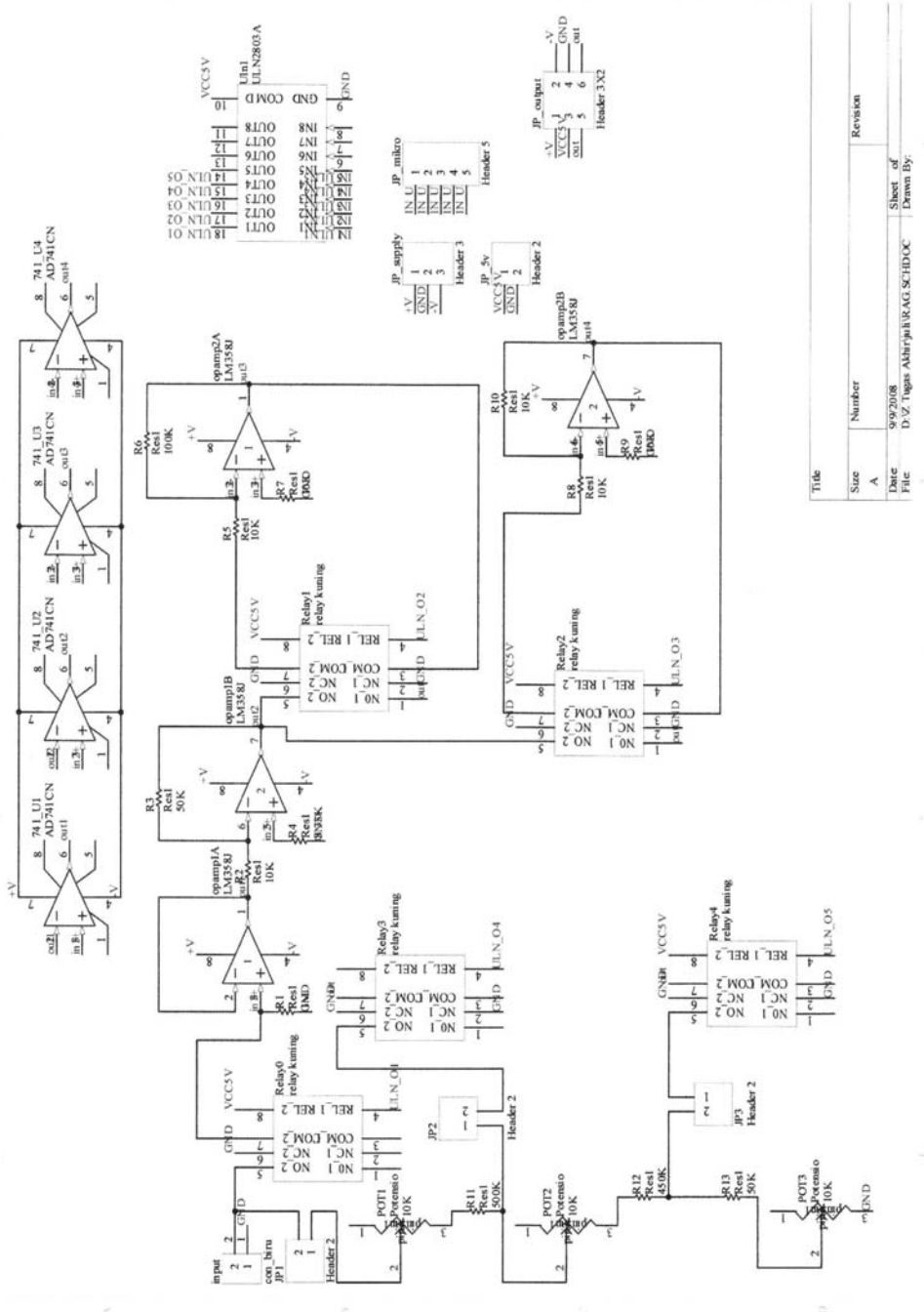
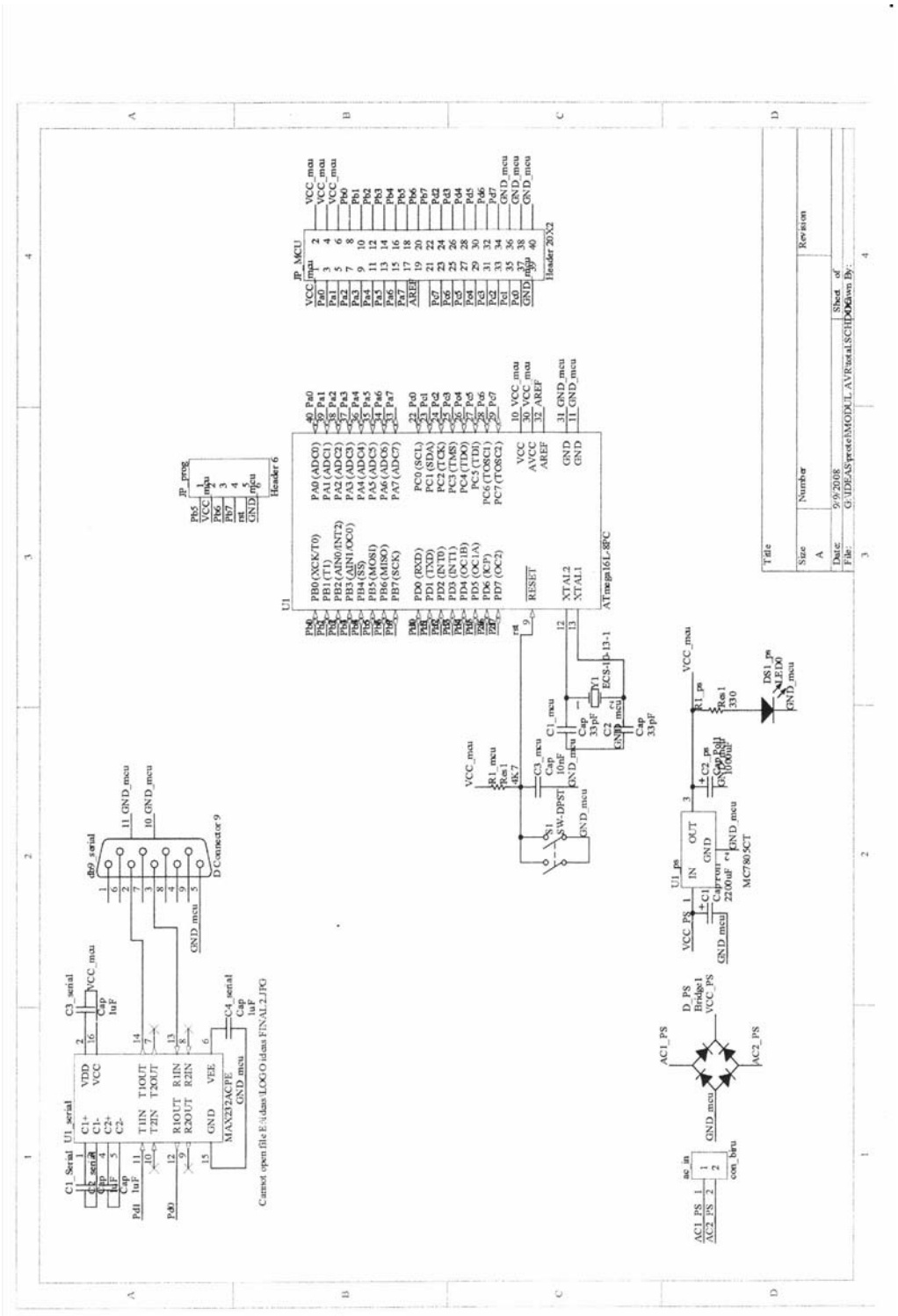
LAMPIRAN A

RANGKAIAN SKEMATIK PERANGKAT KERAS





LAMPIRAN B

LIST PROGRAM MIKROKONTROLER

```
.include "C:\Appnotes\m8535def.inc"

;=================
;serial
;=================
.equ fclock = 16000000
.equ baud_rate = 57600
.equ ubbr_value = ((fclock/(16*baud_rate))-1
.def txbyte = r17
.def rxbyte = r19
.def temp_data = r18
.def data_temp = r20

;=================
;adc
;=================
.def data_adc_l = r26
.def data_adc_h = r27
;=================

.org 0x0000
rjmp start

start:
        ldi r16,low(RAMEND)
        out SPL,r16
        ldi r16,high(RAMEND)
        out SPH,r16

        ldi r16,0b11110000
        out ddra,r16        ;utk set porta sbg input ADC
        ldi r16,0b00110000
        out porta,r16

        ldi r16,0xff
        out ddrc,r16        ;inisialisasi port c low
        ldi r16,0x00
        out portc,r16

        ldi r16,0xff
        out ddrd,r16        ;inisialisasi port d low
```

```
        ldi r16,0x00
        out portd,r16

        ldi r16,0xff
        out ddrb,r16
        ldi r16,0x00        ;inisialisasi port b luar
        out portb,r16

        rcall init_usart
        rcall init_adc

cek_tombol:
        rcall usart_rx
        cpi rxbyte,'7'
        brne cek_tombol

        ldi rxbyte,3
        rcall usart_tx
        rjmp setting_tombol

setting_tombol:

        rcall usart_rx
        mov R24,rxbyte

        cpi R24,'0'
        breq p1                         ;sub program pemilihan kanal
        cpi R24,'1'
        breq p2
        cpi R24,'2'
        breq p3
        cpi R24,'3'
        breq p4

        rjmp setting_tombol

;=====================================
; inisialisasi pilih Pengaturan
;=====================================
p1:
        push r16

        ldi r16,0xff
```

```
        out DDRB,r16
        out DDRC,r16
        out DDRD,r16
                                        ;Reset Port A,B dengan nilai logika 0
        ldi r16,0x00
        out DDRA,r16
        out DDRC,r16
        out DDRD,r16

        ldi r16,0x03    ;Mengaktifkan penguatan 30x
        out portB,r16   ;kanal 1 dan 2  :P.B0, P.B1, P.B5, P.B6

        ldi r16,0x00    ;Mengaktifkan penguatan 30x
        out portC,r16   ;kanal 3        :P.C2, P.C3,

        ldi r16,0x00    ;Mengaktifkan penguatan 30x
        out portD,r16   ;kanal 4        :P.D2, P.D3

        ldi xByte,a
        rcall usart_tx
        pop r16
        rjmp kon_AD_6

p2:
        push r16
        ldi r16,0xff
        out DDRB,r16
        out DDRC,r16
        out DDRD,r16

        ldi r16,0x04    ;Mengaktifkan penguatan 5x
        out portB,r16   ;kanal 1 dan 2  :P.B2, P.B7,

        ldi r16,0x10    ;Mengaktifkan penguatan 5x
        out portC,r16   ;kanal 3        :P.C4,

        ldi r16,0x10    ;Mengaktifkan penguatan 5x
        out portD,r16   ;kanal 4        :P.D4,

        ldi xByte,b
        rcall usart_tx
        pop r16
        rjmp kon_AD_6
```

```
kembali:
        rjmp setting_koneksi

p3:
        push r16
        ldi r16,0xff
        out ddrb,r16
        out ddrc,r16
        out ddrd,r16

        ldi r16,0x08      ;Mengaktifkan penguatan 0.5x
        out portb,r16     ;kanal 1,          ;PB3.

        ldi r16,0x21      ;Mengaktifkan penguatan 0.5x
        out portb,r16     ;kanal 2 dan 3     ;PC0,PC5.

        ldi r16,0x20      ;Mengaktifkan penguatan 0.5x
        out portb,r16     ;kanal 4                       ;PD5.

        ldi txbyte,'c'
        rcall usart_tx
        pop r16
        rjmp konADC

p4:
        push r16
        ldi r16,0xff
        out ddrb,r16
        out ddrc,r16
        out ddrd,r16

        ldi r16,0x03      ;Mengaktifkan penguatan 0.05x
        out portb,r16     ;kanal 1     ;PB4.

        ldi r16,0x42      ;Mengaktifkan penguatan 0.05x
        out portb,r16     ;kanal 2 dan 3     ;PC1,PC6.

        ldi r16,0x40      ;Mengaktifkan penguatan 0.05x
        out portb,r16     ;kanal 4                       ;PD6.

        ldi txbyte,'d'
        rcall usart_tx
```

```
                pop r16
                ;jmp kon_R0_6

;====================================
;sub program get R0_6
;====================================

kon_R0_6:

                rcall usart_rx
                mov R22,r16ya
                sbrs R22,4
                jmp loop
                nop
                sbrs R22,5
                jmp loop
                nop
                jmp kembali
loop:
                nop
                nop
                sbis r16ya,re2
                jmp re03
                in r16ya,ach
                jmp kon_R0_6
re03:
                sbrs R22,0
                jmp re11
                nop
                rcall R0_60
re11:
                sbrs R22,1
                jmp re12
                nop
                rcall R0_61
re12:
                sbrs R22,2
                jmp re13
                nop
                rcall R0_62
re13:
                sbrs R22,3
```

```
        rjmp loop
        nop
        rjmp INT_G2


;=====================================
; Pemilihan multiplexer masukan
;=====================================
INT_G0:
        ldi r16,0b01000000
        out adcsra,r16
        push r16
        ldi r16,0b00000111
        out admux,r16
        NOP
        ldi r16,0b01000111
        out admux,r16

        ldi txbyte,1
        rcall usart_tx
        rcall get_data_adc0

        pop r16
        ret

get_data_adc0:
        sbi adcsra,adsc
tunggu_adc0:
        sbis adcsra,adif
        rjmp tunggu_adc0
        in data_adc_h,adch

        rcall print_adc0
        ret

print_adc0:
        mov txbyte,data_adc_h
        rcall usart_tx
        ret


INT_G1:
        ldi r16,0b01010001
```

```
                out ddrax,r16
                push r16
                ldi r16,0b00000111
                out ddrsra,r16
                SBI P
                ldi r16,0b10000111
                out ddrsra,r16

                ldi txbyte,2
                rcall usart_tx
                rcall spi_data_adc1

                pop r16
                ret

spi_data_adc1:
                sbi ddrsra,adc
tunggu_adc1:
                sbis ddrsra,adcf
                rjmp tunggu_adc1
                in data_adc_h,adch

                rcall print_adc1
                ret

print_adc1:
                mov txbyte,data_adc_h
                rcall usart_tx
                ret

LED_G2:
                ldi r16,0b01000000
                out ddrax,r16
                push r16
                ldi r16,0b00000111
                out ddrsra,r16
                SBI P
                ldi r16,0b10000111
                out ddrsra,r16

                ldi txbyte,3
                rcall usart_tx
                rcall spi_data_adc1
```

```
        pop r16
        ret

get_data_adc2:
        sbi adcsra,adsc
tunggu_adc2:
        sbis adcsra,adif
        rjmp tunggu_adc2
        in data_adc_h,adch

        rcall print_adc2
        ret

print_adc2:
        mov txbyte,data_adc_h
        rcall usart_tx
        ret

LCD_G3:
        ldi r16,0b01000111
        out ddrax,r16
        push r16
        ldi r16,0b00000111
        out portax,r16
        NOP
        ldi r16,0b01000111
        out portax,r16

        ldi txbyte,4
        rcall usart_tx
        rcall get_data_adc3

        pop r16
        rjmp loop

get_data_adc3:
        sbi adcsra,adsc
tunggu_adc3:
        sbis adcsra,adif
        rjmp tunggu_adc3
        in data_adc_h,adch
```

```
                rcall print_sdc3
                ret

print_sdc3:
                mov tekan,data_sdc_h
                rcall usart_tx
                ret



;=====================================
; LCD 6
;=====================================
init_sdc:
                push r16
                ldi r16,0b01000000
                out ddrax,r16
                ldi r16,0b11111111
                out portax,r16
                pop r16
                ret

;-------------------------------------
; LCD 6 mux 1
;-------------------------------------
/*

spi_data_sdc1:
                ldi r16,0b01000000
                out portax,r16
                push r16
                ldi r16,0b00000010
                out portax,r16
                NOP
                ldi r16,0b10000010
                out portax,r16



                rcall spi_data_sdc
                pop r16
                ret
```

```
get_data_adc:
        sbi address,adc
tunggu_adc:
        sbis address,adcf
        jmp tunggu_adc
        in data_adc_h,adch

        rcall print_adc
        ret

print_adc:
        mov txbyte,data_adc_h
        rcall usart_tx
;=====================================
;U S A R T
;=====================================
usart_rx:
        sbis ucsra,rxc
        jmp usart_rx
        in rxbyte,udr
        ret
usart_tx:
        sbis ucsra,udre
        jmp usart_tx
        out udr,txbyte
        ret

init_usart:
        ldi r16,high(ubbr_value)
        out ubrrh,r16
        ldi r16,low(ubbr_value)
        out ubrrl,r16

        ldi r16,(1<<u2x)
        out ucsra,r16

        ldi r16,(1<<rxen)|(1<<txen)|(1<<rxcie)
        out ucsrb,r16

        ldi r16,(1<<ursel)|(3<<ucsz0)
        out ucsrc,r16

        ret
```

LAMPIRAN C

LIST PROGRAM DELPHI

Windows, Messages, System Utils, Classes, Graphics, Controls, Forms, Dialogs,

StdCtrls, ExtCtrls, ComCtrls, Buttons, sButtonControl, sCustomButton,

sPanel, sGroupBox, sMemo, sScrollBox, sMaskEdit, sCustomComboEdit, sCurrEdit,

sTrackBar, sCustomMemoManager, sCalculator, GIFImage, GIFMultiGraphic,

GIFAdvancedTimer, jpeg, GIFImage, GIFMouse, GIFHighResTimer, GIFAdvancedLabel,

GIFMasterContainer, Menus, GIFRadioButton;

TForm1 = class(TForm)

GroupBox1: TsGroupBox;

PointBox1: TsPointBox;

PointBox2: TsPointBox;

PointBox3: TsPointBox;

PointBox4: TsPointBox;

Edit1: TsEdit;

ComPort: TsComPort;

cb1: TsComboBox;

cb2: TsComboBox;

cb3: TsComboBox;

cb4: TsComboBox;

sSpinEdit1: TsSpinEdit;

sSpinEdit2: TsSpinEdit;

sSpinEdit3: TsSpinEdit;

sSpinEdit4: TsSpinEdit;

sSpinEdit5: TsSpinEdit;

sSpinEdit6: TsSpinEdit;

sSpinEdit7: TsSpinEdit;

sSpinEdit8: TsSpinEdit;

sSpinEdit9: TsSpinEdit;

sSpinEdit10: TsSpinEdit;

sSpinEdit11: TsSpinEdit;

sSpinEdit12: TsSpinEdit;

cb1_ch: TsGIFCheckBox;

cb2_ch: TsGIFCheckBox;

cb3_ch: TsGIFCheckBox;

cb4_ch: TsGIFCheckBox;

Button1: TsButton;

Button2: TsButton;

Button3: TsButton;

Button4: TsButton;

Button5: TsButton;

Button6: TsButton;

Button7: TsButton;

Local9: TLocal;

Local8: TLocal;

Local10: TLocal;

Local11: TLocal;

Local12: TLocal;

Local13: TLocal;

Local14: TLocal;

Local15: TLocal;

Local16: TLocal;

Local17: TLocal;

Local18: TLocal;

Local19: TLocal;

Local20: TLocal;

sButton1: TsButton;

sButton2: TsButton;

sButton3: TsButton;

sButton4: TsButton;

Button1: TButton;

Button3: TButton;

Timer1: TTimer;

Timer4: TTimer;

CHAlphaBlend_Timer1: TCHAlphaBlend_Timer;

CHAlphaBlend_Timer2: TCHAlphaBlend_Timer;

Label2: TLabel;

Label1: TLabel;

Edit2: TEdit;

Edit3: TEdit;

CHAdvanced_Label2: TCHAdvanced_Label;

CHAdvanced_Label3: TCHAdvanced_Label;

CHAdvanced_Label4: TCHAdvanced_Label;

CHAdvanced_Label5: TCHAdvanced_Label;

CHAdvanced_Label6: TCHAdvanced_Label;

CHAdvanced_Label7: TCHAdvanced_Label;

Image1: TImage;

Image2: TImage;

Image7: TImage;

Image5: TImage;

Image3: TImage;

Image13: TImage;

Image10: TImage;

Image11: TImage;

Image12: TImage;

Image14: TImage;

Image4: TImage;

Image15: TImage;

Image16: TImage;

Image17: TImage;

Image18: TImage;

Image20: TImage;

Image21: TImage;

GUIExtruded Label1: TGUIExtruded Label;

GUIExtruded Label2: TGUIExtruded Label;

GUIExtruded Label3: TGUIExtruded Label;

GUIExtruded Label10: TGUIExtruded Label;

GUIExtruded Label11: TGUIExtruded Label;

GUIExtruded Label12: TGUIExtruded Label;

GUIExtruded Label13: TGUIExtruded Label;

GUIExtruded Label14: TGUIExtruded Label;

GUIExtruded Label15: TGUIExtruded Label;

GUIExtruded Label16: TGUIExtruded Label;

GUIExtruded Label17: TGUIExtruded Label;

GUIExtruded Label18: TGUIExtruded Label;

GUIExtruded Label19: TGUIExtruded Label;

GUIExtruded Label20: TGUIExtruded Label;

GUIExtruded Label21: TGUIExtruded Label;

procedure Paint Box1 Paint(Sender: TObject);

procedure Paint Box1 MouseDown(Sender: TObject; Button: TMouse Button;
Shift: TShift State; X, Y: Integer);

procedure Paint Box1 Mouse Move(Sender: TObject; Shift: TShift State; X,
Y: Integer);

procedure Paint Box1 Mouse Up(Sender: TObject; Button: TMouse Button;
Shift: TShift State; X, Y: Integer);

procedure Form KeyDown(Sender: TObject; var Key: Word;
Shift: TShift State);

procedure Form Create(Sender: TObject);

procedure Paint Box2 MouseDown(Sender: TObject; Button: TMouse Button;
Shift: TShift State; X, Y: Integer);

procedure Paint Box2 Mouse Move(Sender: TObject; Shift: TShift State; X,
Y: Integer);

procedure Paint Box2 Mouse Up(Sender: TObject; Button: TMouse Button;
Shift: TShift State; X, Y: Integer);

procedure Button1 Click(Sender: TObject);

procedure Button2 Click(Sender: TObject);

procedure Gem Port Open(Sender: TObject);

procedure Gem Port Close(Sender: TObject);

procedure Gem Port Re Close(Sender: TObject; Count: Integer);

procedure My Change(Sender: TObject);

procedure By Change(Sender: TObject);

procedure Mby Change(Sender: TObject);

procedure Speed Button2 Change(Sender: TObject);

procedure Button4 Click(Sender: TObject);

procedure Timer1 Timer(Sender: TObject);

procedure Spin Edit1 Change(Sender: TObject);

procedure X2 Change(Sender: TObject);

procedure Button3 Click(Sender: TObject);

procedure Mx Change(Sender: TObject);

procedure My2 Change(Sender: TObject);

procedure Mz2 Change(Sender: TObject);

```
    procedure CH_High_Res_Timer2_Timer(Sender: TObject);
    procedure Button4Click(Sender: TObject);
    procedure ch1_cbchange(Sender: TObject);
    procedure Button9Click(Sender: TObject);
    procedure Timer4Timer(Sender: TObject);
    procedure SpinEdit5Change(Sender: TObject);
    procedure SpinEdit6Change(Sender: TObject);
    procedure SpinEdit2Change(Sender: TObject);
    procedure SpinEdit3Change(Sender: TObject);
    procedure SpinEdit4Change(Sender: TObject);
    procedure SpinEdit7Change(Sender: TObject);
    procedure SpinEdit8Change(Sender: TObject);
    procedure CH_RadioButton2Click(Sender: TObject);
    procedure CH_RadioButton1Click(Sender: TObject);
    procedure SpinEdit9Change(Sender: TObject);
    procedure SpinEdit10Change(Sender: TObject);
    procedure SpinEdit11Change(Sender: TObject);
    procedure SpinEdit12Change(Sender: TObject);
  private
    { Private declarations }
  public

  end;

var
  Form1: TForm1;
  cx1,cx2,cx3,cx4,n1,n2,n3,n4:integer;
  c,ac1,ac2,ac3,ac4,act,z,tm,cha,jo:integer;
  px1,px2,px3,px4,pos1,pos2,pos3,pos4:integer;
  pda0,pda1,pda2,pda3,pdb0,pdb1,pdb2,pdb3,nk,ds,penanda,b,pengali:integer;
  pewaktu,st:string;
  flag1,flag1a,nwaktu:real;
  x,f:word;
  a:array[1..10000] of integer;
  a1:array[1..9999] of integer;
  a2:array[1..9999] of integer;
  a3:array[1..9999] of integer;
  a4:array[1..9999] of integer;
  val:byte;
implementation

uses xygraph, xycopy, xygraph3d, math;
var res,err : array[1..12] of integer;
    labels : array of string;
    d0,d1,dd : double;
    y,m,d,h,n,s,ms : word;
    dmin : double;
    ystring : string;
```

R :DFM

```
// ----- listing program xygraph (menampilkan latar) ----- //
procedure TForm1.PaintBox1Paint(Sender: TObject);
var
  logscale : boolean;
begin
  logscale := false;
  xycleargraph(paintbox1,clwhite,clblack,11/10);
  xystartgraph(0,100,0,100,20,5,22,48,clipon);
  xyxaxis(clblack,0,nwaktu,0,1,pewaktu,1,gridoff,logscale,fixed,0);
  xyxaxis(clwhite,0,0,0,0,'',4,gridoff,logscale,fixed,0);
  xyyaxis(clblack,flagta,flag1,0,1,'',5,gridoff,logscale,fixed,0);
  xyyaxis(clsilver,-5,5,0,1,'',4,gridon,logscale,fixed,0);
  xyinitruler(clsilver,931,558,-1,0+0);
  //xyinitruler dipakai untuk menentukan tampilan pada kursor
end;
procedure showdata;
var s : string;
begin
  with form1.Edit1 do with xyexportd do
    begin
      str(xw:5:2,s); text := 'x='+s;
    end;
  end;
// program mengubah pengali level tegangan //
procedure TForm1.sSpinEdit1Change(Sender: TObject);
var
  d:integer;
begin
  d:=sspinedit1.Value;
  case d of
  1: begin
     px1:=1;
     cx1:=0;
     end;
  2: begin
     px1:=2;
     cx1:=275;
     end;
  3: begin
     px1:=3;
     cx1:=550;
     end;
  4: begin
     px1:=4;
     cx1:=825;
     end;
  5: begin
```

```
    pt1.x=5;
    pt1.y=425;
  }
}
public void Form1_Paint_1(object sender, PaintEventArgs e)
{
  Graphics
  e.Graphics.DrawLine(
  {
    pt2.x=1;
    pt2.y=5;
  }
  Graphics
    pt2.x=2;
    pt2.y=275;
  }
  Graphics
    pt2.x=3;
    pt2.y=550;
  }
  Graphics
    pt2.x=4;
    pt2.y=825;
  }
  Graphics
    pt1.x=5;
    pt1.y=425;
  }
}
public void Form1_Paint_1(object sender, PaintEventArgs e)
{
  Graphics
  e.Graphics.DrawLine(
  {
    pt3.x=1;
    pt3.y=5;
  }
  Graphics
    pt3.x=2;
    pt3.y=275;
  }
```

```
3: begin
   px3:=3;
   cx3:=550;
   end;
4: begin
   px3:=4;
   cx3:=825;
   end;
5: begin
   px3:=5;
   cx3:=825;
   end;
else
end;
end;
procedure TForm1.SpinEdit4Change(Sender: TObject);
var
d:integer;
begin
d:=spinedit4.Value;
case d of
1: begin
   px4:=1;
   cx4:=0;
   end;
2: begin
   px4:=2;
   cx4:=275;
   end;
3: begin
   px4:=3;
   cx4:=550;
   end;
4: begin
   px4:=4;
   cx4:=825;
   end;
5: begin
   px4:=5;
   cx4:=825;
   end;
else
end;
end;
//-----------------------------------------------------------//
// --- listing program memisahkan data masukan --- //
procedure TForm1.Button9Click(Sender: TObject);
var
nilai,m:integer;
```

```
z1,z2,z4,x2,x1,z3,x3,x4,da:integer;
begin
if nk=3 then
begin
button4.Click;
button4.Click;
//timer3.Enabled:=true;
//timer6.Enabled:=true;
end
else
begin
ds:=1;
da:=20;
paintbox1.Repaint;
paintbox2.Repaint;
paintbox3.Repaint;
paintbox4.Repaint;
paintbox1.canvas.MoveTo(20,255);
paintbox2.canvas.MoveTo(20,255);
paintbox3.canvas.MoveTo(20,255);
paintbox4.canvas.MoveTo(20,255);
begin
for m:=1 to (c-1) do
begin
nilai:=a[(ds)];
if nilai=1 then
 begin
  a1[n1]:=a[(ds+1)];
  z1:=px1*2*a[(ds+1)];
  x1:=532-(pos1*z1-cx1);
  paintbox2.Canvas.Pen.Color:=clBlack;
  paintbox2.Canvas.pen.Width:=1;
  paintbox2.Canvas.LineTo(((pda0*da)-pdb0),x1);
  n1:=n1+1;
  ds:=ds+1;
  da:=da+1;
  end
 else if nilai=2 then
 begin
  a2[n2]:=a[(ds+1)];
  z2:=px2*2*a[(ds+1)];
  x2:=532-(pos2*z2-cx2);
  paintbox1.Canvas.Pen.Color:=clBlue;
  paintbox1.Canvas.pen.Width:=1;
  paintbox1.Canvas.LineTo(((pda1*da)-pdb1),x2);
  n2:=n1+1;
  ds:=ds+1;
  da:=da+1;
  end
```

```
else if nilai=3 then
begin
  a3[n3]:=a[(ds)];
  z3:=px3*2*a[(ds+1)];
  x3:=532-(pos3*z3-cx3);
  paintbox3.Canvas.Pen.Color:=clred;
  paintbox3.Canvas.pen.Width:=1;
  paintbox3.Canvas.LineTo((pda2*da-pdb2),x3);
  n3:=n1+1;
  ds:=ds+1;
  da:=da+1;
 end
else if nilai=4 then
begin
  a4[n4]:=a[(ds+1)];
  z4:=px4*2*a[(ds+1)];
  x4:=532-(pos4*z4-cx4);
  paintbox4.Canvas.Pen.Color:=clgreen;
  paintbox4.Canvas.pen.Width:=1;
  paintbox4.Canvas.LineTo(((pda3*da)-pdb3),x4);
  n4:=n1+1;
  ds:=ds+1;
  da:=da+1;
 end
else
ds:=ds+1;
da:=da+1;
end;
nk:=nk+1;
end;
end;
end;
//------------------------------------------------------//
//----listing Program untuk menmpilkan garis bantu mouse----//
//dikutip dari program xygraph sebagai program pemroses gambar//
procedure TForm1.PaintBox1MouseDown(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  xyexportd.xp := -1;
  xymousedown(button,shift,x,y);
  if (xyexportd.xp =0) and (xyexportd.iqr=3) and
   not (ssCtrl in shift) then
   begin
     Edit1.top := round(paintbox1.height*0.65)-6;
     Edit1.show;
     showdata;
   end;
end;
procedure TForm1.PaintBox1MouseMove(Sender: TObject; Shift: TShiftState; X,
```

```
  Y: Integer);
begin
  xymousemove(shift,x,y);
  if (xyexportd.xp =0) and (xyexportd.iqr=3) and
   not (ssCtrl in shift) then showdata;
end;
procedure TForm1.PaintBox1MouseUp(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  xyexportd.xp := -1;
  edit1.hide;
  xymouseup(button,shift,x,y);
end;
procedure TForm1.PaintBox2MouseDown(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin xymousedown(button,shift,x,y); end;
procedure TForm1.PaintBox2MouseMove(Sender: TObject; Shift: TShiftState; X,
  Y: Integer);
begin xymousemove(shift,x,y); end;
procedure TForm1.PaintBox2MouseUp(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin xymouseup(button,shift,x,y); end;
procedure TForm1.FormKeyDown(Sender: TObject; var Key: Word;
  Shift: TShiftState);
begin xykeydown(key,shift); end;


//---------------------------------------------------------//
// ---------------- Listing Start Program ----------------//
procedure TForm1.FormCreate(Sender: TObject);
begin
 b:=0;
 flag1:=5;
 flag1a:=-5;
 WindowState := wsMaximized;
 paintbox1.Left:=0;
 paintbox1.Top:=-0;
 paintbox1.Height:=578;
 paintbox1.Width:=1024 ;
 pos1:=0;pos2:=0;pos3:=0;pos4:=0;
 cx1:=0;cx2:=0;cx3:=0;cx4:=0;
 px1:=1;px2:=1;px3:=1;px4:=1;
 pda0:=1;pda1:=1;pda2:=1;pda3:=1;
 pewaktu:=mili second;
 nwaktu:=5;
 {   inisialisasi awal di sini }
end;



// proses koneksi awal //
```

```
procedure TForm1.sButton1Click(Sender: TObject);
begin
if ComPort.Connected = true then
   ComPort.Close
 else
   ComPort.Open;
end;
procedure TForm1.ComPortOpen(Sender: TObject);
begin
 sButton1.Caption := 'Close';
 comport.WriteStr('2');
 timer4.Enabled:=true;
end;
//proses memasukan data masukan kedalam array//
procedure TForm1.ComPortRxChar(Sender: TObject; Count: Integer);
 begin
 comport.Read(val,1);
   begin
   c:=c+1;
   edit2.Text:=inttostr(c);
   a[c]:= val;
   if c =1000 then
     button9.Click
      else if c = 1001 then
      c:=1
      else
     end;
   end;
//-----------------------------------------//
// proses inisialisasi awal komunikasi serial USART//
procedure TForm1.ComPortClose(Sender: TObject);
begin
  if sButton1 nil then
 begin
   sButton1.Caption := 'Open';
   sbutton2.Visible:=true;
  end;
end;
procedure TForm1.sButton2Click(Sender: TObject);
begin
 ComPort.ShowSetupDialog;
end;
//-------------------------------------------------------//
//  pemilihan kanal masukan //
procedure TForm1.ch1qChange(Sender: TObject);
begin
ch2q.Enabled:=false;
ch3q.Enabled:=false;
ch4q.Enabled:=false;
```

```
begin
  if ch1q.ItemIndex = 0 then
   begin
     ch2q.ItemIndex:=0;
     ch3q.ItemIndex:=0;
     ch4q.ItemIndex:=0;
    end
  else if ch1q.ItemIndex = 1 then
   begin
     ch2q.ItemIndex:=1;
     ch3q.ItemIndex:=1;
     ch4q.ItemIndex:=1;
    end
  else if ch1q.ItemIndex = 2 then
   begin
     ch2q.ItemIndex:=2;
     ch3q.ItemIndex:=2;
     ch4q.ItemIndex:=2;
    end
  else if ch1q.ItemIndex = 3 then
   begin
     ch2q.ItemIndex:=3;
     ch3q.ItemIndex:=3;
     ch4q.ItemIndex:=3;
    end
  end;
end;
procedure TForm1.ch2qChange(Sender: TObject);
begin
 if ch2q.ItemIndex = 0 then
  begin
  end
 else if ch2q.ItemIndex = 1 then
  begin
  end
 else if ch2q.ItemIndex = 2 then
  begin
  end
 else if ch2q.ItemIndex = 3 then
  begin
  end
 end;
procedure TForm1.ch3qChange(Sender: TObject);
begin
 if ch3q.ItemIndex = 0 then
 begin
 end
 else if ch3q.ItemIndex = 1 then
 begin
```

```
  end
  else if ch3q.ItemIndex = 2 then
 begin
  end
  else if ch3q.ItemIndex = 3 then
 begin
  end
 end;
 procedure TForm1.ch4qChange(Sender: TObject);
begin
  if ch4q.ItemIndex = 0 then
  begin
   end
   else if ch4q.ItemIndex = 1 then
  begin
   end
   else if ch4q.ItemIndex = 2 then
  begin
   end
   else if ch4q.ItemIndex = 3 then
  begin
   end
 end;
 procedure TForm1.SpeedButton2Change(Sender: TObject);
begin
  paintbox1.NewInstance;
 end;
 procedure TForm1.Button4Click(Sender: TObject);
begin
 if MessageDlg('Exit now?', mtConfirmation, [mbYes, mbNo], 0) = mrYes then
  begin
   timer1.Enabled:=true;
  end;
 end;
 procedure TForm1.Timer1Timer(Sender: TObject);
begin
  close;
 end;
 procedure TForm1.ch2_cbchange(Sender: TObject);
begin
  begin
   if ch2_cb.Checked = true then
   ac2:=2
   else ac2:=0
  end;
 end;
 procedure TForm1.Button3Click(Sender: TObject);
begin
 CH.HighResTimer2.Enabled:=true;
```

```
if ch1q.ItemIndex = 0 then
begin
  comport.WriteStr('0');
  CH.AdvancedLabel4.Caption:='0.01 Volt/Skala';
  CH.AdvancedLabel5.caption:='0.01 Volt/Skala';
  CH.AdvancedLabel6.caption:='0.01 Volt/Skala';
  CH.AdvancedLabel7.caption:='0.01 Volt/Skala';
end
else if ch1q.ItemIndex = 1 then
  begin
    comport.WriteStr('@');
    CH.AdvancedLabel4.Caption:='0.1 Volt/Skala';
    CH.AdvancedLabel5.Caption:='0.1 Volt/Skala';
    CH.AdvancedLabel6.Caption:='0.1 Volt/Skala';
    CH.AdvancedLabel7.Caption:='0.1 Volt/Skala';
  end
else if ch1q.ItemIndex = 2 then
  begin
    comport.WriteStr('[illegible]');
    CH.AdvancedLabel4.Caption:='0,5 Volt/Skala';
    CH.AdvancedLabel5.Caption:='0,5 Volt/Skala';
    CH.AdvancedLabel6.Caption:='0,5 Volt/Skala';
    CH.AdvancedLabel7.Caption:='0,5 Volt/Skala';
  end
else if ch1q.ItemIndex = 3 then
  begin
    comport.WriteStr('[illegible]');
    CH.AdvancedLabel4.Caption:='1 Volt/Skala';
    CH.AdvancedLabel5.Caption:='1 Volt/Skala';
    CH.AdvancedLabel6.Caption:='1 Volt/Skala';
    CH.AdvancedLabel7.Caption:='1 Volt/Skala';
  end
else if ch1q.ItemIndex = 4 then
  begin
    comport.WriteStr('p');
    CH.AdvancedLabel4.Caption:='10 Volt/Skala';
    CH.AdvancedLabel5.Caption:='10 Volt/Skala';
    CH.AdvancedLabel6.Caption:='10 Volt/Skala';
    CH.AdvancedLabel7.Caption:='10 Volt/Skala';
  end
else


end;


procedure TForm1.ch4_cbchange(Sender: TObject);
begin
  begin
```

```
    if ch4_cb.Checked = true then
    ac4:=8
    else ac4:=0
   end;

  end;

  procedure TForm1.ch3_cbchange(Sender: TObject);
 begin
 begin
  if ch3_cb.Checked = true then
  ac3:=4
  else ac3:=0
  end;

  end;

  procedure TForm1.CHHighResTimer2Timer(Sender: TObject);
 begin
    CHHighResTimer2.Enabled:=false;
   if sbutton3.caption='Setting Channel' then
    begin
    sbutton3.caption:='Activated';
    ch1q.Visible:=false; ch2q.Visible:=false;
    ch3q.Visible:=false; ch4q.Visible:=false;
    end
   else
    begin
    sbutton3.caption:='Setting Channel';
    ch1q.Visible:=true; ch2q.Visible:=true;
    ch3q.Visible:=true; ch4q.Visible:=true;
     CHAdvancedLabel4.caption:='Amp Gain';
     CHAdvancedLabel5.caption:='Amp Gain';
     CHAdvancedLabel6.caption:='Amp Gain';
     CHAdvancedLabel7.caption:='Amp Gain';
    end

   end;

  procedure TForm1.ch1_cbchange(Sender: TObject);
 begin
  if ch1_cb.Checked = true then
  ac1:=1
  else ac1:=0;

  end;
```

```
procedure TForm1.Button4Click(Sender: TObject);
begin
act:=ac1+ac2+ac3+ac4;
comport.ClearBuffer(true,true);
nwaktu:=69;
nk:=0;
c:=0;
ds:=1;
n1:=1;
n2:=1;
n3:=1;
n4:=1;

case act of
1:comport.WriteStr(a);
2:comport.WriteStr(b);
3:comport.WriteStr(c);
4:comport.WriteStr(d);
5:comport.WriteStr(e);
6:comport.WriteStr(f);
7:comport.WriteStr(g);
8:comport.WriteStr(h);
9:comport.WriteStr(i);
10:comport.WriteStr(j);
11:comport.WriteStr(k);
12:comport.WriteStr(l);
13:comport.WriteStr(m);
14:comport.WriteStr(n);
15:comport.WriteStr(o);
else
comport.WriteStr(p)
end;
end;
procedure TForm1.Timer4Timer(Sender: TObject);
begin
timer4.Enabled:=false;
if val=5 then
sbutton3.Visible:=true;
CHAdvancedLabel20.Visible:=true;
CHAdvancedLabel21.Visible:=true;
end;
// ---- Listing program menggeser gambar    ---- //
procedure TForm1.SpinEdit5Change(Sender: TObject);
begin
if sspinedit5.Value=1 then
pos1:=50
else if sspinedit5.Value=2 then
pos1:=100
```

```
else if spinedit5.Value=3 then
pos1:=152
else if spinedit5.Value=4 then
pos1:=202
else if spinedit5.Value=5 then
pos1:=252
else if spinedit5.Value=-1 then
pos1:=-50
else if spinedit5.Value=-2 then
pos1:=-100
else if spinedit5.Value=-3 then
pos1:=-152
else if spinedit5.Value=-4 then
pos1:=-202
else if spinedit5.Value=-5 then
pos1:=-252
else
pos1:=0
end;
procedure TForm1.SpinEdit6Change(Sender: TObject);
begin
if spinedit6.Value=1 then
pos2:=50
else if spinedit6.Value=2 then
pos2:=100
else if spinedit6.Value=3 then
pos2:=152
else if spinedit6.Value=4 then
pos2:=202
else if spinedit6.Value=5 then
pos2:=252
else if spinedit6.Value=-1 then
pos2:=-50
else if spinedit6.Value=-2 then
pos2:=-100
else if spinedit6.Value=-3 then
pos2:=-152
else if spinedit6.Value=-4 then
pos2:=-202
else if spinedit5.Value=-5 then
pos2:=-252
else
pos2:=0
end;
procedure TForm1.SpinEdit7Change(Sender: TObject);
begin
if spinedit7.Value=1 then
pos3:=50
else if spinedit7.Value=2 then
```

```
pos3:=100
else if sspinedit7.Value=3 then
pos3:=162
else if sspinedit7.Value=4 then
pos3:=202
else if sspinedit7.Value=5 then
pos3:=252
else if sspinedit7.Value=-1 then
pos3:=-50
else if sspinedit7.Value=-2 then
pos3:=-100
else if sspinedit7.Value=-3 then
pos3:=-162
else if sspinedit7.Value=-4 then
pos3:=-202
else if sspinedit7.Value=-5 then
pos3:=-252
else
pos3:=0
end;
procedure TForm1.SpinEdit8Change(Sender: TObject);
begin
if sspinedit8.Value=1 then
pos4:=50
else if sspinedit8.Value=2 then
pos4:=100
else if sspinedit8.Value=3 then
pos4:=152
else if sspinedit8.Value=4 then
pos4:=202
else if sspinedit8.Value=5 then
pos4:=252
else if sspinedit8.Value=-1 then
pos4:=-50
else if sspinedit8.Value=-2 then
pos4:=-100
else if sspinedit8.Value=-3 then
pos4:=-152
else if sspinedit8.Value=-4 then
pos4:=-202
else if sspinedit8.Value=-5 then
pos4:=-252
else
pos4:=0
end;
// ----------------------------------------------//
// proses pengulangan penggambaran //
procedure TForm1.CHRadioButton2Click(Sender: TObject);
begin
```

```
button4.Visible:=true;
ch2_cb.Enabled:=true;
ch3_cb.Enabled:=true;
ch4_cb.Enabled:=true;
end;
procedure TForm1.CHRadioButton1Click(Sender: TObject);
begin
button4.Visible:=false;
ch2_cb.Enabled:=false;
ch3_cb.Enabled:=false;
ch4_cb.Enabled:=false;
end;
procedure TForm1.SpinEdit9Change(Sender: TObject);
begin
if spinedit9.Value=1 then
begin
pda0:=1;
pdb0:=0;
end
else if spinedit9.Value=2 then
begin
pda0:=2;
pdb0:=20;
end
else if spinedit9.Value=3 then
begin
pda0:=3;
pdb0:=40;
end
else if spinedit9.Value=4 then
begin
pda0:=4;
pdb0:=60;
end
else if spinedit9.Value=5 then
begin
pda0:=5;
pdb0:=80;
end
else
end;

procedure TForm1.SpinEdit10Change(Sender: TObject);
begin
if spinedit10.Value=1 then
begin
pda1:=1;
pdb1:=0;
end
```

```
else if sspinedit10.Value=2 then
begin
pdla1:=2;
pdlb1:=20;
end
else if sspinedit10.Value=3 then
begin
pdla1:=3;
pdlb1:=40;
end
else if sspinedit10.Value=4 then
begin
pdla1:=4;
pdlb1:=60;
end
else if sspinedit10.Value=5 then
begin
pdla1:=5;
pdlb1:=80;
end
else
end;
procedure TForm1.SpinEdit11Change(Sender: TObject);
begin
if sspinedit11.Value=1 then
begin
pdla2:=1;
pdlb2:=0;
end
else if sspinedit11.Value=2 then
begin
pdla2:=2;
pdlb2:=20;
end
else if sspinedit11.Value=3 then
begin
pdla2:=3;
pdlb2:=40;
end
else if sspinedit11.Value=4 then
begin
pdla2:=4;
pdlb2:=60;
end
else if sspinedit11.Value=5 then
begin
pdla2:=5;
pdlb2:=80;
end
```

```
else
end;
procedure TForm1.SpinEdit2Change(Sender: TObject);
begin
begin
if sspinedit12.Value=1 then
begin
pda3:=1;
pdb3:=0;
end
else if sspinedit12.Value=2 then
begin
pda3:=2;
pdb3:=40;
end
else if sspinedit12.Value=3 then
begin
pda3:=3;
pdb3:=60;
end
else if sspinedit12.Value=4 then
begin
pda3:=4;
pdb3:=80;
end
else if sspinedit12.Value=5 then
begin
pda3:=5;
pdb3:=100;
end
else
end;
end;
end;
```

LAMPIRAN D

FOTO ALAT DAN PERANGKAT LUNAK

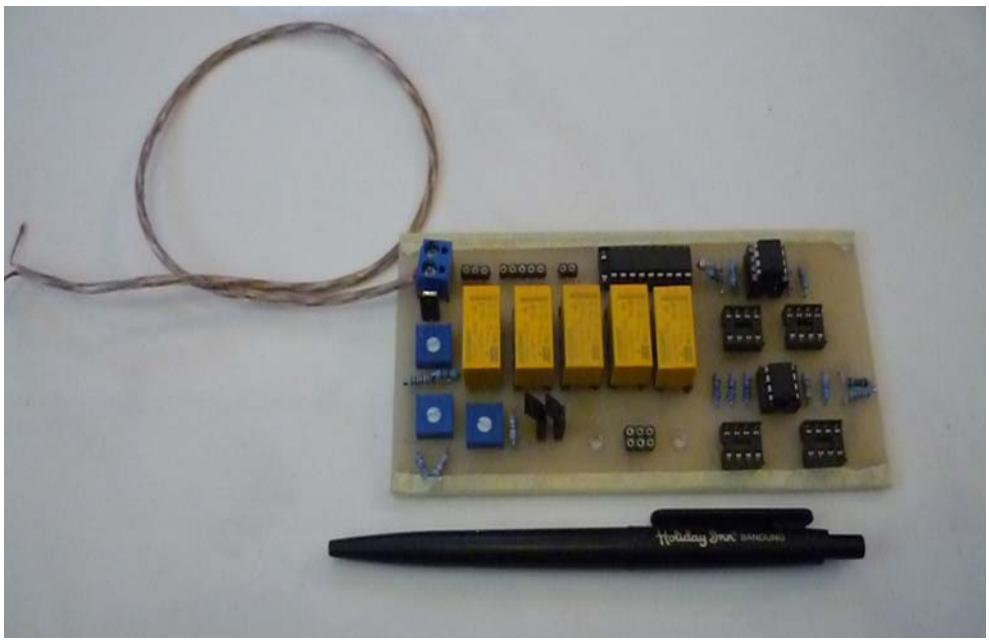


Foto Hasil Rangkaian Pada Keluaran Rangkaian

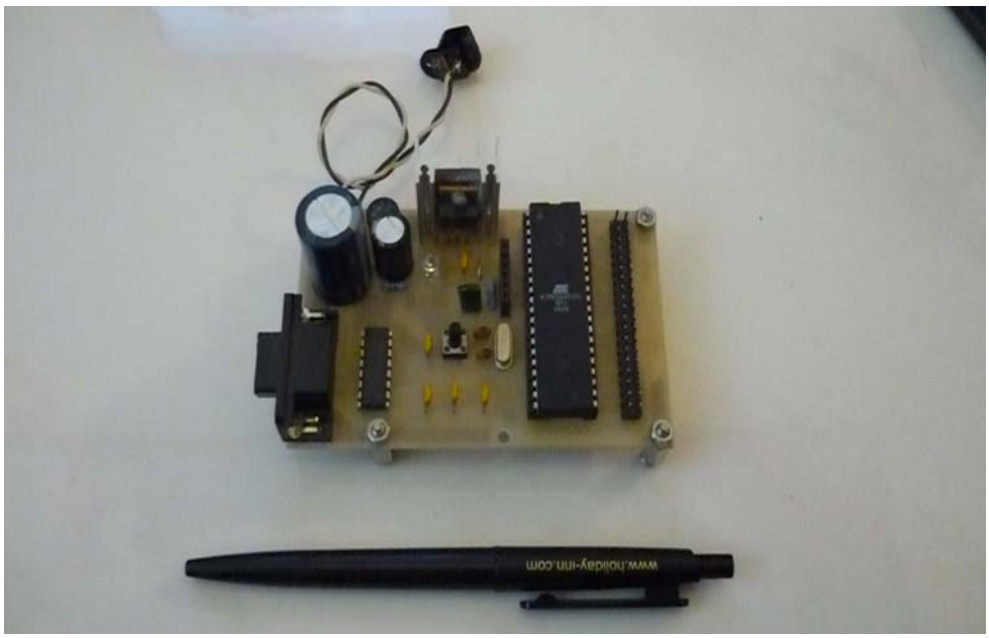
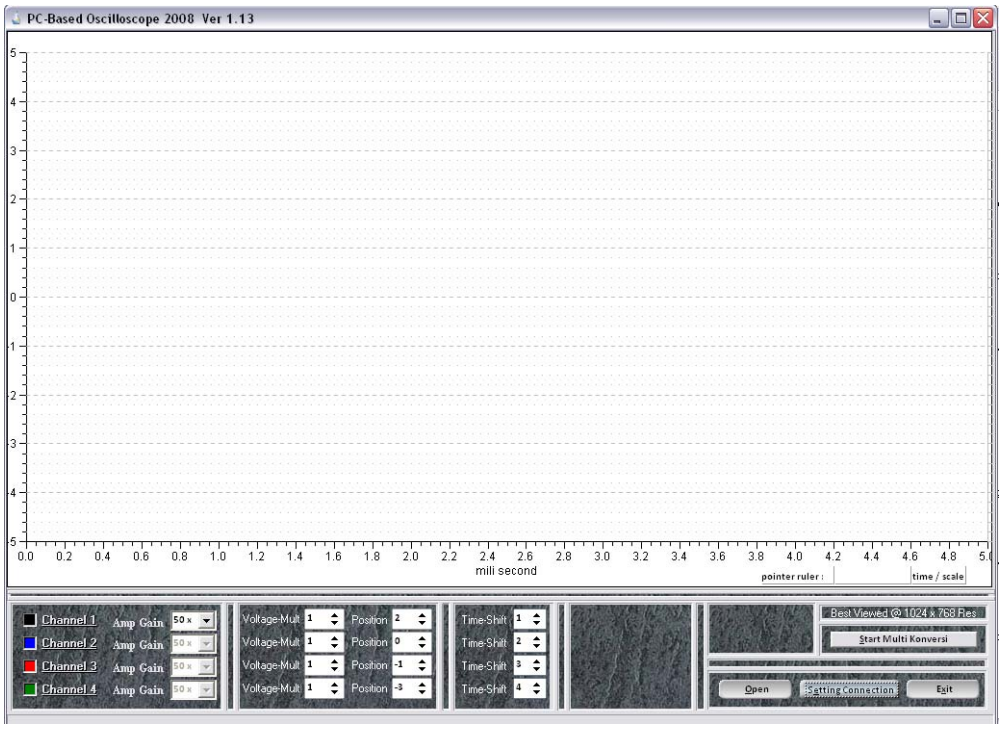


Foto Rangkaian Digital Mikrokontroler Lengkap 8535

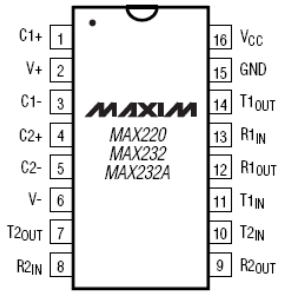

PC-Based Oscilloscope 2008 Ver 1.13
mili second
pointer ruler :
time / scale
Channel 1
Channel 2
Channel 3
Channel 4
Amp Gain
Voltage-Mult
Position
Time-Shift
Best Viewed @ 1024 x 768 Res
Start Multi Konversi
Open
Setting Connection
Exit

LAMPIRAN E

DATASHEET KOMPONEN

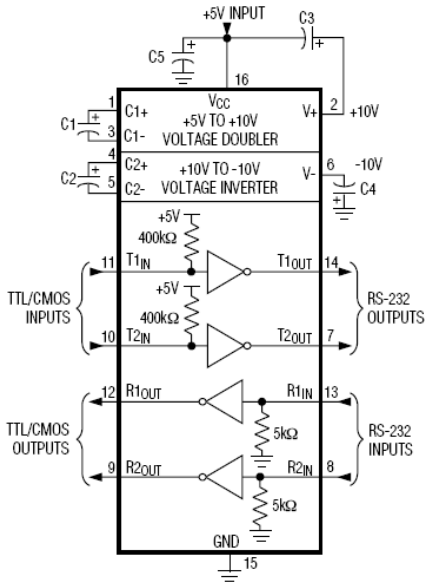
+5V-Powered, Multichannel RS-232 Drivers/Receivers

TOP VIEW



DIP/SO

CAPACITANCE (µF)					
DEVICE	C1	C2	C3	C4	C5
MAX220	0.047	0.33	0.33	0.33	0.33
MAX232	1.0	1.0	1.0	1.0	1.0
MAX232A	0.1	0.1	0.1	0.1	0.1



ELECTRICAL CHARACTERISTICS—MAX220/222/232A/233A/242/243

(V_{CC} = +5V ±10%, C1–C4 = 0.1µF, MAX220, C1 = 0.047µF, C2–C4 = 0.33µF, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
RS-232 TRANSMITTERS						
Output Voltage Swing	All transmitter outputs loaded with 3kΩ to GND		±5	±8		V
Input Logic Threshold Low				1.4	0.8	V
Input Logic Threshold High	All devices except MAX220		2	1.4		V
	MAX220: V_{CC} = 5.0V		2.4			
Logic Pullup/Input Current	All except MAX220, normal operation			5	40	µA
	$\overline{SHDN}$ = 0V, MAX222/MAX242, shutdown, MAX220			±0.01	±1	
Output Leakage Current	V_{CC} = 5.5V, $\overline{SHDN}$ = 0V, V_{OUT} = ±15V, MAX222/MAX242			±0.01	±10	µA
	V_{CC} = $\overline{SHDN}$ = 0V	V_{OUT} = ±15V		±0.01	±10	
		MAX220, V_{OUT} = ±12V			±25	
Data Rate				200	116	kbps
Transmitter Output Resistance	V_{CC} = V+ = V- = 0V, V_{OUT} = ±2V		300	10M		Ω
Output Short-Circuit Current	V_{OUT} = 0V	V_{OUT} = 0V	±7	±22		mA
		MAX220			±60	
RS-232 RECEIVERS						
RS-232 Input Voltage Operating Range					±30	V
		MAX220			±25	
RS-232 Input Threshold Low	V_{CC} = 5V	All except MAX243 $R2_{IN}$	0.8	1.3		V
		MAX243 $R2_{IN}$ (Note 4)	-3			
RS-232 Input Threshold High	V_{CC} = 5V	All except MAX243 $R2_{IN}$		1.8	2.4	V
		MAX243 $R2_{IN}$ (Note 4)		-0.5	-0.1	

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
RS-232 Input Hysteresis	All except MAX220/MAX243, V_{CC} = 5V, no hysteresis in SHDN		0.2	0.5	1.0	V
	MAX220			0.3		
	MAX243			1		
RS-232 Input Resistance	T_A = +25°C (MAX220)		3	5	7	kΩ
			3	5	7	
TTL/CMOS Output Voltage Low	I_{OUT} = 3.2mA			0.2	0.4	V
	I_{OUT} = 1.6mA (MAX220)				0.4	
TTL/CMOS Output Voltage High	I_{OUT} = -1.0mA		3.5	V_{CC} - 0.2		V
TTL/CMOS Output Short-Circuit Current	Sourcing V_{OUT} = GND		-2	-10		mA
	Shrinking V_{OUT} = V_{CC}		10	30		
TTL/CMOS Output Leakage Current	$\overline{SHDN}$ = V_{CC} or $\overline{EN}$ = V_{CC} ($\overline{SHDN}$ = 0V for MAX222), 0V ≤ V_{OUT} ≤ V_{CC}			±0.05	±10	µA
EN Input Threshold Low	MAX242			1.4	0.8	V
EN Input Threshold High	MAX242		2.0	1.4		V
Operating Supply Voltage			4.5		5.5	V
V_{CC} Supply Current ($\overline{SHDN}$ = V_{CC}), Figures 5, 6, 11, 19	No load	MAX220		0.5	2	µA
		MAX222/MAX232A/MAX233A/ MAX242/MAX243		4	10	
	3kΩ load both inputs	MAX220		12		
		MAX222/MAX232A/MAX233A/ MAX242/MAX243		15		
Shutdown Supply Current	MAX222/ MAX242	T_A = +25°C		0.1	10	µA
		T_A = 0°C to +70°C		2	50	
		T_A = -40°C to +85°C		2	50	
		T_A = -55°C to +125°C		35	100	
$\overline{SHDN}$ Input Leakage Current	MAX222/MAX242				±1	µA
$\overline{SHDN}$ Threshold Low	MAX222/MAX242			1.4	0.8	V
$\overline{SHDN}$ Threshold High	MAX222/MAX242		2.0	1.4		V
Transition Slew Rate	C_L = 50pF to 2500pF, R_L = 3kΩ to 7kΩ, V_{CC} = 5V, T_A = +25°C, measured from +3V to -3V or -3V	MAX222/MAX232A/MAX233/ MAX242/MAX243	6	12	30	V/µs
		MAX220	1.5	3	30.0	
Transmitter Propagation Delay TLL to RS-232 (Normal Operation), Figure 1	t_{PHLT}	MAX222/MAX232A/MAX233/ MAX242/MAX243		1.3	3.5	µs
		MAX220		4	10	
	t_{PLHT}	MAX222/MAX232A/MAX233/ MAX242/MAX243		1.5	3.5	
		MAX220		5	10	

Electrical Characteristics

Absolute Maximum Ratings*

Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C
Voltage on any Pin except $\overline{\text{RESET}}$ with respect to Ground	-0.5V to V_{CC}+0.5V
Voltage on $\overline{\text{RESET}}$ with respect to Ground	-0.5V to +13.0V
Maximum Operating Voltage	6.0V
DC Current per I/O Pin	40.0 mA
DC Current V_{CC} and GND Pins	200.0 mA

*NOTICE: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

DC Characteristics

T_A = -40°C to 85°C, V_{CC} = 2.7V to 5.5V (unless otherwise noted)

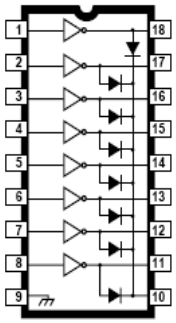
Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{IL}	Input Low Voltage	Except XTAL1 pin	-0.5		0.2 V_{CC}[1]	V
V_{IL1}	Input Low Voltage	XTAL1 pin, External Clock Selected	-0.5		0.1 V_{CC}[1]	V
V_{IH}	Input High Voltage	Except XTAL1 and $\overline{\text{RESET}}$ pins	0.6 V_{CC}[2]		V_{CC} + 0.5	V
V_{IH1}	Input High Voltage	XTAL1 pin, External Clock Selected	0.8 V_{CC}[2]		V_{CC} + 0.5	V
V_{IH2}	Input High Voltage	$\overline{\text{RESET}}$ pin	0.9 V_{CC}[2]		V_{CC} + 0.5	V
V_{OL}	Output Low Voltage[3] (Ports A,B,C,D)	I_{OL} = 20 mA, V_{CC} = 5V I_{OL} = 10 mA, V_{CC} = 3V			0.7 0.5	V V
V_{OH}	Output High Voltage[4] (Ports A,B,C,D)	I_{OH} = -20 mA, V_{CC} = 5V I_{OH} = -10 mA, V_{CC} = 3V	4.2 2.2			V V
I_{IL}	Input Leakage Current I/O Pin	V_{CC} = 5.5V, pin low (absolute value)			1	µA
I_{IH}	Input Leakage Current I/O Pin	V_{CC} = 5.5V, pin high (absolute value)			1	µA
R_{RST}	Reset Pull-up Resistor		30		60	kΩ
R_{PU}	I/O Pin Pull-up Resistor		20		50	kΩ

Symbol	Parameter	Condition	Min	Typ	Max	Units
I_{CC}	Power Supply Current	Active 4 MHz, V_{CC} = 3V (ATmega8535L)		4		mA
		Active 8 MHz, V_{CC} = 5V (ATmega8535)		14		mA
		Idle 4 MHz, V_{CC} = 3V (ATmega8535L)		3		mA
		Idle 8 MHz, V_{CC} = 5V (ATmega8535)		10		mA
	Power-down mode[5]	WDT enabled, V_{CC} = 3V		< 10		µA
		WDT disabled, V_{CC} = 3V		< 3		µA
V_{ACIO}	Analog Comparator Input Offset Voltage	V_{CC} = 5V V_{in} = V_{CC}/2			40	mV
I_{ACLK}	Analog Comparator Input Leakage Current	V_{CC} = 5V V_{in} = V_{CC}/2	-50		50	nA
t_{ACID}	Analog Comparator Propagation Delay	V_{CC} = 2.7V V_{CC} = 4.0V		750 500		ns

Types ULx2803A, ULx2803LW, ULx2804A, and ULx2804LW
ELECTRICAL CHARACTERISTICS at +25°C (unless otherwise noted).

Characteristic	Symbol	Test Fig.	Applicable Devices	Test Conditions	Limits			
					Min.	Typ.	Max.	Units
Output Leakage Current	I_{CEX}	1A	All	V_{CE} = 50 V, T_A = 25°C	—	< 1	50	µA
				V_{CE} = 50 V, T_A = 70°C	—	< 1	100	µA
		1B	ULx2804x	V_{CE} = 50 V, T_A = 70°C, V_{IN} = 1.0 V	—	< 5	500	µA
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$	2	All	I_C = 100 mA, I_B = 250 µA	—	0.9	1.1	V
				I_C = 200 mA, I_B = 350 µA	—	1.1	1.3	V
				I_C = 350 mA, I_B = 500 µA	—	1.3	1.6	V
Input Current	$I_{IN(ON)}$	3	ULx2803x	V_{IN} = 3.85 V	—	0.93	1.35	mA
			ULx2804x	V_{IN} = 5.0 V	—	0.35	0.5	mA
				V_{IN} = 12 V	—	1.0	1.45	mA
	$I_{IN(OFF)}$	4	All	I_C = 500 µA, T_A = 70°C	50	65	—	µA
Input Voltage	$V_{IN(ON)}$	5	ULx2803x	V_{CE} = 2.0 V, I_C = 200 mA	—	—	2.4	V
				V_{CE} = 2.0 V, I_C = 250 mA	—	—	2.7	V
				V_{CE} = 2.0 V, I_C = 300 mA	—	—	3.0	V
			ULx2804x	V_{CE} = 2.0 V, I_C = 125 mA	—	—	5.0	V
				V_{CE} = 2.0 V, I_C = 200 mA	—	—	6.0	V
				V_{CE} = 2.0 V, I_C = 275 mA	—	—	7.0	V
				V_{CE} = 2.0 V, I_C = 350 mA	—	—	8.0	V
Input Capacitance	C_{IN}	—	All		—	15	25	pF
Turn-On Delay	t_{PLH}	8	All	0.5 E_{IN} to 0.5 E_{OUT}	—	0.25	1.0	µs
Turn-Off Delay	t_{PHL}	8	All	0.5 E_{IN} to 0.5 E_{OUT}	—	0.25	1.0	µs
Clamp Diode Leakage Current	I_R	6	All	V_R = 50 V, T_A = 25°C	—	—	50	µA
				V_R = 50 V, T_A = 70°C	—	—	100	µA
Clamp Diode Forward Voltage	V_F	7	All	I_F = 350 mA	—	1.7	2.0	V

Complete part number includes prefix to operating temperature range: ULN = -20°C to +85°C, ULQ = -40°C to +85°C and a suffix to identify package style: A = DIP, LW = SOIC.



Dwg. No. A-10,822A

Note that the ULx28xxA series (dual in-line package) and ULx28xxLW series (small-outline IC package) are electrically identical and share a common terminal number assignment.

2803 THRU 2824
HIGH-VOLTAGE, HIGH-CURRENT DARLINGTON ARRAYS

ABSOLUTE MAXIMUM RATINGS

Output Voltage, V_{CE}
- (x2803x and x2804x) ..... **50 V**
- (x2823x and x2824x) ..... **95 V**

Input Voltage, V_{IN} ..... **30 V**

Continuous Output Current, I_C .... **500 mA**

Continuous Input Current, I_{IN} ..... **25 mA**

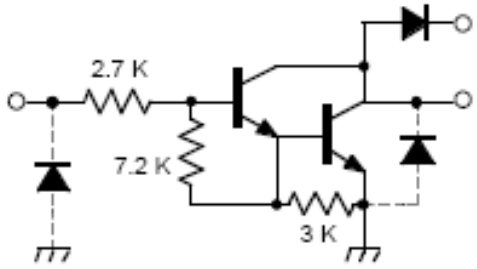
Power Dissipation, P_D
- (one Darlington pair) ..... **1.0 W**
- (total package) ..... **See Graph**

Operating Temperature Range, T_A
- Prefix 'ULN' ..... **-20°C to + 85°C**
- Prefix 'ULQ' ..... **-40°C to +85°C**

Storage Temperature Range

PARTIAL SCHEMATICS

ULx28x3A/LW (Each Driver)



Dwg. FP-052-2

National Semiconductor

January 1995

LM136-2.5/LM236-2.5/LM336-2.5V Reference Diode

General Description

The LM136-2.5/LM236-2.5 and LM336-2.5 integrated circuits are precision 2.5V shunt regulator diodes. These monolithic IC voltage references operate as a low-temperature-coefficient 2.5V zener with 0.2Ω dynamic impedance. A third terminal on the LM136-2.5 allows the reference voltage and temperature coefficient to be trimmed easily.

The LM136-2.5 series is useful as a precision 2.5V low voltage reference for digital voltmeters, power supplies or op amp circuitry. The 2.5V make it convenient to obtain a stable reference from 5V logic supplies. Further, since the LM136-2.5 operates as a shunt regulator, it can be used as either a positive or negative voltage reference.

The LM136-2.5 is rated for operation over −55°C to +125°C while the LM236-2.5 is rated over a −25°C to +85°C temperature range.

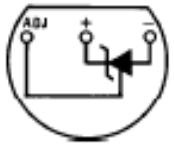
The LM336-2.5 is rated for operation over a 0°C to +70°C temperature range. See the connection diagrams for available packages.

Features

- Low temperature coefficient
- Wide operating current of 400 μA to 10 mA
- 0.2Ω dynamic impedance
- ± 1% initial tolerance available
- Guaranteed temperature stability
- Easily trimmed for minimum temperature drift
- Fast turn-on
- Three lead transistor package

Connection Diagrams

TO-92
Plastic Package

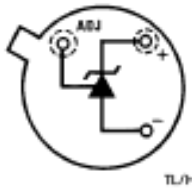


TL/H/5715–8

Bottom View

Order Number LM236Z-2.5,
LM236AZ-2.5, LM336Z-2.5 or
LM336BZ-2.5
See NS Package Number Z03A

TO-46
Metal Can Package

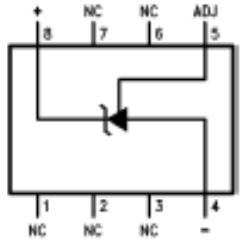


TL/H/5715–20

Bottom View

Order Number LM136H-2.5,
LM136H-2.5/883, LM236H-2.5,
LM136AH-2.5, LM136AH-2.5/883
or LM236AH-2.5
See NS Package Number H03H

SO Package



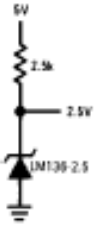
TL/H/5715–12

Top View

Order Number LM236M-2.5,
LM236AM-2.5, LM336M-2.5
or LM336BM-2.5
See NS Package Number M08A

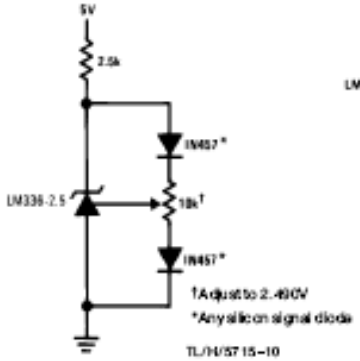
Typical Applications

2.5V Reference



TL/H/5715–9

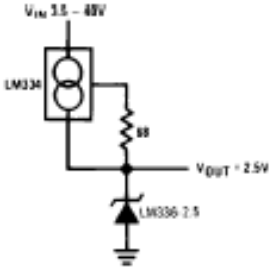
2.5V Reference with Minimum
Temperature Coefficient



†Adjust to 2.490V
*Any silicon signal diode

TL/H/5715–10

Wide Input Range Reference



TL/H/5715–11

HRS2/HRS2H	
Dimension (mm) WxDxH	20.8x9.9x12.2
Feature	• High Reliability • High Sensitive • FCC Part68 Surge Strength 1500V Available 3000 V (20 ¦Ìs) • 2 Form C
Contact Material	AuAg
Rated Switching Current	1A 120VAC / 24VDC
Max. Switching Voltage	60VDC 120 VAC
Max. Switching Current	2 A
Max. Switching Power	240 VA 60 W
Min. Switching Current & Voltage	5VDC 1mA
Contact Resistance m¦¸ at 6VDC 1A	100
Coil Voltage	3 - 24 VDC
Coil Power Consumption (mW)	150 / 200 / 360
Dielectric Strength between Contacts between Coil and Contacts	1,000V 1,000V
Insulation Resistance M¦¸ (at 500VDC)	100
Life Expectancy (ops.) Electrical Mechanical	100,000 10,000,000
Operating Temp. Range	-30 - +60 ¡æ
Operating Teme	6 ms
Release Time	4 ms
Structure Washable	Washable
Terminal Shape	P.C.B
Dimension (in mm) Wiring Diagram Drilling Plan