LAMPIRAN A

LISTING PROGRAM APLIKASI DENGAN DELPHI 6…. A-1

LISTING PROGRAM APLIKASI DENGAN

AVR STUDIO 4…….. A-26

Listing Program Delphi 6

```
unit Unit1;

interface

uses
  Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
  Dialogs, StdCtrls, Buttons, ExtCtrls, Gauges, QCCom32;

type
  TForm1 = class(TForm)
    BitBtn1: TBitBtn;
    p11: TGauge;
    p12: TGauge;
    p13: TGauge;
    p14: TGauge;
    p15: TGauge;
    p16: TGauge;
    p17: TGauge;
    p18: TGauge;
    p21: TGauge;
    p22: TGauge;
    p23: TGauge;
    p24: TGauge;
    p25: TGauge;
    p26: TGauge;
    p27: TGauge;
    p28: TGauge;
    p31: TGauge;
    p32: TGauge;
    p33: TGauge;
    p34: TGauge;
    p35: TGauge;
    p36: TGauge;
    p37: TGauge;
    p38: TGauge;
    p41: TGauge;
    p42: TGauge;
    p43: TGauge;
    p44: TGauge;
    p45: TGauge;
    p46: TGauge;
    p47: TGauge;
    p48: TGauge;
    p51: TGauge;
    p52: TGauge;
    p53: TGauge;
    p54: TGauge;
    p55: TGauge;
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p56: TGauge;
p57: TGauge;
p58: TGauge;
p61: TGauge;
p62: TGauge;
p63: TGauge;
p64: TGauge;
p65: TGauge;
p66: TGauge;
p67: TGauge;
p68: TGauge;
p71: TGauge;
p72: TGauge;
p73: TGauge;
p74: TGauge;
p75: TGauge;
p76: TGauge;
p77: TGauge;
p78: TGauge;
p81: TGauge;
p82: TGauge;
p83: TGauge;
p84: TGauge;
p85: TGauge;
p86: TGauge;
p87: TGauge;
p88: TGauge;
com: TQCCom32;
Timer1: TTimer;
Panel1: TPanel;
Panel2: TPanel;
Panel3: TPanel;
Panel4: TPanel;
Panel5: TPanel;
Panel6: TPanel;
Panel7: TPanel;
Panel8: TPanel;
Timer2: TTimer;
Edit1: TEdit;
Label1: TLabel;
Edit2: TEdit;
Label2: TLabel;
Edit3: TEdit;
Label3: TLabel;
BitBtn2: TBitBtn;
pkalibrasi: TPanel;
procedure FormCreate(Sender: TObject);
procedure Timer1Timer(Sender: TObject);
procedure Timer2Timer(Sender: TObject);
procedure BitBtn2Click(Sender: TObject);
```

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  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  Form1: TForm1;
  datars232:string;
  hitung:longint;
  valueGelap,valueterang,ValueKosong:longint;

  stp11,stp12,stp13,stp14,stp15,stp16,stp17,stp18,
  stp21,stp22,stp23,stp24,stp25,stp26,stp27,stp28,
  stp31,stp32,stp33,stp34,stp35,stp36,stp37,stp38,
  stp41,stp42,stp43,stp44,stp45,stp46,stp47,stp48,
  stp51,stp52,stp53,stp54,stp55,stp56,stp57,stp58,
  stp61,stp62,stp63,stp64,stp65,stp66,stp67,stp68,
  stp71,stp72,stp73,stp74,stp75,stp76,stp77,stp78,
  stp81,stp82,stp83,stp84,stp85,stp86,stp87,stp88:byte;

  data11,data12,data13,data14,data15,data16,data17,data18,
  data21,data22,data23,data24,data25,data26,data27,data28,
  data31,data32,data33,data34,data35,data36,data37,data38,
  data41,data42,data43,data44,data45,data46,data47,data48,
  data51,data52,data53,data54,data55,data56,data57,data58,
  data61,data62,data63,data64,data65,data66,data67,data68,
  data71,data72,data73,data74,data75,data76,data77,data78,
  data81,data82,data83,data84,data85,data86,data87,data88 :integer;


data11awal,data12awal,data13awal,data14awal,data15awal,data16awal,data17awal,da
ta18awal,

data21awal,data22awal,data23awal,data24awal,data25awal,data26awal,data27awal,da
ta28awal,

data31awal,data32awal,data33awal,data34awal,data35awal,data36awal,data37awal,da
ta38awal,

data41awal,data42awal,data43awal,data44awal,data45awal,data46awal,data47awal,da
ta48awal,

data51awal,data52awal,data53awal,data54awal,data55awal,data56awal,data57awal,da
ta58awal,

data61awal,data62awal,data63awal,data64awal,data65awal,data66awal,data67awal,da
ta68awal,
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data71awal,data72awal,data73awal,data74awal,data75awal,data76awal,data77awal,da
ta78awal,

data81awal,data82awal,data83awal,data84awal,data85awal,data86awal,data87awal,da
ta88awal :integer;

implementation

{$R *.dfm}

procedure TForm1.FormCreate(Sender: TObject);
begin
pkalibrasi.Visible:=false;
com.Pick;
com.Flush;
stp11:=0;stp12:=0;stp13:=0;stp14:=0;stp15:=0;stp16:=0;stp17:=0;stp18:=0;
stp21:=0;stp22:=0;stp23:=0;stp24:=0;stp25:=0;stp26:=0;stp27:=0;stp28:=0;
stp31:=0;stp32:=0;stp33:=0;stp34:=0;stp35:=0;stp36:=0;stp37:=0;stp38:=0;
stp41:=0;stp42:=0;stp43:=0;stp44:=0;stp45:=0;stp46:=0;stp47:=0;stp48:=0;
stp51:=0;stp52:=0;stp53:=0;stp54:=0;stp55:=0;stp56:=0;stp57:=0;stp58:=0;
stp61:=0;stp62:=0;stp63:=0;stp64:=0;stp65:=0;stp66:=0;stp67:=0;stp68:=0;
stp71:=0;stp72:=0;stp73:=0;stp74:=0;stp75:=0;stp76:=0;stp77:=0;stp78:=0;
stp81:=0;stp82:=0;stp83:=0;stp84:=0;stp85:=0;stp86:=0;stp87:=0;stp88:=0;
hitung:=0;
end;

procedure cekwarna;
begin
{ValueGelap:=20;
ValueTerang:=20;
ValueKosong:=5;
 }
{=============================================================
===========}
 if (data11>=(data11awal-ValueKosong)) and (data11<=(data11awal+ValueKosong))
then stp11:=0;
 if (data11<=(data11awal-ValueGelap)) then stp11:=1;  {detek hitam tampil putih}
 if (data11>=(data11awal+ValueTerang)) then stp11:=2; {detek putih tampil hitam}

 if (data12>=(data12awal-ValueKosong)) and (data12<=(data12awal+ValueKosong))
then stp12:=0;
 if (data12<=(data12awal-ValueGelap)) then stp12:=1;  {detek hitam tampil putih}
 if (data12>=(data12awal+ValueTerang)) then stp12:=2; {detek putih tampil hitam}

 if (data13>=(data13awal-ValueKosong)) and (data13<=(data13awal+ValueKosong))
then stp13:=0;
 if (data13<=(data13awal-ValueGelap)) then stp13:=1;  {detek hitam tampil putih}
 if (data13>=(data13awal+ValueTerang)) then stp13:=2; {detek putih tampil hitam}
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 if (data14>=(data14awal-ValueKosong)) and (data14<=(data14awal+ValueKosong))
then stp14:=0;
 if (data14<=(data14awal-ValueGelap)) then stp14:=1;  {detek hitam tampil putih}
 if (data14>=(data14awal+ValueTerang)) then stp14:=2; {detek putih tampil hitam}

 if (data15>=(data15awal-ValueKosong)) and (data15<=(data15awal+ValueKosong))
then stp15:=0;
 if (data15<=(data15awal-ValueGelap)) then stp15:=1;  {detek hitam tampil putih}
 if (data15>=(data15awal+ValueTerang)) then stp15:=2; {detek putih tampil hitam}

 if (data16>=(data16awal-ValueKosong)) and (data16<=(data16awal+ValueKosong))
then stp16:=0;
 if (data16<=(data16awal-ValueGelap)) then stp16:=1;  {detek hitam tampil putih}
 if (data16>=(data16awal+ValueTerang)) then stp16:=2; {detek putih tampil hitam}

 if (data17>=(data17awal-ValueKosong)) and (data17<=(data17awal+ValueKosong))
then stp17:=0;
 if (data17<=(data17awal-ValueGelap)) then stp17:=1;  {detek hitam tampil putih}
 if (data17>=(data17awal+ValueTerang)) then stp17:=2; {detek putih tampil hitam}

 if (data18>=(data18awal-ValueKosong)) and (data18<=(data18awal+ValueKosong))
then stp18:=0;
 if (data18<=(data18awal-ValueGelap)) then stp18:=1;  {detek hitam tampil putih}
 if (data18>=(data18awal+ValueTerang)) then stp18:=2; {detek putih tampil hitam}


{2==========================================================
==========}
 if (data21>=(data21awal-ValueKosong)) and (data21<=(data21awal+ValueKosong))
then stp21:=0;
 if (data21<=(data21awal-ValueGelap)) then stp21:=1;  {detek hitam tampil putih}
 if (data21>=(data21awal+ValueTerang)) then stp21:=2; {detek putih tampil hitam}

 if (data22>=(data22awal-ValueKosong)) and (data22<=(data22awal+ValueKosong))
then stp22:=0;
 if (data22<=(data22awal-ValueGelap)) then stp22:=1;  {detek hitam tampil putih}
 if (data22>=(data22awal+ValueTerang)) then stp22:=2; {detek putih tampil hitam}

 if (data23>=(data23awal-ValueKosong)) and (data23<=(data23awal+ValueKosong))
then stp23:=0;
 if (data23<=(data23awal-ValueGelap)) then stp23:=1;  {detek hitam tampil putih}
 if (data23>=(data23awal+ValueTerang)) then stp23:=2; {detek putih tampil hitam}

 if (data24>=(data24awal-ValueKosong)) and (data24<=(data24awal+ValueKosong))
then stp24:=0;
 if (data24<=(data24awal-ValueGelap)) then stp24:=1;  {detek hitam tampil putih}
 if (data24>=(data24awal+ValueTerang)) then stp24:=2; {detek putih tampil hitam}

 if (data25>=(data25awal-ValueKosong)) and (data25<=(data25awal+ValueKosong))
then stp25:=0;
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 if (data25<=(data25awal-ValueGelap)) then stp25:=1;  {detek hitam tampil putih}
 if (data25>=(data25awal+ValueTerang)) then stp25:=2; {detek putih tampil hitam}

 if (data26>=(data26awal-ValueKosong)) and (data26<=(data26awal+ValueKosong))
then stp26:=0;
 if (data26<=(data26awal-ValueGelap)) then stp26:=1;  {detek hitam tampil putih}
 if (data26>=(data26awal+ValueTerang)) then stp26:=2; {detek putih tampil hitam}

 if (data27>=(data27awal-ValueKosong)) and (data27<=(data27awal+ValueKosong))
then stp27:=0;
 if (data27<=(data27awal-ValueGelap)) then stp27:=1;  {detek hitam tampil putih}
 if (data27>=(data27awal+ValueTerang)) then stp27:=2; {detek putih tampil hitam}

 if (data28>=(data28awal-ValueKosong)) and (data28<=(data28awal+ValueKosong))
then stp28:=0;
 if (data28<=(data28awal-ValueGelap)) then stp28:=1;  {detek hitam tampil putih}
 if (data28>=(data28awal+ValueTerang)) then stp28:=2; {detek putih tampil hitam}

{3============================================================
============}
 if (data31>=(data31awal-ValueKosong)) and (data31<=(data31awal+ValueKosong))
then stp31:=0;
 if (data31<=(data31awal-ValueGelap)) then stp31:=1;  {detek hitam tampil putih}
 if (data31>=(data31awal+ValueTerang)) then stp31:=2; {detek putih tampil hitam}

 if (data32>=(data32awal-ValueKosong)) and (data32<=(data32awal+ValueKosong))
then stp32:=0;
 if (data32<=(data32awal-ValueGelap)) then stp32:=1;  {detek hitam tampil putih}
 if (data32>=(data32awal+ValueTerang)) then stp32:=2; {detek putih tampil hitam}

 if (data33>=(data33awal-ValueKosong)) and (data33<=(data33awal+ValueKosong))
then stp33:=0;
 if (data33<=(data33awal-ValueGelap)) then stp33:=1;  {detek hitam tampil putih}
 if (data33>=(data33awal+ValueTerang)) then stp33:=2; {detek putih tampil hitam}

 if (data34>=(data34awal-ValueKosong)) and (data34<=(data34awal+ValueKosong))
then stp34:=0;
 if (data34<=(data34awal-ValueGelap)) then stp34:=1;  {detek hitam tampil putih}
 if (data34>=(data34awal+ValueTerang)) then stp34:=2; {detek putih tampil hitam}

 if (data35>=(data35awal-ValueKosong)) and (data35<=(data35awal+ValueKosong))
then stp35:=0;
 if (data35<=(data35awal-ValueGelap)) then stp35:=1;  {detek hitam tampil putih}
 if (data35>=(data35awal+ValueTerang)) then stp35:=2; {detek putih tampil hitam}

 if (data36>=(data36awal-ValueKosong)) and (data36<=(data36awal+ValueKosong))
then stp36:=0;
 if (data36<=(data36awal-ValueGelap)) then stp36:=1;  {detek hitam tampil putih}
 if (data36>=(data36awal+ValueTerang)) then stp36:=2; {detek putih tampil hitam}
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 if (data37>=(data37awal-ValueKosong)) and (data37<=(data37awal+ValueKosong))
then stp37:=0;
 if (data37<=(data37awal-ValueGelap)) then stp37:=1;  {detek hitam tampil putih}
 if (data37>=(data37awal+ValueTerang)) then stp37:=2; {detek putih tampil hitam}

 if (data38>=(data38awal-ValueKosong)) and (data38<=(data38awal+ValueKosong))
then stp38:=0;
 if (data38<=(data38awal-ValueGelap)) then stp38:=1;  {detek hitam tampil putih}
 if (data38>=(data38awal+ValueTerang)) then stp38:=2; {detek putih tampil hitam}

{4============================================================
============}
 if (data41>=(data41awal-ValueKosong)) and (data41<=(data41awal+ValueKosong))
then stp41:=0;
 if (data41<=(data41awal-ValueGelap)) then stp41:=1;  {detek hitam tampil putih}
 if (data41>=(data41awal+ValueTerang)) then stp41:=2; {detek putih tampil hitam}

 if (data42>=(data42awal-ValueKosong)) and (data42<=(data42awal+ValueKosong))
then stp42:=0;
 if (data42<=(data42awal-ValueGelap)) then stp42:=1;  {detek hitam tampil putih}
 if (data42>=(data42awal+ValueTerang)) then stp42:=2; {detek putih tampil hitam}

 if (data43>=(data43awal-ValueKosong)) and (data43<=(data43awal+ValueKosong))
then stp43:=0;
 if (data43<=(data43awal-ValueGelap)) then stp43:=1;  {detek hitam tampil putih}
 if (data43>=(data43awal+ValueTerang)) then stp43:=2; {detek putih tampil hitam}

 if (data44>=(data44awal-ValueKosong)) and (data44<=(data44awal+ValueKosong))
then stp44:=0;
 if (data44<=(data44awal-ValueGelap)) then stp44:=1;  {detek hitam tampil putih}
 if (data44>=(data44awal+ValueTerang)) then stp44:=2; {detek putih tampil hitam}

 if (data45>=(data45awal-ValueKosong)) and (data45<=(data45awal+ValueKosong))
then stp45:=0;
 if (data45<=(data45awal-ValueGelap)) then stp45:=1;  {detek hitam tampil putih}
 if (data45>=(data45awal+ValueTerang)) then stp45:=2; {detek putih tampil hitam}

 if (data46>=(data46awal-ValueKosong)) and (data46<=(data46awal+ValueKosong))
then stp46:=0;
 if (data46<=(data46awal-ValueGelap)) then stp46:=1;  {detek hitam tampil putih}
 if (data46>=(data46awal+ValueTerang)) then stp46:=2; {detek putih tampil hitam}

 if (data47>=(data47awal-ValueKosong)) and (data47<=(data47awal+ValueKosong))
then stp47:=0;
 if (data47<=(data47awal-ValueGelap)) then stp47:=1;  {detek hitam tampil putih}
 if (data47>=(data47awal+ValueTerang)) then stp47:=2; {detek putih tampil hitam}

 if (data48>=(data48awal-ValueKosong)) and (data48<=(data48awal+ValueKosong))
then stp48:=0;
 if (data48<=(data48awal-ValueGelap)) then stp48:=1;  {detek hitam tampil putih}
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 if (data48>=(data48awal+ValueTerang)) then stp48:=2; {detek putih tampil hitam}

{5=============================================================
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 if (data51>=(data51awal-ValueKosong)) and (data51<=(data51awal+ValueKosong))
then stp51:=0;
 if (data51<=(data51awal-ValueGelap)) then stp51:=1;  {detek hitam tampil putih}
 if (data51>=(data51awal+ValueTerang)) then stp51:=2; {detek putih tampil hitam}

 if (data52>=(data52awal-ValueKosong)) and (data52<=(data52awal+ValueKosong))
then stp52:=0;
 if (data52<=(data52awal-ValueGelap)) then stp52:=1;  {detek hitam tampil putih}
 if (data52>=(data52awal+ValueTerang)) then stp52:=2; {detek putih tampil hitam}

 if (data53>=(data53awal-ValueKosong)) and (data53<=(data53awal+ValueKosong))
then stp53:=0;
 if (data53<=(data53awal-ValueGelap)) then stp53:=1;  {detek hitam tampil putih}
 if (data53>=(data53awal+ValueTerang)) then stp53:=2; {detek putih tampil hitam}

 if (data54>=(data54awal-ValueKosong)) and (data54<=(data54awal+ValueKosong))
then stp54:=0;
 if (data54<=(data54awal-ValueGelap)) then stp54:=1;  {detek hitam tampil putih}
 if (data54>=(data54awal+ValueTerang)) then stp54:=2; {detek putih tampil hitam}

 if (data55>=(data55awal-ValueKosong)) and (data55<=(data55awal+ValueKosong))
then stp55:=0;
 if (data55<=(data55awal-ValueGelap)) then stp55:=1;  {detek hitam tampil putih}
 if (data55>=(data55awal+ValueTerang)) then stp55:=2; {detek putih tampil hitam}

 if (data56>=(data56awal-ValueKosong)) and (data56<=(data56awal+ValueKosong))
then stp56:=0;
 if (data56<=(data56awal-ValueGelap)) then stp56:=1;  {detek hitam tampil putih}
 if (data56>=(data56awal+ValueTerang)) then stp56:=2; {detek putih tampil hitam}

 if (data57>=(data57awal-ValueKosong)) and (data57<=(data57awal+ValueKosong))
then stp57:=0;
 if (data57<=(data57awal-ValueGelap)) then stp57:=1;  {detek hitam tampil putih}
 if (data57>=(data57awal+ValueTerang)) then stp57:=2; {detek putih tampil hitam}

 if (data58>=(data58awal-ValueKosong)) and (data58<=(data58awal+ValueKosong))
then stp58:=0;
 if (data58<=(data58awal-ValueGelap)) then stp58:=1;  {detek hitam tampil putih}
 if (data58>=(data58awal+ValueTerang)) then stp58:=2; {detek putih tampil hitam}

{6=============================================================
============}
 if (data61>=(data61awal-ValueKosong)) and (data61<=(data61awal+ValueKosong))
then stp61:=0;
 if (data61<=(data61awal-ValueGelap)) then stp61:=1;  {detek hitam tampil putih}
 if (data61>=(data61awal+ValueTerang)) then stp61:=2; {detek putih tampil hitam}
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 if (data62>=(data62awal-ValueKosong)) and (data62<=(data62awal+ValueKosong))
then stp62:=0;
 if (data62<=(data62awal-ValueGelap)) then stp62:=1;  {detek hitam tampil putih}
 if (data62>=(data62awal+ValueTerang)) then stp62:=2; {detek putih tampil hitam}

 if (data63>=(data63awal-ValueKosong)) and (data63<=(data63awal+ValueKosong))
then stp63:=0;
 if (data63<=(data63awal-ValueGelap)) then stp63:=1;  {detek hitam tampil putih}
 if (data63>=(data63awal+ValueTerang)) then stp63:=2; {detek putih tampil hitam}

 if (data64>=(data64awal-ValueKosong)) and (data64<=(data64awal+ValueKosong))
then stp64:=0;
 if (data64<=(data64awal-ValueGelap)) then stp64:=1;  {detek hitam tampil putih}
 if (data64>=(data64awal+ValueTerang)) then stp64:=2; {detek putih tampil hitam}

 if (data65>=(data65awal-ValueKosong)) and (data65<=(data65awal+ValueKosong))
then stp65:=0;
 if (data65<=(data65awal-ValueGelap)) then stp65:=1;  {detek hitam tampil putih}
 if (data65>=(data65awal+ValueTerang)) then stp65:=2; {detek putih tampil hitam}

 if (data66>=(data66awal-ValueKosong)) and (data66<=(data66awal+ValueKosong))
then stp66:=0;
 if (data66<=(data66awal-ValueGelap)) then stp66:=1;  {detek hitam tampil putih}
 if (data66>=(data66awal+ValueTerang)) then stp66:=2; {detek putih tampil hitam}

 if (data67>=(data67awal-ValueKosong)) and (data67<=(data67awal+ValueKosong))
then stp67:=0;
 if (data67<=(data67awal-ValueGelap)) then stp67:=1;  {detek hitam tampil putih}
 if (data67>=(data67awal+ValueTerang)) then stp67:=2; {detek putih tampil hitam}

 if (data68>=(data68awal-ValueKosong)) and (data68<=(data68awal+ValueKosong))
then stp68:=0;
 if (data68<=(data68awal-ValueGelap)) then stp68:=1;  {detek hitam tampil putih}
 if (data68>=(data68awal+ValueTerang)) then stp68:=2; {detek putih tampil hitam}


{7=============================================================
============}
 if (data71>=(data71awal-ValueKosong)) and (data71<=(data71awal+ValueKosong))
then stp71:=0;
 if (data71<=(data71awal-ValueGelap)) then stp71:=1;  {detek hitam tampil putih}
 if (data71>=(data71awal+ValueTerang)) then stp71:=2; {detek putih tampil hitam}

 if (data72>=(data72awal-ValueKosong)) and (data72<=(data72awal+ValueKosong))
then stp72:=0;
 if (data72<=(data72awal-ValueGelap)) then stp72:=1;  {detek hitam tampil putih}
 if (data72>=(data72awal+ValueTerang)) then stp72:=2; {detek putih tampil hitam}
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 if (data73>=(data73awal-ValueKosong)) and (data73<=(data73awal+ValueKosong))
then stp73:=0;
 if (data73<=(data73awal-ValueGelap)) then stp73:=1;  {detek hitam tampil putih}
 if (data73>=(data73awal+ValueTerang)) then stp73:=2; {detek putih tampil hitam}

 if (data74>=(data74awal-ValueKosong)) and (data74<=(data74awal+ValueKosong))
then stp74:=0;
 if (data74<=(data74awal-ValueGelap)) then stp74:=1;  {detek hitam tampil putih}
 if (data74>=(data74awal+ValueTerang)) then stp74:=2; {detek putih tampil hitam}

 if (data75>=(data75awal-ValueKosong)) and (data75<=(data75awal+ValueKosong))
then stp75:=0;
 if (data75<=(data75awal-ValueGelap)) then stp75:=1;  {detek hitam tampil putih}
 if (data75>=(data75awal+ValueTerang)) then stp75:=2; {detek putih tampil hitam}

 if (data76>=(data76awal-ValueKosong)) and (data76<=(data76awal+ValueKosong))
then stp76:=0;
 if (data76<=(data76awal-ValueGelap)) then stp76:=1;  {detek hitam tampil putih}
 if (data76>=(data76awal+ValueTerang)) then stp76:=2; {detek putih tampil hitam}

 if (data77>=(data77awal-ValueKosong)) and (data77<=(data77awal+ValueKosong))
then stp77:=0;
 if (data77<=(data77awal-ValueGelap)) then stp77:=1;  {detek hitam tampil putih}
 if (data77>=(data77awal+ValueTerang)) then stp77:=2; {detek putih tampil hitam}

 if (data78>=(data78awal-ValueKosong)) and (data78<=(data78awal+ValueKosong))
then stp78:=0;
 if (data78<=(data78awal-ValueGelap)) then stp78:=1;  {detek hitam tampil putih}
 if (data78>=(data78awal+ValueTerang)) then stp78:=2; {detek putih tampil hitam}

{8=============================================================
============}
 if (data81>=(data81awal-ValueKosong)) and (data81<=(data81awal+ValueKosong))
then stp81:=0;
 if (data81<=(data81awal-ValueGelap)) then stp81:=1;  {detek hitam tampil putih}
 if (data81>=(data81awal+ValueTerang)) then stp81:=2; {detek putih tampil hitam}

 if (data82>=(data82awal-ValueKosong)) and (data82<=(data82awal+ValueKosong))
then stp82:=0;
 if (data82<=(data82awal-ValueGelap)) then stp82:=1;  {detek hitam tampil putih}
 if (data82>=(data82awal+ValueTerang)) then stp82:=2; {detek putih tampil hitam}

 if (data83>=(data83awal-ValueKosong)) and (data83<=(data83awal+ValueKosong))
then stp83:=0;
 if (data83<=(data83awal-ValueGelap)) then stp83:=1;  {detek hitam tampil putih}
 if (data83>=(data83awal+ValueTerang)) then stp83:=2; {detek putih tampil hitam}

 if (data84>=(data84awal-ValueKosong)) and (data84<=(data84awal+ValueKosong))
then stp84:=0;
 if (data84<=(data84awal-ValueGelap)) then stp84:=1;  {detek hitam tampil putih}
```

```
 if (data84>=(data84awal+ValueTerang)) then stp84:=2; {detek putih tampil hitam}

 if (data85>=(data85awal-ValueKosong)) and (data85<=(data85awal+ValueKosong))
then stp85:=0;
 if (data85<=(data85awal-ValueGelap)) then stp85:=1;  {detek hitam tampil putih}
 if (data85>=(data85awal+ValueTerang)) then stp85:=2; {detek putih tampil hitam}

 if (data86>=(data86awal-ValueKosong)) and (data86<=(data86awal+ValueKosong))
then stp86:=0;
 if (data86<=(data86awal-ValueGelap)) then stp86:=1;  {detek hitam tampil putih}
 if (data86>=(data86awal+ValueTerang)) then stp86:=2; {detek putih tampil hitam}

 if (data87>=(data87awal-ValueKosong)) and (data87<=(data87awal+ValueKosong))
then stp87:=0;
 if (data87<=(data87awal-ValueGelap)) then stp87:=1;  {detek hitam tampil putih}
 if (data87>=(data87awal+ValueTerang)) then stp87:=2; {detek putih tampil hitam}


 if (data88>=(data88awal-ValueKosong)) and (data88<=(data88awal+ValueKosong))
then stp88:=0;
 if (data88<=(data88awal-ValueGelap)) then stp88:=1;  {detek hitam tampil putih}
 if (data88>=(data88awal+ValueTerang)) then stp88:=2; {detek putih tampil hitam}

end;


procedure TForm1.Timer1Timer(Sender: TObject);
begin
ValueKosong:=Strtoint(Edit1.Text);
ValueGelap:=Strtoint(Edit2.Text);
ValueTerang:=Strtoint(Edit3.Text);

datars232:=com.read;
if length(datars232)>17 then
begin
 if copy(datars232,1,1)='B' then
 begin
   if copy(datars232,2,1)='1' then
   begin
     data14:=(ord(datars232[3]));
     data14:=data14+(ord(datars232[4]));
     data13:=(ord(datars232[5]));
     data13:=data13+(ord(datars232[6]));
     data12:=(ord(datars232[7]));
     data12:=data12+(ord(datars232[8]));
     data11:=(ord(datars232[9]));
     data11:=data11+(ord(datars232[10]));
     data15:=(ord(datars232[11]));
     data15:=data15+(ord(datars232[12]));
     data16:=(ord(datars232[13]));
```

```
    data16:=data16+(ord(datars232[14]));
    data17:=(ord(datars232[15]));
    data17:=data17+(ord(datars232[16]));
    data18:=(ord(datars232[17]));
    data18:=data18+(ord(datars232[18]));

    panel1.caption:=inttostr(data11)+' '+inttostr(data12)+' '+inttostr(data13)+'
'+inttostr(data14)+' '+
    inttostr(data15)+' '+inttostr(data16)+' '+inttostr(data17)+' '+inttostr(data18)+' ';


  end;
  if copy(datars232,2,1)='2' then
  begin
    data24:=(ord(datars232[3]));
    data24:=data24+(ord(datars232[4]));
    data23:=(ord(datars232[5]));
    data23:=data23+(ord(datars232[6]));
    data22:=(ord(datars232[7]));
    data22:=data22+(ord(datars232[8]));
    data21:=(ord(datars232[9]));
    data21:=data21+(ord(datars232[10]));
    data25:=(ord(datars232[11]));
    data25:=data25+(ord(datars232[12]));
    data26:=(ord(datars232[13]));
    data26:=data26+(ord(datars232[14]));
    data27:=(ord(datars232[15]));
    data27:=data27+(ord(datars232[16]));
    data28:=(ord(datars232[17]));
    data28:=data28+(ord(datars232[18]));

    panel2.caption:=inttostr(data21)+' '+inttostr(data22)+' '+inttostr(data23)+'
'+inttostr(data24)+' '+
    inttostr(data25)+' '+inttostr(data26)+' '+inttostr(data27)+' '+inttostr(data28)+' ';


  end;
  if copy(datars232,2,1)='3' then
  begin
    data34:=(ord(datars232[3]));
    data34:=data34+(ord(datars232[4]));
    data33:=(ord(datars232[5]));
    data33:=data33+(ord(datars232[6]));
    data32:=(ord(datars232[7]));
    data32:=data32+(ord(datars232[8]));
    data31:=(ord(datars232[9]));
    data31:=data31+(ord(datars232[10]));
    data35:=(ord(datars232[11]));
    data35:=data35+(ord(datars232[12]));
    data36:=(ord(datars232[13]));
```

```
    data36:=data36+(ord(datars232[14]));
    data37:=(ord(datars232[15]));
    data37:=data37+(ord(datars232[16]));
    data38:=(ord(datars232[17]));
    data38:=data38+(ord(datars232[18]));

    panel3.caption:=inttostr(data31)+' '+inttostr(data32)+' '+inttostr(data33)+'
'+inttostr(data34)+' '+
    inttostr(data35)+' '+inttostr(data36)+' '+inttostr(data37)+' '+inttostr(data38)+' ';

  end;
  if copy(datars232,2,1)='4' then
  begin
    data44:=(ord(datars232[3]));
    data44:=data44+(ord(datars232[4]));
    data43:=(ord(datars232[5]));
    data43:=data43+(ord(datars232[6]));
    data42:=(ord(datars232[7]));
    data42:=data42+(ord(datars232[8]));
    data41:=(ord(datars232[9]));
    data41:=data41+(ord(datars232[10]));
    data45:=(ord(datars232[11]));
    data45:=data45+(ord(datars232[12]));
    data46:=(ord(datars232[13]));
    data46:=data46+(ord(datars232[14]));
    data47:=(ord(datars232[15]));
    data47:=data47+(ord(datars232[16]));
    data48:=(ord(datars232[17]));
    data48:=data48+(ord(datars232[18]));

    panel4.caption:=inttostr(data41)+' '+inttostr(data42)+' '+inttostr(data43)+'
'+inttostr(data44)+' '+
    inttostr(data45)+' '+inttostr(data46)+' '+inttostr(data47)+' '+inttostr(data48)+' ';
  end;
  if copy(datars232,2,1)='5' then
  begin
    data54:=(ord(datars232[3]));
    data54:=data54+(ord(datars232[4]));
    data53:=(ord(datars232[5]));
    data53:=data53+(ord(datars232[6]));
    data52:=(ord(datars232[7]));
    data52:=data52+(ord(datars232[8]));
    data51:=(ord(datars232[9]));
    data51:=data51+(ord(datars232[10]));
    data55:=(ord(datars232[11]));
    data55:=data55+(ord(datars232[12]));
    data56:=(ord(datars232[13]));
    data56:=data56+(ord(datars232[14]));
    data57:=(ord(datars232[15]));
    data57:=data57+(ord(datars232[16]));
```

```
    data58:=(ord(datars232[17]));
    data58:=data58+(ord(datars232[18]));

    panel5.caption:=inttostr(data51)+' '+inttostr(data52)+' '+inttostr(data53)+'
'+inttostr(data54)+' '+
    inttostr(data55)+' '+inttostr(data56)+' '+inttostr(data57)+' '+inttostr(data58)+' ';
  end;
  if copy(datars232,2,1)='6' then
  begin
    data64:=(ord(datars232[3]));
    data64:=data64+(ord(datars232[4]));
    data63:=(ord(datars232[5]));
    data63:=data63+(ord(datars232[6]));
    data62:=(ord(datars232[7]));
    data62:=data62+(ord(datars232[8]));
    data61:=(ord(datars232[9]));
    data61:=data61+(ord(datars232[10]));
    data65:=(ord(datars232[11]));
    data65:=data65+(ord(datars232[12]));
    data66:=(ord(datars232[13]));
    data66:=data66+(ord(datars232[14]));
    data67:=(ord(datars232[15]));
    data67:=data67+(ord(datars232[16]));
    data68:=(ord(datars232[17]));
    data68:=data68+(ord(datars232[18]));

    panel6.caption:=inttostr(data61)+' '+inttostr(data62)+' '+inttostr(data63)+'
'+inttostr(data64)+' '+
    inttostr(data65)+' '+inttostr(data66)+' '+inttostr(data67)+' '+inttostr(data68)+' ';
  end;
  if copy(datars232,2,1)='7' then
  begin
    data74:=(ord(datars232[3]));
    data74:=data74+(ord(datars232[4]));
    data73:=(ord(datars232[5]));
    data73:=data73+(ord(datars232[6]));
    data72:=(ord(datars232[7]));
    data72:=data72+(ord(datars232[8]));
    data71:=(ord(datars232[9]));
    data71:=data71+(ord(datars232[10]));
    data75:=(ord(datars232[11]));
    data75:=data75+(ord(datars232[12]));
    data76:=(ord(datars232[13]));
    data76:=data76+(ord(datars232[14]));
    data77:=(ord(datars232[15]));
    data77:=data77+(ord(datars232[16]));
    data78:=(ord(datars232[17]));
    data78:=data78+(ord(datars232[18]));
```

```
    panel7.caption:=inttostr(data71)+' '+inttostr(data72)+' '+inttostr(data73)+'
'+inttostr(data74)+' '+
    inttostr(data75)+' '+inttostr(data76)+' '+inttostr(data77)+' '+inttostr(data78)+' ';
  end;
  if copy(datars232,2,1)='8' then
  begin
    data84:=(ord(datars232[3]));
    data84:=data84+(ord(datars232[4]));
    data83:=(ord(datars232[5]));
    data83:=data83+(ord(datars232[6]));
    data82:=(ord(datars232[7]));
    data82:=data82+(ord(datars232[8]));
    data81:=(ord(datars232[9]));
    data81:=data81+(ord(datars232[10]));
    data85:=(ord(datars232[11]));
    data85:=data85+(ord(datars232[12]));
    data86:=(ord(datars232[13]));
    data86:=data86+(ord(datars232[14]));
    data87:=(ord(datars232[15]));
    data87:=data87+(ord(datars232[16]));
    data88:=(ord(datars232[17]));
    data88:=data88+(ord(datars232[18]));

    panel8.caption:=inttostr(data81)+' '+inttostr(data82)+' '+inttostr(data83)+'
'+inttostr(data84)+' '+
    inttostr(data85)+' '+inttostr(data86)+' '+inttostr(data87)+' '+inttostr(data88)+' ';
  end;
 end;
end;

cekwarna;


{0=kosong 1=putih 2=hitam}
{baris ke 1}
if stp11=0 then p11.backcolor:=clAqua;
if stp11=1 then p11.backcolor:=clwhite;
if stp11=2 then p11.backcolor:=clblack;

if stp12=0 then p12.backcolor:=clAqua;
if stp12=1 then p12.backcolor:=clwhite;
if stp12=2 then p12.backcolor:=clblack;

if stp13=0 then p13.backcolor:=clAqua;
if stp13=1 then p13.backcolor:=clwhite;
if stp13=2 then p13.backcolor:=clblack;

if stp14=0 then p14.backcolor:=clAqua;
if stp14=1 then p14.backcolor:=clwhite;
if stp14=2 then p14.backcolor:=clblack;
```

```
if stp15=0 then p15.backcolor:=clAqua;
if stp15=1 then p15.backcolor:=clwhite;
if stp15=2 then p15.backcolor:=clblack;

if stp16=0 then p16.backcolor:=clAqua;
if stp16=1 then p16.backcolor:=clwhite;
if stp16=2 then p16.backcolor:=clblack;

if stp17=0 then p17.backcolor:=clAqua;
if stp17=1 then p17.backcolor:=clwhite;
if stp17=2 then p17.backcolor:=clblack;

if stp18=0 then p18.backcolor:=clAqua;
if stp18=1 then p18.backcolor:=clwhite;
if stp18=2 then p18.backcolor:=clblack;

{baris ke 2}
if stp21=0 then p21.backcolor:=clAqua;
if stp21=1 then p21.backcolor:=clwhite;
if stp21=2 then p21.backcolor:=clblack;

if stp22=0 then p22.backcolor:=clAqua;
if stp22=1 then p22.backcolor:=clwhite;
if stp22=2 then p22.backcolor:=clblack;

if stp23=0 then p23.backcolor:=clAqua;
if stp23=1 then p23.backcolor:=clwhite;
if stp23=2 then p23.backcolor:=clblack;

if stp24=0 then p24.backcolor:=clAqua;
if stp24=1 then p24.backcolor:=clwhite;
if stp24=2 then p24.backcolor:=clblack;

if stp25=0 then p25.backcolor:=clAqua;
if stp25=1 then p25.backcolor:=clwhite;
if stp25=2 then p25.backcolor:=clblack;

if stp26=0 then p26.backcolor:=clAqua;
if stp26=1 then p26.backcolor:=clwhite;
if stp26=2 then p26.backcolor:=clblack;

if stp27=0 then p27.backcolor:=clAqua;
if stp27=1 then p27.backcolor:=clwhite;
if stp27=2 then p27.backcolor:=clblack;

if stp28=0 then p28.backcolor:=clAqua;
if stp28=1 then p28.backcolor:=clwhite;
if stp28=2 then p28.backcolor:=clblack;
```

```
{baris ke 3}
if stp31=0 then p31.backcolor:=clAqua;
if stp31=1 then p31.backcolor:=clwhite;
if stp31=2 then p31.backcolor:=clblack;

if stp32=0 then p32.backcolor:=clAqua;
if stp32=1 then p32.backcolor:=clwhite;
if stp32=2 then p32.backcolor:=clblack;

if stp33=0 then p33.backcolor:=clAqua;
if stp33=1 then p33.backcolor:=clwhite;
if stp33=2 then p33.backcolor:=clblack;

if stp34=0 then p34.backcolor:=clAqua;
if stp34=1 then p34.backcolor:=clwhite;
if stp34=2 then p34.backcolor:=clblack;

if stp35=0 then p35.backcolor:=clAqua;
if stp35=1 then p35.backcolor:=clwhite;
if stp35=2 then p35.backcolor:=clblack;

if stp36=0 then p36.backcolor:=clAqua;
if stp36=1 then p36.backcolor:=clwhite;
if stp36=2 then p36.backcolor:=clblack;

if stp37=0 then p37.backcolor:=clAqua;
if stp37=1 then p37.backcolor:=clwhite;
if stp37=2 then p37.backcolor:=clblack;

if stp38=0 then p38.backcolor:=clAqua;
if stp38=1 then p38.backcolor:=clwhite;
if stp38=2 then p38.backcolor:=clblack;


{baris ke 4}
if stp41=0 then p41.backcolor:=clAqua;
if stp41=1 then p41.backcolor:=clwhite;
if stp41=2 then p41.backcolor:=clblack;

if stp42=0 then p42.backcolor:=clAqua;
if stp42=1 then p42.backcolor:=clwhite;
if stp42=2 then p42.backcolor:=clblack;

if stp43=0 then p43.backcolor:=clAqua;
if stp43=1 then p43.backcolor:=clwhite;
if stp43=2 then p43.backcolor:=clblack;

if stp44=0 then p44.backcolor:=clAqua;
if stp44=1 then p44.backcolor:=clwhite;
```

```
if stp44=2 then p44.backcolor:=clblack;

if stp45=0 then p45.backcolor:=clAqua;
if stp45=1 then p45.backcolor:=clwhite;
if stp45=2 then p45.backcolor:=clblack;

if stp46=0 then p46.backcolor:=clAqua;
if stp46=1 then p46.backcolor:=clwhite;
if stp46=2 then p46.backcolor:=clblack;

if stp47=0 then p47.backcolor:=clAqua;
if stp47=1 then p47.backcolor:=clwhite;
if stp47=2 then p47.backcolor:=clblack;

if stp48=0 then p48.backcolor:=clAqua;
if stp48=1 then p48.backcolor:=clwhite;
if stp48=2 then p48.backcolor:=clblack;


{baris ke 5}
if stp51=0 then p51.backcolor:=clAqua;
if stp51=1 then p51.backcolor:=clwhite;
if stp51=2 then p51.backcolor:=clblack;

if stp52=0 then p52.backcolor:=clAqua;
if stp52=1 then p52.backcolor:=clwhite;
if stp52=2 then p52.backcolor:=clblack;

if stp53=0 then p53.backcolor:=clAqua;
if stp53=1 then p53.backcolor:=clwhite;
if stp53=2 then p53.backcolor:=clblack;

if stp54=0 then p54.backcolor:=clAqua;
if stp54=1 then p54.backcolor:=clwhite;
if stp54=2 then p54.backcolor:=clblack;

if stp55=0 then p55.backcolor:=clAqua;
if stp55=1 then p55.backcolor:=clwhite;
if stp55=2 then p55.backcolor:=clblack;

if stp56=0 then p56.backcolor:=clAqua;
if stp56=1 then p56.backcolor:=clwhite;
if stp56=2 then p56.backcolor:=clblack;

if stp57=0 then p57.backcolor:=clAqua;
if stp57=1 then p57.backcolor:=clwhite;
if stp57=2 then p57.backcolor:=clblack;

if stp58=0 then p58.backcolor:=clAqua;
if stp58=1 then p58.backcolor:=clwhite;
```

```
if stp58=2 then p58.backcolor:=clblack;


{baris ke 6}
if stp61=0 then p61.backcolor:=clAqua;
if stp61=1 then p61.backcolor:=clwhite;
if stp61=2 then p61.backcolor:=clblack;

if stp62=0 then p62.backcolor:=clAqua;
if stp62=1 then p62.backcolor:=clwhite;
if stp62=2 then p62.backcolor:=clblack;

if stp63=0 then p63.backcolor:=clAqua;
if stp63=1 then p63.backcolor:=clwhite;
if stp63=2 then p63.backcolor:=clblack;

if stp64=0 then p64.backcolor:=clAqua;
if stp64=1 then p64.backcolor:=clwhite;
if stp64=2 then p64.backcolor:=clblack;

if stp65=0 then p65.backcolor:=clAqua;
if stp65=1 then p65.backcolor:=clwhite;
if stp65=2 then p65.backcolor:=clblack;

if stp66=0 then p66.backcolor:=clAqua;
if stp66=1 then p66.backcolor:=clwhite;
if stp66=2 then p66.backcolor:=clblack;

if stp67=0 then p67.backcolor:=clAqua;
if stp67=1 then p67.backcolor:=clwhite;
if stp67=2 then p67.backcolor:=clblack;

if stp68=0 then p68.backcolor:=clAqua;
if stp68=1 then p68.backcolor:=clwhite;
if stp68=2 then p68.backcolor:=clblack;


{baris ke 7}
if stp71=0 then p71.backcolor:=clAqua;
if stp71=1 then p71.backcolor:=clwhite;
if stp71=2 then p71.backcolor:=clblack;

if stp72=0 then p72.backcolor:=clAqua;
if stp72=1 then p72.backcolor:=clwhite;
if stp72=2 then p72.backcolor:=clblack;

if stp73=0 then p73.backcolor:=clAqua;
if stp73=1 then p73.backcolor:=clwhite;
if stp73=2 then p73.backcolor:=clblack;
```

```
if stp74=0 then p74.backcolor:=clAqua;
if stp74=1 then p74.backcolor:=clwhite;
if stp74=2 then p74.backcolor:=clblack;

if stp75=0 then p75.backcolor:=clAqua;
if stp75=1 then p75.backcolor:=clwhite;
if stp75=2 then p75.backcolor:=clblack;

if stp76=0 then p76.backcolor:=clAqua;
if stp76=1 then p76.backcolor:=clwhite;
if stp76=2 then p76.backcolor:=clblack;

if stp77=0 then p77.backcolor:=clAqua;
if stp77=1 then p77.backcolor:=clwhite;
if stp77=2 then p77.backcolor:=clblack;

if stp78=0 then p78.backcolor:=clAqua;
if stp78=1 then p78.backcolor:=clwhite;
if stp78=2 then p78.backcolor:=clblack;

{baris ke 8}
if stp81=0 then p81.backcolor:=clAqua;
if stp81=1 then p81.backcolor:=clwhite;
if stp81=2 then p81.backcolor:=clblack;

if stp82=0 then p82.backcolor:=clAqua;
if stp82=1 then p82.backcolor:=clwhite;
if stp82=2 then p82.backcolor:=clblack;

if stp83=0 then p83.backcolor:=clAqua;
if stp83=1 then p83.backcolor:=clwhite;
if stp83=2 then p83.backcolor:=clblack;

if stp84=0 then p84.backcolor:=clAqua;
if stp84=1 then p84.backcolor:=clwhite;
if stp84=2 then p84.backcolor:=clblack;

if stp85=0 then p85.backcolor:=clAqua;
if stp85=1 then p85.backcolor:=clwhite;
if stp85=2 then p85.backcolor:=clblack;

if stp86=0 then p86.backcolor:=clAqua;
if stp86=1 then p86.backcolor:=clwhite;
if stp86=2 then p86.backcolor:=clblack;

if stp87=0 then p87.backcolor:=clAqua;
if stp87=1 then p87.backcolor:=clwhite;
if stp87=2 then p87.backcolor:=clblack;

if stp88=0 then p88.backcolor:=clAqua;
```

```
if stp88=1 then p88.backcolor:=clwhite;
if stp88=2 then p88.backcolor:=clblack;


end;

procedure TForm1.Timer2Timer(Sender: TObject);
begin
datars232:=com.read;
hitung:=hitung+1;
if hitung=40 then
begin
 timer2.Enabled:=false;
 timer1.enabled:=true;
 pkalibrasi.Visible:=false;
end;
if length(datars232)>17 then
begin
 if copy(datars232,1,1)='B' then
 begin
   if copy(datars232,2,1)='1' then
   begin
     data14awal:=(ord(datars232[3]));
     data14awal:=data14awal+(ord(datars232[4]));
     data13awal:=(ord(datars232[5]));
     data13awal:=data13awal+(ord(datars232[6]));
     data12awal:=(ord(datars232[7]));
     data12awal:=data12awal+(ord(datars232[8]));
     data11awal:=(ord(datars232[9]));
     data11awal:=data11awal+(ord(datars232[10]));
     data15awal:=(ord(datars232[11]));
     data15awal:=data15awal+(ord(datars232[12]));
     data16awal:=(ord(datars232[13]));
     data16awal:=data16awal+(ord(datars232[14]));
     data17awal:=(ord(datars232[15]));
     data17awal:=data17awal+(ord(datars232[16]));
     data18awal:=(ord(datars232[17]));
     data18awal:=data18awal+(ord(datars232[18]));

     panel1.caption:=inttostr(data11)+' '+inttostr(data12)+' '+inttostr(data13)+'
'+inttostr(data14)+' '+
     inttostr(data15)+' '+inttostr(data16)+' '+inttostr(data17)+' '+inttostr(data18)+' ';
   end;
   if copy(datars232,2,1)='2' then
   begin
     data24awal:=(ord(datars232[3]));
     data24awal:=data24awal+(ord(datars232[4]));
     data23awal:=(ord(datars232[5]));
     data23awal:=data23awal+(ord(datars232[6]));
     data22awal:=(ord(datars232[7]));
```

```
    data22awal:=data22awal+(ord(datars232[8]));
    data21awal:=(ord(datars232[9]));
    data21awal:=data21awal+(ord(datars232[10]));
    data25awal:=(ord(datars232[11]));
    data25awal:=data25awal+(ord(datars232[12]));
    data26awal:=(ord(datars232[13]));
    data26awal:=data26awal+(ord(datars232[14]));
    data27awal:=(ord(datars232[15]));
    data27awal:=data27awal+(ord(datars232[16]));
    data28awal:=(ord(datars232[17]));
    data28awal:=data28awal+(ord(datars232[18]));

    panel2.caption:=inttostr(data21)+' '+inttostr(data22)+' '+inttostr(data23)+'
'+inttostr(data24)+' '+
    inttostr(data25)+' '+inttostr(data26)+' '+inttostr(data27)+' '+inttostr(data28)+' ';

  end;
  if copy(datars232,2,1)='3' then
  begin
    data34awal:=(ord(datars232[3]));
    data34awal:=data34awal+(ord(datars232[4]));
    data33awal:=(ord(datars232[5]));
    data33awal:=data33awal+(ord(datars232[6]));
    data32awal:=(ord(datars232[7]));
    data32awal:=data32awal+(ord(datars232[8]));
    data31awal:=(ord(datars232[9]));
    data31awal:=data31awal+(ord(datars232[10]));
    data35awal:=(ord(datars232[11]));
    data35awal:=data35awal+(ord(datars232[12]));
    data36awal:=(ord(datars232[13]));
    data36awal:=data36awal+(ord(datars232[14]));
    data37awal:=(ord(datars232[15]));
    data37awal:=data37awal+(ord(datars232[16]));
    data38awal:=(ord(datars232[17]));
    data38awal:=data38awal+(ord(datars232[18]));

    panel3.caption:=inttostr(data31)+' '+inttostr(data32)+' '+inttostr(data33)+'
'+inttostr(data34)+' '+
    inttostr(data35)+' '+inttostr(data36)+' '+inttostr(data37)+' '+inttostr(data38)+' ';
  end;
  if copy(datars232,2,1)='4' then
  begin
    data44awal:=(ord(datars232[3]));
    data44awal:=data44awal+(ord(datars232[4]));
    data43awal:=(ord(datars232[5]));
    data43awal:=data43awal+(ord(datars232[6]));
    data42awal:=(ord(datars232[7]));
    data42awal:=data42awal+(ord(datars232[8]));
    data41awal:=(ord(datars232[9]));
    data41awal:=data41awal+(ord(datars232[10]));
```

```
    data45awal:=(ord(datars232[11]));
    data45awal:=data45awal+(ord(datars232[12]));
    data46awal:=(ord(datars232[13]));
    data46awal:=data46awal+(ord(datars232[14]));
    data47awal:=(ord(datars232[15]));
    data47awal:=data47awal+(ord(datars232[16]));
    data48awal:=(ord(datars232[17]));
    data48awal:=data48awal+(ord(datars232[18]));

    panel4.caption:=inttostr(data41)+' '+inttostr(data42)+' '+inttostr(data43)+'
'+inttostr(data44)+' '+
    inttostr(data45)+' '+inttostr(data46)+' '+inttostr(data47)+' '+inttostr(data48)+' ';
  end;
  if copy(datars232,2,1)='5' then
  begin
    data54awal:=(ord(datars232[3]));
    data54awal:=data54awal+(ord(datars232[4]));
    data53awal:=(ord(datars232[5]));
    data53awal:=data53awal+(ord(datars232[6]));
    data52awal:=(ord(datars232[7]));
    data52awal:=data52awal+(ord(datars232[8]));
    data51awal:=(ord(datars232[9]));
    data51awal:=data51awal+(ord(datars232[10]));
    data55awal:=(ord(datars232[11]));
    data55awal:=data55awal+(ord(datars232[12]));
    data56awal:=(ord(datars232[13]));
    data56awal:=data56awal+(ord(datars232[14]));
    data57awal:=(ord(datars232[15]));
    data57awal:=data57awal+(ord(datars232[16]));
    data58awal:=(ord(datars232[17]));
    data58awal:=data58awal+(ord(datars232[18]));

    panel5.caption:=inttostr(data51)+' '+inttostr(data52)+' '+inttostr(data53)+'
'+inttostr(data54)+' '+
    inttostr(data55)+' '+inttostr(data56)+' '+inttostr(data57)+' '+inttostr(data58)+' ';
  end;
  if copy(datars232,2,1)='6' then
  begin
    data64awal:=(ord(datars232[3]));
    data64awal:=data64awal+(ord(datars232[4]));
    data63awal:=(ord(datars232[5]));
    data63awal:=data63awal+(ord(datars232[6]));
    data62awal:=(ord(datars232[7]));
    data62awal:=data62awal+(ord(datars232[8]));
    data61awal:=(ord(datars232[9]));
    data61awal:=data61awal+(ord(datars232[10]));
    data65awal:=(ord(datars232[11]));
    data65awal:=data65awal+(ord(datars232[12]));
    data66awal:=(ord(datars232[13]));
    data66awal:=data66awal+(ord(datars232[14]));
```

```
    data67awal:=(ord(datars232[15]));
    data67awal:=data67awal+(ord(datars232[16]));
    data68awal:=(ord(datars232[17]));
    data68awal:=data68awal+(ord(datars232[18]));

    panel6.caption:=inttostr(data61)+' '+inttostr(data62)+' '+inttostr(data63)+'
'+inttostr(data64)+' '+
    inttostr(data65)+' '+inttostr(data66)+' '+inttostr(data67)+' '+inttostr(data68)+' ';
   end;
   if copy(datars232,2,1)='7' then
   begin
    data74awal:=(ord(datars232[3]));
    data74awal:=data74awal+(ord(datars232[4]));
    data73awal:=(ord(datars232[5]));
    data73awal:=data73awal+(ord(datars232[6]));
    data72awal:=(ord(datars232[7]));
    data72awal:=data72awal+(ord(datars232[8]));
    data71awal:=(ord(datars232[9]));
    data71awal:=data71awal+(ord(datars232[10]));
    data75awal:=(ord(datars232[11]));
    data75awal:=data75awal+(ord(datars232[12]));
    data76awal:=(ord(datars232[13]));
    data76awal:=data76awal+(ord(datars232[14]));
    data77awal:=(ord(datars232[15]));
    data77awal:=data77awal+(ord(datars232[16]));
    data78awal:=(ord(datars232[17]));
    data78awal:=data78awal+(ord(datars232[18]));

    panel7.caption:=inttostr(data71)+' '+inttostr(data72)+' '+inttostr(data73)+'
'+inttostr(data74)+' '+
    inttostr(data75)+' '+inttostr(data76)+' '+inttostr(data77)+' '+inttostr(data78)+' ';
   end;
   if copy(datars232,2,1)='8' then
   begin
    data84awal:=(ord(datars232[3]));
    data84awal:=data84awal+(ord(datars232[4]));
    data83awal:=(ord(datars232[5]));
    data83awal:=data83awal+(ord(datars232[6]));
    data82awal:=(ord(datars232[7]));
    data82awal:=data82awal+(ord(datars232[8]));
    data81awal:=(ord(datars232[9]));
    data81awal:=data81awal+(ord(datars232[10]));
    data85awal:=(ord(datars232[11]));
    data85awal:=data85awal+(ord(datars232[12]));
    data86awal:=(ord(datars232[13]));
    data86awal:=data86awal+(ord(datars232[14]));
    data87awal:=(ord(datars232[15]));
    data87awal:=data87awal+(ord(datars232[16]));
    data88awal:=(ord(datars232[17]));
    data88awal:=data88awal+(ord(datars232[18]));
```

```
    panel8.caption:=inttostr(data81)+' '+inttostr(data82)+' '+inttostr(data83)+'
'+inttostr(data84)+' '+
    inttostr(data85)+' '+inttostr(data86)+' '+inttostr(data87)+' '+inttostr(data88)+' ';
  end;
 end;
end;

end;

procedure TForm1.BitBtn2Click(Sender: TObject);
begin
pkalibrasi.visible:=true;
hitung:=0;
timer1.enabled:=false;
timer2.enabled:=true;
end;

end.
```

LISTING PROGRAM AVR STUDIO 4

```
.include "c:\avr\m16def.inc"

.equ    sensorkolom1        =PC0
.equ    sensorkolom2        =PC1
.equ    sensorkolom3        =PC2
.equ    sensorkolom4        =PC3
.equ    sensorkolom5        =PC4
.equ    sensorkolom6        =PC5
.equ    sensorkolom7        =PC6
.equ    sensorkolom8        =PC7

.def    temp1  =r3
.def    temp2  =r4


.def    rlpm    = R0

.def    rbin1L = R10
.def    rbin1H = R11
.def    rbin2L = R12
.def    rbin2H = R13

.def    mpr             = R16
.def    var1    = R17
.def    var2    = R18
.def    var3    = R19
.def    temp1  =R20
.def    temp2  =R21

.equ    fclock  = 11059200
.equ    baud_rate       =9600
.equ    ubbr_value      =(fclock/(16*baud_rate))-1


.dseg
dataADCH:    .byte   1
dataADCL:    .byte   1
dataADC:     .byte   1

.cseg
.org    $0000
rjmp    start
```

```
;-----------------------------------------------------------------------
;Start of program
start:          ldi mpr,low(RAMEND)
                out SPL,mpr
                ldi mpr,high(RAMEND)
                out SPH,mpr
                ldi mpr,ubbr_value          ;baud generator
                out UBRRL,mpr               ;set divider
                ldi mpr,0b00011000  ;enable TX and RX
                out UCR,mpr         ;to UART Control Register


;PORTC           --IIIIII
                ldi mpr,0b11111111
                out DDRC,mpr
                ldi mpr,0b00000000  ;cut pull-up input
                out PORTC,mpr

;PORTD           IIIOOOIO
                ldi mpr,0b00011101
                out DDRD,mpr
                ldi mpr,0b11100010  ;pull-up input
                out PORTD,mpr

                sbi PORTD,4


                ldi var1,2
delaystartup:
                rcall delay500ms
                dec var1
                cpi var1,0
                brne delaystartup

intro:
;               ldi mpr,12
;               rcall txchar
;               ldi ZH,high(adcparstr*2)
;               ldi ZL,low(adcparstr*2)
;               rcall txstr

                ldi mpr,0b10000010  ;set ADC enable
                out ADCSR,mpr

mainloop:
                rcall   PembacaanKolom1
                rcall   delaykeypad
                rcall   delaykeypad
                rcall   delaykeypad
                rcall   PembacaanKolom2
```

```
        rcall   delaykeypad
        rcall   delaykeypad
        rcall   delaykeypad
        rcall   PembacaanKolom3
        rcall   delaykeypad
        rcall   delaykeypad
        rcall   delaykeypad
        rcall   PembacaanKolom4
        rcall   delaykeypad
        rcall   delaykeypad
        rcall   delaykeypad
        rcall   PembacaanKolom5
        rcall   delaykeypad
        rcall   delaykeypad
        rcall   delaykeypad
        rcall   PembacaanKolom6
        rcall   delaykeypad
        rcall   delaykeypad
        rcall   delaykeypad
        rcall   PembacaanKolom7
        rcall   delaykeypad
        rcall   delaykeypad
        rcall   delaykeypad
        rcall   PembacaanKolom8
        rcall   delaykeypad
        rcall   delaykeypad
        rcall   delaykeypad
        rcall   delaykeypad
        rcall   delaykeypad

        rjmp    mainloop


PembacaanKolom1:

        ldi     mpr,0x01
        out     PORTC,mpr
        rcall   delaykeypad
        rcall   delaykeypad

        ldi     mpr,'B'
        rcall   txchar
        ldi     mpr,'1'
        rcall   txchar

        rcall   BACAADC

        ldi             mpr,0x0a
        rcall   txchar
```

```
                ldi             mpr,0x0d
                rcall   txchar
                ret

PembacaanKolom2:

                ldi     mpr,0x02
                out     PORTC,mpr
                rcall   delaykeypad
                rcall   delaykeypad

                ldi     mpr,'B'
                rcall   txchar
                ldi     mpr,'2'
                rcall   txchar

                rcall   BACAADC

                ldi             mpr,0x0a
                rcall   txchar
                ldi             mpr,0x0d
                rcall   txchar
                ret

PembacaanKolom3:

                ldi     mpr,0x04
                out     PORTC,mpr
                rcall   delaykeypad
                rcall   delaykeypad

                ldi     mpr,'B'
                rcall   txchar
                ldi     mpr,'3'
                rcall   txchar

                rcall   BACAADC

                ldi             mpr,0x0a
                rcall   txchar
                ldi             mpr,0x0d
                rcall   txchar
                ret

PembacaanKolom4:

                ldi     mpr,0x08
                out     PORTC,mpr
                rcall   delaykeypad
                rcall   delaykeypad
```

```
        ldi     mpr,'B'
        rcall   txchar
        ldi     mpr,'4'
        rcall   txchar

        rcall   BACAADC

        ldi             mpr,0x0a
        rcall   txchar
        ldi             mpr,0x0d
        rcall   txchar
        ret

PembacaanKolom5:

        ldi     mpr,0x10
        out     PORTC,mpr
        rcall   delaykeypad
        rcall   delaykeypad

        ldi     mpr,'B'
        rcall   txchar
        ldi     mpr,'5'
        rcall   txchar

        rcall   BACAADC

        ldi             mpr,0x0a
        rcall   txchar
        ldi             mpr,0x0d
        rcall   txchar
        ret

PembacaanKolom6:

        ldi     mpr,0x20
        out     PORTC,mpr
        rcall   delaykeypad
        rcall   delaykeypad

        ldi     mpr,'B'
        rcall   txchar
        ldi     mpr,'6'
        rcall   txchar

        rcall   BACAADC

        ldi             mpr,0x0a
        rcall   txchar
```

```
                ldi             mpr,0x0d
                rcall   txchar
                ret

PembacaanKolom7:

                ldi     mpr,0x40
                out     PORTC,mpr
                rcall   delaykeypad
                rcall   delaykeypad

                ldi     mpr,'B'
                rcall   txchar
                ldi     mpr,'7'
                rcall   txchar

                rcall   BACAADC

                ldi             mpr,0x0a
                rcall   txchar
                ldi             mpr,0x0d
                rcall   txchar
                ret

PembacaanKolom8:

                ldi     mpr,0x80
                out     PORTC,mpr
                rcall   delaykeypad
                rcall   delaykeypad

                ldi     mpr,'B'
                rcall   txchar
                ldi     mpr,'8'
                rcall   txchar

                rcall   BACAADC

                ldi             mpr,0x0a
                rcall   txchar
                ldi             mpr,0x0d
                rcall   txchar
                ret

BACAADC:
_readadc01:
                ldi mpr,0b01000000   ;set ADMUX int ref ch0
                out ADMUX,mpr
                rcall readadcave
                rcall sendvalue
```

```
_readadc11:
                ldi mpr,0b01000001   ;set ADMUX int ref ch1
                out ADMUX,mpr
                rcall readadcave
                rcall sendvalue
_readadc21:
                ldi mpr,0b01000010   ;set ADMUX int ref ch2
                out ADMUX,mpr
                rcall readadcave
                rcall sendvalue
_readadc31:
                ldi mpr,0b01000011   ;set ADMUX int ref ch3
                out ADMUX,mpr
                rcall readadcave
                rcall sendvalue
_readadc41:
                ldi mpr,0b01000100   ;set ADMUX int ref ch4
                out ADMUX,mpr
                rcall readadcave
                rcall sendvalue
_readadc51:
                ldi mpr,0b01000101   ;set ADMUX int ref ch5
                out ADMUX,mpr
                rcall readadcave
                rcall sendvalue

_readadc61:
                ldi mpr,0b01000110   ;set ADMUX int ref ch6
                out ADMUX,mpr
                rcall readadcave
                rcall sendvalue
_readadc71:
                ldi mpr,0b01000111   ;set ADMUX int ref ch7
                out ADMUX,mpr
                rcall readadcave
                rcall sendvalue
                ret



adcparstr:      .db "ADC parameter :",13,10,0



;---------------
;Subroutine for string transfer
txstr:          sbis USR,UDRE               ;wait Tx buff empty
                rjmp txstr
                lpm                 ;read next char from prog mem
```

```
                and rlpm,rlpm       ;null = end of string
                brne txsend
                ret
txsend:         lpm                 ;read the same char again
                out UDR,rlpm        ;Tx character read
                adiw ZL,1           ;point to next char in memory
                rjmp txstr

;---------------
;Transmit character
txchar:         sbis USR,UDRE
                rjmp txchar
                out UDR,mpr
                ret

;---------------
;Receive character
rxchar:         sbis USR,RXC
                rjmp rxchar
                in mpr,UDR
                ret

;---------------
;Read ADC (var2 + 1) times and get average
readadcave:     sbi ADCSR,ADSC
                ldi var2,3

_adcave1:       sbis ADCSR,ADIF
                rjmp _adcave1
                sbi ADCSR,ADIF          ;clear flag by setting bit
                in mpr,ADCL
                mov rbin2L,mpr
                in mpr,ADCH
                mov rbin2H,mpr

_adcave2:       sbi ADCSR,ADSC
_adcave3:       sbis ADCSR,ADIF
                rjmp _adcave3
                sbi ADCSR,ADIF          ;clear flag by setting bit
                in mpr,ADCL
                mov rbin1L,mpr
                in mpr,ADCH
                mov rbin1H,mpr

                add rbin2L,rbin1L       ;add adc(n)+adc(n-1)
                adc rbin2H,rbin1H
                dec var2
                brne _adcave2
                lsr rbin2H
                ror rbin2L
```

```
                lsr rbin2H
                ror rbin2L
_adcend:        mov rbin1H,rbin2H
                mov rbin1L,rbin2L


                in      TEMP1,ADCL      ; Read 10 bit ADC value
                in      TEMP2,ADCH
                ror     TEMP2           ; Divide ADC value by 4
                ror     TEMP1
                ror     TEMP2
                ror     TEMP1
                sts     dataADC,temp1
                ret



;---------------
;ASCII to 2HEX
ascii2hex:      push mpr
                push mpr
                swap mpr
                andi mpr,0x0F
                cpi mpr,10              ;nibble > 9?
                brcs _ascii2hex1        ;no
                ldi var1,7              ;add 7 to get hex A to F
                add mpr,var1
_ascii2hex1:    ldi var1,'0'
                add mpr,var1
                rcall txchar
                pop mpr
                andi mpr,0x0F
                cpi mpr,10              ;nibble > 9?
                brcs _ascii2hex2        ;no
                ldi var1,7              ;add 7 to get hex A to F
                add mpr,var1
_ascii2hex2:    ldi var1,'0'
                add mpr,var1
                rcall txchar
                pop mpr
                ret

;---------------
;Delay 500ms @8mhz
delay500ms:     push R23
                push R24
                push R25
                ldi R23,0x6B
_wg500loop0: ldi R24,0x46
_wg500loop1: ldi R25,0xB1
```

```
_wg500loop2: dec R25
             brne _wg500loop2
             dec R24
             brne _wg500loop1
             dec R23
             brne _wg500loop0
             pop R25
             pop R24
             pop R23
             ret

;---------------
;Bin2ToBCD5
;converts a 16-bit-binary to a 5-digit-BCD
;in rbin1H:rbin1L

sendvalue:
;            mov mpr,rbin1H
;            rcall txchar
;            mov mpr,rbin1L

             ldi        mpr,1
             rcall  txchar
             lds        mpr,dataadc
             rcall  txchar
             ret

;sendvalue:
bin2tobcd5:  push rbin1H          ;save number
             push rbin1L
             ldi mpr,high(10000)  ;start with 10.000
             mov rbin2H,mpr
             ldi mpr,low(10000)
             mov rbin2L,mpr
             rcall bin2todigit    ;calculate digit

             ldi mpr,high(1000)   ;next with 1.000
             mov rbin2H,mpr
             ldi mpr,low(1000)
             mov rbin2L,mpr
             rcall bin2todigit    ;calculate digit
             rcall txchar

             ldi mpr,high(100)    ;next with 100
             mov rbin2H,mpr
             ldi mpr,low(100)
             mov rbin2L,mpr
             rcall bin2todigit    ;calculate digit
             rcall txchar
```

```
                ldi mpr,high(10)        ;next with 10
                mov rbin2H,mpr
                ldi mpr,low(10)
                mov rbin2L,mpr
                rcall bin2todigit       ;calculate digit
                rcall txchar
                mov mpr,rbin1L                  ;remainder are ones
                ori mpr,0x30
                rcall txchar
                pop rbin1L
                pop rbin1H
                ret

;---------------
;Bin2ToDigit
;converts one decimal digit by continued substraction of a BCD
bin2todigit:    clr mpr                 ;digit count is zero
_bin2todigita: cp rbin1H,rbin2H         ;number bigger than decimal?
                brcs _bin2todigitc      ;MSB smaller than decimal
                brne _bin2todigitb      ;MSB bigger than decimal
                cp rbin1L,rbin2L        ;LSB bigger or equal decimal
                brcs _bin2todigitc      ;LSB smaller than decimal
_bin2todigitb: sub rbin1L,rbin2L        ;substract LSB decimal
                sbc rbin1H,rbin2H       ;substract MSB decimal
                inc mpr                         ;increment digit count
                rjmp _bin2todigita      ;next loop
_bin2todigitc: ori mpr,0x30
                ret


;-------------------------------------
; sub routine delay penekanan keypad
;-------------------------------------
delaykeypad:
        ldi     R17,250
delayk1:
        ldi     R18,200
delayk2:
        dec     R18
        brne    delayk2
        dec     R17
        brne    delayk1
        ret
```

LAMPIRAN B

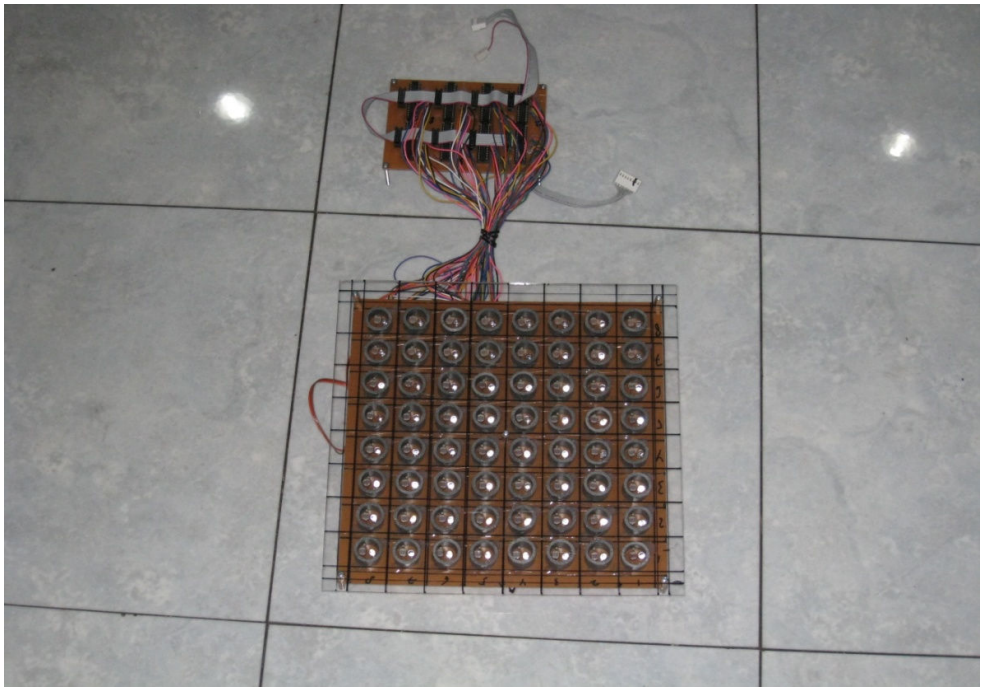
Papan Othelo+ SensorLDR + Led

dan Rangkaian elektronik switch……..... B-2

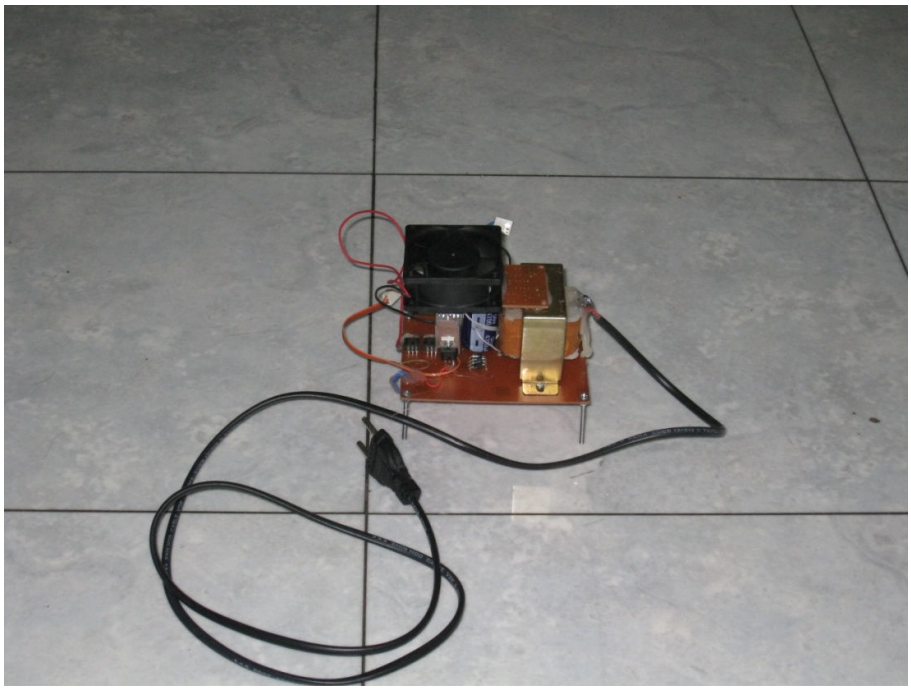
Rangkaian Catu Daya..... B-2

Rangkain pengendali dan kabel serial..... B-3

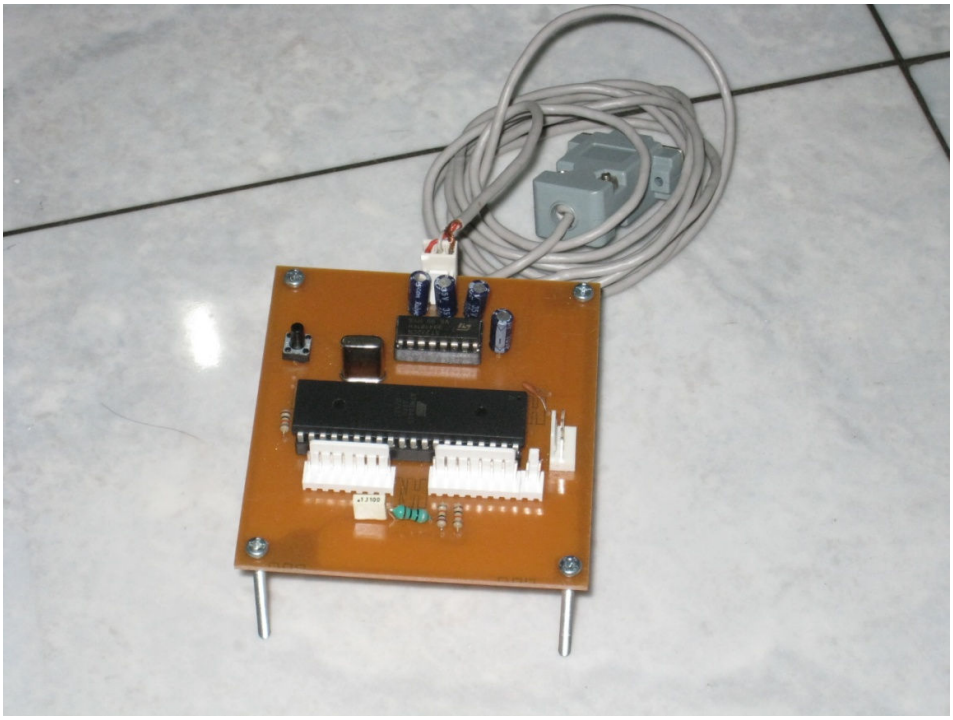
Papan Othelo+SensorLDR+Led dan Rangkaian elektronik switch



Rangkaian Catu Daya



Rangkain pengendali dan kabel serial



LAMPIRAN C

Datasheet CD4066BC..... C-1

Datasheet ICL232 ..... C-9

Datasheet L7800AB/AC C-14

FAIRCHILD
SEMICONDUCTOR™

November 1983
Revised December 1998

CD4066BC
Quad Bilateral Switch

General Description

The CD4066BC is a quad bilateral switch intended for the transmission or multiplexing of analog or digital signals. It is pin-for-pin compatible with CD4016BC, but has a much lower "ON" resistance, and "ON" resistance is relatively constant over the input-signal range.

Features

- Wide supply voltage range 3V to 15V
- High noise immunity 0.45 V_{DD} (typ.)
- Wide range of digital and analog switching ±7.5 V_{PEAK}
- "ON" resistance for 15V operation 80Ω
- Matched "ON" resistance ΔR_{ON}=5Ω (typ.) over 15V signal input
- "ON" resistance flat over peak-to-peak signal range
- High "ON"/"OFF" output voltage ratio 65 dB (typ.) @ f_{is} = 10 kHz, R_L = 10 kΩ
- High degree linearity 0.1% distortion (typ.) High degree linearity @ f_{is} = 1 kHz, V_{is} = $5V_{p-p}$, $V_{DD}-V_{SS}$ = 10V, R_L = 10 kΩ
- Extremely low "OFF" switch leakage: 0.1 nA (typ.) @ $V_{DD}-V_{SS}$ = 10V, T_A = 25°C
- Extremely high control input impedance 10^{12}Ω(typ.)
- Low crosstalk between switches –50 dB (typ.) @ f_{is} = 0.9 MHz, R_L = 1 kΩ
- Frequency response, switch "ON" 40 MHz (typ.)

Applications

- Analog signal switching/multiplexing
  - Signal gating
  - Squelch control
  - Chopper
  - Modulator/Demodulator
  - Commutating switch
- Digital signal switching/multiplexing
- CMOS logic implementation
- Analog-to-digital/digital-to-analog conversion
- Digital control of frequency, impedance, phase, and analog-signal-gain

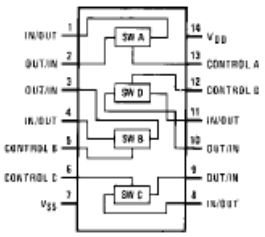
Ordering Code:

Order Number	Package Number	Package Description
CD4066BCM	M14A	14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150" Narrow Body
CD4066BCJ	M14D	14-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
CD4066BCN	N14A	14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide

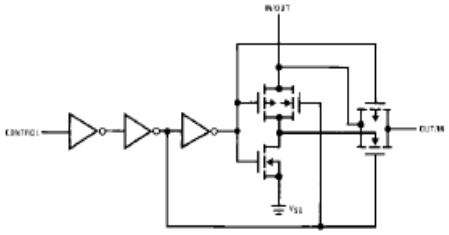
Devices also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.

Connection Diagram

Pin Assignments for SOIC, SOP and DIP



Schematic Diagram



Absolute Maximum Ratings

(Note 1)
(Note 2)

Supply Voltage (V_{DD})	–0.5V to +18V
Input Voltage (V_{IN})	–0.5V to V_{CC}+0.5V
Storage Temperature Range (T_S)	–65°C to +150°C
Power Dissipation (P_D)	
Dual-In-Line	700 mW
Small Outline	500 mW
Lead Temperature (T_L)	
(Soldering, 10 seconds)	300°C

Recommended Operating Conditions (Note 2)

Supply Voltage (V_{DD})	3V to 15V
Input Voltage (V_{IN})	0V to V_{DD}
Operating Temperature Range (T_A)	–40°C to +85°C

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The tables of "Recommended Operating Conditions" and "Electrical Characteristics" provide conditions for actual device operation.

Note 2: V_{SS} = 0V unless otherwise specified.

DC Electrical Characteristics (Note 2)

Symbol	Parameter	Conditions	–40°C		+25°C			+85°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
I_{DD}	Quiescent Device Current	V_{DD} = 5V		1.0		0.01	1.0		7.5	µA
		V_{DD} = 10V		2.0		0.01	2.0		15	µA
		V_{DD} = 15V		4.0		0.01	4.0		30	µA
SIGNAL INPUTS AND OUTPUTS										
R_{ON}	"ON" Resistance	R_L = 10 kΩ to (V_{DD} – V_{SS}/2)								
		V_C = V_{DD}, V_{SS} to V_{DD}								
		V_{DD} = 5V		850		270	1050		1200	Ω
		V_{DD} = 10V		330		120	400		520	Ω
		V_{DD} = 15V		210		80	240		300	Ω
ΔR_{ON}	Δ"ON" Resistance Between	R_L = 10 kΩ to (V_{DD} – V_{SS}/2)								
	Any 2 of 4 Switches	V_{CC} = V_{DD}, V_{IS} = V_{SS} to V_{DD}								
		V_{DD} = 10V				10				Ω
		V_{DD} = 15V				5				Ω
I_{IS}	Input or Output Leakage	V_C = 0		±50		±0.1	±50		±200	nA
	Switch "OFF"									
CONTROL INPUTS										
V_{ILC}	LOW Level Input	V_{IS} = V_{SS} and V_{DD}								
	Voltage	V_{OS} = V_{DD} and V_{SS}								
		I_{IS} = ± 10µA								
		V_{DD} = 5V		1.5		2.25	1.5		1.5	V
		V_{DD} = 10V		3.0		4.5	3.0		3.0	V
		V_{DD} = 15V		4.0		6.75	4.0		4.0	V
V_{IHC}	HIGH Level Input	V_{DD} = 5V	3.5		3.5	2.75		3.5		V
	Voltage	V_{DD} = 10V (Note 7)	7.0		7.0	5.5		7.0		V
		V_{DD} = 15V	11.0		11.0	8.25		11.0		V
I_{IN}	Input Current	V_{DD}–V_{SS} = 15V		± 0.3		± 10^{-5}	± 0.3		± 1.0	µA
		V_{DD}≥V_{IS}≥V_{SS}								
		V_{DD}≥V_C≥V_{SS}								

AC Electrical Characteristics (Note 3)

$T_A = 25°C$, $t_r = t_f = 20$ ns and $V_{SS} = 0V$ unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{PHL}, t_{PLH}	Propagation Delay Time Signal	$V_C = V_{DD}$, $C_L = 50$ pF, (Figure 1)				
	Input to Signal Output	$R_L = 200k$				
		$V_{DD} = 5V$		25	55	ns
		$V_{DD} = 10V$		15	35	ns
		$V_{DD} = 15V$		10	25	ns
t_{PZH}, t_{PZL}	Propagation Delay Time	$R_L = 1.0$ kΩ, $C_L = 50$ pF, (Figure 2, Figure 3)				
	Control Input to Signal	$V_{DD} = 5V$			125	ns
	Output High Impedance to	$V_{DD} = 10V$			60	ns
	Logical Level	$V_{DD} = 15V$			50	ns
t_{PHZ}, t_{PLZ}	Propagation Delay Time	$R_L = 1.0$ kΩ, $C_L = 50$ pF, (Figure 2, Figure 3)				
	Control Input to Signal	$V_{DD} = 5V$			125	ns
	Output Logical Level to	$V_{DD} = 10V$			60	ns
	High Impedance	$V_{DD} = 15V$			50	ns
	Sine Wave Distortion	$V_C = V_{DD} = 5V$, $V_{SS} = -5V$		0.1		%
		$R_L = 10$ kΩ, $V_{IS} = 5V_{p-p}$, f= 1 kHz, (Figure 4)				
	Frequency Response-Switch	$V_C = V_{DD} = 5V$, $V_{SS} = -5V$,		40		MHz
	"ON" (Frequency at –3 dB)	$R_L = 1$ kΩ, $V_{IS} = 5V_{p-p}$,				
		20 Log_{10} V_{OS}/V_{OS} (1 kHz)–dB,				
		(Figure 4)				
	Feedthrough — Switch "OFF"	$V_{DD} = 5.0V$, $V_{CC} = V_{SS} = -5.0V$,		1.25		
	(Frequency at –50 dB)	$R_L = 1$ kΩ, $V_{IS} = 5.0V_{p-p}$, 20 Log_{10},				
		$V_{OS}/V_{IS} = -50$ dB, (Figure 4)				
	Crosstalk Between Any Two	$V_{DD} = V_{C(A)} = 5.0V$; $V_{SS} = V_{C(B)} = 5.0V$,		0.9		MHz
	Switches (Frequency at –50 dB)	R_L 1 kΩ, $V_{IS(A)} = 5.0$ V_{p-p}, 20 Log_{10},				
		$V_{OS(B)}/V_{IS(A)} = -50$ dB (Figure 5)				
	Crosstalk; Control Input to	$V_{DD} = 10V$, $R_L = 10$ kΩ, $R_{IN} = 1.0$ kΩ,		150		mV_{p-p}
	Signal Output	$V_{CC} = 10V$ Square Wave, $C_L = 50$ pF				
		(Figure 6)				
	Maximum Control Input	$R_L = 1.0$ kΩ, $C_L = 50$ pF, (Figure 7)				
		$V_{OS(f)} = ½ V_{OS}$(1.0 kHz)				
		$V_{DD} = 5.0V$		6.0		MHz
		$V_{DD} = 10V$		8.0		MHz
		$V_{DD} = 15V$		8.5		MHz
C_{IS}	Signal Input Capacitance			8.0		pF
C_{OS}	Signal Output Capacitance	$V_{DD} = 10V$		8.0		pF
C_{IOS}	Feedthrough Capacitance	$V_C = 0V$		0.5		pF
C_{IN}	Control Input Capacitance			5.0	7.5	pF

Note 3: AC Parameters are guaranteed by DC correlated testing.

Note 4: These devices should not be connected to circuits with the power "ON".

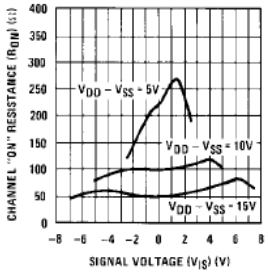
Note 5: In all cases, there is approximately 5 pF of probe and jig capacitance in the output; however, this capacitance is included in C_L wherever it is specified.

Note 6: V_{IS} is the voltage at the in/out pin and V_{OS} is the voltage at the out/in pin. V_C is the voltage at the control input.

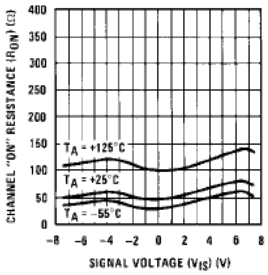
Note 7: Conditions for V_{IHC}: a) $V_{IS} = V_{DD}$, I_{OS} = standard B series I_{OH} b) $V_{IS} = 0V$, I_{OL} = standard B series I_{OL}.

Typical Performance Characteristics

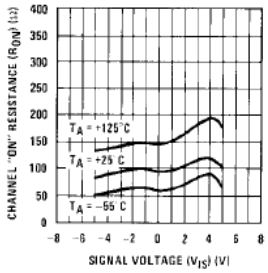
"ON" Resistance vs Signal Voltage for $T_A = 25°C$



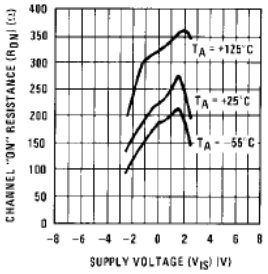
"ON" Resistance as a Function of Temperature for $V_{DD}–V_{SS} = 15V$



"ON" Resistance as a Function of Temperature for $V_{DD}–V_{SS} = 10V$



"ON" Resistance as a Function of Temperature for $V_{DD}–V_{SS} = 5V$



Special Considerations

In applications where separate power sources are used to drive V_{DD} and the signal input, the V_{DD} current capability should exceed V_{DD}/R_L (R_L = effective external load of the 4 CD4066BC bilateral switches). This provision avoids any permanent current flow or clamp action of the V_{DD} supply when power is applied or removed from CD4066BC.

In certain applications, the external load-resistor current may include both V_{DD} and signal-line components. To avoid drawing V_{DD} current when switch current flows into terminals 1, 4, 8 or 11, the voltage drop across the bidirectional switch must not exceed 0.6V at $T_A \leq 25°C$, or 0.4V at $T_A > 25°C$ (calculated from R_{ON} values shown).

No V_{DD} current will flow through R_L if the switch current flows into terminals 2, 3, 9 or 10.

AC Test Circuits and Switching Time Waveforms

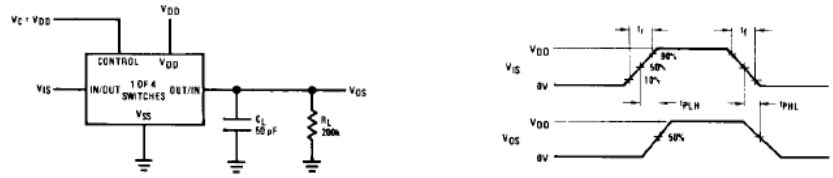


FIGURE 1. t_{PHL}, t_{PLH} Propagation Delay Time Signal Input to Signal Output

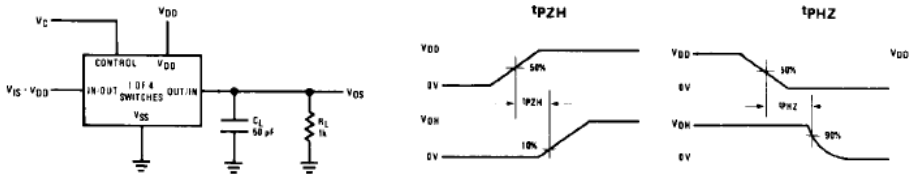


FIGURE 2. t_{PZH}, t_{PHZ} Propagation Delay Time Control to Signal Output

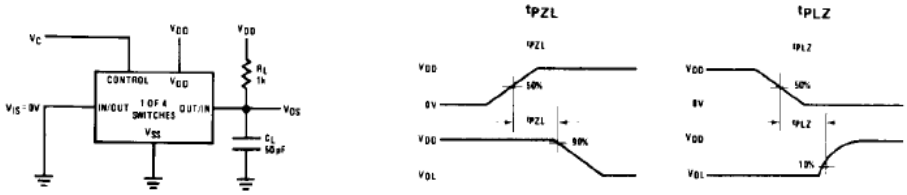
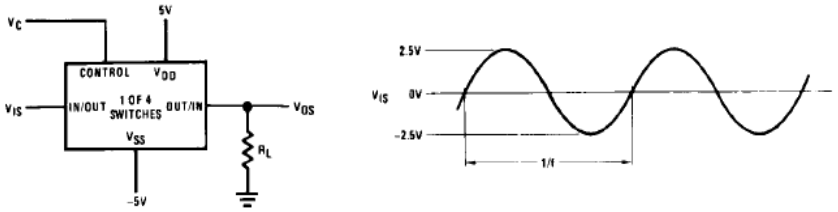


FIGURE 3. t_{PZL}, t_{PLZ} Propagation Delay Time Control to Signal Output



$V_C = V_{DD}$ for distortion and frequency response tests

$V_C = V_{SS}$ for feedthrough test

FIGURE 4. Sine Wave Distortion, Frequency Response and Feedthrough

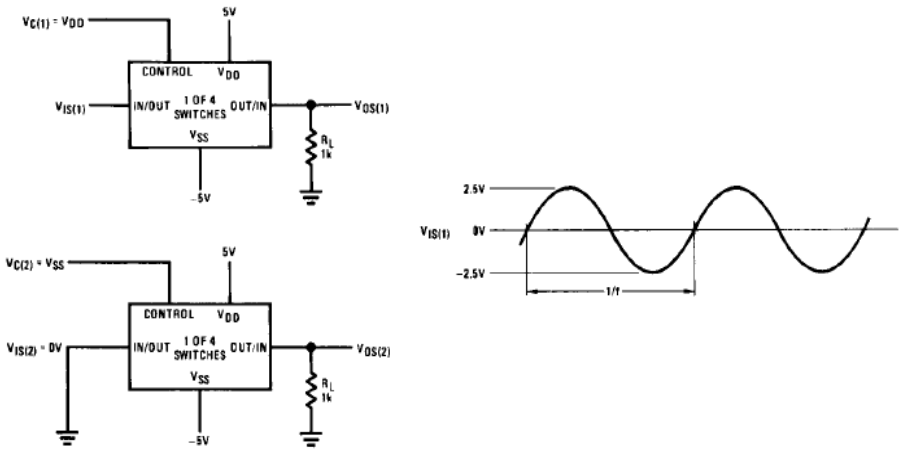


FIGURE 5. Crosstalk Between Any Two Switches

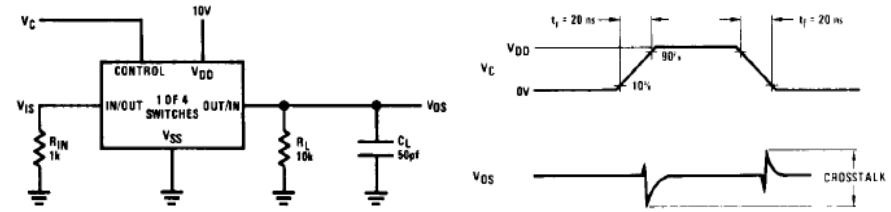


FIGURE 6. Crosstalk: Control Input to Signal Output

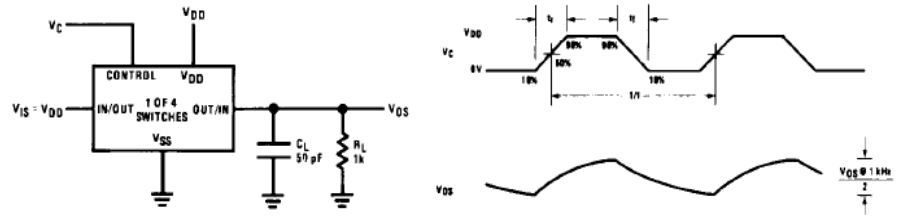
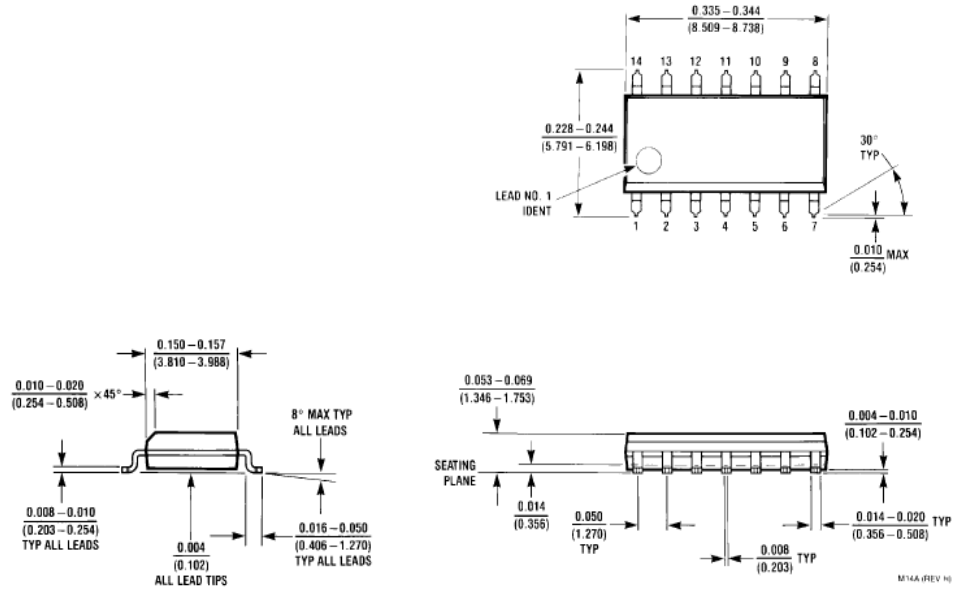
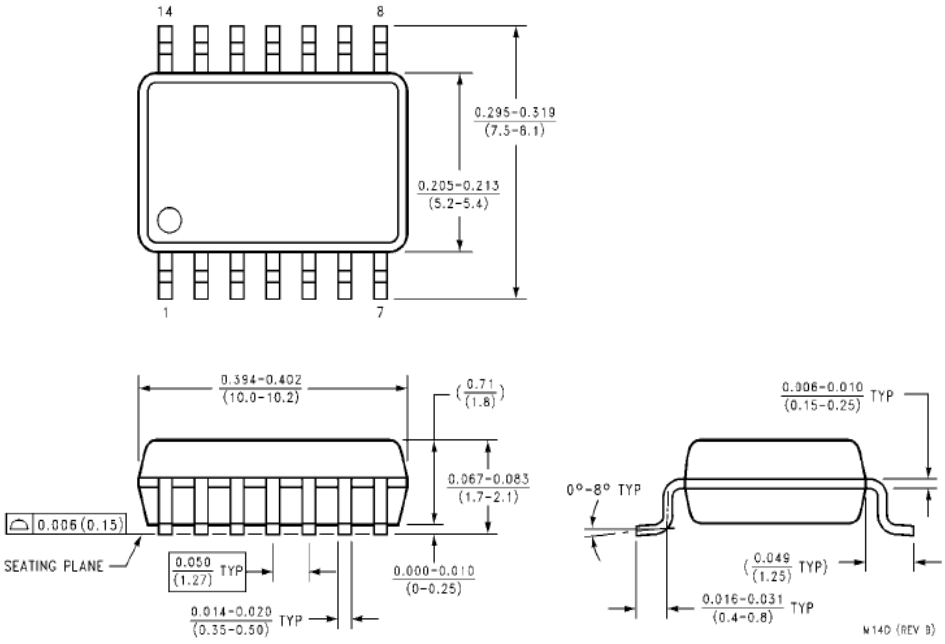


FIGURE 7. Maximum Control Input Frequency

Physical Dimensions inches (millimeters) unless otherwise noted

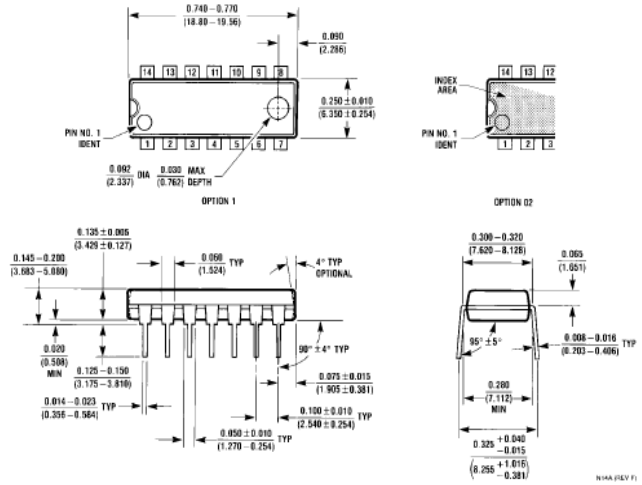


14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150" Narrow Body
Package Number M14A



14-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
Package Number M14D

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
Package Number N14A

LIFE SUPPORT POLICY

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1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

www.fairchildsemi.com

HARRIS SEMICONDUCTOR

ICL232

+5V Powered Dual RS-232 Transmitter/Receiver

December 1993

Features

- Meets All RS-232C Specifications
- Requires Only Single +5V Power Supply
- Onboard Voltage Doubler/Inverter
- Low Power Consumption
- 2 Drivers
  - ±9V Output Swing for +5V Input
  - 300Ω Power-off Source Impedance
  - Output Current Limiting
  - TTL/CMOS Compatible
  - 30V/μs Maximum Slew Rate
- 2 Receivers
  - ±30V Input Voltage Range
  - 3kΩ to 7kΩ Input Impedance
  - 0.5V Hysteresis to Improve Noise Rejection
- All Critical Parameters are Guaranteed Over the Entire Commercial, Industrial and Military Temperature Ranges

Applications

- Any System Requiring RS-232 Communications Port
  - Computer - Portable and Mainframe
  - Peripheral - Printers and Terminals
  - Portable Instrumentation
  - Modems
  - Dataloggers

Description

The ICL232 is a dual RS-232 transmitter/receiver interface circuit that meets all EIA RS-232C specifications. It requires a single +5V power supply, and features two onboard charge pump voltage converters which generate +10V and -10V supplies from the 5V supply.

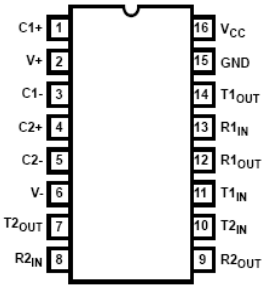
The drivers feature true TTL/CMOS input compatibility, slew-rate-limited output, and 300Ω power-off source impedance. The receivers can handle up to +30V, and have a 3kΩ to 7kΩ input impedance. The receivers also have hysteresis to improve noise rejection.

Ordering Information

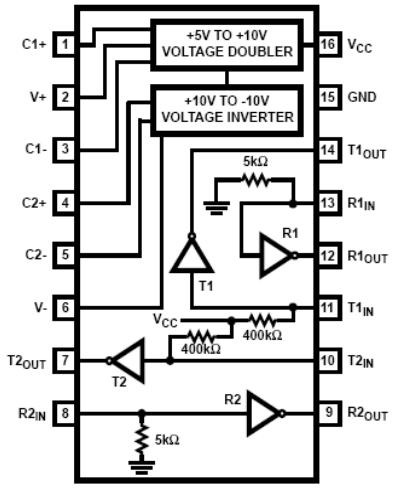
PART NUMBER	TEMPERATURE RANGE	PACKAGE
ICL232CPE	0°C to +70°C	16 Lead Plastic DIP
ICL232CJE	0°C to +70°C	16 Lead Ceramic DIP
ICL232CBE	0°C to +70°C	16 Lead SOIC (W)
ICL232IPE	-40°C to +85°C	16 Lead Plastic DIP
ICL232IJE	-40°C to +85°C	16 Lead Ceramic DIP
ICL232IBE	-40°C to +85°C	16 Lead SOIC (W)
ICL232MJE	-55°C to + 125°C	16 Lead Ceramic DIP

Pinouts

ICL232
(PDIP, CDIP, SOIC)
TOP VIEW



Functional Diagram



CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.

File Number 3020.2

Specifications ICL232

Absolute Maximum Ratings

V_{CC} to Ground . . . . . (GND -0.3V) <V_{CC} < 6V
V+ to Ground . . . . . (V_{CC} -0.3V) <V+ < 12V
V- to Ground . . . . . -12V < V- < (GND +0.3V)
Input Voltages
  $T1_{IN}$, $T2_{IN}$ . . . . . (V- -0.3V) < V_{IN} < (V+ +0.3V)
  $R1_{IN}$, $R2_{IN}$ . . . . . ±30V
Output Voltages
  $T1_{OUT}$, $T2_{OUT}$ . . . . . (V- -0.3V) < V_{TXOUT} < (V+ +0.3V)
  $R1_{OUT}$, $R2_{OUT}$ . . . . . (GND -0.3V) < V_{RXOUT} < (V_{CC} +0.3V)
Short Circuit Duration
  $T1_{OUT}$, $T2_{OUT}$ . . . . . Continuous
  $R1_{OUT}$, $R2_{OUT}$ . . . . . Continuous
Storage Temperature Range . . . . . -65°C to +150°C
Lead Temperature (Soldering 10s) . . . . . +300°C

Thermal Information

Thermal Resistance	θ_{JA}	θ_{JC}
Ceramic DIP Package	80°C/W	24°C/W
Plastic DIP Package	100°C/W	-
SOIC Package	100°C/W	-

Maximum Power Dissipation 250mW
Operating Temperature Range
  ICL232C . . . . . 0°C to +70°C
  ICL232I . . . . . -40°C to +85°C
  ICL232M . . . . . -55°C to +125°C

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Specifications

Test Conditions: V_{CC} = +5V ±10%, T_A = Operating Temperature Range. Test Circuit as in Figure 8 Unless Otherwise Specified

PARAMETER	TEST CONDITIONS	LIMITS			UNITS
		MIN	TYP	MAX	
Transmitter Output Voltage Swing, T_{OUT}	$T1_{OUT}$ and $T2_{OUT}$ loaded with 3kΩ to Ground	±5	±9	±10	V
Power Supply Current, I_{CC}	Outputs Unloaded, T_A = +25°C	-	5	10	mA
T_{IN}, Input Logic Low, V_{IL}		-	-	0.8	V
T_{IN}, Input Logic High, V_{IH}		2.0	-	-	V
Logic Pullup Current, I_P	$T1_{IN}$, $T2_{IN}$ = 0V	-	15	200	µA
RS-232 Input Voltage Range, V_{IN}		-30	-	+30	V
Receiver Input Impedance, R_{IN}	V_{IN} = ±3V	3.0	5.0	7.0	kΩ
Receiver Input Low Threshold, V_{IN} (H-L)	V_{CC} = 5.0V, T_A = +25°C	0.8	1.2	-	V
Receiver Input High Threshold, V_{IN} (L-H)	V_{CC} = 5.0V, T_A = +25°C	-	1.7	2.4	V
Receiver Input Hysteresis, V_{HYST}		0.2	0.5	1.0	V
TTL/CMOS Receiver Output Voltage Low, V_{OL}	I_{OUT} = 3.2mA	-	0.1	0.4	V
TTL/CMOS Receiver Output Voltage High, V_{OH}	I_{OUT} = -1.0mA	3.5	4.6	-	V
Propagation Delay, t_{PD}	RS-232 to TTL	-	0.5	-	µs
Instantaneous Slew Rate, SR	C_L = 10pF, R_L = 3kΩ, T_A = +25°C (Notes 1, 2)	-	-	30	V/µs
Transition Region Slew Rate, SR_T	R_L = 3kΩ, C_L = 2500pF Measured from +3V to -3V or -3V to +3V	-	3	-	V/µs
Output Resistance, R_{OUT}	V_{CC} = V+ = V- = 0V, V_{OUT} = ±2V	300	-	-	Ω
RS-232 Output Short Circuit Current, I_{SC}	$T1_{OUT}$ or $T2_{OUT}$ shorted to GND	-	±10	-	mA

NOTES:

1. Guaranteed by design.
2. See Figure 4 for definition.

Typical Performance Curves

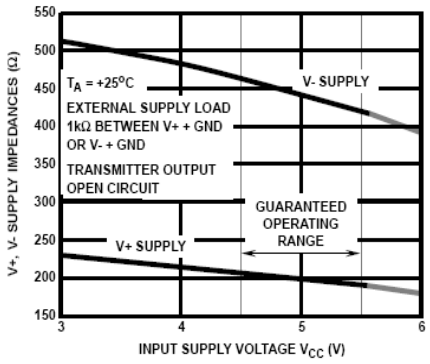


FIGURE 1. V+, V- OUTPUT IMPEDANCES vs V_{CC}

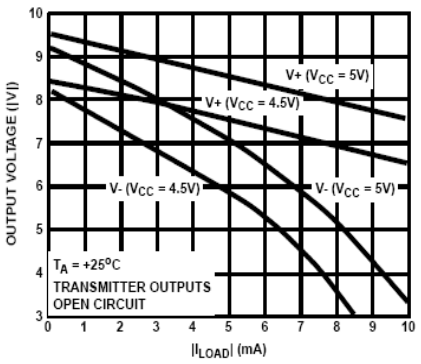


FIGURE 2. V+, V- OUTPUT VOLTAGES vs LOAD CURRENT

Pin Descriptions

PLASTIC DIP, CERAMIC DIP	SOIC	PIN NAME	DESCRIPTION
1	1	C1+	External capacitor "+" for internal voltage doubler.
2	2	V+	Internally generated +10V (typical) supply.
3	3	C1-	External capacitor "-" for internal voltage doubler.
4	4	C2+	External capacitor "+" internal voltage inverter.
5	5	C2-	External capacitor "-" internal voltage inverter.
6	6	V-	Internally generated -10V (typical) supply.
7	7	$T2_{OUT}$	RS-232 Transmitter 2 output ±10V (typical).
8	8	$R2_{IN}$	RS-232 Receiver 2 input, with internal 5K pulldown resistor to GND.
9	9	R2out	Receiver 2 TTL/CMOS output.
10	10	$T2_{IN}$	Transmitter 2 TTL/CMOS input, with internal 400K pullup resistor to V_{CC}.
11	11	$T1_{IN}$	Transmitter 1 TTL/CMOS input, with internal 400K pullup resistor to V_{CC}.
12	12	$R1_{OUT}$	Receiver 1 TTL/CMOS output.
13	13	$R1_{IN}$	RS-232 Receiver 1 input, with internal 5K pulldown resistor to GND.
14	14	$T1_{OUT}$	RS-232 Transmitter 1 output ±10V (typical).
15	15	GND	Supply Ground.
16	16	VCC	Positive Power Supply +5V ±10%

Detailed Description

The ICL232 is a dual RS-232 transmitter/receiver powered by a single +5V power supply which meets all EIA RS232C specifications and features low power consumption. The functional diagram illustrates the major elements of the ICL232. The circuit is divided into three sections: a voltage doubler/inverter, dual transmitters, and dual receivers.

Voltage Converter

An equivalent circuit of the dual charge pump is illustrated in Figure 3.

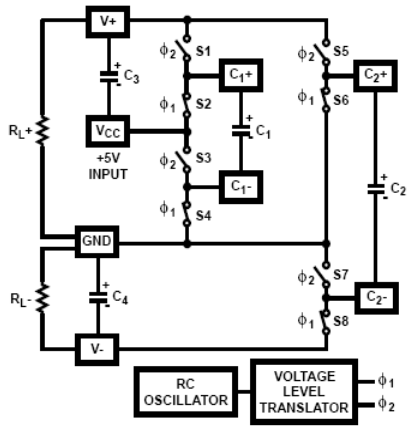
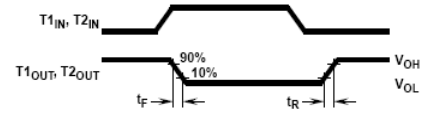


FIGURE 3. DUAL CHARGE PUMP

The voltage quadrupler contains two charge pumps which use two phases of an internally generated clock to generate +10V and -10V. The nominal clock frequency is 16kHz. During phase one of the clock, capacitor C1 is charged to V_{CC}. During phase two, the voltage on C1 is added to V_{CC}, producing a signal across C2 equal to twice V_{CC}. At the same time, C3 is also charged to $2V_{CC}$, and then during phase one, it is inverted with respect to ground to produce a signal across C4 equal to $-2V_{CC}$. The voltage converter accepts input voltages up to 5.5V. The output impedance of the doubler (V+) is approximately 200Ω, and the output impedance of the inverter (V-) is approximately 450Ω. Typical graphs are presented which show the voltage converters output vs input voltage and output voltages vs load characteristics. The test circuit (Figure 8) uses 1µF capacitors for C1-C4, however, the value is not critical. Increasing the values of C1 and C2 will lower the output impedance of the voltage doubler and inverter, and increasing the values of the reservoir capacitors, C3 and C4, lowers the ripple on the V+ and V- supplies.



Instantaneous Slew Rate (SR) = $\frac{(0.8)(V_{OH} - V_{OL})}{t_R}$ or $\frac{(0.8)(V_{OL} - V_{OH})}{t_F}$

FIGURE 4. SLEW RATE DEFINITION

Transmitters

The transmitters are TTL/CMOS compatible inverters which translate the inputs to RS-232 outputs. The input logic threshold is about 26% of V_{CC}, or 1.3V for V_{CC} = 5V. A logic 1 at the input results in a voltage of between -5V and V- at the output, and a logic 0 results in a voltage between +5V and (V+ -0.6V). Each transmitter input has an internal 400kΩ pullup resistor so any unused input can be left unconnected and its output remains in its low state. The output voltage swing meets the RS-232C specification of ±5V minimum with the worst case conditions of: both transmitters driving 3kΩ minimum load impedance, V_{CC} = 4.5V, and maximum allowable operating temperature. The transmitters have an internally limited output slew rate which is less than 30V/µs. The outputs are short circuit protected and can be shorted to ground indefinitely. The powered down output impedance is a minimum of 300Ω with ±2V applied to the outputs and V_{CC} = 0V.

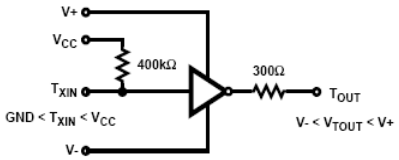


FIGURE 5. TRANSMITTER

Receivers

The receiver inputs accept up to ±30V while presenting the required 3kΩ to 7kΩ input impedance even it the power is off (V_{CC} = 0V). The receivers have a typical input threshold of 1.3V which is within the ±3V limits, known as the transition region, of the RS-232 specification. The receiver output is 0V to V_{CC}. The output will be low whenever the input is greater than 2.4V and high whenever the input is floating or driven between +0.8V and -30V. The receivers feature 0.5V hysteresis to improve noise rejection.

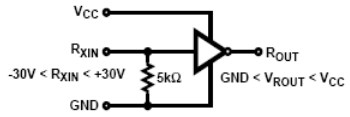
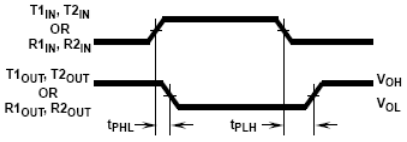


FIGURE 6. RECEIVER



Average Propagation Delay = $\frac{t_{PHL} + t_{PLH}}{2}$

FIGURE 7. PROPAGATION DELAY DEFINITION

Test Circuits

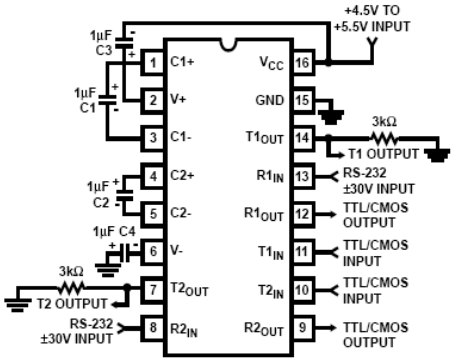


FIGURE 8. GENERAL TEST CIRCUIT

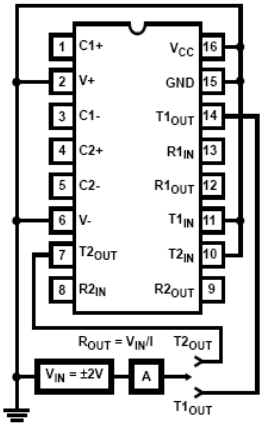


FIGURE 9. POWER-OFF SOURCE RESISTANCE CONFIGURATION

Applications

The ICL232 may be used for all RS-232 data terminal and communication links. It is particularly useful in applications where ±12V power supplies are not available for conventional RS-232 interface circuits. The applications presented represent typical interface configurations.

A simple duplex RS-232 port with CTS/RTS handshaking is illustrated in Figure 10. Fixed output signals such as DTR (data terminal ready) and DSRS (data signaling rate select) is generated by driving them through a 5kΩ resistor connected to V+.

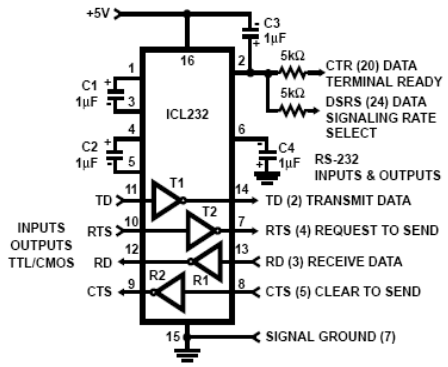


FIGURE 10. SIMPLE DUPLEX RS-232 PORT WITH CTS/RTS HANDSHAKING

In applications requiring four RS-232 inputs and outputs (Figure 11), note that each circuit requires two charge pump capacitors (C1 and C2) but can share common reservoir capacitors (C3 and C4). The benefit of sharing common reservoir capacitors is the elimination of two capacitors and the reduction of the charge pump source impedance which effectively increases the output swing of the transmitters.

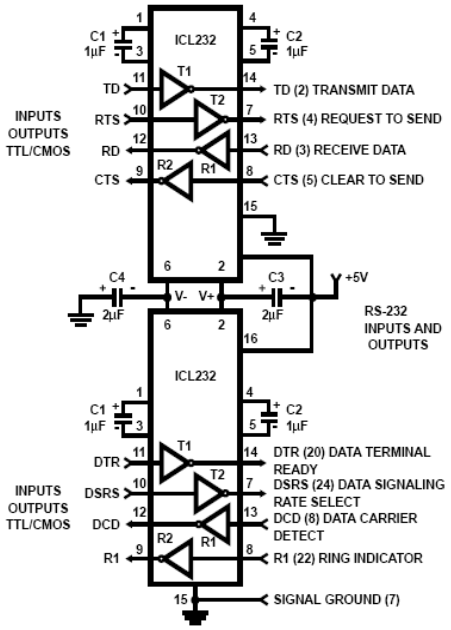
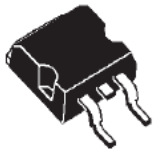


FIGURE 11. COMBINING TWO ICL232s FOR 4 PAIRS OF RS-232 INPUTS AND OUTPUTS

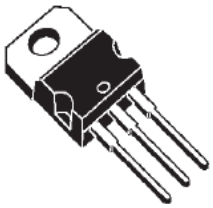
L7800AB/AC SERIES

PRECISION 1A REGULATORS

- OUTPUT CURRENT IN EXCESS OF 1 A
- OUTPUT VOLTAGES OF 5; 6; 8; 9; 12; 15; 18; 20; 24V
- THERMAL OVERLOAD PROTECTION
- OUTPUT TRANSITION SOA PROTECTION
- 2% OUTPUT VOLTAGE TOLERANCE
- GUARANTEED IN EXTENDED TEMPERATURE RANGE



D^2PAK

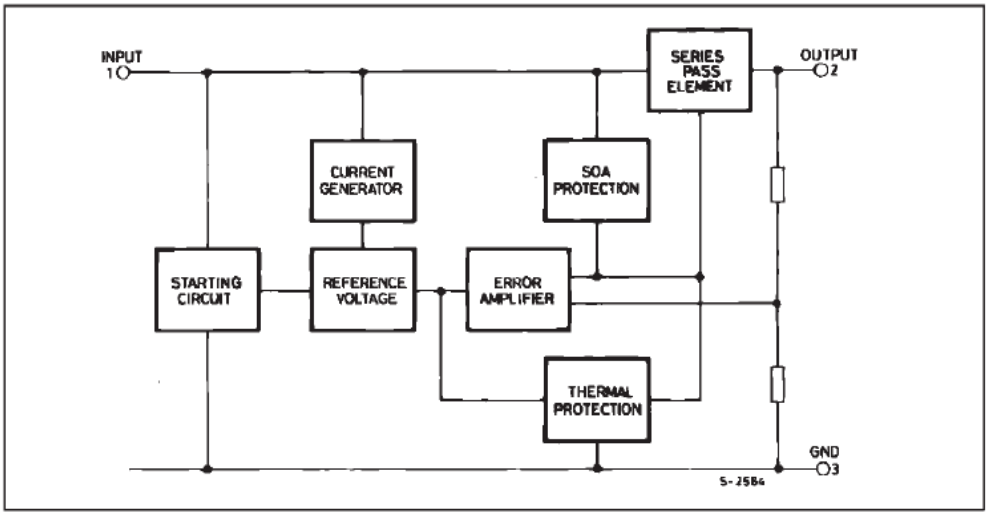


TO-220

DESCRIPTION

The L7800A series of three-terminal positive regulators is available in TO-220 and D^2PAK packages and several fixed output voltages, making it useful in a wide range of applications.These regulators can provide local on-card regulation, eliminating the distribution problems associated with single point regulation. Each type employs internal current limiting, thermal shut-down and safe area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

BLOCK DIAGRAM



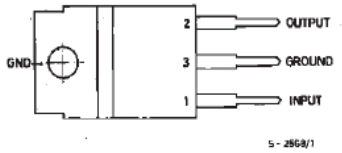
ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_i	DC Input Voltage (for V_O = 5 to 18V) (for V_O = 20, 24V)	35 40	V V
I_o	Output Current	Internally limited	
P_{tot}	Power Dissipation	Internally limited	
T_{op}	Operating Junction Temperature Range (for **L7800AC**) (for **L7800AB**)	0 to 150 -40 to 125	°C °C
T_{stg}	Storage Temperature Range	- 65 to 150	°C

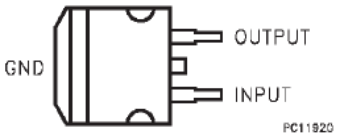
THERMAL DATA

Symbol	Parameter		D^2PAK	TO-220	Unit
$R_{thj\text{-}case}$	Thermal Resistance Junction-case	Max	3	3	°C/W
$R_{thj\text{-}amb}$	Thermal Resistance Junction-ambient	Max	62.5	50	°C/W

CONNECTION DIAGRAM AND ORDERING NUMBERS (top view)



TO-220

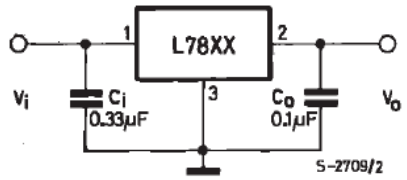


D^2PAK

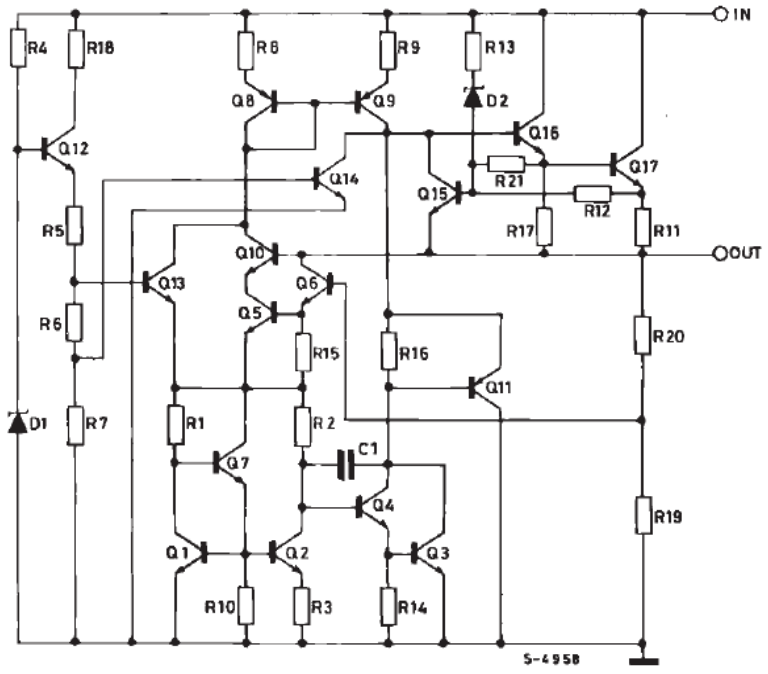
Type	TO-220	D^2PAK (*)	Output Voltage
L7805AB	L7805ABV	L7805ABD2T	5V
L7805AC	L7805ACV	L7805ACD2T	5V
L7806AB	L7806ABV	L7806ABD2T	6V
L7806AC	L7806ACV	L7806ACD2T	6V
L7808AB	L7808ABV	L7808ABD2T	8V
L7808AC	L7808ACV	L7808ACD2T	8V
L7809AB	L7809ABV	L7809ABD2T	9V
L7809AC	L7809ACV	L7809ACD2T	9V
L7812AB	L7812ABV	L7812ABD2T	12V
L7812AC	L7812ACV	L7812ACD2T	12V
L7815AB	L7815ABV	L7815ABD2T	15V
L7815AC	L7815ACV	L7815ACD2T	15V
L7818AB	L7818ABV		18V
L7818AC	L7818ACV		18V
L7820AB	L7820ABV		24V
L7820AC	L7820ACV		24V
L7824AB	L7824ABV		
L7824AC	L7824ACV		

(*) AVAILABLE IN TAPE AND REEL WITH "-TR" SUFFIX

APPLICATION CIRCUIT



SCHEMATIC DIAGRAM



TEST CIRCUITS

Figure 1 : DC Parameter

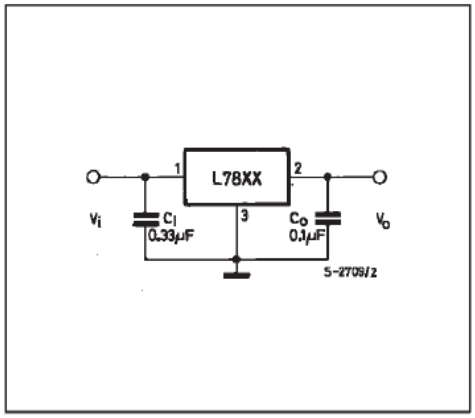


Figure 2 : Load Regulation.

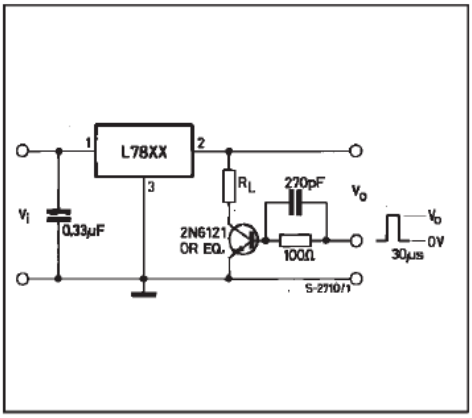
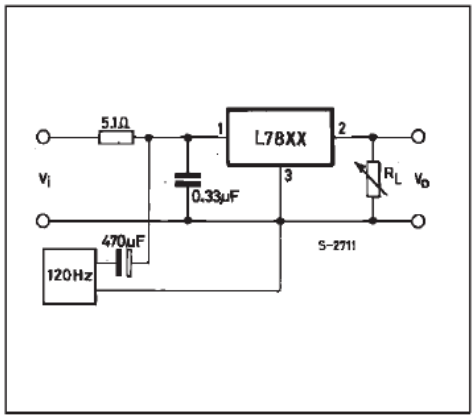


Figure 3 : Ripple Rejection.



ELECTRICAL CHARACTERISTICS FOR L7805A (V_i = 10V, I_o = 1 A, T_j = 0 to 125 °C (L7805AC), T_j = -40 to 125 °C (L7805AB) unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_o	Output Voltage	T_j = 25 °C	4.9	5	5.1	V
V_o	Output Voltage	I_o = 5 mA to 1 A $P_o \leq$ 15 W V_i = 7.5 to 20 V	4.8	5	5.2	V
ΔV_o*	Line Regulation	V_i = 7.5 to 25 V I_o = 500 mA V_i = 8 to 12 V V_i = 8 to 12 V T_j = 25 °C V_i = 7.3 to 20 V T_j = 25 °C		7 10 2 7	50 5 25 50	mV mV mV mV
ΔV_o*	Load Regulation	I_o = 5 mA to 1 A I_o = 5 mA to 1.5 A T_j = 25 °C I_o = 250 to 750 mA		25 30 8	100 100 50	mV mV mV
I_d	Quiescent Current	T_j = 25 °C		4.3	6 6	mA
ΔI_d	Quiescent Current Change	V_i = 8 to 25 V I_o = 500 mA V_i = 7.5 to 20 V T_j = 25 °C I_o = 5 mA to 1 A			0.8 0.8 0.5	mA mA mA
SVR	Supply Voltage Rejection	V_i = 8 to 18 V f = 120 Hz I_o = 500 mA		68		dB
V_d	Dropout Voltage	I_o = 1 A T_j = 25 °C		2		V
e_N	Output Noise Voltage	B = 10Hz to 100KHz T_j = 25 °C		10		µV/V_o
R_o	Output Resistance	f = 1KHz		17		mΩ
I_{sc}	Short Circuit Current	V_i = 35 V T_{amb} = 25 °C		0.2		A
I_{scp}	Short Circuit Peack Current	T_j = 25 °C		2.2		A
$\frac{\Delta V_o}{\Delta T}$	Output Voltage Drift			-1.1		mV/°C

* Load and line regulation are specified at constant junction temperature. Changes in V_o due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

ELECTRICAL CHARACTERISTICS FOR L7806A (V_i = 11V, I_o = 1 A, T_j = 0 to 125 °C (L7806AC), T_j = -40 to 125 °C (L7806AB) unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_o	Output Voltage	T_j = 25 °C	5.88	6	6.12	V
V_o	Output Voltage	I_o = 5 mA to 1 A $P_o \leq$ 15 W V_i = 8.6 to 21 V	5.76	6	6.24	V
ΔV_o*	Line Regulation	V_i = 8.6 to 25 V I_o = 500 mA V_i = 9 to 13 V V_i = 9 to 13 V T_j = 25 °C V_i = 8.3 to 21 V T_j = 25 °C		9 11 3 9	60 60 30 60	mV mV mV mV
ΔV_o*	Load Regulation	I_o = 5 mA to 1 A I_o = 5 mA to 1.5 A T_j = 25 °C I_o = 250 to 750 mA		25 30 10	100 100 50	mV mV mV
I_d	Quiescent Current	T_j = 25 °C		4.3	6 6	mA
ΔI_d	Quiescent Current Change	V_i = 9 to 25 V I_o = 500 mA V_i = 8.6 to 21 V T_j = 25 °C I_o = 5 mA to 1 A			0.8 0.8 0.5	mA mA mA
SVR	Supply Voltage Rejection	V_i = 9 to 19 V f = 120 Hz I_o = 500 mA		65		dB
V_d	Dropout Voltage	I_o = 1 A T_j = 25 °C		2		V
e_N	Output Noise Voltage	B = 10Hz to 100KHz T_j = 25 °C		10		$\mu V/V_o$
R_o	Output Resistance	f = 1KHz		17		mΩ
I_{sc}	Short Circuit Current	V_i = 35 V T_{amb} = 25 °C		0.2		A
I_{scp}	Short Circuit Peack Current	T_j = 25 °C		2.2		A
$\frac{\Delta V_o}{\Delta T}$	Output Voltage Drift			-0.8		mV/°C

* Load and line regulation are specified at constant junction temperature. Changes in V_o due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

ELECTRICAL CHARACTERISTICS FOR L7808A (V_i = 14V, I_o = 1 A, T_j = 0 to 125 °C (L7808AC), T_j = -40 to 125 °C (L7808AB) unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_o	Output Voltage	T_j = 25 °C	7.84	8	8.16	V
V_o	Output Voltage	I_o = 5 mA to 1 A $P_o \leq$ 15 W V_i = 10.6 to 23 V	7.7	8	8.3	V
ΔV_o*	Line Regulation	V_i = 10.6 to 25 V I_o = 500 mA V_i = 11 to 17 V V_i = 11 to 17 V T_j = 25 °C V_i = 10.4 to 23 V T_j = 25 °C		12 15 5 12	80 80 40 80	mV mV mV mV
ΔV_o*	Load Regulation	I_o = 5 mA to 1 A I_o = 5 mA to 1.5 A T_j = 25 °C I_o = 250 to 750 mA		25 30 10	100 100 50	mV mV mV
I_d	Quiescent Current	T_j = 25 °C		4.3	6 6	mA
ΔI_d	Quiescent Current Change	V_i = 11 to 25 V I_o = 500 mA V_i = 10.6 to 23 V T_j = 25 °C I_o = 5 mA to 1 A			0.8 0.8 0.5	mA mA mA
SVR	Supply Voltage Rejection	V_i = 11.5 to 21.5 V f = 120 Hz I_o = 500 mA		62		dB
V_d	Dropout Voltage	I_o = 1 A T_j = 25 °C		2		V
e_N	Output Noise Voltage	B = 10Hz to 100KHz T_j = 25 °C		10		µV/V_o
R_o	Output Resistance	f = 1KHz		18		mΩ
I_{sc}	Short Circuit Current	V_i = 35 V T_{amb} = 25 °C		0.2		A
I_{scp}	Short Circuit Peack Current	T_j = 25 °C		2.2		A
$\frac{\Delta V_o}{\Delta T}$	Output Voltage Drift			-0.8		mV/°C

* Load and line regulation are specified at constant junction temperature. Changes in V_o due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

ELECTRICAL CHARACTERISTICS FOR L7809A (V_i = 15V, I_o = 1 A, T_j = 0 to 125 °C (L7809AC), T_j = -40 to 125 °C (L7809AB) unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_o	Output Voltage	T_j = 25 °C	8.82	9	9.18	V
V_o	Output Voltage	I_o = 5 mA to 1 A $P_o \leq$ 15 W V_i = 10.6 to 23 V	8.65	9	9.35	V
ΔV_o*	Line Regulation	V_i = 10.6 to 25 V I_o = 500 mA V_i = 11 to 17 V V_i = 11 to 17 V T_j = 25 °C V_i = 10.4 to 23 V T_j = 25 °C		12 15 5 12	90 90 45 90	mV mV mV mV
ΔV_o*	Load Regulation	I_o = 5 mA to 1 A I_o = 5 mA to 1.5 A T_j = 25 °C I_o = 250 to 750 mA		25 30 10	100 100 50	mV mV mV
I_d	Quiescent Current	T_j = 25 °C		4.3	6 6	mA
ΔI_d	Quiescent Current Change	V_i = 11 to 25 V I_o = 500 mA V_i = 10.6 to 23 V T_j = 25 °C I_o = 5 mA to 1 A			0.8 0.8 0.5	mA mA mA
SVR	Supply Voltage Rejection	V_i = 11.5 to 21.5 V f = 120 Hz I_o = 500 mA		61		dB
V_d	Dropout Voltage	I_o = 1 A T_j = 25 °C		2		V
e_N	Output Noise Voltage	B = 10Hz to 100KHz T_j = 25 °C		10		$\mu V/V_o$
R_o	Output Resistance	f = 1KHz		18		mΩ
I_{sc}	Short Circuit Current	V_i = 35 V T_{amb} = 25 °C		0.2		A
I_{scp}	Short Circuit Peack Current	T_j = 25 °C		2.2		A
$\frac{\Delta V_o}{\Delta T}$	Output Voltage Drift			-0.8		mV/°C

* Load and line regulation are specified at constant junction temperature. Changes in V_o due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

ELECTRICAL CHARACTERISTICS FOR L7812A (V_i = 19V, I_o = 1 A, T_j = 0 to 125 °C (L7812AC), T_j = -40 to 125 °C (L7812AB) unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_o	Output Voltage	T_j = 25 °C	11.75	12	12.25	V
V_o	Output Voltage	I_o = 5 mA to 1 A $P_o \leq$ 15 W V_i = 14.8 to 27 V	11.5	12	12.5	V
ΔV_o*	Line Regulation	V_i = 14.8 to 30 V I_o = 500 mA V_i = 16 to 22 V V_i = 16 to 22 V T_j = 25 °C V_i = 14.5 to 27 V T_j = 25 °C		13 16 6 13	120 120 60 120	mV mV mV mV
ΔV_o*	Load Regulation	I_o = 5 mA to 1 A I_o = 5 mA to 1.5 A T_j = 25 °C I_o = 250 to 750 mA		25 30 10	100 100 50	mV mV mV
I_d	Quiescent Current	T_j = 25 °C		4.4	6 6	mA
ΔI_d	Quiescent Current Change	V_i = 15 to 30 V I_o = 500 mA V_i = 14.8 to 27 V T_j = 25 °C I_o = 5 mA to 1 A			0.8 0.8 0.5	mA mA mA
SVR	Supply Voltage Rejection	V_i = 15 to 25 V f = 120 Hz I_o = 500 mA		60		dB
V_d	Dropout Voltage	I_o = 1 A T_j = 25 °C		2		V
e_N	Output Noise Voltage	B = 10Hz to 100KHz T_j = 25 °C		10		µV/V_o
R_o	Output Resistance	f = 1KHz		18		mΩ
I_{sc}	Short Circuit Current	V_i = 35 V T_{amb} = 25 °C		0.2		A
I_{scp}	Short Circuit Peack Current	T_j = 25 °C		2.2		A
$\frac{\Delta V_o}{\Delta T}$	Output Voltage Drift			-1		mV/°C

* Load and line regulation are specified at constant junction temperature. Changes in V_o due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

ELECTRICAL CHARACTERISTICS FOR L7815A (V_i = 23V, I_o = 1 A, T_j = 0 to 125 °C (L7815AC), T_j = -40 to 125 °C (L7815AB) unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_o	Output Voltage	T_j = 25 °C	14.7	15	15.3	V
V_o	Output Voltage	I_o = 5 mA to 1 A $P_o \leq$ 15 W V_i = 17.9 to 30 V	14.4	15	15.6	V
ΔV_o*	Line Regulation	V_i = 17.9 to 30 V I_o = 500 mA V_i = 20 to 26 V V_i = 20 to 26 V T_j = 25 °C V_i = 17.5 to 30 V T_j = 25 °C		13 16 6 13	150 150 75 150	mV mV mV mV
ΔV_o*	Load Regulation	I_o = 5 mA to 1 A I_o = 5 mA to 1.5 A T_j = 25 °C I_o = 250 to 750 mA		25 30 10	100 100 50	mV mV mV
I_d	Quiescent Current	T_j = 25 °C		4.4	6 6	mA
ΔI_d	Quiescent Current Change	V_i = 17.5 to 30 V I_o = 500 mA V_i = 17.5 to 30 V T_j = 25 °C I_o = 5 mA to 1 A			0.8 0.8 0.5	mA mA mA
SVR	Supply Voltage Rejection	V_i = 18.5 to 28.5 V f = 120 Hz I_o = 500 mA		58		dB
V_d	Dropout Voltage	I_o = 1 A T_j = 25 °C		2		V
e_N	Output Noise Voltage	B = 10Hz to 100KHz T_j = 25 °C		10		$\mu V/V_o$
R_o	Output Resistance	f = 1KHz		19		mΩ
I_{sc}	Short Circuit Current	V_i = 35 V T_{amb} = 25 °C		0.2		A
I_{scp}	Short Circuit Peack Current	T_j = 25 °C		2.2		A
$\frac{\Delta V_o}{\Delta T}$	Output Voltage Drift			-1		mV/°C

* Load and line regulation are specified at constant junction temperature. Changes in V_o due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

ELECTRICAL CHARACTERISTICS FOR L7818A (V_i = 27V, I_o = 1 A, T_j = 0 to 125 °C (L7818AC), T_j = -40 to 125 °C (L7818AB) unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_o	Output Voltage	T_j = 25 °C	17.64	18	18.36	V
V_o	Output Voltage	I_o = 5 mA to 1 A $P_o \leq$ 15 W V_i = 21 to 33 V	17.3	18	18.7	V
ΔV_o*	Line Regulation	V_i = 21 to 33 V I_o = 500 mA V_i = 24 to 30 V V_i = 24 to 30 V T_j = 25 °C V_i = 20.6 to 33 V T_j = 25 °C		25 28 10 5	180 180 90 180	mV mV mV mV
ΔV_o*	Load Regulation	I_o = 5 mA to 1 A I_o = 5 mA to 1.5 A T_j = 25 °C I_o = 250 to 750 mA		25 30 10	100 100 50	mV mV mV
I_d	Quiescent Current	T_j = 25 °C		4.5	6 6	mA
ΔI_d	Quiescent Current Change	V_i = 21 to 33 V I_o = 500 mA V_i = 21 to 33 V T_j = 25 °C I_o = 5 mA to 1 A			0.8 0.8 0.5	mA mA mA
SVR	Supply Voltage Rejection	V_i = 22 to 32 V f = 120 Hz I_o = 500 mA		57		dB
V_d	Dropout Voltage	I_o = 1 A T_j = 25 °C		2		V
e_N	Output Noise Voltage	B = 10Hz to 100KHz T_j = 25 °C		10		µV/V_o
R_o	Output Resistance	f = 1KHz		19		mΩ
I_{sc}	Short Circuit Current	V_i = 35 V T_{amb} = 25 °C		0.2		A
I_{scp}	Short Circuit Peack Current	T_j = 25 °C		2.2		A
$\frac{\Delta V_o}{\Delta T}$	Output Voltage Drift			-1		mV/°C

* Load and line regulation are specified at constant junction temperature. Changes in V_o due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

ELECTRICAL CHARACTERISTICS FOR L7820A (V_i = 28V, I_o = 1 A, T_j = 0 to 125 °C (L7820AC), T_j = -40 to 125 °C (L7820AB) unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_o	Output Voltage	T_j = 25 °C	19.6	20	20.4	V
V_o	Output Voltage	I_o = 5 mA to 1 A $P_o \leq$ 15 W V_i = 23 to 35 V	19.2	20	20.8	V
ΔV_o*	Line Regulation	V_i = 23 to 35 V I_o = 500 mA V_i = 26 to 32 V V_i = 26 to 32 V T_j = 25 °C V_i = 23 to 32 V T_j = 25 °C			200 200 100 200	mV mV mV mV
ΔV_o*	Load Regulation	I_o = 5 mA to 1 A I_o = 5 mA to 1.5 A T_j = 25 °C I_o = 250 to 750 mA		25 30 10	100 100 50	mV mV mV
I_d	Quiescent Current	T_j = 25 °C		4.5	6 6	mA
ΔI_d	Quiescent Current Change	V_i = 23 to 35 V I_o = 500 mA V_i = 23 to 35 V T_j = 25 °C I_o = 5 mA to 1 A			0.8 0.8 0.5	mA mA mA
SVR	Supply Voltage Rejection	V_i = 24 to 35 V f = 120 Hz I_o = 500 mA		56		dB
V_d	Dropout Voltage	I_o = 1 A T_j = 25 °C		2		V
e_N	Output Noise Voltage	B = 10Hz to 100KHz T_j = 25 °C		10		$\mu V/V_o$
R_o	Output Resistance	f = 1KHz		20		mΩ
I_{sc}	Short Circuit Current	V_i = 35 V T_{amb} = 25 °C		0.2		A
I_{scp}	Short Circuit Peack Current	T_j = 25 °C		2.2		A
$\frac{\Delta V_o}{\Delta T}$	Output Voltage Drift			-1		mV/°C

* Load and line regulation are specified at constant junction temperature. Changes in V_o due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

ELECTRICAL CHARACTERISTICS FOR L7824A (V_i = 33V, I_o = 1 A, T_j = 0 to 125 °C (L7824AC), T_j = -40 to 125 °C (L7824AB) unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_o	Output Voltage	T_j = 25 °C	23.5	24	24.5	V
V_o	Output Voltage	I_o = 5 mA to 1 A $P_o \leq$ 15 W V_i = 27.3 to 38 V	23	24	25	V
ΔV_o*	Line Regulation	V_i = 27 to 38 V I_o = 500 mA V_i = 30 to 36 V V_i = 30 to 36 V T_j = 25 °C V_i = 26.7 to 38 V T_j = 25 °C		31 35 14 31	240 240 120 240	mV mV mV mV
ΔV_o*	Load Regulation	I_o = 5 mA to 1 A I_o = 5 mA to 1.5 A T_j = 25 °C I_o = 250 to 750 mA		25 30 10	100 100 50	mV mV mV
I_d	Quiescent Current	T_j = 25 °C		4.6	6 6	mA
ΔI_d	Quiescent Current Change	V_i = 27.3 to 38 V I_o = 500 mA V_i = 27.3 to 38 V T_j = 25 °C I_o = 5 mA to 1 A			0.8 0.8 0.5	mA mA mA
SVR	Supply Voltage Rejection	V_i = 28 to 38 V f = 120 Hz I_o = 500 mA		54		dB
V_d	Dropout Voltage	I_o = 1 A T_j = 25 °C		2		V
e_N	Output Noise Voltage	B = 10Hz to 100KHz T_j = 25 °C		10		µV/V_o
R_o	Output Resistance	f = 1KHz		20		mΩ
I_{sc}	Short Circuit Current	V_i = 35 V T_{amb} = 25 °C		0.2		A
I_{scp}	Short Circuit Peack Current	T_j = 25 °C		2.2		A
$\frac{\Delta V_o}{\Delta T}$	Output Voltage Drift			-1.5		mV/°C

* Load and line regulation are specified at constant junction temperature. Changes in V_o due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

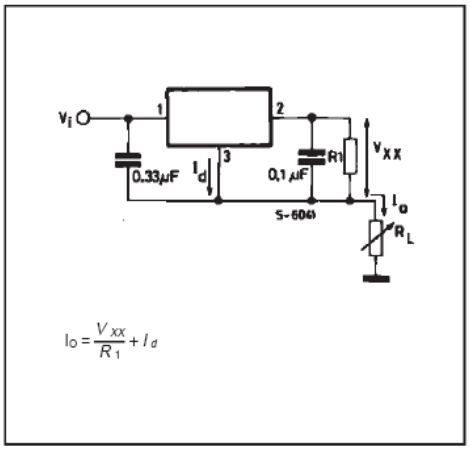
APPLICATIONS INFORMATION

DESIGN CONSIDERATIONS

The L7800A Series of fixed voltage regulators are designed with Thermal Overload Protection that shuts down the circuit when subjected to an excessive power overload condition, Internal Short-circuit Protection that limits the maximum current the circuit will pass, and Output Transistor Safe-Area Compensation that reduces the output short-circuit current as the voltage across the pass transistor is increased.

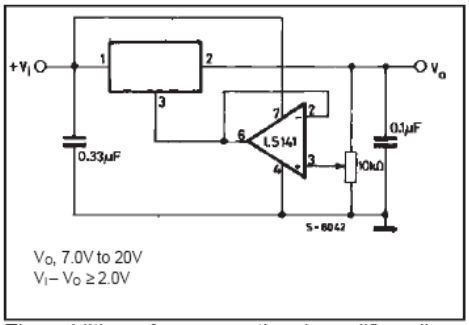
In many low current applications, compensation capacitors are not required. However, it is recommended that the regulator input be bypassed with a capacitor if the regulator is connected to the power supply filter with long wire lengths, or if the output load capacitance is large. An input bypass capacitor should be selected to provide good high-frequency characteristics to insure stable operation under all load conditions. A 0.33µF or larger tantalum, mylar, or other capacitor having low internal impedance at high frequencies should be chosen. The bypass capacitor should be mounted with the shortest possible leads directly across the regulators input terminals. Normally good construction techniques should be used to minimize ground loops and lead resistance drops since the regulator has no external sense lead.

Figure 4 : Current Regulator.



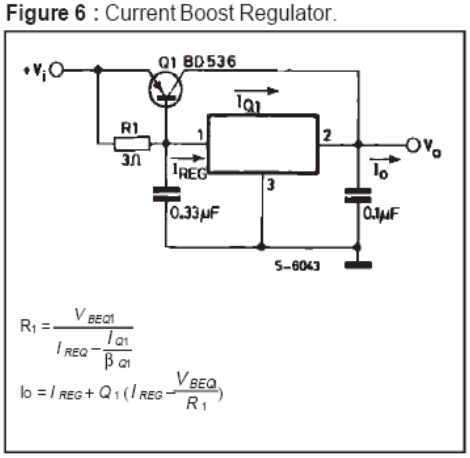
$$I_O = \frac{V_{XX}}{R_1} + I_d$$

Figure 5 : Adjustable Output Regulator.



The addition of an operational amplifier allows adjustment to higher or intermediate values while retaining regulation characteristics. The minimum voltage obtainable with this arrangement is 2.0V greater than the regulator voltage.

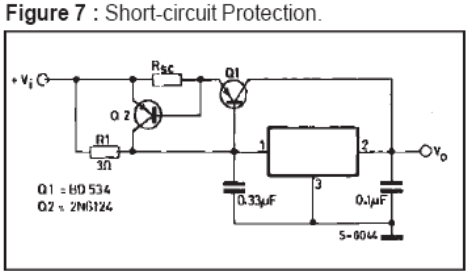
Figure 6 : Current Boost Regulator.



$$R_1 = \frac{V_{BEQ1}}{I_{REG} - \frac{I_{Q1}}{\beta_{Q1}}}$$

$$I_O = I_{REG} + Q_1 \left(I_{REG} - \frac{V_{BEQ}}{R_1}\right)$$

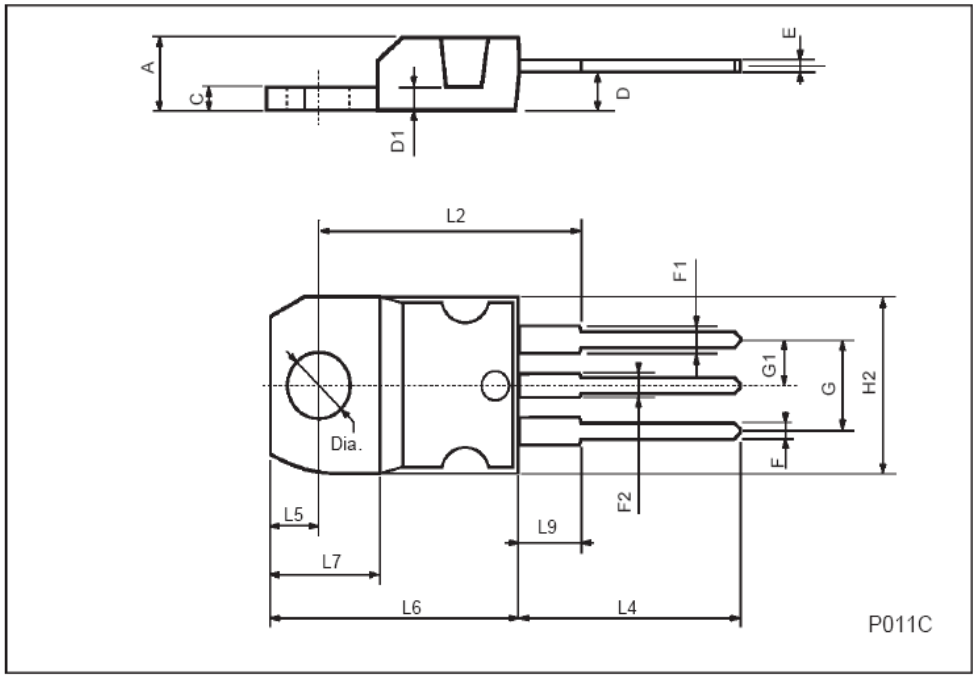
Figure 7 : Short-circuit Protection.



The circuit of figure 6 can be modified to provide supply protection against short circuit by adding a short-circuit sense resistor, R_{SC}, and an additional PNP transistor. The current sensing PNP must be able to handle the short-circuit current of the three-terminal regulator. Therefore, a four-ampere plastic power transistor is specified.

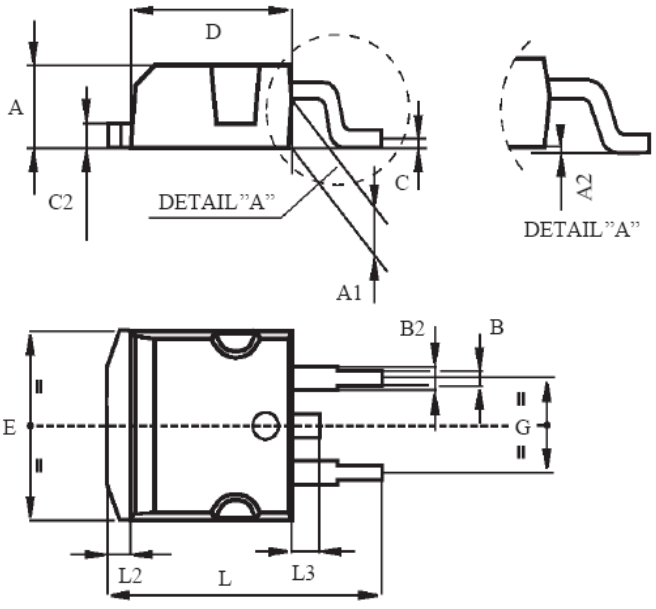
TO-220 MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
C	1.23		1.32	0.048		0.051
D	2.40		2.72	0.094		0.107
D1		1.27			0.050	
E	0.49		0.70	0.019		0.027
F	0.61		0.88	0.024		0.034
F1	1.14		1.70	0.044		0.067
F2	1.14		1.70	0.044		0.067
G	4.95		5.15	0.194		0.203
G1	2.4		2.7	0.094		0.106
H2	10.0		10.40	0.393		0.409
L2		16.4			0.645	
L4	13.0		14.0	0.511		0.551
L5	2.65		2.95	0.104		0.116
L6	15.25		15.75	0.600		0.620
L7	6.2		6.6	0.244		0.260
L9	3.5		3.93	0.137		0.154
DIA.	3.75		3.85	0.147		0.151



TO-263 (D^2PAK) MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
E	10		10.4	0.393		0.409
G	4.88		5.28	0.192		0.208
L	15		15.85	0.590		0.624
L2	1.27		1.4	0.050		0.055
L3	1.4		1.75	0.055		0.068



LAMPIRAN D

Perhitungan Catu Daya..... D-1

Perhitungan Total Arus Yang Disupply Ke Rangkaian Papan peraga Permainan Othelo

Regulator 1:

Pada Saat keadaan kosong:

Diketahui: V rata – rata = 2.38V

R =10K

V led=2V

$V_{(\text{ pada 220 ohm})}$=5-Vled=5-2=3V

r=220 ohm

$I_1=\frac{2.38\,V}{10K}$ =0.238 mAx64 kotak=15.36 mA

$I_2=\frac{3\,V}{220}$ =13 mAx64 kotak= 832 mA

$I_{total} = I_1 + I_2$

= 832mA+15.36 mA=847.36 mA

Pada Saat keadaan putih di bawah:

Diketahui: V rata – rata = 2.66V

R =10K

V led=2V

$V_{(\text{ pada 220 ohm})}$=5-Vled=5-2=3V

r=220 ohm

$I_1=\frac{2.66\,V}{10K}$ =0.266 mAx64 kotak=17.02 mA

$I_2=\frac{3\,V}{220}$ =13 mAx64 kotak= 832 mA

$I_{total} = I_1 + I_2$

= 832mA+15.36 mA=849.02 mA

Pada Saat keadaan hitam di bawah:

Diketahui: V rata – rata = 1.25V

R =10K

V led=2V

$V_{(\text{ pada 220 ohm})}$=5-Vled=5-2=3V

r=220 ohm

$I_1=\frac{1.25\,V}{10K}$ =0.125 mAx64 kotak=8 mA

$I_2=\frac{3\,V}{220}$ =13 mAx64 kotak= 832 mA

$I_{total} = I_1 + I_2$

= 832mA+8 mA=840 mA

Rata-rata total arus pada regulator 2 = $\frac{847.36\text{ mA}+849.02\text{ mA}+840\text{ mA}}{3}$

= 845, 46 mA

Regulator 2:

Hasil Pengukuran Arus yang terpakai pada Rangkaian Elektronik Switch dengan menggunakan ampere meter sebesar ± 20mA.

Hasil Pengukuran Arus yang terpakai pada Mikrokontroler dengan menggunakan ampere meter sebesar ±20 mA.

Hasil Pengukuran Arus yang terpakai pada ICL232 dengan menggunakan ampere meter sebesar ±10 mA.

Total Arus pada regulator 2= ± 20mA+ 20 mA+ 10 mA= ± 50 mA.