</tbody>
</table>

**PIN CONNECTIONS (top view)**

**THERMAL DATA**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>PowerSO20</th>
<th>Multiwatt15</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th,j-case}$</td>
<td>Thermal Resistance Junction-case Max.</td>
<td>-</td>
<td>3</td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th,j-amb}$</td>
<td>Thermal Resistance Junction-ambient Max.</td>
<td>13 (°)</td>
<td>35</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

* Mounted on aluminum substrate
PIN FUNCTIONS (refer to the block diagram)

<table>
<thead>
<tr>
<th>MW</th>
<th>PowerSO</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:15</td>
<td>2:19</td>
<td>Sense A; Sense B</td>
<td>Between this pin and ground is connected the sense resistor to control the current of the load.</td>
</tr>
<tr>
<td>2:3</td>
<td>4:5</td>
<td>Out 1; Out 2</td>
<td>Outputs of the Bridge A, the current that flows through the load connected between these two pins is monitored at pin 1.</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>VSS</td>
<td>Supply Voltage for the Power Output Stages. A non-inductive 100nF capacitor must be connected between this pin and ground.</td>
</tr>
<tr>
<td>5:7</td>
<td>7:9</td>
<td>Input 1; Input 2</td>
<td>TTL Compatible Inputs of the Bridge A.</td>
</tr>
<tr>
<td>6:11</td>
<td>8:14</td>
<td>Enable A; Enable B</td>
<td>TTL Compatible Enable Input; the L state disables the bridge A (enable A) and/or the bridge B (enable B).</td>
</tr>
<tr>
<td>8</td>
<td>1.10, 11, 20</td>
<td>GND</td>
<td>Ground.</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>VSS</td>
<td>Supply Voltage for the Logic Blocks. A 100nF capacitor must be connected between this pin and ground.</td>
</tr>
<tr>
<td>10:12</td>
<td>13:15</td>
<td>Input 3; Input 4</td>
<td>TTL Compatible Inputs of the Bridge B.</td>
</tr>
<tr>
<td>13:14</td>
<td>18:17</td>
<td>Operate 3; Operate 4</td>
<td>Outputs of the Bridge B. The current that flows through the load connected between these two pins is monitored at pin 15.</td>
</tr>
<tr>
<td>–</td>
<td>3:18</td>
<td>N.C.</td>
<td>Not Connected</td>
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ELECTRICAL CHARACTERISTICS (V_G = 42V; V_H = 5V; T_J = 25°C; unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>V_G</td>
<td>Supply Voltage (pin 4)</td>
<td>Operative</td>
<td>V_G</td>
<td>+2.5</td>
<td>46</td>
<td>V</td>
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<td>V_SS</td>
<td>Logic Supply Voltage (pin 9)</td>
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<td>4</td>
<td>5</td>
<td>7</td>
<td>V</td>
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<td>I_G</td>
<td>Quiescent Supply Current (pin 4)</td>
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<td>V_G</td>
<td>L = 0</td>
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<td>22</td>
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<td></td>
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<td>V_G = V_i</td>
<td>50</td>
<td>70</td>
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<td>mA</td>
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<td>Quiescent Current from V_SS (pin 9)</td>
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<td>L = 0</td>
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<td></td>
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<td>V_G = V_i</td>
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<td>12</td>
<td></td>
<td>mA</td>
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<tr>
<td>V_L</td>
<td>Input Low Voltage</td>
<td>(pins 5, 7, 10, 12)</td>
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<td></td>
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<td></td>
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<tr>
<td>V_H</td>
<td>Input High Voltage</td>
<td>(pins 5, 7, 10, 12)</td>
<td>2.3</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>I_L</td>
<td>Low Voltage Input Current</td>
<td>(pins 5, 7, 10, 12)</td>
<td></td>
<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>I_H</td>
<td>High Voltage Input Current</td>
<td>(pins 5, 7, 10, 12)</td>
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<td></td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>V_BE</td>
<td>Enable Low Voltage (pins 6, 11)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>V_BE</td>
<td>Enable High Voltage (pins 6, 11)</td>
<td></td>
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<tr>
<td>V_BE</td>
<td>Low Voltage Enable Current</td>
<td>(pins 6, 11)</td>
<td></td>
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<tr>
<td>V_BE</td>
<td>High Voltage Enable Current</td>
<td>(pins 6, 11)</td>
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<tr>
<td>V(SAT)</td>
<td>Source Saturation Voltage</td>
<td>L_S = 1A</td>
<td>0.85</td>
<td>1.35</td>
<td>1.7</td>
<td>mA</td>
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<tr>
<td>V(SAT)</td>
<td>Source Saturation Voltage</td>
<td>L_S = 2A</td>
<td>2</td>
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<td>mA</td>
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<tr>
<td>V(ISAT)</td>
<td>Sink Saturation Voltage</td>
<td>L_S = 1A</td>
<td>3.85</td>
<td>1.2</td>
<td>1.6</td>
<td>V</td>
</tr>
<tr>
<td>V(ISAT)</td>
<td>Sink Saturation Voltage</td>
<td>L_S = 2A</td>
<td>(5)</td>
<td>1.7</td>
<td>2.3</td>
<td>V</td>
</tr>
<tr>
<td>V_HLV</td>
<td>Total Drop</td>
<td>L_S = 1A</td>
<td>1.80</td>
<td></td>
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<td>V</td>
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<tr>
<td>V_HLV</td>
<td>Total Drop</td>
<td>L_S = 2A</td>
<td>(5)</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_Sense</td>
<td>Sensing Voltage (pins 1, 15)</td>
<td></td>
<td></td>
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### ELECTRICAL CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>T1 (νs)</td>
<td>Source Current Turn-off Delay</td>
<td>0.5 V / to 0.9 I L (2); (4)</td>
<td>1.5</td>
<td></td>
<td></td>
<td>μs</td>
</tr>
<tr>
<td>T2 (νs)</td>
<td>Source Current Fall Time</td>
<td>0.9 I L / to 0.1 I L (2); (4)</td>
<td>0.2</td>
<td></td>
<td></td>
<td>μs</td>
</tr>
<tr>
<td>T3 (νs)</td>
<td>Source Current Turn-on Delay</td>
<td>0.5 V / to 0.1 I L (2); (4)</td>
<td>2</td>
<td></td>
<td></td>
<td>μs</td>
</tr>
<tr>
<td>T4 (νs)</td>
<td>Source Current Rise Time</td>
<td>0.1 I L / to 0.9 I L (2); (4)</td>
<td>0.7</td>
<td></td>
<td></td>
<td>μs</td>
</tr>
<tr>
<td>T5 (νs)</td>
<td>Sink Current Turn-off Delay</td>
<td>0.5 V / to 0.9 I L (3); (4)</td>
<td>0.7</td>
<td></td>
<td></td>
<td>μs</td>
</tr>
<tr>
<td>T6 (νs)</td>
<td>Sink Current Fall Time</td>
<td>0.9 I L / to 0.1 I L (3); (4)</td>
<td>0.25</td>
<td></td>
<td></td>
<td>μs</td>
</tr>
<tr>
<td>T7 (νs)</td>
<td>Sink Current Turn-on Delay</td>
<td>0.5 V / to 0.9 I L (3); (4)</td>
<td>1.6</td>
<td></td>
<td></td>
<td>μs</td>
</tr>
<tr>
<td>T8 (νs)</td>
<td>Sink Current Rise Time</td>
<td>0.1 I L / to 0.9 I L (3); (4)</td>
<td>0.2</td>
<td></td>
<td></td>
<td>μs</td>
</tr>
<tr>
<td>fC (νs)</td>
<td>Commutation Frequency</td>
<td>1.2 / 2A</td>
<td>25</td>
<td>40</td>
<td></td>
<td>kHz</td>
</tr>
</tbody>
</table>

1) Sensing voltage can be -1 V for t ≤ 50 μsec; steady state Vmin min ≥ -0.5 V.
2) See Fig. 2.
3) See Fig. 4.
4) The load must be a pure resistor.

---

**Figure 1**: Typical Saturation Voltage vs. Output Current.

**Figure 2**: Switching Times Test Circuits.

*Note*: For INPUT Switching set EN = H and ENABLE Switching set IN = H.
Figure 3: Source Current Delay Times vs. Input or Enable Switching.

Figure 4: Switching Times Test Circuits.

Notes:
- For INPUT Switching, set EN = H
- For ENABLE Switching, set N = L
Figure 5: Sink Current Delay Times vs. Input 0 V Enable Switching.

Figure 6: Bidirectional DC Motor Control

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{en} = H$</td>
<td>$C = H; D = L$ Forward</td>
</tr>
<tr>
<td></td>
<td>$C = L; D = H$ Reverse</td>
</tr>
<tr>
<td></td>
<td>$C = D$           Fast Motor Stop</td>
</tr>
<tr>
<td>$V_{en} = L$</td>
<td>$C = X; D = X$ Free Running Motor Stop</td>
</tr>
</tbody>
</table>

L = Low   H = High   X = Don't care
APPLICATION INFORMATION (Refer to the block diagram)

1.1. POWER OUTPUT STAGE

The L298 integrates two power output stages (A, B). The power output stage is a bridge configuration and its outputs can drive an inductive load in common or differential mode. The current that flows through the load comes out from the bridge at the sense output: an external resistor (RSEN A, RSEN B) allows detection of the intensity of this current.

1.2. INPUT STAGE

Each bridge is driven by means of four gates. The input of which are In1, In2, EnA and In3, In4, EnB. The In inputs set the bridge state when the En input is high; a low state of the En input inhibits the bridge. All the inputs are TTL compatible.

2. SUGGESTIONS

A non-inductive capacitor, usually of 100 nF, must be foreseen between each set of Vs and Vss, to ground, as near as possible to GND pin. When the large capacitor of the power supply is too far from the IC, a second smaller one must be foreseen near the L298.

The sense resistor, not of a wire wound type, must be grounded near the negative pole of Vs that must be near the GND pin of the IC.

Each input must be connected to the source of the driving signals by means of a very short path.

Turn-On and Turn-Off: Before to Turn-ON the Supply Voltage and before to Turn Off, the Enable input must be driven to the Low state.

3. APPLICATIONS

Fig 6 shows a bidirectional DC motor control Schematic Diagram for which only one bridge is needed. The external bridge of diodes D1 to D4 is made by four fast recovery elements (t recovery < 200 nsec) that must be chosen of a VF as low as possible at the worst case of the load current.

The sense output voltage can be used to control the current amplitude by chopping the inputs, or to provide overcurrent protection by switching low the enable input.

The brake function (Fast motor stop) requires that the Absolute Maximum Rating of 2 Amps must never be overcome.

When the repetitive peak current needed from the load is higher than 2 Amps, a paralleled configuration can be chosen (See Fig. 7).

An external bridge of diodes are required when inductive loads are driven and when the inputs of the IC are chopped; Shottky diodes would be preferred.
This solution can drive until 3 Amps in DC operation and until 3.5 Amps of a repetitive peak current. On Fig 8 it is shown the driving of a two-phase bipolar stepper motor; the needed signals to drive the inputs of the L298 are generated, in this example, from the IC L297.

Fig 9 shows an example of P.C.B. designed for the application of Fig 8.

**Figure 8 : Two Phase Bipolar Stepper Motor Circuit.**

This circuit drives bipolar stepper motors with winding currents up to 2 A. The diodes are fast 2 A types.

\[ R_{sh} = R_{so} = 0.6 \, \Omega \]

D1 to D8 = 2 A Fast diodes \{ \begin{align*}
V_F &\leq 1.2 \, V \\
I_F &\leq 2 \, A \\
\text{tr} &\leq 200 \, \text{ns}
\end{align*} \}
Figure 9: Suggested Printed Circuit Board Layout for the Circuit of fig. 8 (1:1 scale).

Figure 10: Two Phase Bipolar Stepper Motor Control Circuit by Using the Current Controller L6506.

R_q and R_{sense} depend from the load current.
<table>
<thead>
<tr>
<th>DIM.</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
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</thead>
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<td>5</td>
<td></td>
<td></td>
<td>0.197</td>
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<tr>
<td>B</td>
<td>2.65</td>
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<td></td>
<td>0.083</td>
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<td>0.019</td>
<td>0.022</td>
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<td>F</td>
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<td>G</td>
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<td>1.4</td>
<td>0.045</td>
<td>0.050</td>
<td>0.055</td>
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<td>G1</td>
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<td>H1</td>
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<td>0.722</td>
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<td>H2</td>
<td></td>
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<td>20.2</td>
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<td>S</td>
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<td>0.102</td>
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<tr>
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OUTLINE AND MECHANICAL DATA

Multiwatt15 H
### OUTLINE AND MECHANICAL DATA

#### JEDEC MO-166

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<th>Min. TYP. Max</th>
<th>Min. TYP. Max</th>
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<tr>
<td>T</td>
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<td>0.50</td>
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1. "D and F do not include mold flash or protrusions.
2. Mold flash or protrusions shall not exceed 0.18 mm (0.007")
3. Critical dimensions E, S, and T.