LAMPIRAN A


```
unit rfid;

interface

uses
  Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
  Dialogs, ExtCtrls, QCCom32, StdCtrls, Buttons, DB, DBTables, Grids,
  DBGrids;

type
  TForm1 = class(TForm)
    com: TQCCom32;
    Pnokartu: TPanel;
    Timer1: TTimer;
    BitBtn1: TBitBtn;
    pjam: TPanel;
    ptanggal: TPanel;
    Label1: TLabel;
    Panel4: TPanel;
    pkomputer1: TPanel;
    Panel2: TPanel;
    BitBtn2: TBitBtn;
    BitBtn3: TBitBtn;
    DataSource1: TDataSource;
    DataSource2: TDataSource;
    Tcustomer: TTable;
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```
Tlog: TTable;
DBGrid1: TDBGrid;
Ttarif: TTable;
DataSource3: TDataSource;
Lkomputer1: TLabel;
LTkomputer1: TLabel;
pkomputer2: TPanel;
LKomputer2: TLabel;
LTkomputer2: TLabel;
pkomputer3: TPanel;
LKomputer3: TLabel;
LTkomputer3: TLabel;
pkomputer4: TPanel;
LKomputer4: TLabel;
LTKomputer4: TLabel;
BitBtn4: TBitBtn;
BitBtn5: TBitBtn;
BitBtn6: TBitBtn;
BitBtn7: TBitBtn;
BitBtn8: TBitBtn;
BitBtn9: TBitBtn;
BitBtn10: TBitBtn;
BitBtn11: TBitBtn;
pst1hidup: TPanel;
pst1masalah: TPanel;
pst1mati: TPanel;
pst2hidup: TPanel;
pst2masalah: TPanel;
pst2mati: TPanel;
pst3hidup: TPanel;
pst3masalah: TPanel;
pst3mati: TPanel;
pst4hidup: TPanel;
pst4masalah: TPanel;
pst4mati: TPanel;
Panel1: TPanel;
Panel3: TPanel;
procedure Timer1Timer(Sender: TObject);
procedure BitBtn3Click(Sender: TObject);
procedure FormCreate(Sender: TObject);
procedure BitBtn2Click(Sender: TObject);
procedure BitBtn4Click(Sender: TObject);
procedure BitBtn6Click(Sender: TObject);
procedure BitBtn8Click(Sender: TObject);
procedure BitBtn10Click(Sender: TObject);
procedure BitBtn5Click(Sender: TObject);
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```
    procedure BitBtn7Click(Sender: TObject);
    procedure BitBtn9Click(Sender: TObject);
    procedure BitBtn11Click(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  Form1: TForm1;
  datars232,datacom:string;
  datakartu:string;
  datakartuN,datacomN:longint;
  code:integer;
  detik,detiklama:integer;
  STKomputer1,STKomputer2,STKomputer3,STKomputer4:boolean;
  Jam1,Menit1,Detik1,
  Jam2,Menit2,Detik2,
  Jam3,Menit3,Detik3,
  Jam4,Menit4,Detik4:integer;
  Rupiah1,Rupiah2,Rupiah3,Rupiah4,TarifRupiah,
  RupiahDBF1,RupiahDBF2,RupiahDBF3,RupiahDBF4:integer;
  STmasuk:boolean;
  NomorKomputer:string;
  STKomputer:integer;
  ketemu,dataataustatus:boolean;
  statuskom1,statuskom2,statuskom3,statuskom4:boolean; {status dari komputer}
  statusdatakom1,statusdatakom2,statusdatakom3,statusdatakom4:boolean; {status dari alat}

implementation
uses unitcustomer,unittarif;
{$R *.dfm}

procedure TForm1.Timer1Timer(Sender: TObject);
begin
pjam.caption:=formatdatetime('hh:mm:ss',time);
ptanggal.caption:=formatdatetime('dd/mm/yyyy',date);
detik:=strtoint(copy(pjam.caption,7,2));
{Pengambilan jam dan tanggal dari system computer}

{pengecekan perubahan detik}
if detik<>detiklama then
begin
 detiklama:=detik;
 if STKomputer1 then
```

```
   begin
{penampilan status computer 1 ke layar jika aktif}
   pkomputer1.Color:=cllime;
     detik1:=detik1+1;
     if detik1=60 then
        begin
          detik1:=0;
          menit1:=menit1+1;
          if menit1=60 then
           begin
             menit1:=0;
             jam1:=jam1+1;
             rupiah1:=rupiah1+Tarifrupiah;
           end;
        end;
   Lkomputer1.caption:=inttostr(jam1)+':'+inttostr(menit1)+':'+inttostr(detik1);
   LTkomputer1.caption:='Rp. '+inttostr(rupiah1);
   end; {end komputer1}
 if STKomputer2 then
   begin
{penampilan status computer 2 ke layar jika aktif}

   pkomputer2.Color:=cllime;
     detik2:=detik2+1;
     if detik2=60 then
        begin
          detik2:=0;
          menit2:=menit2+1;
          if menit2=60 then
           begin
             menit2:=0;
             jam2:=jam2+1;
             rupiah2:=rupiah2+Tarifrupiah;
           end;
        end;
   Lkomputer2.caption:=inttostr(jam2)+':'+inttostr(menit2)+':'+inttostr(detik2);
   LTkomputer2.caption:='Rp. '+inttostr(rupiah2);
   end; {end komputer2}
  if STKomputer3 then
   begin
{penampilan status computer 3 ke layar jika aktif}

   pkomputer3.Color:=cllime;
     detik3:=detik3+1;
     if detik3=60 then
        begin
```

```
          detik3:=0;
          menit3:=menit3+1;
          if menit3=60 then
           begin
             menit3:=0;
             jam3:=jam3+1;
             rupiah3:=rupiah3+Tarifrupiah;
           end;
        end;
    Lkomputer3.caption:=inttostr(jam3)+':'+inttostr(menit3)+':'+inttostr(detik3);
    LTkomputer3.caption:='Rp. '+inttostr(rupiah3);
    end; {end komputer3}
  if STKomputer4 then
    begin
{penampilan status computer 4 ke layar jika aktif}

    pkomputer4.Color:=cllime;
      detik4:=detik4+1;
      if detik4=60 then
        begin
          detik4:=0;
          menit4:=menit4+1;
          if menit4=60 then
           begin
             menit4:=0;
             jam4:=jam4+1;
             rupiah4:=rupiah4+Tarifrupiah;
           end;
        end;
    Lkomputer4.caption:=inttostr(jam4)+':'+inttostr(menit4)+':'+inttostr(detik4);
    LTkomputer4.caption:='Rp. '+inttostr(rupiah4);
    end; {end komputer4}
end; {detik}

if not STkomputer1 then
    begin
{jika status pemakaian computer 1 off}
     PKomputer1.color:=clwhite;
     Pkomputer1.Caption:='0000000000';
     LKomputer1.caption:='KOMPUTER 1';
     LTKomputer1.caption:='Rp. 0';
     jam1:=0;menit1:=0;detik1:=0;rupiah1:=TarifRupiah;
    end;
if not STkomputer2 then
    begin
{jika status pemakaian computer 2 off}
```

```
     PKomputer2.color:=clwhite;
     Pkomputer2.Caption:='0000000000';
     LKomputer2.caption:='KOMPUTER 2';
     LTKomputer2.caption:='Rp. 0';
     jam2:=0;menit2:=0;detik2:=0;rupiah2:=TarifRupiah;
    end;
if not STkomputer3 then
    begin
{jika status pemakaian computer 3 off}

     PKomputer3.color:=clwhite;
     Pkomputer3.Caption:='0000000000';
     LKomputer3.caption:='KOMPUTER 3';
     LTKomputer3.caption:='Rp. 0';
     jam3:=0;menit3:=0;detik3:=0;rupiah3:=TarifRupiah;
    end;
if not STkomputer4 then
    begin
{jika status pemakaian computer 4 off}

     PKomputer4.color:=clwhite;
     Pkomputer4.Caption:='0000000000';
     LKomputer4.caption:='KOMPUTER 4';
     LTKomputer4.caption:='Rp. 0';
     jam4:=0;menit4:=0;detik4:=0;rupiah4:=TarifRupiah;
    end;

datars232:=com.Read; { pengambilan data serial dari COM}
if length(datars232)>6 then
begin

  if copy(datars232,1,1)<>'S' then
  begin
{pengambilan data nomor kartu}
  datakartu:='$'+copy(datars232,4,8);
  val(datakartu,datakartuN,code);
  datakartu:=inttostr(datakartuN);


  if length(datakartu)=7 then datakartu:='000'+datakartu;
  if length(datakartu)=6 then datakartu:='0000'+datakartu;
  pnokartu.Caption:=datakartu;
  dataataustatus:=true;
  end else
     begin
```

```
      dataataustatus:=false;
      datacom:=copy(datars232,2,1);
      val(datacom,datacomN,code);

      if (datacomN and $01)=$01 then statusdatakom1:=true else statusdatakom1:=false;
      if (datacomN and $02)=$02 then statusdatakom2:=true else statusdatakom2:=false;
      if (datacomN and $04)=$04 then statusdatakom3:=true else statusdatakom3:=false;
      if (datacomN and $08)=$08 then statusdatakom4:=true else statusdatakom4:=false;

    end;
  STMasuk:=true;

  if (datakartu=pkomputer1.caption) and dataataustatus then
    begin
 {jika computer 1 pada posisi online dan siap di offkan}
      STmasuk:=false;
      STKomputer1:=false;
      STkomputer:=STKomputer-8;

      Tlog.refresh;
      Tlog.first;
      while not tlog.Eof do
      begin
        if (pkomputer1.caption=tlog.fieldbyname('NO_RFID').asstring)
          and (tlog.FieldByName('JM_KELUAR').asstring='') then
        begin
          Tlog.edit;
          Tlog.FieldByName('JM_KELUAR').asstring:=pjam.caption;
          Tlog.FieldByName('RUPIAH').asinteger:=Rupiah1;
          Tlog.FieldByName('DURASI').asstring:=LKomputer1.caption;
          Tlog.post;
          Tlog.last;
          com.Write('5');
          com.Write('5');
          com.Write('5');
          statuskom1:=false;
        end;
        Tlog.Next;
      end;{end while}

      Tcustomer.Refresh;
      Tcustomer.First;
      while not tcustomer.Eof do
      begin
        if (pkomputer1.Caption=tcustomer.FieldByName('NO_RFID').asstring)
        then
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```
        begin
          Rupiah1:=RupiahDBF1-Rupiah1;
          tcustomer.edit;
          tcustomer.FieldByName('DEPOSIT').asinteger:=Rupiah1;
          tcustomer.Post;
          tcustomer.Last;
          formcustomer.table1.Refresh;
        end;
        tcustomer.Next;
      end;

    end;
  if (datakartu=pkomputer2.caption) and dataataustatus then
    begin
{jika computer 2 pada posisi online dan siap di offkan}

      STmasuk:=false;
      STKomputer2:=false;
      STkomputer:=STKomputer-4;
      Tlog.refresh;
      Tlog.first;
      while not tlog.Eof do
      begin
        if (pkomputer2.caption=tlog.fieldbyname('NO_RFID').asstring)
           and (tlog.FieldByName('JM_KELUAR').asstring='') then
        begin
          Tlog.edit;
          Tlog.FieldByName('JM_KELUAR').asstring:=pjam.caption;
          Tlog.FieldByName('RUPIAH').asinteger:=Rupiah2;
          Tlog.FieldByName('DURASI').asstring:=LKomputer2.caption;
          Tlog.post;
          Tlog.last;
          com.Write('6');
          com.Write('6');
          com.Write('6');
          statuskom2:=false;
        end;
        Tlog.Next;
      end;
      Tcustomer.Refresh;
      Tcustomer.First;
      while not tcustomer.Eof do
      begin
        if (pkomputer2.Caption=tcustomer.FieldByName('NO_RFID').asstring)
        then
        begin
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        Rupiah2:=RupiahDBF2-Rupiah2;
        tcustomer.edit;
        tcustomer.FieldByName('DEPOSIT').asinteger:=Rupiah2;
        tcustomer.Post;
        tcustomer.Last;
        formcustomer.table1.Refresh;
      end;
      tcustomer.Next;
    end;
  end;
 if (datakartu=pkomputer3.caption) and dataataustatus then
  begin
{jika computer 3 pada posisi online dan siap di offkan}

    STmasuk:=false;
    STKomputer3:=false;
    STkomputer:=STKomputer-2;
    Tlog.refresh;
    Tlog.first;
    while not tlog.Eof do
    begin
      if (pkomputer3.caption=tlog.fieldbyname('NO_RFID').asstring)
         and (tlog.FieldByName('JM_KELUAR').asstring='') then
      begin
        Tlog.edit;
        Tlog.FieldByName('JM_KELUAR').asstring:=pjam.caption;
        Tlog.FieldByName('RUPIAH').asinteger:=Rupiah3;
        Tlog.FieldByName('DURASI').asstring:=LKomputer3.caption;
        Tlog.post;
        Tlog.last;
        com.Write('7');
        com.Write('7');
        com.Write('7');
        statuskom3:=false;
      end;
      Tlog.Next;
    end;
    Tcustomer.Refresh;
    Tcustomer.First;
    while not tcustomer.Eof do
    begin
      if (pkomputer3.Caption=tcustomer.FieldByName('NO_RFID').asstring)
      then
      begin
        Rupiah3:=RupiahDBF3-Rupiah3;
        tcustomer.edit;
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```
        tcustomer.FieldByName('DEPOSIT').asinteger:=Rupiah3;
        tcustomer.Post;
        tcustomer.Last;
        formcustomer.table1.Refresh;
      end;
      tcustomer.Next;
    end;
  end;
 if (datakartu=pkomputer4.caption) and dataataustatus then
   begin
{jika computer 4 pada posisi online dan siap di offkan}

    STmasuk:=false;
    STKomputer4:=false;
    STkomputer:=STKomputer-1;
    Tlog.refresh;
    Tlog.first;
    while not tlog.Eof do
    begin
      if (pkomputer4.caption=tlog.fieldbyname('NO_RFID').asstring)
         and (tlog.FieldByName('JM_KELUAR').asstring='') then
      begin
        Tlog.edit;
        Tlog.FieldByName('JM_KELUAR').asstring:=pjam.caption;
        Tlog.FieldByName('RUPIAH').asinteger:=Rupiah4;
        Tlog.FieldByName('DURASI').asstring:=LKomputer4.caption;
        Tlog.post;
        Tlog.last;
        com.Write('8');
        com.Write('8');
        com.Write('8');
        statuskom4:=false;
      end;
      Tlog.Next;
    end;
    Tcustomer.Refresh;
    Tcustomer.First;
    while not tcustomer.Eof do
    begin
      if (pkomputer4.Caption=tcustomer.FieldByName('NO_RFID').asstring)
      then
      begin
        Rupiah4:=RupiahDBF4-Rupiah4;
        tcustomer.edit;
        tcustomer.FieldByName('DEPOSIT').asinteger:=Rupiah4;
        tcustomer.Post;
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        tcustomer.Last;
        formcustomer.table1.Refresh;
      end;
      tcustomer.Next;
    end;
  end;

{pengecekan untuk computer baru mulai}
 if (STMasuk) and dataataustatus then
 begin
 ketemu:=false;
 Tcustomer.refresh;
 Tcustomer.First;
 while not tcustomer.eof do
 begin
   if datakartu=Tcustomer.FieldByName('NO_RFID').asstring then
     begin
     ketemu:=true;
      if (STKomputer=14)
{jika status computer 4 aktif maka ambil data dan berikan kode nomor computer 4}

        then
       begin
        STKomputer:=STKomputer+$01;
        NomorKomputer:='4';
        STkomputer4:=true;
        Pkomputer4.caption:=datakartu;
        RupiahDBF4:=Tcustomer.Fieldbyname('DEPOSIT').asinteger;
        com.Write('4');
        com.Write('4');
        com.Write('4');
        statuskom4:=true;
       end;
      if (STKomputer=12) or (STKomputer=13)
        then
{jika status computer 3 aktif maka ambil data dan berikan kode nomor computer 3}

       begin
        STKomputer:=STKomputer+$02;
        NomorKomputer:='3';
        STkomputer3:=true;
        Pkomputer3.caption:=datakartu;
        RupiahDBF3:=Tcustomer.Fieldbyname('DEPOSIT').asinteger;
        com.Write('3');
        com.Write('3');
        com.Write('3');
```

```
    statuskom3:=true;
   end;
  if (STKomputer=8) or (STKomputer=9) or
    (STKomputer=10) or (STKomputer=11)
    Then
{jika status computer 2 aktif maka ambil data dan berikan kode nomor computer 2}

   begin
    STKomputer:=STKomputer+$04;
    NomorKomputer:='2';
    STkomputer2:=true;
    Pkomputer2.caption:=datakartu;
    RupiahDBF2:=Tcustomer.Fieldbyname('DEPOSIT').asinteger;
    com.Write('2');
    com.Write('2');
    com.Write('2');
    statuskom2:=true;
   end;

  if (STKomputer=0) or (STKomputer=1) or
    (STKomputer=2) or (STKomputer=3) or
    (STKomputer=4) or (STKomputer=5) or
    (STKomputer=6) or
    (STKomputer=7) then
   Begin
{jika status computer 1 aktif maka ambil data dan berikan kode nomor computer 1}

    STKomputer:=STKomputer+$08;
    NomorKomputer:='1';
    STkomputer1:=true;
    Pkomputer1.caption:=datakartu;
    RupiahDBF1:=Tcustomer.Fieldbyname('DEPOSIT').asinteger;
    com.Write('1');
    com.Write('1');
    com.Write('1');
    statuskom1:=true;
   end;


  Tlog.refresh;
  Tlog.last;
  Tlog.insert;
  Tlog.FieldByName('TGL_MASUK').asstring:=ptanggal.caption;
  Tlog.FieldByName('JM_MASUK').asstring:=pjam.caption;
  Tlog.FieldByName('NAMA').asstring:=Tcustomer.fieldbyname('NAMA').asstring;
  Tlog.FieldByName('NO_RFID').asstring:=datakartu;
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      Tlog.FieldByName('KOMPUTER').asstring:=NomorKomputer;

      Tlog.post;
      Tcustomer.Last;

     end;
   Tcustomer.Next;
 end;{end while}
 if not ketemu then MessageDlg('NOMOR TIDAK TERDAFTAR', mtInformation,
    [mbOk], 0);
 end;{end if STmasuk}

{penampilan status}
 if not dataataustatus then
 begin
 {status listrik komputer 1}
   if statuskom1 and statusdatakom1 then
   begin
     pst1hidup.color:=clgreen;
     pst1masalah.color:=clbtnface;
     pst1mati.color:=clbtnface;
   end;
   if statuskom1 and (not statusdatakom1) then
   begin
     pst1hidup.color:=clbtnface;
     pst1masalah.color:=clred;
     pst1mati.color:=clbtnface;
   end;
   if (not statuskom1) and (not statusdatakom1) then
   begin
     pst1hidup.color:=clbtnface;
     pst1masalah.color:=clbtnface;
     pst1mati.color:=clgreen;
   end;
 {status listrik komputer 2}
   if statuskom2 and statusdatakom2 then
   begin
     pst2hidup.color:=clgreen;
     pst2masalah.color:=clbtnface;
     pst2mati.color:=clbtnface;
   end;
   if statuskom2 and (not statusdatakom2) then
   begin
     pst2hidup.color:=clbtnface;
     pst2masalah.color:=clred;
     pst2mati.color:=clbtnface;
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 end;
 if (not statuskom2) and (not statusdatakom2) then
 begin
  pst2hidup.color:=clbtnface;
  pst2masalah.color:=clbtnface;
  pst2mati.color:=clgreen;
 end;
{status listrik komputer 3}
 if statuskom3 and statusdatakom3 then
 begin
  pst3hidup.color:=clgreen;
  pst3masalah.color:=clbtnface;
  pst3mati.color:=clbtnface;
 end;
 if statuskom3 and (not statusdatakom3) then
 begin
  pst3hidup.color:=clbtnface;
  pst3masalah.color:=clred;
  pst3mati.color:=clbtnface;
 end;
 if (not statuskom3) and (not statusdatakom3) then
 begin
  pst3hidup.color:=clbtnface;
  pst3masalah.color:=clbtnface;
  pst3mati.color:=clgreen;
 end;
{status listrik komputer 4}
 if statuskom4 and statusdatakom4 then
 begin
  pst4hidup.color:=clgreen;
  pst4masalah.color:=clbtnface;
  pst4mati.color:=clbtnface;
 end;
 if statuskom4 and (not statusdatakom4) then
 begin
  pst4hidup.color:=clbtnface;
  pst4masalah.color:=clred;
  pst4mati.color:=clbtnface;
 end;
 if (not statuskom4) and (not statusdatakom4) then
 begin
  pst4hidup.color:=clbtnface;
  pst4masalah.color:=clbtnface;
  pst4mati.color:=clgreen;
 end;
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  end;
end;

end;

procedure TForm1.BitBtn3Click(Sender: TObject);
begin
FormCustomer.show;
end;

procedure TForm1.FormCreate(Sender: TObject);
begin

{start awal program dimulai dari sini}
com.pick;
detiklama:=00;
STKomputer1:=false;
STKomputer2:=false;
STKomputer3:=false;
STKomputer4:=false;
statuskom1:=false;
statuskom2:=false;
statuskom3:=false;
statuskom4:=false;
statusdatakom1:=false;
statusdatakom2:=false;
statusdatakom3:=false;
statusdatakom4:=false;
STKomputer:=0;
Jam1:=0;
Menit1:=0;
detik1:=0;
Jam2:=0;
Menit2:=0;
detik2:=0;
Jam3:=0;
Menit3:=0;
detik3:=0;
Jam4:=0;
Menit4:=0;
detik4:=0;
Ttarif.Refresh;
TTarif.First;
TarifRupiah:=Ttarif.fieldbyname('RUPIAH').AsInteger;
Rupiah1:=TarifRupiah;
Rupiah2:=TarifRupiah;
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Rupiah3:=TarifRupiah;
Rupiah4:=TarifRupiah;
NomorKomputer:='0';
com.flush;
Tlog.last;
end;

procedure TForm1.BitBtn2Click(Sender: TObject);
begin
formtarif.show;
end;

procedure TForm1.BitBtn4Click(Sender: TObject);
begin
{pengiriman data “1” ke modul melalui serial }
com.write('1');
com.write('1');
com.write('1');
statuskom1:=true;
end;

procedure TForm1.BitBtn6Click(Sender: TObject);
begin
{pengiriman data “2” ke modul melalui serial }

com.write('2');
com.write('2');
com.write('2');
statuskom2:=true;
end;

procedure TForm1.BitBtn8Click(Sender: TObject);
begin
{pengiriman data “3” ke modul melalui serial }

com.write('3');
com.write('3');
com.write('3');
statuskom3:=true;
end;

procedure TForm1.BitBtn10Click(Sender: TObject);
begin
{pengiriman data “4” ke modul melalui serial }

com.write('4');
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com.write('4');
com.write('4');
statuskom4:=true;
end;

procedure TForm1.BitBtn5Click(Sender: TObject);
begin
{pengiriman data "5" ke modul melalui serial }

com.write('5');
com.write('5');
com.write('5');
statuskom1:=false;
end;

procedure TForm1.BitBtn7Click(Sender: TObject);
begin
{pengiriman data "6" ke modul melalui serial }

com.write('6');
com.write('6');
com.write('6');
statuskom2:=false;
end;

procedure TForm1.BitBtn9Click(Sender: TObject);
begin
{pengiriman data "7" ke modul melalui serial }

com.write('7');
com.write('7');
com.write('7');
statuskom3:=false;
end;

procedure TForm1.BitBtn11Click(Sender: TObject);
begin
{pengiriman data "8" ke modul melalui serial }

com.write('8');
com.write('8');
com.write('8');
statuskom4:=false;
end;

end.
```

LISTING PROGRAM AVR STUDIO 4

```
.include "c:\avr\m8535def.inc"

{inisialisasi port}
.equ    kontrol1    =PB0
.equ    kontrol2    =PB1
.equ    led         =PB2
.equ    relaykom1   =PA0
.equ    relaykom2   =PA1
.equ    relaykom3   =PA2
.equ    relaykom4   =PA3
.equ    portsensor  =PINC

.def    temp    =r20
.def    txbyte  =r17
.def    rxbyte  =r18
.def    dataku  =r21
.def    datasensor  =r16

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

.cseg

.org    $0000
   rjmp    mulai

   reti
   reti
   reti
   reti
   reti
   reti
   reti
   reti
   reti
   reti
   reti
   reti
   reti
```

```
   reti

   reti
 reti
mulai:

ldi     temp,low(RAMEND)
out     spl,temp
ldi     temp,high(RAMEND)
out     sph,temp

;ldi temp,ubbr_value        ;baud generator
;out UBRRL,temp     ;set divider
;ldi temp,0b00011000    ;enable TX and RX
;out UCR,temp       ;to UART Control Register

ldi     temp,0xFF
out     DDRB,temp   ;portB output
out     DDRA,temp
ldi     temp,0x00
out     DDRC,temp   ;port C sebagai input

sbi     PORTB,led
cbi     PORTB,kontrol1
sbi     PORTB,kontrol2

cbi     PORTA,relaykom1
cbi     PORTA,relaykom2
cbi     PORTA,relaykom3
cbi     PORTA,relaykom4

rcall   init_serial
loop:
;hidupkan jalur RFID kekomputer
sbi     PORTB,kontrol1
cbi     PORTB,kontrol2
   rcall   readchr
   cpi     rxbyte,0
   breq    loop
      mov     dataku,rxbyte

   cbi     PORTB,led
   rcall   longdelay
   rcall   longdelay
   sbi     PORTB,led
```

```
   mov     temp,dataku
   cpi     temp,0x31              {membandingkan dengan data dari computer data "1"}
   breq    relay1on
   cpi     temp,0x32              {membandingkan dengan data dari computer data "2"}
   breq    relay2on
   cpi     temp,0x33              {membandingkan dengan data dari computer data "3"}
   breq    relay3on
   cpi     temp,0x34              {membandingkan dengan data dari computer data "4"}
   breq    relay4on
   cpi     temp,0x35              {membandingkan dengan data dari computer data "5"}
   breq    relay1off
   cpi     temp,0x36              {membandingkan dengan data dari computer data "6"}
   breq    relay2off
   cpi     temp,0x37              {membandingkan dengan data dari computer data "7"}
   breq    relay3off
   cpi     temp,0x38              {membandingkan dengan data dari computer data "8"}
   breq    relay4off
   rjmp    loop

{subrutin menghidupkan relay}
relay1on:
sbi     PORTA,relaykom1
rcall   longdelay
rcall   longdelay
rjmp    kirimstatus
relay2on:
sbi     PORTA,relaykom2
rcall   longdelay
rcall   longdelay
rjmp    kirimstatus
relay3on:
sbi     PORTA,relaykom3
rcall   longdelay
rcall   longdelay
rjmp    kirimstatus
relay4on:
sbi     PORTA,relaykom4
rcall   longdelay
rcall   longdelay
rjmp    kirimstatus

{subrutin mematikan relay}
relay1off:
cbi     PORTA,relaykom1
rcall   longdelay
rcall   longdelay
```

```
rjmp    kirimstatus
relay2off:
cbi     PORTA,relaykom2
rcall   longdelay
rcall   longdelay
rjmp    kirimstatus
relay3off:
cbi     PORTA,relaykom3
rcall   longdelay
rcall   longdelay
rjmp    kirimstatus
relay4off:
cbi     PORTA,relaykom4
rcall   longdelay
rcall   longdelay
rjmp    kirimstatus

{pembacaan status listrik dan kemudian dikirimkan kekomputer melalui serial}
kirimstatus:
   rcall   longdelay
;hidupkan jalur Mikrokontroler kekomputer
   cbi     PORTB,kontrol1
   sbi     PORTB,kontrol2
   rcall   longdelay
   in      datasensor,portsensor
   andi    datasensor,0x0f

   ldi     txbyte,'S'
   rcall   txchr
   ldi     temp,0x30
   add     datasensor,temp
   mov     txbyte,datasensor
   rcall   txchr
   ldi     txbyte,0x30
   rcall   txchr
   ldi     txbyte,0x30
   rcall   txchr
   ldi     txbyte,0x30
   rcall   txchr
   ldi     txbyte,0x30
   rcall   txchr
   ldi     txbyte,0x30
   rcall   txchr
   ldi     txbyte,0x30
   rcall   txchr
   ldi     txbyte,0x30
```

```
    rcall   txchr
    ldi     txbyte,0x0d
    rcall   txchr
rjmp    loop

{inisialisasi komunikasi serial 9600bps}
init_serial:
    ldi     temp,high(ubbr_value)
    out     UBRRH,temp
    ldi     temp,low(ubbr_value)
    out     UBRRL,temp

    ldi     temp,(1<<RXEN)|(1<<TXEN)
    out     UCSRB,temp
    ldi     temp, (1<<URSEL)|(3<<UCSZ0)
    out     UCSRC,temp

ret

{pembacaan data melalui serial}
readchr:
    sbis    UCSRA,RXC
    rjmp    readchr
    in      rxbyte,UDR
    ret

{pengiriman data melalui serial}
txchr:

    sbis UCSRA,UDRE
    rjmp txchr
; Put data (r16) into buffer, sends the data
    out UDR,txbyte
    ret

;-------------------------------------
; sub routine long delay
;-------------------------------------
longdelay:
    ldi R17,255
ldelay1:
    ldi R18,255
ldelay2:
    dec R18
    brne    ldelay2
    dec R17
```

```
brne    ldelay1
ret
```

LAMPIRAN B

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 ±7.5 V_{PEAK} analog switching
- "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" 65 dB (typ.) output voltage ratio @ f_{is} = 10 kHz, R_L = 10 kΩ
- High degree linearity 0.1% distortion (typ.) High degree linearity @ f_{is} = 1 kHz, V_{is} = $5V_{p-p}$, High degree linearity $V_{DD}-V_{SS}$ = 10V, R_L = 10 kΩ
- Extremely low "OFF" 0.1 nA (typ.) switch leakage: @ $V_{DD}-V_{SS}$ = 10V, T_A = 25°C
- Extremely high control input impedance 10^{12}Ω(typ.)
- Low crosstalk −50 dB (typ.) between switches @ 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

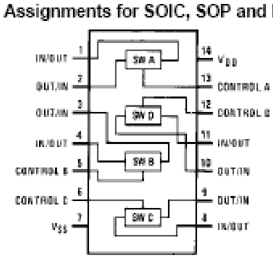
Ordering Code:

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

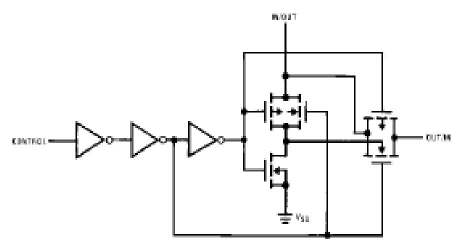
Devices also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.

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 Any 2 of 4 Switches	R_L = 10 kΩ to (V_{DD} – V_{SS}/2)								
		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 Switch "OFF"	V_C = 0		±50		±0.1	±50		±200	nA
CONTROL INPUTS										
V_{ILC}	LOW Level Input Voltage	V_{IS} = V_{SS} and V_{DD}								
		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 Voltage	V_{DD} = 5V	3.5		3.5	2.75		3.5		V
		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		$\pm 10^{-5}$	± 0.3		± 1.0	µA
		$V_{DD} \geq V_{IS} \geq V_{SS}$								
		$V_{DD} \geq V_C \geq V_{SS}$								

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 Input to Signal Output	$V_C = V_{DD}$, $C_L = 50$ pF, (Figure 1) $R_L = 200k$				
		$V_{DD} = 5V$		25	55	ns
		$V_{DD} = 10V$		15	35	ns
		$V_{DD} = 15V$		10	25	ns
t_{PZH}, t_{PZL}	Propagation Delay Time Control Input to Signal Output High Impedance to Logical Level	$R_L = 1.0$ kΩ, $C_L = 50$ pF, (Figure 2, Figure 3)				
		$V_{DD} = 5V$			125	ns
		$V_{DD} = 10V$			60	ns
		$V_{DD} = 15V$			50	ns
t_{PHZ}, t_{PLZ}	Propagation Delay Time Control Input to Signal Output Logical Level to High Impedance	$R_L = 1.0$ kΩ, $C_L = 50$ pF, (Figure 2, Figure 3)				
		$V_{DD} = 5V$			125	ns
		$V_{DD} = 10V$			60	ns
		$V_{DD} = 15V$			50	ns
	Sine Wave Distortion	$V_C = V_{DD} = 5V$, $V_{SS} = -5V$ $R_L = 10$ kΩ, $V_{IS} = 5V_{p-p}$, f= 1 kHz, (Figure 4)		0.1		%
	Frequency Response-Switch "ON" (Frequency at −3 dB)	$V_C = V_{DD} = 5V$, $V_{SS} = -5V$, $R_L = 1$ kΩ, $V_{IS} = 5V_{p-p}$, 20 Log_{10} V_{OS}/V_{OS} (1 kHz)–dB, (Figure 4)		40		MHz
	Feedthrough — Switch "OFF" (Frequency at −50 dB)	$V_{DD} = 5.0V$, $V_{CC} = V_{SS} = -5.0V$, $R_L = 1$ kΩ, $V_{IS} = 5.0V_{p-p}$, 20 Log_{10}, $V_{OS}/V_{IS} = -50$ dB, (Figure 4)		1.25		
	Crosstalk Between Any Two Switches (Frequency at −50 dB)	$V_{DD} = V_{C(A)} = 5.0V$; $V_{SS} = V_{C(B)} = 5.0V$, R_L1 kΩ, $V_{IS(A)} = 5.0$ V_{p-p}, 20 Log_{10}, $V_{OS(B)}/V_{IS(A)} = -50$ dB (Figure 5)		0.9		MHz
	Crosstalk; Control Input to Signal Output	$V_{DD} = 10V$, $R_L = 10$ kΩ, $R_{IN} = 1.0$ kΩ, $V_{CC} = 10V$ Square Wave, $C_L = 50$ pF (Figure 6)		150		mV_{p-p}
	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".

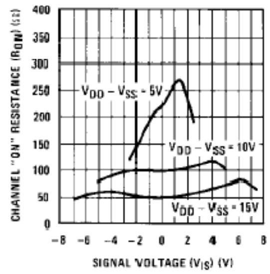
Note 5: In all cases, there is approximately 5 pF of probe and jig capacitance in the output; however, this capacitance is included in C_L wherever it is specified.

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.

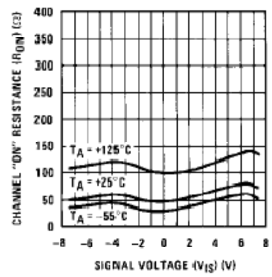
Note 7: Conditions for V_{IHC}: a) $V_{IS} = V_{DD}$, I_{OS} = standard B series I_{OH} b) $V_{IS} = 0V$, I_{OL} = standard B series I_{OL}.

Typical Performance Characteristics

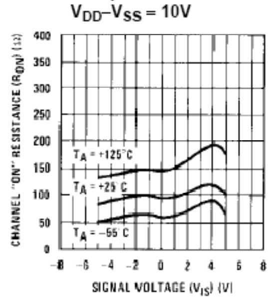
"ON" Resistance vs Signal Voltage for $T_A = 25°C$



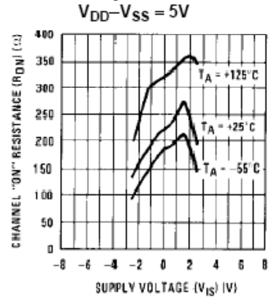
"ON" Resistance as a Function of Temperature for $V_{DD}–V_{SS} = 15V$



"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

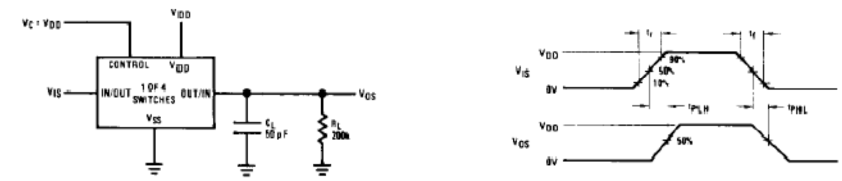


FIGURE 1. t_{PHL}, t_{PLH} Propagation Delay Time Signal Input to Signal Output

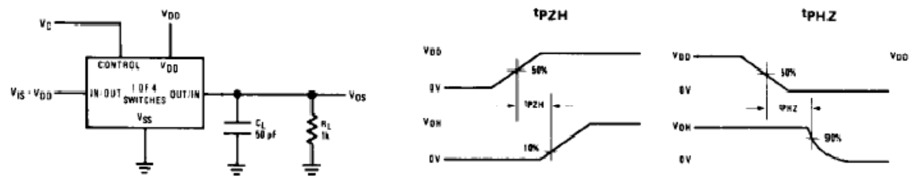


FIGURE 2. t_{PZH}, t_{PHZ} Propagation Delay Time Control to Signal Output

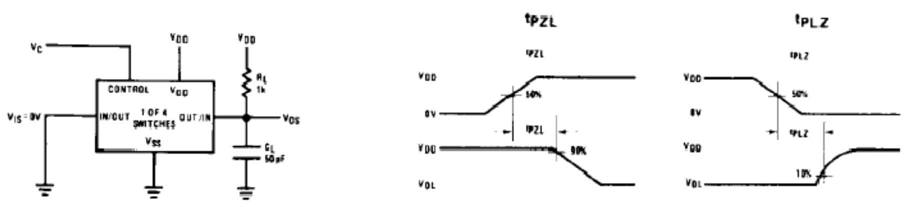
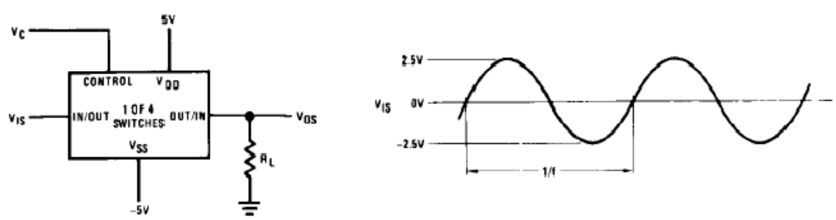


FIGURE 3. t_{PZL}, t_{PLZ} Propagation Delay Time Control to Signal Output



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

$V_C = V_{SS}$ for feedthrough test

FIGURE 4. Sine Wave Distortion, Frequency Response and Feedthrough

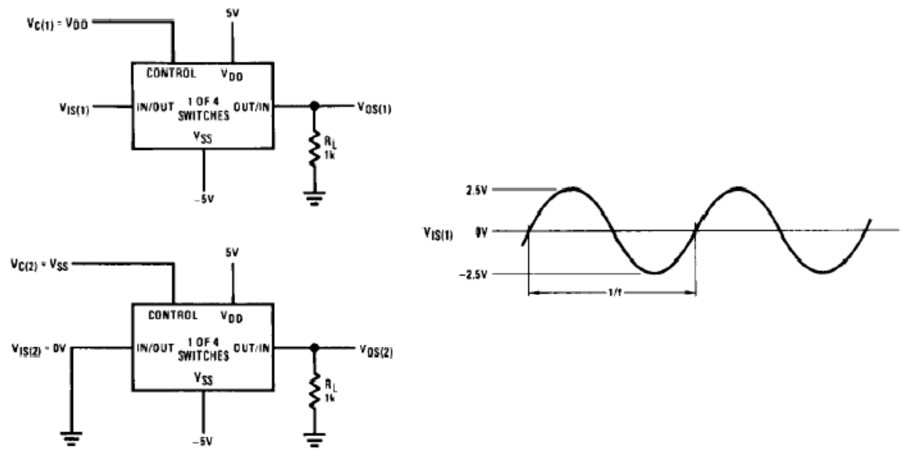


FIGURE 5. Crosstalk Between Any Two Switches

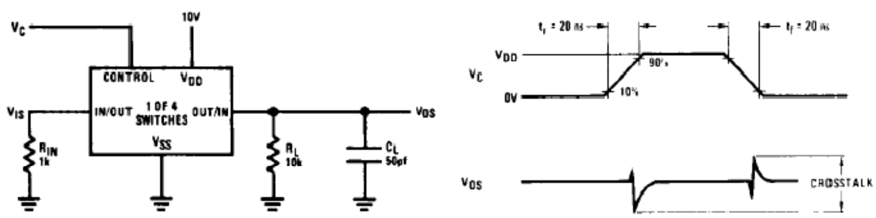


FIGURE 6. Crosstalk: Control Input to Signal Output

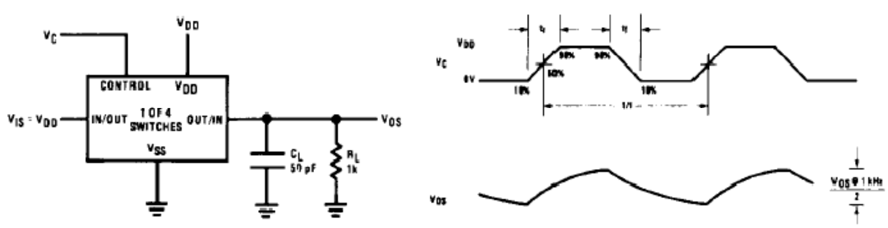
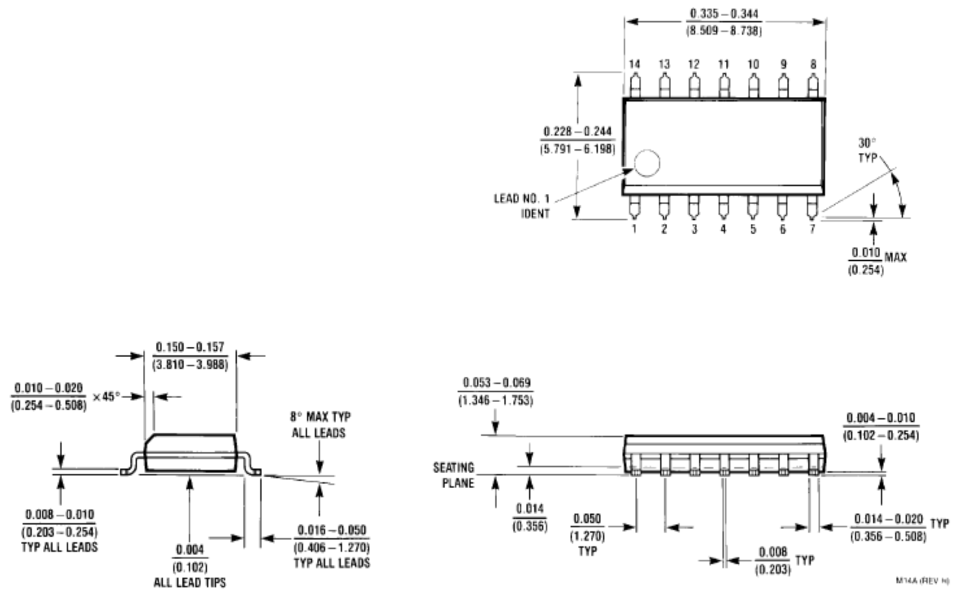
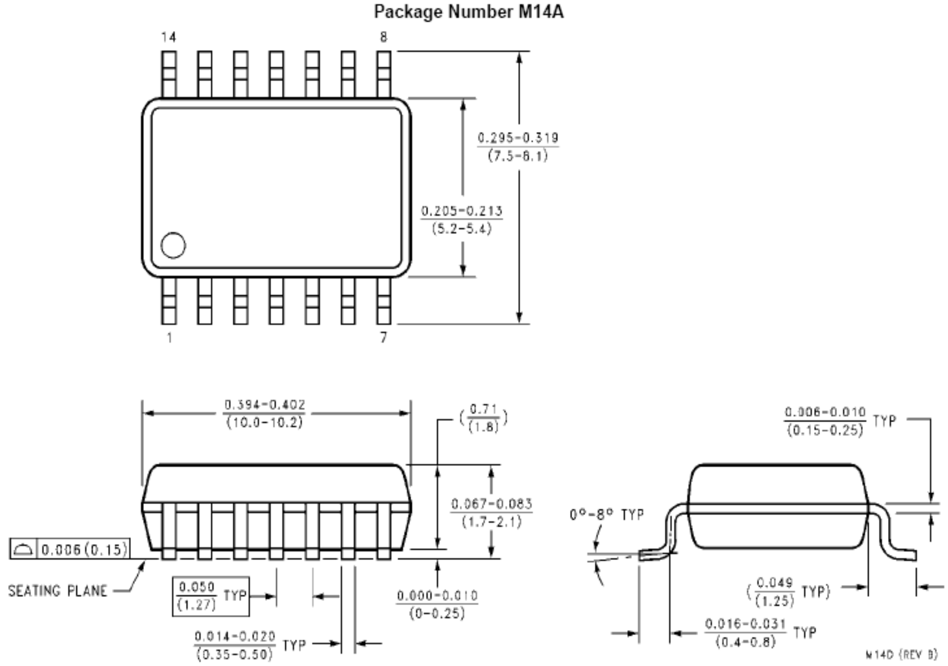


FIGURE 7. Maximum Control Input Frequency

Physical Dimensions inches (millimeters) unless otherwise noted

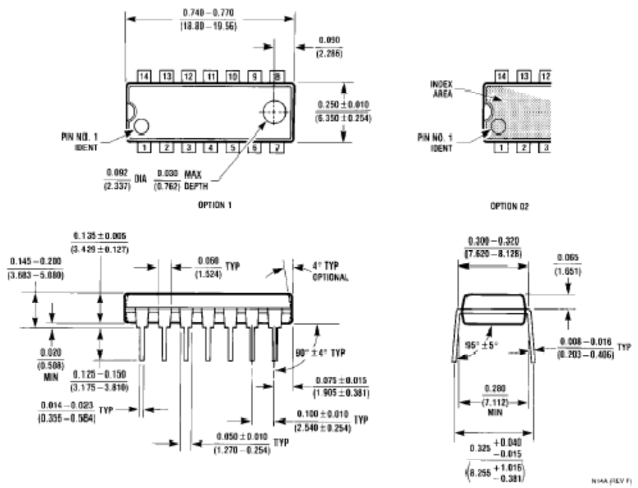


14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150" Narrow Body
Package Number M14A



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

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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.

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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.

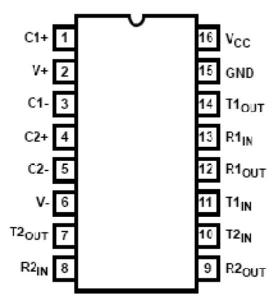
The drivers feature true TTL/CMOS input compatibility, slew-rate-limited output, and 300Ω power-off source impedance. The receivers can handle up to +30V, and have a 3kΩ to 7kΩ input impedance. The receivers also have hysteresis to improve noise rejection.

Ordering Information

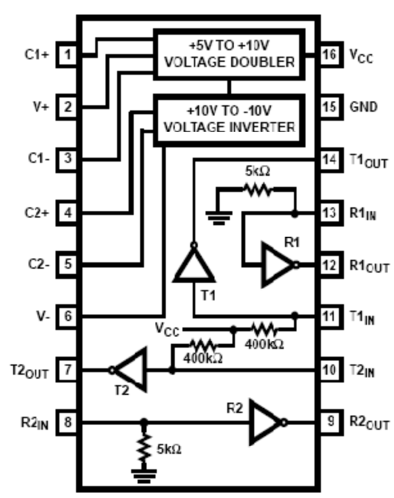
PART NUMBER	TEMPERATURE RANGE	PACKAGE
ICL232CPE	0°C to +70°C	16 Lead Plastic DIP
ICL232CJE	0°C to +70°C	16 Lead Ceramic DIP
ICL232CBE	0°C to +70°C	16 Lead SOIC (W)
ICL232IPE	-40°C to +85°C	16 Lead Plastic DIP
ICL232IJE	-40°C to +85°C	16 Lead Ceramic DIP
ICL232IBE	-40°C to +85°C	16 Lead SOIC (W)
ICL232MJE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

Pinouts

ICL232
(PDIP, CDIP, SOIC)
TOP VIEW



Functional Diagram



File Number 3020.2

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 MIN	TYP	MAX	UNITS
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

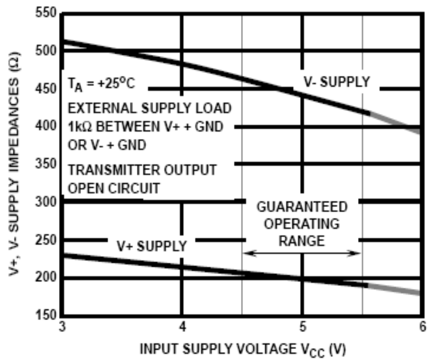


FIGURE 1. V+, V- OUTPUT IMPEDANCES vs V_{CC}

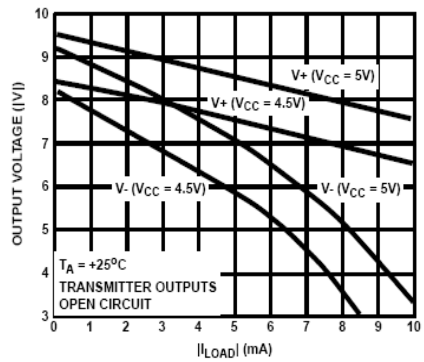


FIGURE 2. V+, V- OUTPUT VOLTAGES vs LOAD CURRENT

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.

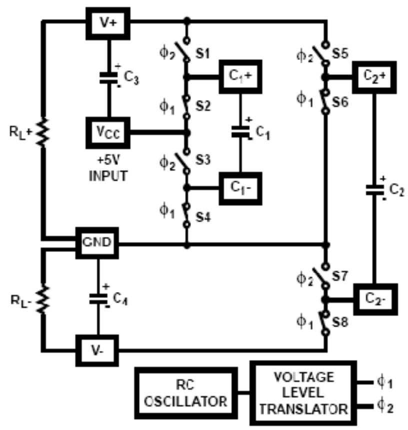
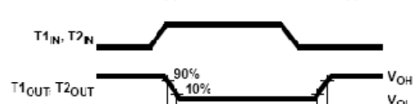


FIGURE 3. DUAL CHARGE PUMP

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.



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

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.

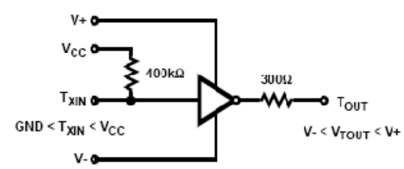


FIGURE 5. TRANSMITTER

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.

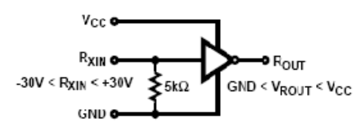
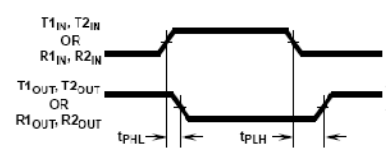


FIGURE 6. RECEIVER



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

FIGURE 7. PROPAGATION DELAY DEFINITION

Test Circuits

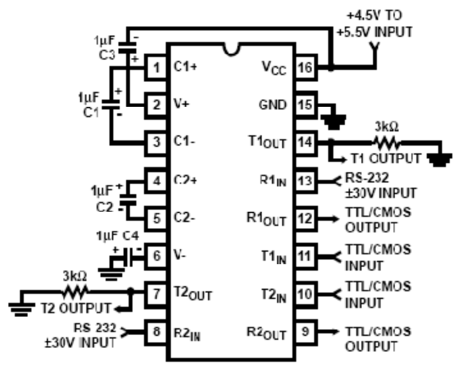


FIGURE 8. GENERAL TEST CIRCUIT

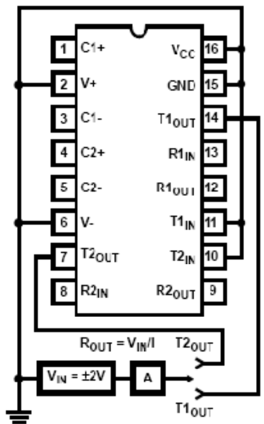


FIGURE 9. POWER-OFF SOURCE RESISTANCE CONFIGURATION

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+.

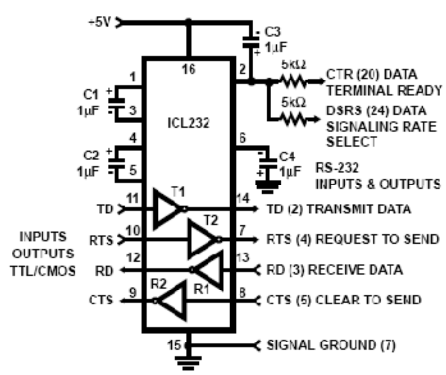


FIGURE 10. SIMPLE DUPLEX RS-232 PORT WITH CTS/RTS HANDSHAKING

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.

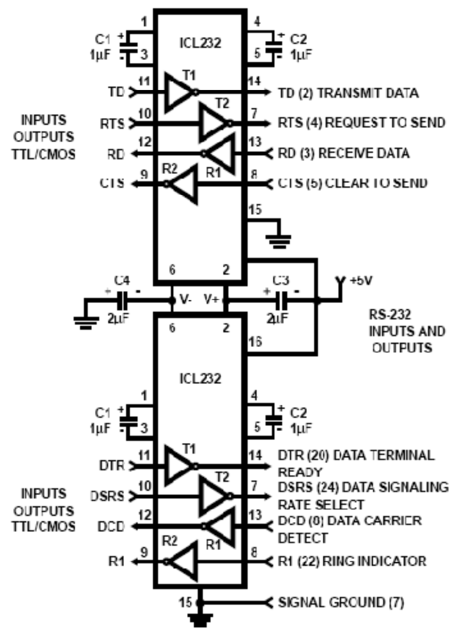
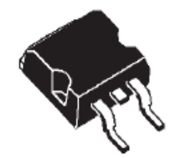


FIGURE 11. COMBINING TWO ICL232s FOR 4 PAIRS OF RS-232 INPUTS AND OUTPUTS

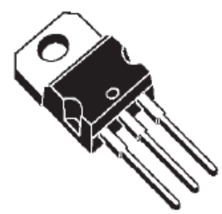
L7800AB/AC SERIES

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

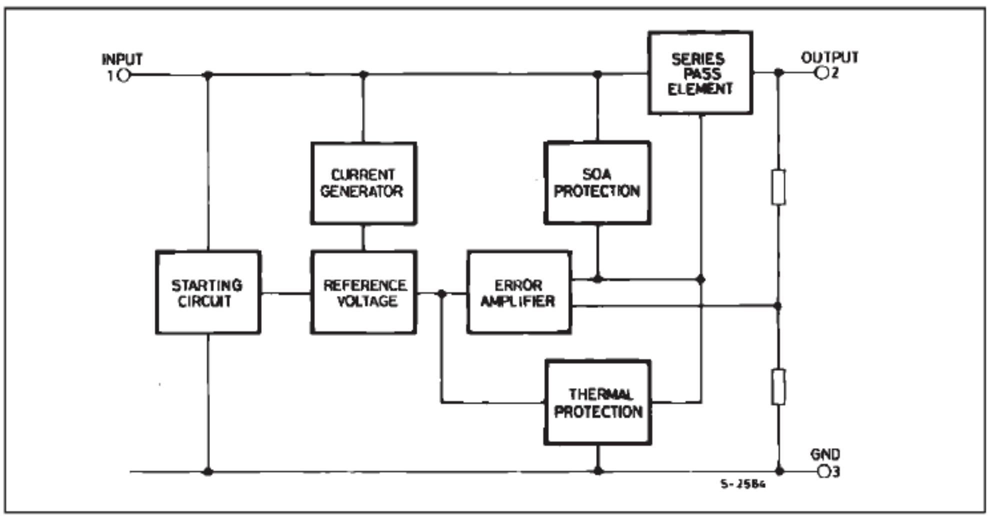


TO-220

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



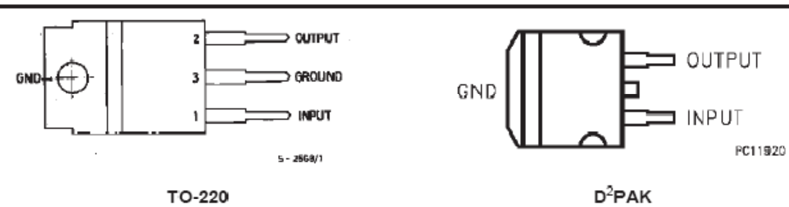
ABSOLUTE MAXIMUM RATINGS

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
$R_{thj-case}$	Thermal Resistance Junction-case	Max	3	3	°C/W
$R_{thj-amb}$	Thermal Resistance Junction-ambient	Max	62.5	50	°C/W

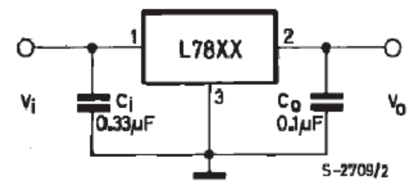
CONNECTION DIAGRAM AND ORDERING NUMBERS (top view)



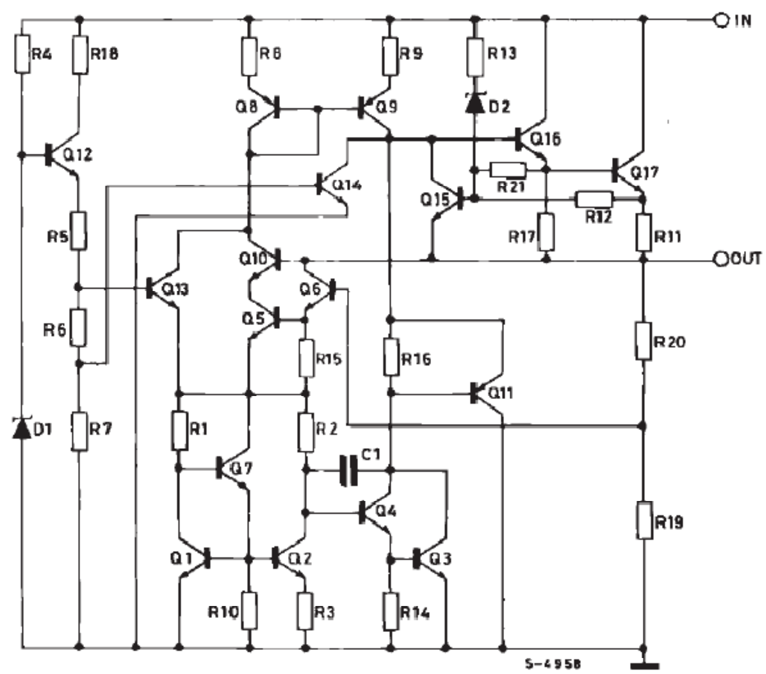
Type	TO-220	D^2PAK (*)	Output Voltage
L7805AB	L7805ABV	L7805ABD2T	5V
L7805AC	L7805ACV	L7805ACD2T	5V
L7806AB	L7806ABV	L7806ABD2T	6V
L7806AC	L7806ACV	L7806ACD2T	6V
L7808AB	L7808ABV	L7808ABD2T	8V
L7808AC	L7808ACV	L7808ACD2T	8V
L7809AB	L7809ABV	L7809ABD2T	9V
L7809AC	L7809ACV	L7809ACD2T	9V
L7812AB	L7812ABV	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

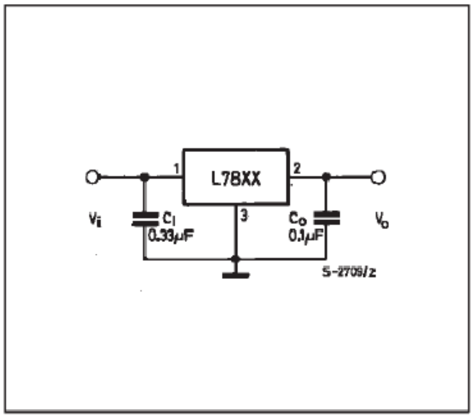


Figure 2 : Load Regulation.

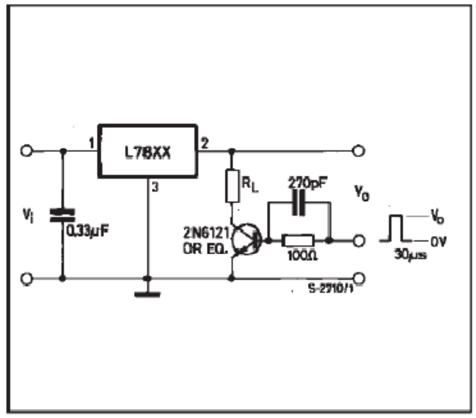
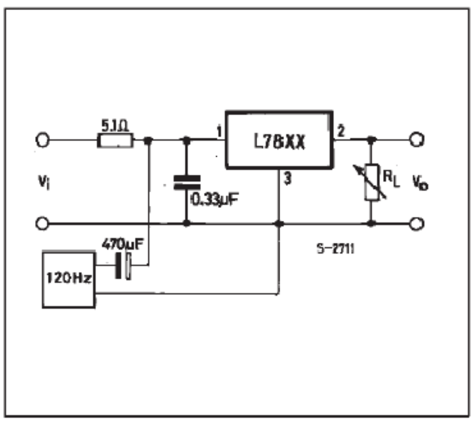


Figure 3 : Ripple Rejection.



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		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			-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		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 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		$\mu V/V_o$
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			-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		$\mu V/V_o$
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 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		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		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.

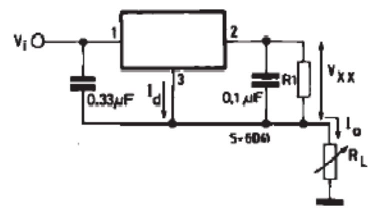
APPLICATIONS INFORMATION

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.

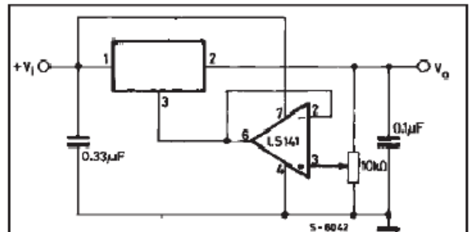
In many low current applications, compensation capacitors are not required. However, it is recommended that the regulator input be bypassed with a capacitor if the regulator is connected to the power supply filter with long wire lengths, or if the output load capacitance is large. An input bypass capacitor 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.



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

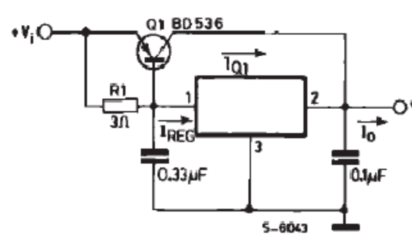
Figure 5 : Adjustable Output Regulator.



V_O, 7.0V to 20V
$V_I - V_O \geq 2.0V$

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.

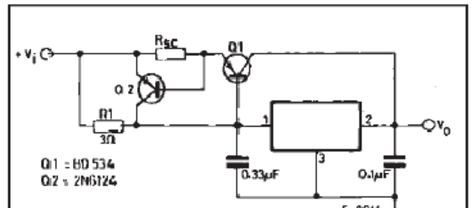
Figure 6 : Current Boost Regulator.



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

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

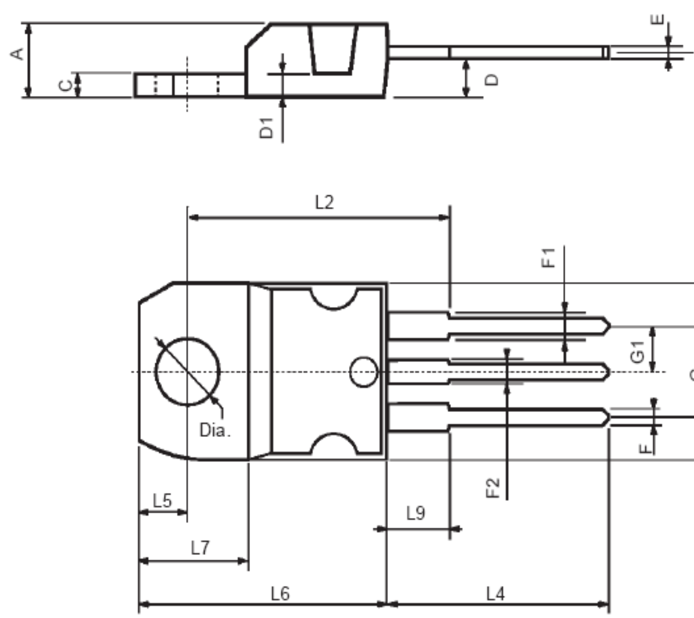
Figure 7 : Short-circuit Protection.



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

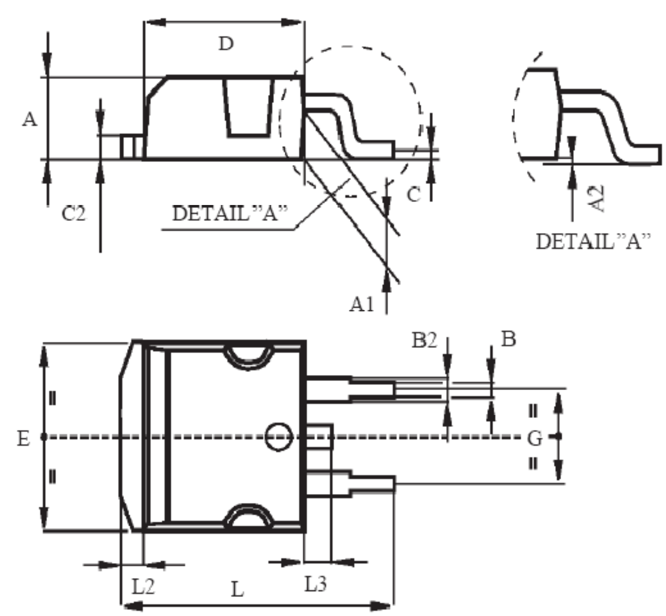
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
C	1.23		1.32	0.048		0.051
D	2.40		2.72	0.094		0.107
D1		1.27			0.050	
E	0.49		0.70	0.019		0.027
F	0.61		0.88	0.024		0.034
F1	1.14		1.70	0.044		0.067
F2	1.14		1.70	0.044		0.067
G	4.95		5.15	0.194		0.203
G1	2.4		2.7	0.094		0.106
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



P011C

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



P011P6/F