LAMPIRAN

Foto Alat Perencanaan Pemakaian Daya Listrik Dengan Rupiah

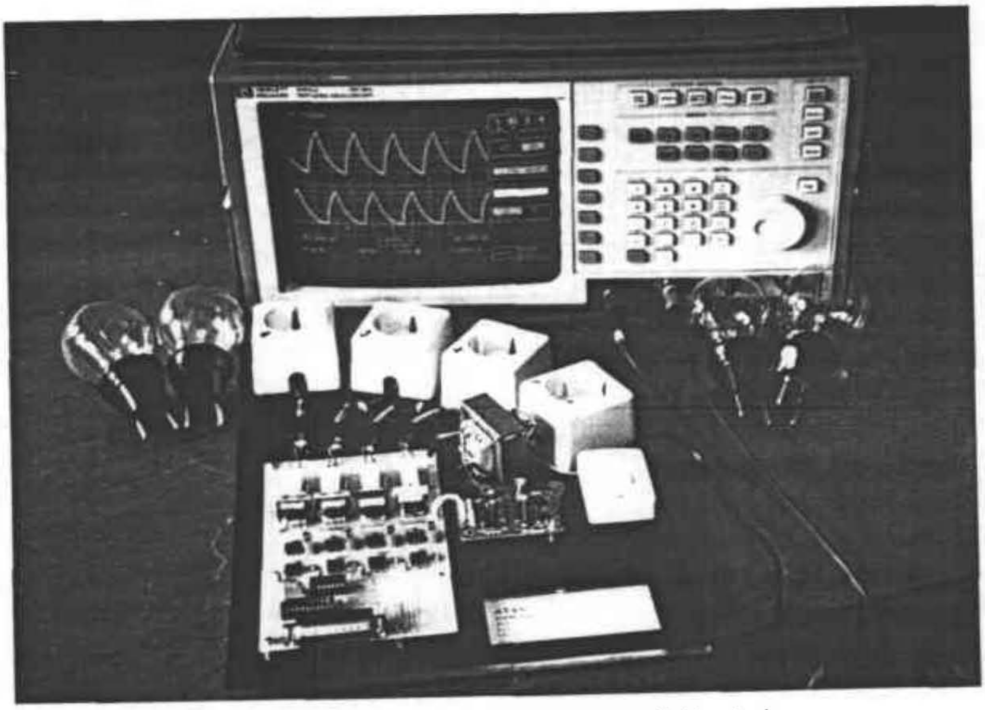


Foto Rangkaian Alat dan Hasil Simulasi

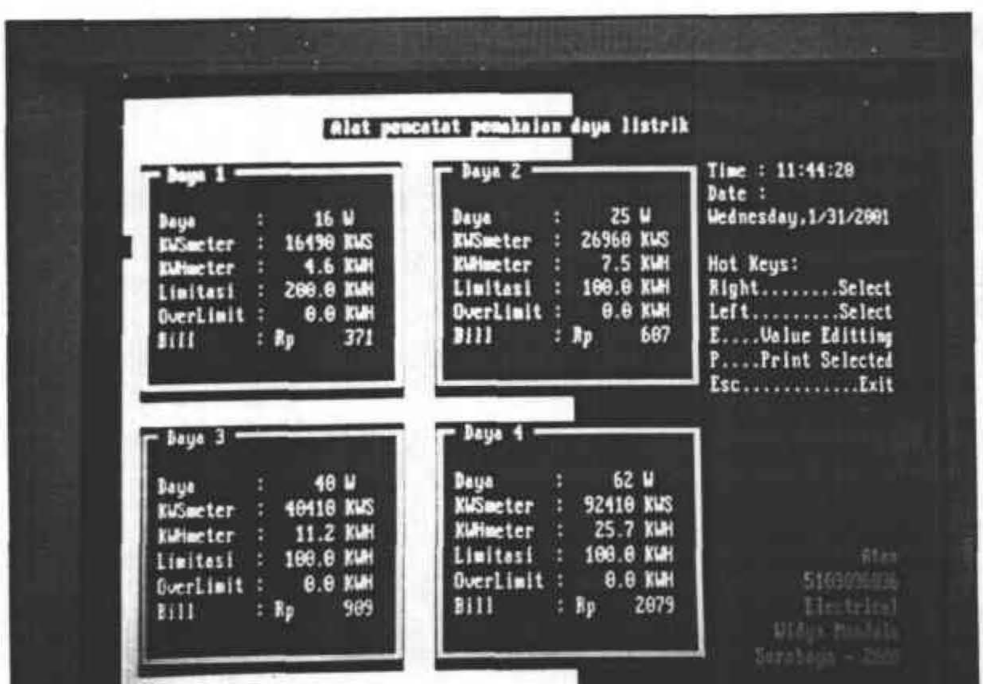
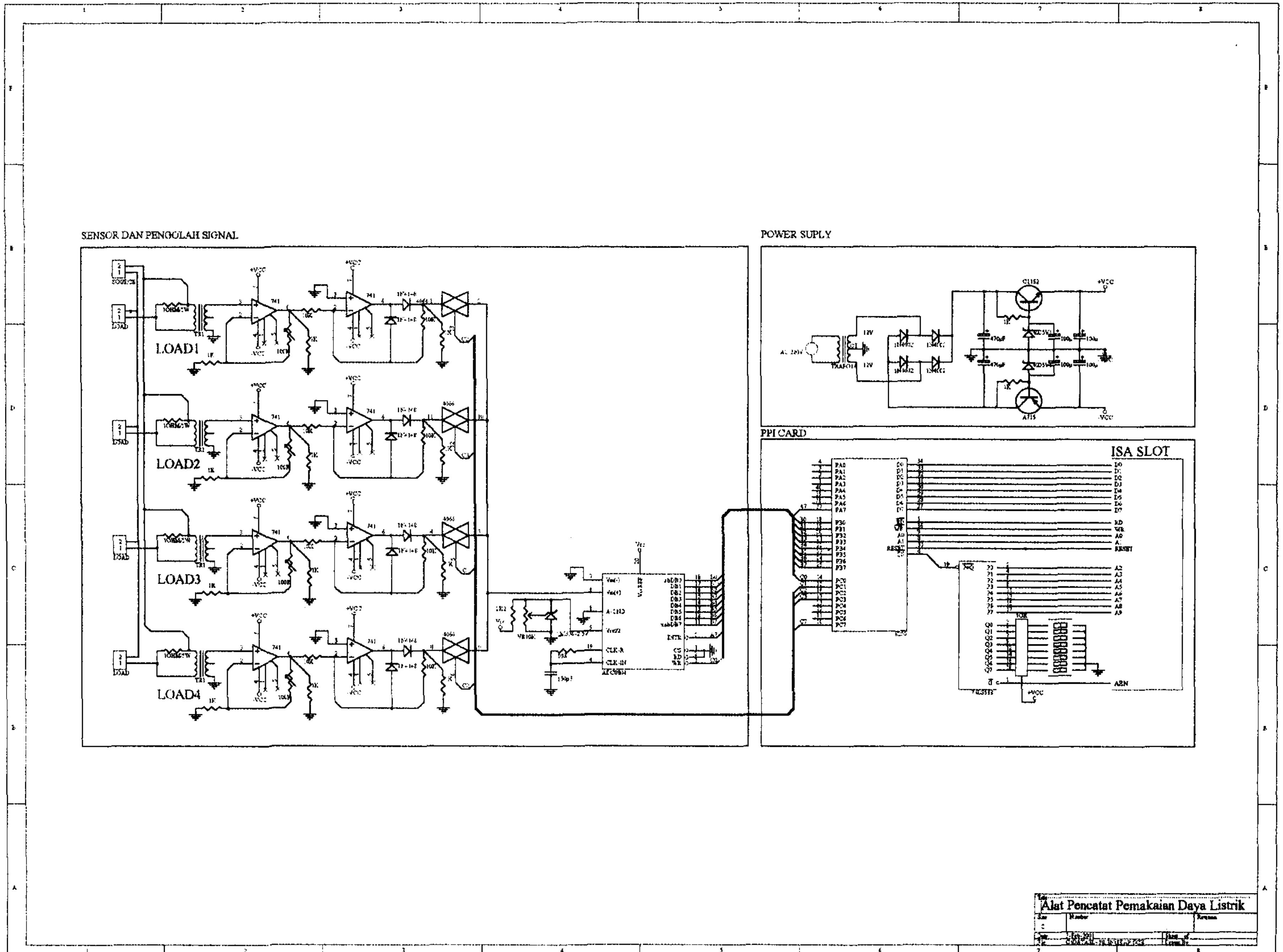


Foto Tampilan Pada Layar Monitor


SENSOR DAN PENGOLAH SIGNAL
LOAD1
LOAD2
LOAD3
LOAD4
POWER SUPLY
PPI CARD
ISA SLOT
Alat Pencatat Pemakaian Daya Listrik

```
{ Program : Pascal
  Tanggal : 12 Januari 2001
  Nama    : Atan
  NRP     : 5103096036
  Tujuan  : Untuk Mencatat Pemakaian Daya Listrik }


Program monitor_Konsumsi_Daya_dengan_4_beban;
uses crt,printer,DOS,sistem;
const PA=$380;
      PB=$381;
      PC=$382;
     CP=$383;
     Voltage = 220;

      RecordFile  = 'record.dat'; {nama file record untuk data}

Type
    RecordData =  record
    RecKWSmeter  : array[1..4]of real;
    RecLimitasi  : array[1..4]of real;
end;

var
   KWHrecord  : file of RecordData;
   Config : RecordData;
   fileAda : boolean;
   fileRecord : boolean;
   priceperKWH: real;
   Tombol : Char;
   Terus : Boolean;
   a,n : word;
   DetikOLD : word;
   TeganganBaca : integer;
   hari : string;
   Year,Month,Day,DayOfWeek : word;
   Jam,Menit,Detik,ssDetik  : word;
   SelectedWindow,x,y  : byte;
   ADC  : array[1..4]of byte;
   Arus,Daya,Rsense,Biaya  : array[1..4]of real;
   KWSmeter,KWHmeter  : array[1..4]of real;
   Limitasi,OverLimit  : array[1..4]of real;
   EditValue : longint;
   PortB : byte;
   MenitOLD : word;
```

```
{procedure-procedure dari unit sistem :
 procedure writexy(x,y,pesan);     menulis dikoordinat (x,y)
 procedure b2b10('11111111');      mengubah format biner ke desimal
 procedure input_Real(batas,hasil);menerima masukkan dalam format bilangan
                        real dengan batas karakter variabel batas
                        dan hasil pada variabel Hasil}
{
 port functions
 Port A    A7  A6  A5  A4  A3  A2  A1  A0  : input
        INTR -  -  -  -  -  -  -
        INTR=interrupt dari ADC
 Port B    B7  B6  B5  B4  B3  B2  B1  B0  : input
        8Bit data from ADC0804

 Port C    C7  C6  C5  C4  C3  C2  C1  C0  :
        L4  -  -  -  L2  L1  L3  WR
        L4=beban 4
        L3=beban 3
        L2=beban 2
        L1=beban 1
        WR=pin WRITE ke ADC untuk memulai pembacaan
}

{procedure untuk merekam setting ke File record.dat}
Procedure RecordSetting(ValueNumber : byte;
                KWSValue    : real;
                LimitValue  : real);
begin
    assign(KWHRecord,RecordFile);
    rewrite(KWHrecord);
    with config do
    begin
        RecKWSmeter[ValueNumber]  := KWSValue;
        RecLimitasi[ValueNumber]  := LimitValue;
        write(KWHrecord,config);
    end;
    close(KWHRecord);
end;

{procedure untuk membaca setting dari File record.dat}
Procedure RecordReading;
begin
    FileRecord:=false;
    assign(KWHRecord,RecordFile);{$I-}
    reset(KWHRecord);{$I+}
    FileAda:=(IOResult=0);
```

```
      if fileada then
      begin
         FileRecord:=true;
         with config do
         begin
             read(KWHRecord,config);
             for n:=1 to 4 do
             begin
                 KWSmeter[n]  := RecKWSmeter[n];
                 Limitasi[n]  := RecLimitasi[n];
             end;
         end;
         close(KWHRecord);
      end;
end;

{inisialisasi PPIcard
 port A ... input
 port B ... input
 port C ... output
}

Procedure initPPI;
begin
  port[CP]:=$92;       {memberikan setting pada control port}
  port[PC]:=$01;       {membuat default pin WR menjadi High}
end;

{procedure untuk mematikan PPI sehingga dalam keadaan TriState}
Procedure ExitPPI;
begin
  port[CP]:=0;   {mematikan PPI dengan cara tidak mengaktifkan
           bit ke 7 dari nilai di Control Port}
end;

{fungsi untuk membaca apakah alat telah ada atau belum
 dengan cara bembaca logic '1' pada Port A bit ke 0
 dan membaca logic '0' pada Port A bit ke 1}
Function AlatAda:boolean;
var periksa:integer;
begin
     for periksa:=1 to 10000 do
     begin
        if (port[PA] and $7F)=$7F then
              AlatAda:=true
        else
```

```
        begin
            AlatAda:=false;
            break;
        end;
    end;
    alatAda:=true;
end;

{untuk membaca intr dari ADC, [port A bit ke 7]
 status: tidak dipakai karena tidak diperlukan}
Function Intr:boolean;
begin
   if (port[PA] and $80)=$00 then
        Intr:=true
   else
        Intr:=false;
end;

{procedure untuk mengaktifkan konversi(pin WR) pada ADC
 terletak pada port C bit 0}
Procedure Clock;
var n:byte;
begin
  port[PC]:=port[PC] and $FE;
  delay(2);
  port[PC]:=port[PC] or  $01;
  delay(2);
  port[PC]:=port[PC] and $FE;
  delay(2);
end;

{ Port C    C7  C6  C5  C4  C3  C2  C1  C0  :
          L4  -   -   -   L2  L1  L3  WR }
{untuk memili channel mana yang diaktifkan seperti pada
 konfigurasi diatas}
Procedure Select(channel:byte);
var temp : word;
begin
 case channel of
 1 : begin
    temp:=port[PC] and $01;
    port[PC]:=temp or  b2b10('00000100');  {L1=1, L2,3,4=0}
   end;
 2 : begin
    temp:=port[PC] and $01;
    port[PC]:=temp or  b2b10('00001000');  {L2=1, L1,3,4=0}
```

```
    end;
 3 : begin
    temp:=port[PC] and $01;
    port[PC]:=temp or b2b10('00000010'); {L3=1, L1,2,4=0}
   end;
 4 : begin
    temp:=port[PC] and $01;
    port[PC]:=temp or b2b10('10000000'); {L4=1, L1,2,3=0}
   end;
 end;
end;

{procedur untuk menyalakan atau mematikan kursor}
Procedure Cursor(status:byte);
begin
    if status=0 then     {cursor mati}
    Begin
       asm;
            push ax
            push cx
            mov  ah,01h
            mov  ch,00100000b
            mov  cl,00000000b
            int  10h
            pop  cx
            pop  ax
       end;
    end;
    if status=1 then     {cursor hidup}
    begin
       asm;
           push ax
           push cx
           mov  ah,01h
           mov  ch,00001110b
           mov  cl,00001111b
           int  10h
           pop  cx
           pop  ax
       end;
    end;
end;
{procedure untuk tampilan pendukung}
Procedure Header;
begin
   {ID}
```

```
    textcolor(14);
    textbackground(0);
    writexy(22,2,' Alat pencatat pemakaian daya listrik ');
    textcolor(12);
    writexy(61,20,'          Atan');
    writexy(61,21,'      5103096036');
    writexy(61,22,'      Electrical');
    writexy(61,23,'    Widya Mandala');
    writexy(61,24,'  Surabaya - 2000') ;

   {HotKeys}
    textcolor(7);
    writexy(61, 8,'Hot Keys:        ');
    writexy(61, 9,'Right........Select');
    writexy(61,10,'Left.........Select');
    writexy(61,11,'E....Value Editting');
    writexy(61,12,'P....Print Selected');
    writexy(61,13,'Esc............Exit');
end;

{procedure untuk membuat tampilan pada background}
procedure ClearScreen;
begin
     textcolor(9);
     textbackground(7);
     for y:=1 to 25 do
        for x:=1 to 46 do
        begin
             gotoxy(x,y);write('°');
        end;
     Header;
     textcolor(7);
     textbackground(0);
end;

{procedure untuk membuat window}
procedure window(x,y,no:byte;Text,BackGround:byte);
begin
     TextColor(Text);
     TextBackGround(BackGround);
     gotoxy(x,y);
     write   ('ÉÍ Daya ',no,' ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ»');
     writexy(x,y+1 ,'º                    º');
     writexy(x,y+2 ,'º                    º');
     writexy(x,y+3 ,'º                    º');
     writexy(x,y+4 ,'º                    º');
```

```
     writexy(x,y+5 ,'º                          º');
     writexy(x,y+6 ,'º                          º');
     writexy(x,y+7 ,'º                          º');
     writexy(x,y+8 ,'º                          º');
     writexy(x,y+9 ,'ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼');
end;

{procedure untuk membaca waktu dari RealTimeClock komputer}
Procedure MyTime;
begin
     textbackground(0);
     textcolor(7);
     GetTime(jam,menit,detik,ssDetik);
     gotoxy(61,4);writeln('Time : ',jam,':',menit,':',detik,'   ');
     GetDate(Year,Month,Day,DayOfWeek);
     case dayOfWeek of
        0 : hari := 'Sunday';
        1 : hari := 'Monday';
        2 : hari := 'Tuesday';
        3 : hari := 'Wednesday';
        4 : hari := 'Thursday';
        5 : hari := 'Friday';
        6 : hari := 'Saturday';
     end;
     gotoxy(61,5);writeln('Date :');
     gotoxy(61,6);writeln(Hari,',',Month,'/',Day,'/',Year,'  ');
end;

{Procedure untuk mendeteksi akhir dari kertas
 status: tidak dipakai}
Procedure EndingPrinting;
begin
     repeat
        writeln(lst);
     until (port[$379]and $20)=$20;
end;

{procedure untuk memilih lalu membaca dari beban}
Procedure SelectLoad(LoadWin:byte);
var k      : integer;
   baca    : array[0..100]of byte;
begin
     {operasi ADC0804}
     Select(LoadWin);
     delay(3);
     {membaca 3 kali dari ADC}
```

```
      Clock;
      Baca[0] := 0;
      for k:=1 to 10 do
      begin
        Clock;
        Baca[k] := Port[PB];
        if baca[K-1]>baca[k] then
             Baca[k] := baca[k-1];
     end;
     portB:=baca[10];
end;

{procedure dari kumpulan rumus-rumus dan tampilan didalam window}
Procedure Properties(n:byte);
begin
 case n of
 1 : begin
    x:=5  ;y:=5;
   end;
 2 : begin
    x:=35 ;y:=5;
   end;
 3 : begin
    x:=5  ;y:=16;
   end;
 4 : begin
    x:=35 ;y:=16;
   end;
end;
MyTime;
  {rumus-rumus}
  if DetikOLD<>detik then
  begin
   SelectLoad(n);
   ADC[n]:= PortB;
   Arus[n]  := 0;{(ADC[n]*0.02);}
   Daya[n]  := (ADC[n])-8;{round(sqrt(Voltage*Arus[n])*1);}
   if Daya[n]<=0 then {menghilangkan pembacaan daya <= 3Watt}
   begin
    Arus[n]:=0;
    Daya[n]:=0;
   end;

   {gotoxy(61,16);writeln('             ');
   gotoxy(61,16);writeln('Port B1 : ',ADC[1]);
   gotoxy(61,17);writeln('             ');
```

```
procedure SelectWindow(no:byte);
const x=3;y=4;
begin
 case no of
 1 : begin
     Window(x   ,y    ,1,15,9);
     Window(x+30,y    ,2,7 ,9);
     Window(x   ,y+11 ,3,7 ,9);
     Window(x+30,y+11 ,4,7 ,9);
    end;
 2 : begin
     Window(x   ,y    ,1,7 ,9);
     Window(x+30,y    ,2,15,9);
     Window(x   ,y+11 ,3,7 ,9);
     Window(x+30,y+11 ,4,7 ,9);
    end;
 3 : begin
     Window(x   ,y    ,1,7 ,9);
     Window(x+30,y    ,2,7 ,9);
     Window(x   ,y+11 ,3,15,9);
     Window(x+30,y+11 ,4,7 ,9);
    end;
 4 : begin
     Window(x   ,y    ,1,7 ,9);
     Window(x+30,y    ,2,7 ,9);
     Window(x   ,y+11 ,3,7 ,9);
     Window(x+30,y+11 ,4,15,9);
    end;
 end;
 SelectedWindow:=no;
 textcolor(7);
 textbackground(0);
end;

{procedure untuk mencetak}
Procedure Printing(n:byte);
begin
 writeln(lst);
 writeln(lst);
 writeln(lst,' Daya pada beban ',n);
 writeln(lst,' ---------------------------');
 writeln(lst,' Tegangan    : ',Voltage,' VAC');
 writeln(lst,' Arus        : ',Arus[n]:5:2,' Amp');
 writeln(lst,' Daya        : ',Daya[n]:5:1,' watt');
 writeln(lst,' ---------------------------');
 writeln(lst,' KWHmeter    : ',KWHmeter[n]:6:1,' KWH');
```

```
 writeln(lst,' Limitasi    : ',Limitasi[n]:6:1,' KWH');
 writeln(lst,' OverLimit   : ',OverLimit[n]:6:1,' KWH');
 writeln(lst,' ---------------------------');
 writeln(lst,' Biaya       : ',Biaya[n]:5:0,' Rp');
 writeln(lst,' ---------------------------');
 writeln(lst,' Current Time : ',Jam,':',menit,':',detik);
 writeln(lst,' Current Date : ',Hari,',',Month,'/',Day,'/',Year);
 {EndingPrinting;}
 SelectWindow(n);
end;

{procedure yang merupakan unit kerja secara keseluruhan yang akan
 mengontrol dan membaca serta mengolah data yang diperoleh}
Procedure Utama;
begin
 {memberi nilai bahwa nilai resitor sensor = 1 ohm}
 Rsense[1]:=1;
 Rsense[2]:=1;
 Rsense[3]:=1;
 Rsense[4]:=1;

 {membaca setting dari file record.dat}
 RecordReading;

 {tampilan}
 Clrscr;
 ClearScreen;
 cursor(0);
 SelectWindow(1);

 {inisialisasi PPI}
 initPPI;
 repeat
  MyTime;                    {baca waktu}
  ShowProperties;              {menampilkan window
                           beserta isinya}
  if keypressed then
   begin
    tombol:=readkey;
    case tombol of
     #77 : begin  {kanan}
          if SelectedWindow<4 then
          begin
           Inc(SelectedWindow);
           SelectWindow(SelectedWindow);
          end
```

```
     else
     SelectWindow(1);
    end;
#75 : begin  {kiri}
     if SelectedWindow>1 then
     begin
      Dec(SelectedWindow);
      SelectWindow(SelectedWindow);
     end
     else
     SelectWindow(4);
    end;
'p' : begin  {Print!!!}
        textbackground(9);
        case SelectedWindow of
        1 : begin
            gotoxy(5+13,12);write('printing...');
            Printing(1);
           end;
        2 : begin
            gotoxy(5+43,12);write('printing...');
            Printing(2);
           end;
        3 : begin
            gotoxy(5+13,23);write('printing...');
            Printing(3);
           end;
        4 : begin
            gotoxy(5+43,23);write('printing...');
            Printing(4);
           end;
        end;
end;
'e' : begin  {Edit!!!}
     textBackGround(0);
     textColor(9);
     clrscr;
     for x:=37 to 79 do
      for y:=1 to 25 do
       writexy(x,y,'Ý');

     textBackGround(0);
     textColor(7);
     cursor(1);
     n:=selectedWindow;
     repeat
```

```
         gotoxy(1,1);
         writeln(' Record editting menu for Daya ',SelectedWindow);
         writeln(' ---------------------------');
         writeln;
         writeln(' 1. KWHmeter Value      ');
         writeln(' 2. Limitation Value    ');
         writeln(' 3. Exit                ');
         writeln;
         write  (' edit number    : ');input_Desimal(1,EditValue);
         writeln;
        until (EditValue=1) or (EditValue=2) or (EditValue=3);
        if EditValue=1 then
         begin
          write(' KWHmeter value : ');input_real(6,KWHmeter[n]);
          RecordSetting(n,KWHmeter[n]*3600,Limitasi[n]);
         end;
        if EditValue=2 then
         begin
          write(' Limit value    : ');input_real(6,Limitasi[n]);
          RecordSetting(n,KWSmeter[n],Limitasi[n]);
         end;
        cursor(0);
        clrscr;
        RecordReading;
        ClearScreen;
        SelectWindow(SelectedWindow);
       end;
  end;
 end;
until tombol=(#27);

{closing & clearing}
for n:=1 to 4 do
 RecordSetting(n,KWSmeter[n],Limitasi[n]);
textcolor(7);
textbackground(0);
cursor(1);
clrscr;
ExitPPI;
end;

{program utama}
begin
 {writeln(' Loading...');}
 menit:=menitOLD;
 if AlatAda=true then
```

```
      Clock;
      Baca[0] := 0;
      for k:=1 to 10 do
      begin
         Clock;
         Baca[k] := Port[PB];
         if baca[K-1]>baca[k] then
               Baca[k] := baca[k-1];
     end;
     portB:=baca[10];
end;

{procedure dari kumpulan rumus-rumus dan tampilan didalam window}
Procedure Properties(n:byte);
begin
 case n of
 1 : begin
     x:=5  ;y:=5;
    end;
 2 : begin
     x:=35 ;y:=5;
    end;
 3 : begin
     x:=5  ;y:=16;
    end;
 4 : begin
     x:=35 ;y:=16;
    end;
 end;
 MyTime;
  {rumus-rumus}
  if DetikOLD<>detik then
  begin
   SelectLoad(n);
   ADC[n]:= PortB;
   Arus[n]  := 0;{(ADC[n]*0.02);}
   Daya[n]  := (ADC[n])-8;{round(sqrt(Voltage*Arus[n])*1);}
   if Daya[n]<=0 then {menghilangkan pembacaan daya <= 3Watt}
   begin
    Arus[n]:=0;
    Daya[n]:=0;
   end;

   {gotoxy(61,16);writeln('            ');
   gotoxy(61,16);writeln('Port B1 : ',ADC[1]);
   gotoxy(61,17);writeln('            ');
```

```
 begin
  delay(100);
 end
else
begin
 delay(100);
 writeln;
 writeln('  device is not detected...');
 writeln('  please check your device again,');
 writeln('  and then restart this program again.');
 writeln;
end;
  Utama
end.
```

National Semiconductor

June 1992

CD4066BM/CD4066BC Quad Bilateral Switch

General Description

The CD4066BM/CD4066BC is a quad bilateral switch intended for the transmission or multiplexing of analog or digital signals. It is pin-for-pin compatible with CD4016BM/CD4016BC, but has a much lower "ON" resistance, and "ON" resistance is relatively constant over the input-signal range.

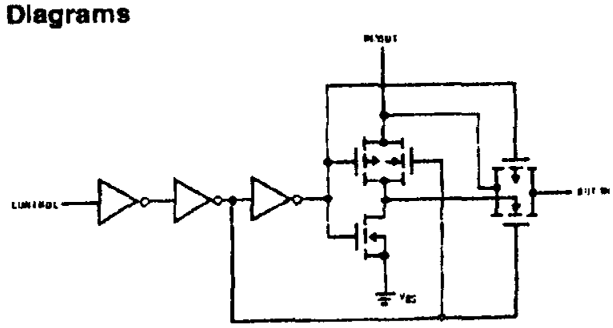
Features

- 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 over 15V signal input — $\Delta R_{ON} = 5\Omega$ (typ.)
- "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.) @ $f_{is} = 1$ 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 — $10^{12}\Omega$ (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

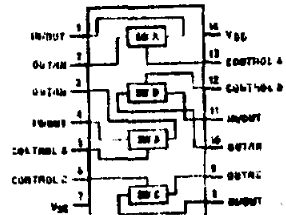
- Analog signal switching/multiplexing
  - Signal gating
  - Squelch control
  - Chopper
  - Modulator/Demodulator
  - Commutating switch
- Digital signal switching/multiplexing
- CMOS logic implementation
- Analog-to-digital/digital-to-analog conversion
- Digital control of frequency, impedance, phase,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

Schematic and Connection Diagrams



Order Number CD4066B

Dual-In-Line Package



Top View

TL/F/5665-1

RRD-B30M105/Printed in U.S.A.

Absolute Maximum Ratings (Notes 1 & 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage (V_{DD})	−0.5V to +18V
Input Voltage (V_{IN})	−0.5V to V_{DD} +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)	
CD4066BM	−55°C to +125°C
CD4066BC	−40°C to +85°C

DC Electrical Characteristics CD4066BM (Note 2)

Symbol	Parameter	Conditions	−55°C Min	−55°C Max	+25°C Min	+25°C Typ	+25°C Max	+125°C Min	+125°C Max	Units
I_{DD}	Quiescent Device Current	V_{DD} = 5V		0.25		0.01	0.25		7.5	μA
		V_{DD} = 10V		0.5		0.01	0.5		15	μA
		V_{DD} = 15V		1.0		0.01	1.0		30	μA
SIGNAL INPUTS AND OUTPUTS										
R_{ON}	"ON" Resistance	R_L = 10 kΩ to $\frac{V_{DD}-V_{SS}}{2}$								
		V_C = V_{DD}, V_{IS} = V_{SS} to V_{DD}								
		V_{DD} = 5V		800		270	1050		1300	Ω
		V_{DD} = 10V		310		120	400		550	Ω
		V_{DD} = 15V		200		80	240		320	Ω
ΔR_{ON}	Δ"ON" Resistance Between any 2 of 4 Switches	R_L = 10 kΩ to $\frac{V_{DD}-V_{SS}}{2}$								
		V_C = 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		±500	nA
		V_{IS} = 15V and 0V,								
		V_{OS} = 0V and 15V								
CONTROL INPUTS										
V_{ILC}	Low Level Input Voltage	V_{IS} = V_{SS} and V_{DD}								
		V_{OS} = V_{DD} and V_{SS}								
		I_{IS} = ±10 μA								
		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 (see note 6)	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		±0.1		$\pm 10^{-5}$	±0.1		±1.0	μA
		V_{DD} > V_{IS} > V_{SS}								
		V_{DD} > V_C > V_{SS}								

DC Electrical Characteristics CD4066BC (Note 2)

Symbol	Parameter	Conditions	−40°C Min	−40°C Max	+25°C Min	+25°C Typ	+25°C Max	+85°C Min	+85°C Max	Units
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

DC Electrical Characteristics (Continued) CD4066BC (Note 2)

Symbol	Parameter	Conditions	−40°C Min	−40°C Max	+25°C Min	+25°C Typ	+25°C Max	+85°C Min	+85°C Max	Units
SIGNAL INPUTS AND OUTPUTS										
R_{ON}	"ON" Resistance	$R_L = 10\ k\Omega$ to $\frac{V_{DD}-V_{SS}}{2}$ $V_C = V_{DD}$, V_{SS} to V_{DD} $V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		 850 330 210		 270 120 80	 1050 400 240		 1200 520 300	 Ω Ω Ω
ΔR_{ON}	Δ"ON" Resistance Between Any 2 of 4 Switches	$R_L = 10\ k\Omega$ to $\frac{V_{DD}-V_{SS}}{2}$ $V_{CC} = V_{DD}$, $V_{IS} = V_{SS}$ to V_{DD} $V_{DD} = 10V$ $V_{DD} = 15V$				 10 5				 Ω 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} $I_{IS} = \pm 10\mu A$ $V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		 1.5 3.0 4.0		 2.25 4.5 6.75	 1.5 3.0 4.0		 1.5 3.0 4.0	 V V V
V_{IHC}	High Level Input Voltage	$V_{DD} = 5V$ $V_{DD} = 10V$ (See note 6) $V_{DD} = 15V$	3.5 7.0 11.0		3.5 7.0 11.0	2.75 5.5 8.25		3.5 7.0 11.0		V V V
I_{IN}	Input Current	$V_{DD} - V_{SS} = 15V$ $V_{DD} > V_{IS} > V_{SS}$ $V_{DD} > V_C > V_{SS}$		±0.3		$\pm 10^{-5}$	±0.3		±1.0	μA

AC Electrical Characteristics* $T_A = 25°C$, $t_r = t_f = 20$ 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*) $R_L = 200k$ $V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		 25 15 10	 55 35 25	 ns ns ns
t_{PZH}, t_{PZL}	Propagation Delay Time Control Input to Signal Output High Impedance to Logical Level	$R_L = 1.0\ k\Omega$, $C_L = 50$ pF, (*Figures 2 and 3*) $V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$			 125 60 50	 ns ns ns
t_{PHZ}, t_{PLZ}	Propagation Delay Time Control Input to Signal Output Logical Level to High Impedance	$R_L = 1.0\ k\Omega$, $C_L = 50$ pF, (*Figures 2 and 3*) $V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$			 125 60 50	 ns ns ns
	Sine Wave Distortion	$V_C = V_{DD} = 5V$, $V_{SS} = -5V$ $R_L = 10\ k\Omega$, $V_{IS} = 5V_{p-p}$, f = 1 kHz, (*Figure 4*)		0.1		%
	Frequency Response-Switch "ON" (Frequency at −3 dB)	$V_C = V_{DD} = 5V$, $V_{SS} = -5V$, $R_L = 1\ k\Omega$, $V_{IS} = 5V_{p-p}$, $20\ Log_{10} V_{OS}/V_{OS}$ (1 kHz) − dB, (*Figure 4*)		40		MHz

AC Electrical Characteristics* (Continued) $T_A = 25°C$, $t_r = t_f = 20$ ns and $V_{SS} = 0V$ unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Units
	Feedthrough — Switch "OFF" (Frequency at −50 dB)	$V_{DD} = 5.0V$, $V_{CC} = V_{SS} = -5.0V$, $R_L = 1\ k\Omega$, $V_{IS} = 5.0V_{p\text{-}p}$, $20\ Log_{10}$, $V_{OS}/V_{IS} = -50$ dB, *(Figure 4)*		1.25		
	Crosstalk Between Any Two Switches (Frequency at −50 dB)	$V_{DD} = V_{C(A)} = 5.0V$; $V_{SS} = V_{C(B)} = 5.0V$, $R_L\ 1\ k\Omega$, $V_{IS(A)} = 5.0\ V_{p\text{-}p}$, $20\ Log_{10}$, $V_{OS(B)}/V_{IS(A)} = -50$ dB *(Figure 5)*		0.9		MHz
	Crosstalk: Control Input to Signal Output	$V_{DD} = 10V$, $R_L = 10\ k\Omega$, $R_{IN} = 1.0\ k\Omega$, $V_{CC} = 10V$ Square Wave, $C_L = 50$ pF *(Figure 6)*		150		$mV_{p\text{-}p}$
	Maximum Control Input	$R_L = 1.0\ k\Omega$, $C_L = 50$ pF, *(Figure 7)* $V_{OS(f)} = \frac{1}{2} V_{OS}(1.0\ kHz)$				
		$V_{DD} = 5.0V$		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			6.0	7.5	pF

*AC Parameters are guaranteed by DC correlated testing.

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.

Note 3: These devices should not be connected to circuits with the power "ON".

Note 4: 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 5: 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 6: 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}

AC Test Circuits and Switching Time Waveforms

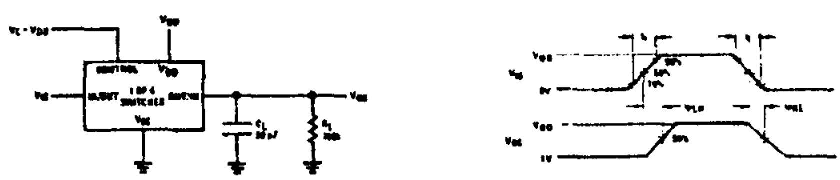


FIGURE 1. t_{PHL}, t_{PLH} Propagation Delay Time Signal Input to Signal Output

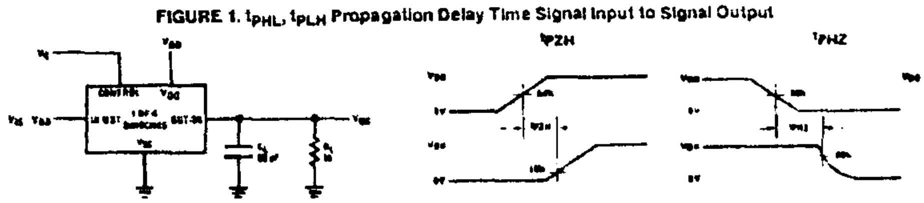
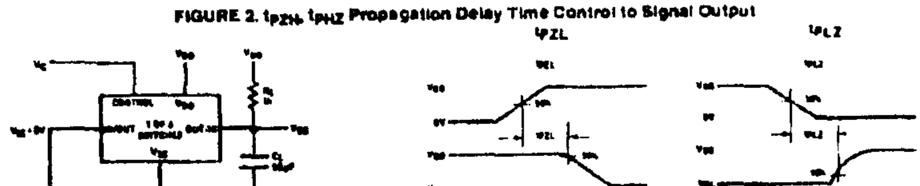


FIGURE 2. t_{PZH}, t_{PHZ} Propagation Delay Time Control to Signal Output



TL/F/5665-2

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

AC Test Circuits and Switching Time Waveforms (Continued)

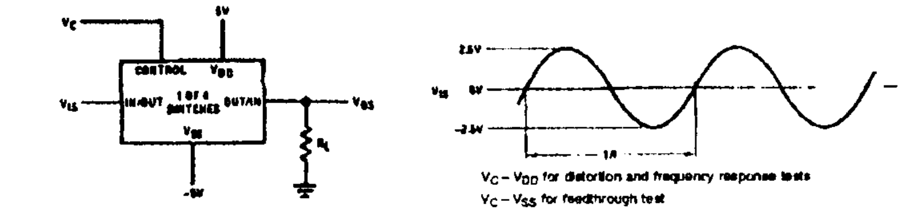


FIGURE 4. Sine Wave Distortion, Frequency Response and Feedthrough

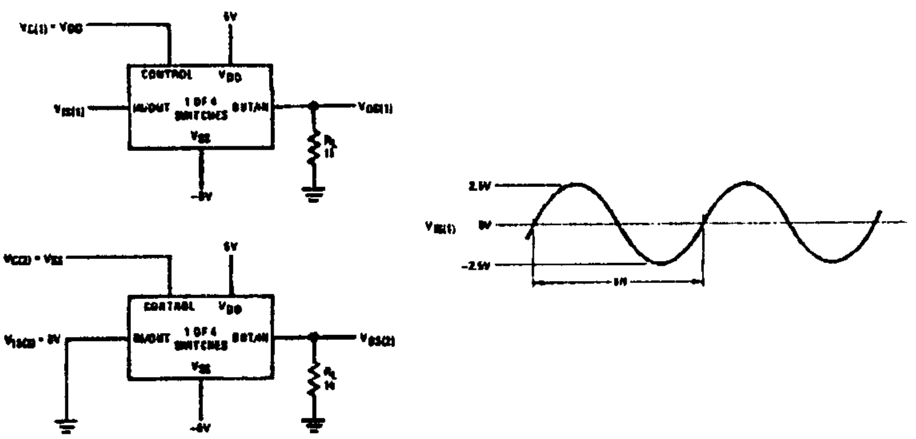


FIGURE 5. Crosstalk Between Any Two Switches

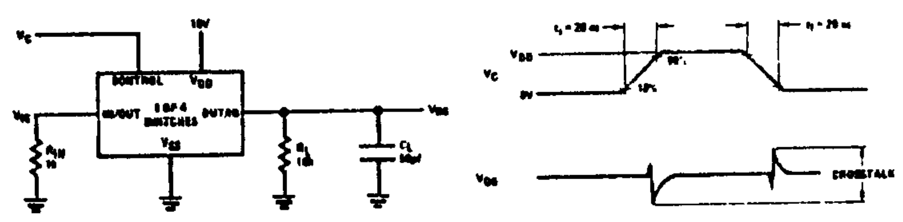


FIGURE 6. Crosstalk: Control Input to Signal Output

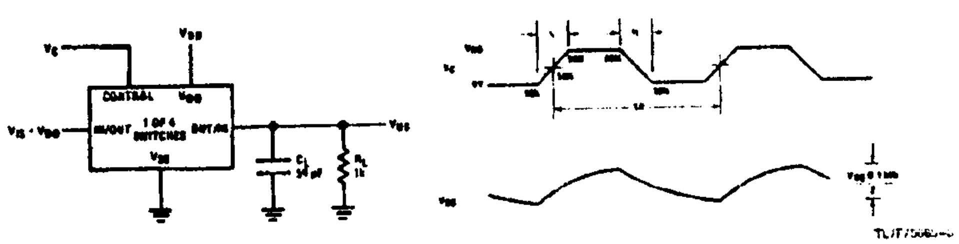
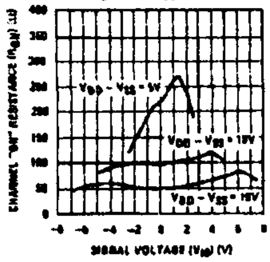


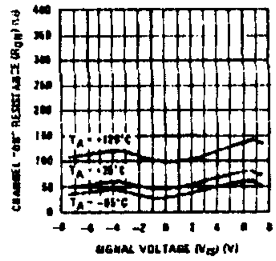
FIGURE 7. Maximum Control Input Frequency

Typical Performance Characteristics

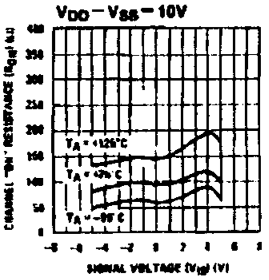
"ON" Resistance vs Signal Voltage for $T_A = 25°C$



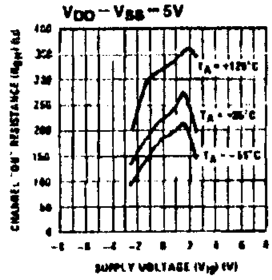
"ON" Resistance as a Function of Temperature for $V_{DD} - V_{SS} = 15V$



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



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



TL/F/5665-4

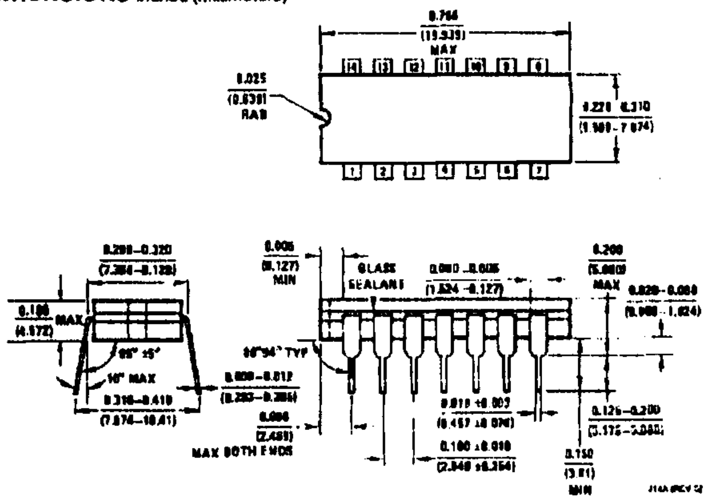
Special Considerations

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 CD4066BM/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 CD4066BM/CD4066BC.

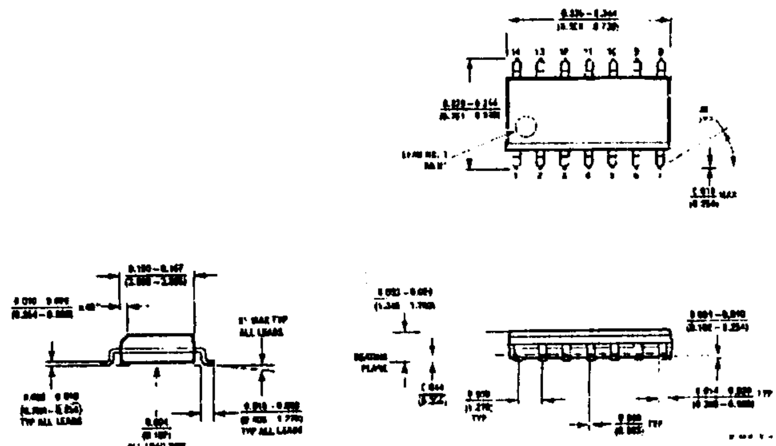
In certain applications, the external load-resistor current may include both V_{DD} and signal-line components. To avoid drawing V_{DD} current when switch current flows into terminals 1, 4, 8 or 11, the voltage drop across the bidirectional switch must not exceed 0.8V at $T_A < 25°C$, or 0.4V at $T_A > 25°C$ (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.

Physical Dimensions inches (millimeters)

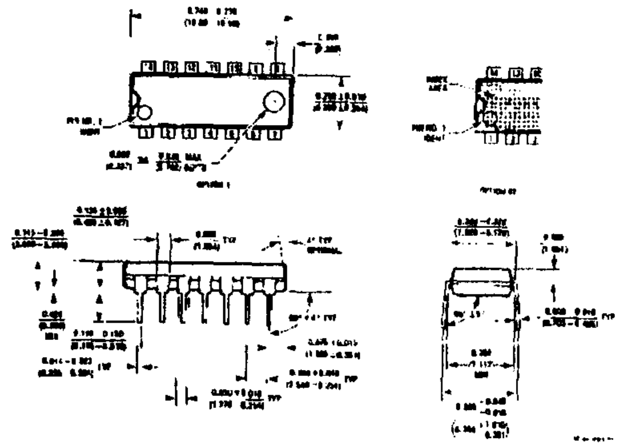


Cerdip (J)
Order Number CD4066BMJ or CD4066BCJ
NS Package Number J14A



S.O. Package (M)
Order Nur.iber CD4066BCM
NS Package Number M14A

Physical Dimensions inches (millimeters) (Continued)



Dual-In-Line Package (N)
Order Number CD4066BMN or CD4066BCN
NS Package Number N14A

National Semiconductor Corporation
1111 West Bardin Road
Arlington, TX 76017
Tel: 1(800) 272-9959
Fax: 1(800) 737-7018

National Semiconductor Europe
Fax: (+49) 0-180-530 85 86
Email: cnjwge@tevm2.nsc.com
Deutsch Tel: (+49) 0-180-530 85 85
English Tel: (+49) 0-180-532 78 32
Français Tel: (+49) 0-180-532 93 58
Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
13th Floor, Straight Block,
Ocean Centre, 5 Canton Rd.
Tsimshatsui, Kowloon
Hong Kong
Tel: (852) 2737-1600
Fax: (852) 2736-9960

National Semiconductor Japan Ltd.
Tel: 81-043-299-2308
Fax: 81-043-299-2408

National Semiconductor

June 1998

ADC0801/ADC0802/ADC0803/ADC0804/ADC0805 8-Bit µP Compatible A/D Converters

General Description

The ADC0801, ADC0802, ADC0803, ADC0804 and ADC0805 are CMOS 8-bit successive approximation A/D converters that use a differential potentiometric ladder — similar to the 256R products. These converters are designed to allow operation with the NSC800 and INS8080A derivative control bus with TRI-STATE® output latches directly driving the data bus. These A/Ds appear like memory locations or I/O ports to the microprocessor and no interfacing logic is needed.

Differential analog voltage inputs allow increasing the common-mode rejection and offsetting the analog zero input voltage value. In addition, the voltage reference input can be adjusted to allow encoding any smaller analog voltage span to the full 8 bits of resolution.

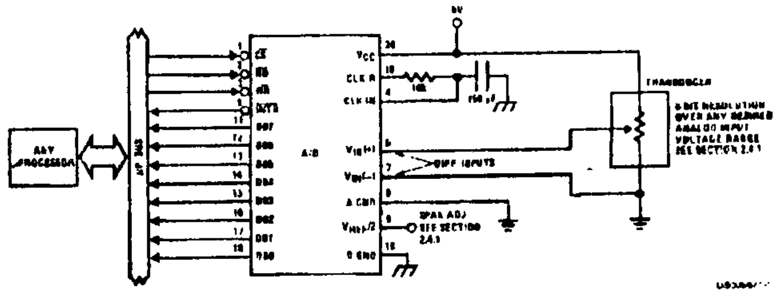
Features

- Compatible with 8080 µP derivatives — no interfacing logic needed - access time - 135 ns
- Easy interface to all microprocessors, or operates "stand alone"
- Differential analog voltage inputs
- Logic inputs and outputs meet both MOS and TTL voltage level specifications
- Works with 2.5V (LM336) voltage reference
- On-chip clock generator
- 0V to 5V analog input voltage range with single 5V supply
- No zero adjust required
- 0.3" standard width 20-pin DIP package
- 20-pin molded chip carrier or small outline package
- Operates ratiometrically or with 5 V_{DC}, 2.5 V_{DC}, or analog span adjusted voltage reference

Key Specifications

- Resolution: 8 bits
- Total error: ±¼ LSB, ±½ LSB and ±1 LSB
- Conversion time: 100 µs

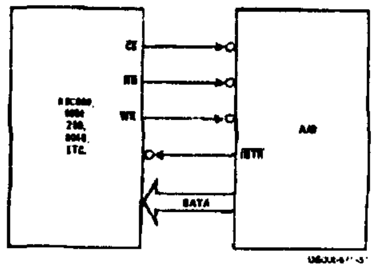
Typical Applications



TRI-STATE® is a registered trademark of National Semiconductor Corp.
Z-80® is a registered trademark of Zilog Corp.

Typical Applications (Continued)

8080 Interface



Error Specification (Includes Full-Scale, Zero Error, and Non-Linearity)			
Part Number	Full-Scale Adjusted	$V_{REF}/2=2.500\ V_{DC}$ (No Adjustments)	$V_{REF}/2$=No Connection (No Adjustments)
ADC0801	±¼ LSB		
ADC0802		±½ LSB	
ADC0803	±½ LSB		
ADC0804		±1 LSB	
ADC0805			±1 LSB

Absolute Maximum Ratings (Notes 1, 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Supply Voltage (V_{CC}) (Note 3)	6.5V
Voltage	
Logic Control Inputs	−0.3V to +18V
At Other Input and Outputs	−0.3V to (V_{CC}+0.3V)
Lead Temp. (Soldering, 10 seconds)	
Dual-In-Line Package (plastic)	260˚C
Dual-In-Line Package (ceramic)	300˚C
Surface Mount Package	
Vapor Phase (60 seconds)	215˚C
Infrared (15 seconds)	220˚C
Storage Temperature Range	−65˚C to +150˚C
Package Dissipation at T_A=25˚C	875 mW
ESD Susceptibility (Note 10)	800V

Operating Ratings (Notes 1, 2)

Temperature Range	T_{MIN}≤T_A≤T_{MAX}
ADC0801/02LJ, ADC0802LJ/883	−55˚C≤T_A≤+125˚C
ADC0801/02/03/04LCJ	−40˚C≤T_A≤+85˚C
ADC0801/02/03/05LCN	−40˚C≤T_A≤+85˚C
ADC0804LCN	0˚C≤T_A≤+70˚C
ADC0802/03/04LCV	0˚C≤T_A≤+70˚C
ADC0802/03/04LCWM	0˚C≤T_A≤+70˚C
Range of V_{CC}	4.5 V_{DC} to 6.3 V_{DC}

Electrical Characteristics

The following specifications apply for V_{CC}=5 V_{DC}, T_{MIN}≤T_A≤T_{MAX} and f_{CLK}=640 kHz unless otherwise specified.

Parameter	Conditions	Min	Typ	Max	Units
ADC0801: Total Adjusted Error (Note 8)	With Full-Scale Adj. (See Section 2.5.2)			±¼	LSB
ADC0802: Total Unadjusted Error (Note 8)	V_{REF}/2=2.500 V_{DC}			±½	LSB
ADC0803: Total Adjusted Error (Note 8)	With Full-Scale Adj. (See Section 2.5.2)			±½	LSB
ADC0804: Total Unadjusted Error (Note 8)	V_{REF}/2=2.500 V_{DC}			±1	LSB
ADC0805: Total Unadjusted Error (Note 8)	V_{REF}/2-No Connection			±1	LSB
V_{REF}/2 Input Resistance (Pin 9)	ADC0801/02/03/05	2.5	8.0		kΩ
	ADC0804 (Note 9)	0.75	1.1		kΩ
Analog Input Voltage Range	(Note 4) V(+) or V(−)	Gnd−0.05		V_{CC}+0.05	V_{DC}
DC Common-Mode Error	Over Analog Input Voltage Range		±1/16	±⅛	LSB
Power Supply Sensitivity	V_{CC}=5 V_{DC} ±10% Over Allowed V_{IN}(+) and V_{IN}(−) Voltage Range (Note 4)		±1/16	±⅛	LSB

AC Electrical Characteristics

The following specifications apply for V_{CC}=5 V_{DC} and T_{MIN}≤T_A≤T_{MAX} unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
T_C	Conversion Time	f_{CLK}=640 kHz (Note 6)	103		114	µs
T_C	Conversion Time	(Notes 5, 6)	66		73	1/f_{CLK}
f_{CLK}	Clock Frequency	V_{CC}=5V, (Note 5)	100	640	1460	kHz
	Clock Duty Cycle		40		60	%
CR	Conversion Rate in Free-Running Mode	$\overline{INTR}$ tied to $\overline{WR}$ with $\overline{CS}$ =0 V_{DC}, f_{CLK}=640 kHz	8770		9708	conv/s
$t_{W(\overline{WR})L}$	Width of $\overline{WR}$ Input (Start Pulse Width)	$\overline{CS}$ =0 V_{DC} (Note 7)	100			ns
t_{ACC}	Access Time (Delay from Falling Edge of $\overline{RD}$ to Output Data Valid)	C_L=100 pF		135	200	ns
t_{1H}, t_{0H}	TRI-STATE Control (Delay from Rising Edge of $\overline{RD}$ to Hi-Z State)	C_L=10 pF, R_L=10k (See TRI-STATE Test Circuits)		125	200	ns
t_{WI}, t_{RI}	Delay from Falling Edge of $\overline{WR}$ or $\overline{RD}$ to Reset of $\overline{INTR}$			300	450	ns

AC Electrical Characteristics (Continued)

The following specifications apply for $V_{CC}=5\ V_{DC}$ and $T_{MIN}\le T_A\le T_{MAX}$ unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
C_{IN}	Input Capacitance of Logic Control Inputs			5	7.5	pF
C_{OUT}	TRI-STATE Output Capacitance (Data Buffers)			5	7.5	pF
CONTROL INPUTS [Note: CLK IN (Pin 4) is the input of a Schmitt trigger circuit and is therefore specified separately]						
V_{IN} (1)	Logical "1" Input Voltage (Except Pin 4 CLK IN)	$V_{CC}=5.25\ V_{DC}$	2.0		15	V_{DC}
V_{IN} (0)	Logical "0" Input Voltage (Except Pin 4 CLK IN)	$V_{CC}=4.75\ V_{DC}$			0.8	V_{DC}
I_{IN} (1)	Logical "1" Input Current (All Inputs)	$V_{IN}=5\ V_{DC}$		0.005	1	μA_{DC}
I_{IN} (0)	Logical "0" Input Current (All Inputs)	$V_{IN}=0\ V_{DC}$	−1	−0.005		μA_{DC}
CLOCK IN AND CLOCK R						
V_T+	CLK IN (Pin 4) Positive Going Threshold Voltage		2.7	3.1	3.5	V_{DC}
V_T-	CLK IN (Pin 4) Negative Going Threshold Voltage		1.5	1.8	2.1	V_{DC}
V_H	CLK IN (Pin 4) Hysteresis $(V_T+)-(V_T-)$		0.6	1.3	2.0	V_{DC}
V_{OUT} (0)	Logical "0" CLK R Output Voltage	$I_O=360\ \mu A$, $V_{CC}=4.75\ V_{DC}$			0.4	V_{DC}
V_{OUT} (1)	Logical "1" CLK R Output Voltage	$I_O=-360\ \mu A$, $V_{CC}=4.75\ V_{DC}$	2.4			V_{DC}
DATA OUTPUTS AND $\overline{INTR}$						
V_{OUT} (0)	Logical "0" Output Voltage Data Outputs $\overline{INTR}$ Output	 $I_{OUT}=1.6$ mA, $V_{CC}=4.75\ V_{DC}$ $I_{OUT}=1.0$ mA, $V_{CC}=4.75\ V_{DC}$			 0.4 0.4	 V_{DC} V_{DC}
V_{OUT} (1)	Logical "1" Output Voltage	$I_O=-360\ \mu A$, $V_{CC}=4.75\ V_{DC}$	2.4			V_{DC}
V_{OUT} (1)	Logical "1" Output Voltage	$I_O=-10\ \mu A$, $V_{CC}=4.75\ V_{DC}$	4.5			V_{DC}
I_{OUT}	TRI-STATE Disabled Output Leakage (All Data Buffers)	$V_{OUT}=0\ V_{DC}$ $V_{OUT}=5\ V_{DC}$	−3		 3	μA_{DC} μA_{DC}
I_{SOURCE}		V_{OUT} Short to Gnd, $T_A=25°C$	4.5	6		mA_{DC}
I_{SINK}		V_{OUT} Short to V_{CC}, $T_A=25°C$	9.0	16		mA_{DC}
POWER SUPPLY						
I_{CC}	Supply Current (Includes Ladder Current) ADC0801/02/03/04LCJ/05 ADC0804LCN/LCV/LCWM	$f_{CLK}=640$ kHz, $V_{REF}/2=NC$, $T_A=25°C$ and $\overline{CS}=5V$		 1.1 1.9	 1.8 2.5	 mA mA

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. DC and AC electrical specifications do not apply when operating the device beyond its specified operating conditions.

Note 2: All voltages are measured with respect to Gnd, unless otherwise specified. The separate A Gnd point should always be wired to the D Gnd.

Note 3: A zener diode exists, internally, from V_{CC} to Gnd and has a typical breakdown voltage of 7 V_{DC}.

Note 4: For $V_{IN}(-)\ge V_{IN}(+)$ the digital output code will be 0000 0000. Two on-chip diodes are tied to each analog input (see block diagram) which will forward conduct for analog input voltages one diode drop below ground or one diode drop greater than the V_{CC} supply. Be careful, during testing at low V_{CC} levels (4.5V), as high level analog inputs (5V) can cause this input diode to conduct—especially at elevated temperatures, and cause errors for analog inputs near full-scale. The spec allows 50 mV forward bias of either diode. This means that as long as the analog V_{IN} does not exceed the supply voltage by more than 50 mV, the output code will be correct. To achieve an absolute 0 V_{DC} to 5 V_{DC} input voltage range will therefore require a minimum supply voltage of 4.950 V_{DC} over temperature variations, initial tolerance and loading.

Note 5: Accuracy is guaranteed at $f_{CLK}=640$ kHz. At higher clock frequencies accuracy can degrade. For lower clock frequencies, the duty cycle limits can be extended so long as the minimum clock high time interval or minimum clock low time interval is no less than 275 ns.

AC Electrical Characteristics (Continued)

Note 6: With an asynchronous start pulse, up to 8 clock periods may be required before the internal clock phases are proper to start the conversion process. The start request is internally latched, see *Figure 4* and section 2.0.

Note 7: The $\overline{CS}$ input is assumed to bracket the $\overline{WR}$ strobe input and therefore timing is dependent on the $\overline{WR}$ pulse width. An arbitrarily wide pulse width will hold the converter in a reset mode and the start of conversion is initiated by the low to high transition of the $\overline{WR}$ pulse (see timing diagrams).

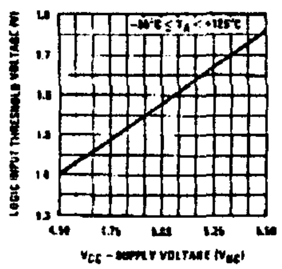
Note 8: None of these A/Ds requires a zero adjust (see section 2.5.1). To obtain zero code at other analog input voltages see section 2.5 and *Figure 7*.

Note 9: The $V_{REF}/2$ pin is the center point of a two-resistor divider connected from V_{CC} to ground. In all versions of the ADC0801, ADC0802, ADC0803, and ADC0805, and in the ADC0804LCJ, each resistor is typically 16 kΩ. In all versions of the ADC0804 except the ADC0804LCJ, each resistor is typically 2.2 kΩ.

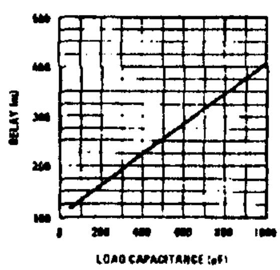
Note 10: Human body model, 100 pF discharged through a 1.5 kΩ resistor.

Typical Performance Characteristics

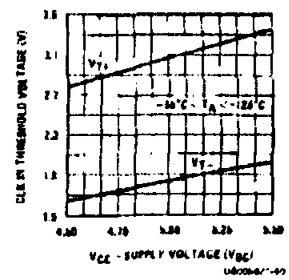
Logic Input Threshold Voltage vs. Supply Voltage



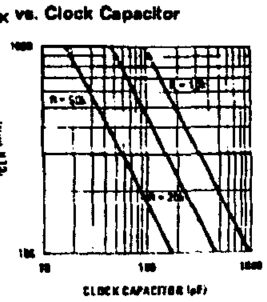
Delay From Falling Edge of RD to Output Data Valid vs. Load Capacitance



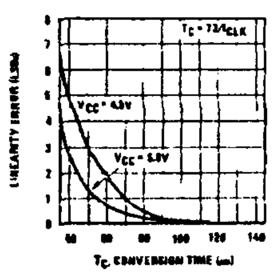
CLK IN Schmitt Trip Levels vs. Supply Voltage



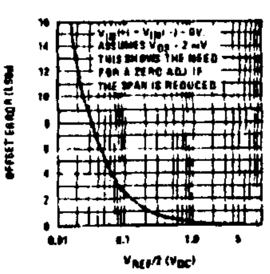
f_{CLK} vs. Clock Capacitor



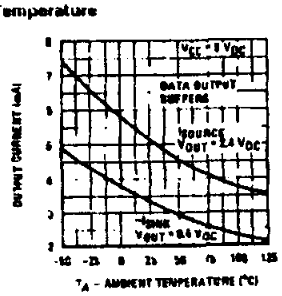
Full-Scale Error vs Conversion Time



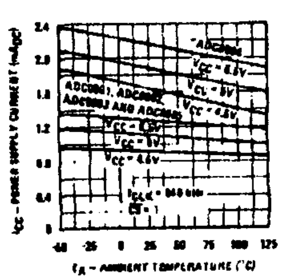
Effect of Unadjusted Offset Error vs. $V_{REF}/2$ Voltage



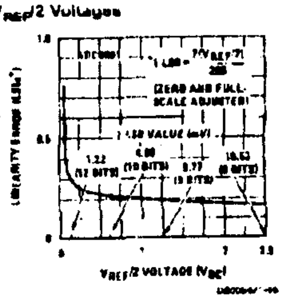
Output Current vs Temperature



Power Supply Current vs Temperature (Note 9)

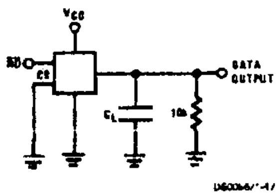


Linearity Error at Low $V_{REF}/2$ Voltages

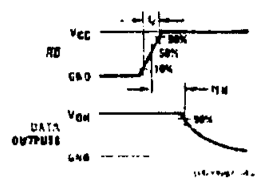


TRI-STATE Test Circuits and Waveforms

t_{1H}

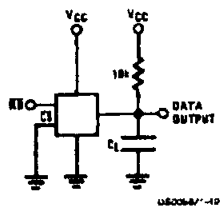


t_{1H}, C_L=10 pF

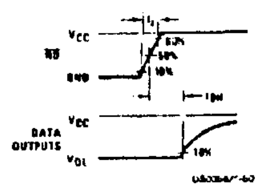


t_r=20 ns

t_{0H}

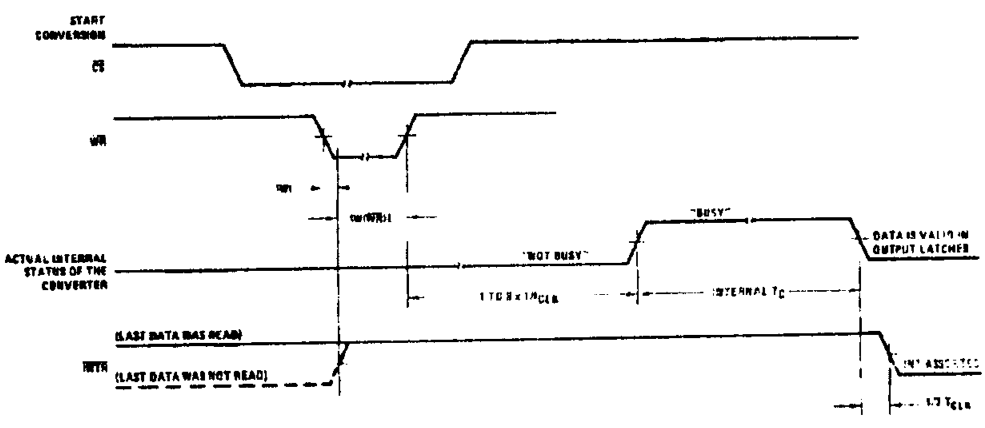


t_{0H}, C_L=10 pF



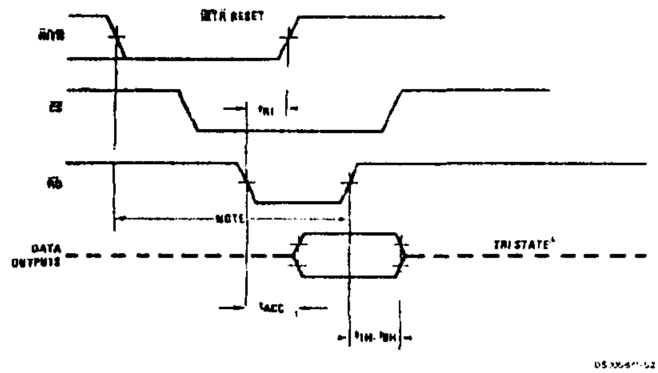
t_r=20 ns

Timing Diagrams (All timing is measured from the 50% voltage points)



Timing Diagrams (All timing is measured from the 50% voltage points) (Continued)

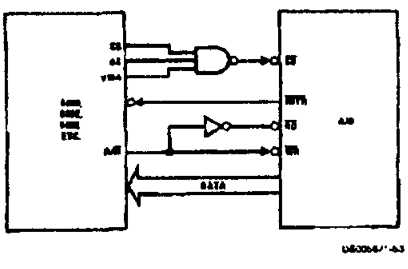
Output Enable and Reset with INTR



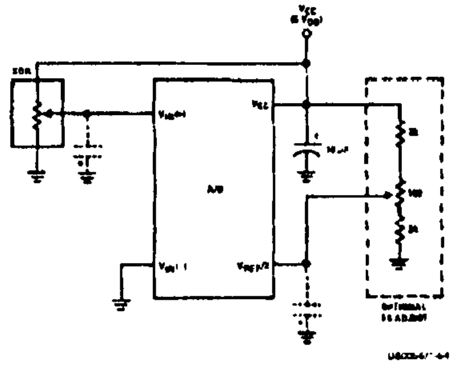
Note: Read strobe must occur 8 clock periods ($8/f_{CLK}$) after assertion of interrupt to guarantee reset of $\overline{INTR}$.

Typical Applications

6800 Interface



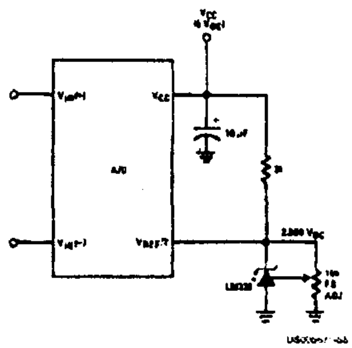
Ratiometric with Full-Scale Adjust



Note: before using caps at V_{IN} or $V_{REF}/2$, see section 2.3.2 Input Bypass Capacitors

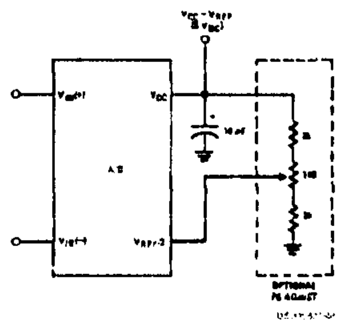
Typical Applications (Continued)

Absolute with a 2.500V Reference

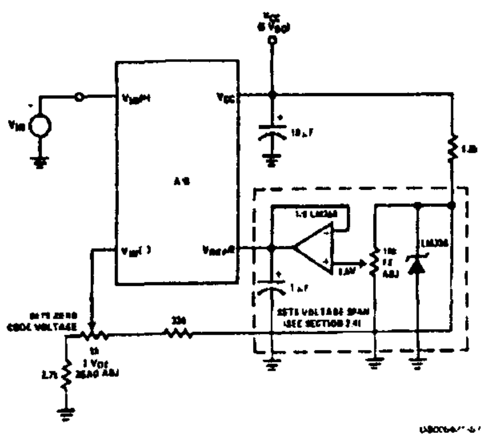


*For low power, see also LM385–2.5

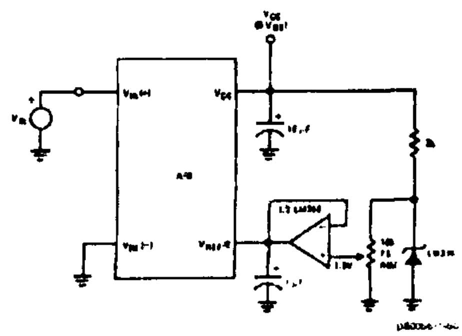
Absolute with a 5V Reference



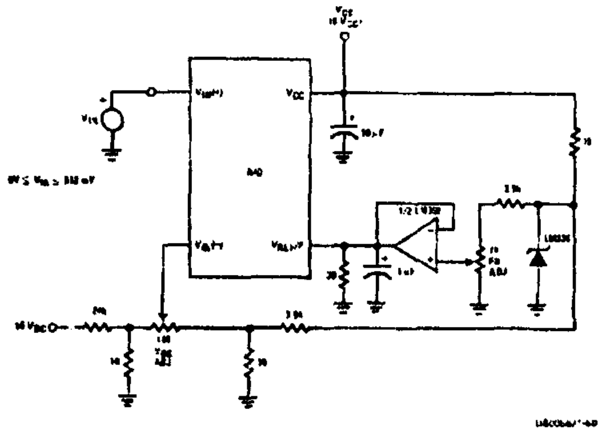
Zero-Shift and Span Adjust: 2V ≤ V_{IN} ≤ 5V



Span Adjust: 0V ≤ V_{IN} ≤ 3V

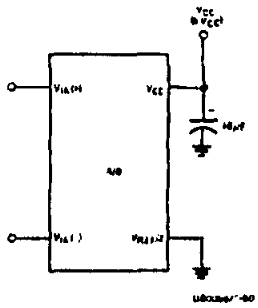


Directly Converting a Low-Level Signal



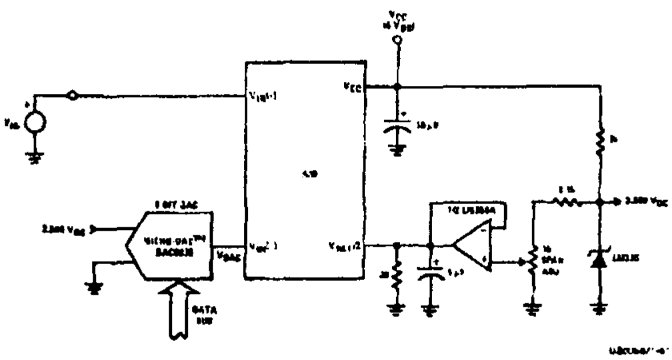
$V_{REF}/2 = 256$ mV

A µP Interfaced Comparator



For:
$V_{IN}(+) > V_{IN}(-)$
Output = FF_{HEX}
For
$V_{IN}(+) < V_{IN}(-)$
Output = 00_{HEX}

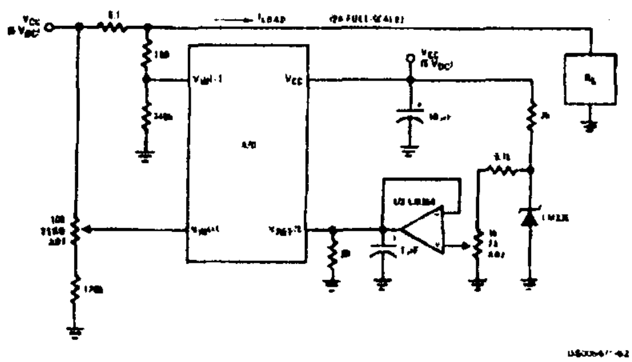
1 mV Resolution with µP Controlled Range



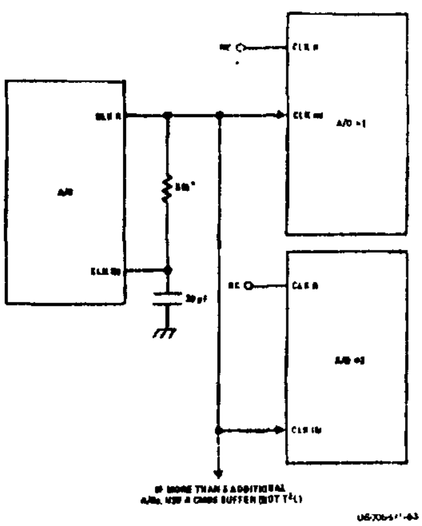
$V_{REF}/2 = 128$ mV
1 LSB = 1 mV
$V_{DAC} \leq V_{IN} \leq (V_{DAC} + 256$ mV)
$0 \leq V_{DAC} < 2.5$V

Typical Applications (Continued)

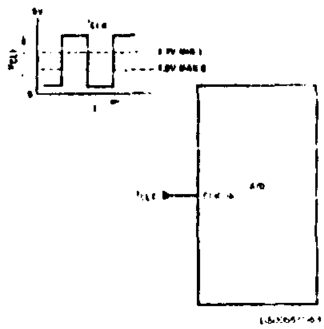
Digitizing a Current Flow



Self-Clocking Multiple A/Ds



External Clocking

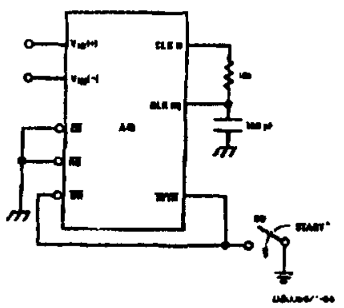


100 kHz ≤ f_{CLK} ≤ 1460 kHz

* Use a large R value
to reduce loading
at CLK R output

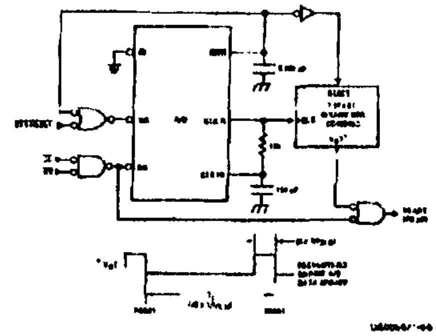
Typical Applications (Continued)

Self-Clocking in Free-Running Mode

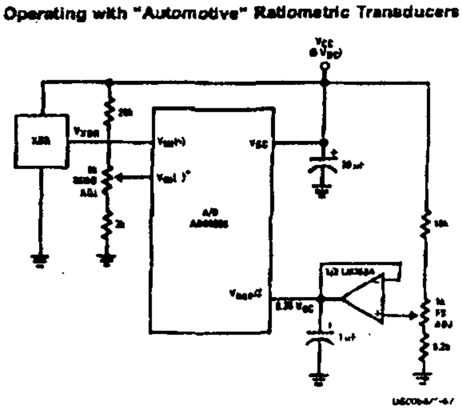


*After power-up, a momentary grounding of the $\overline{WR}$ input is needed to guarantee operation.

µP Interface for Free-Running A/D



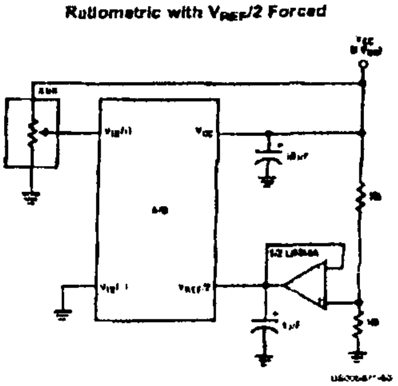
Operating with "Automotive" Ratiometric Transducers



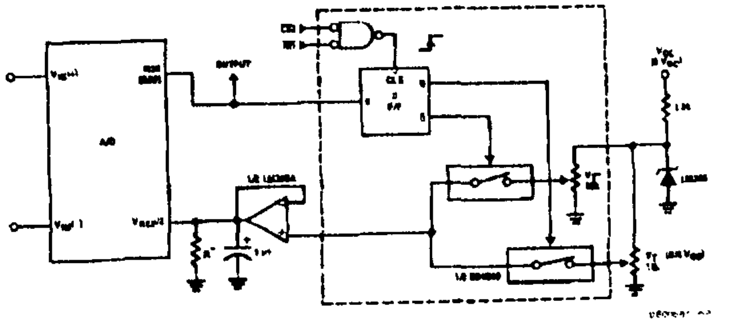
$^*V_{IN}(-) = 0.15\ V_{CC}$

15% of $V_{CC} \le V_{XDR} \le 85\%$ of V_{CC}

Ratiometric with $V_{REF}/2$ Forced



µP Compatible Differential-Input Comparator with Pre-Set V_{OS} (with or without Hysteresis)



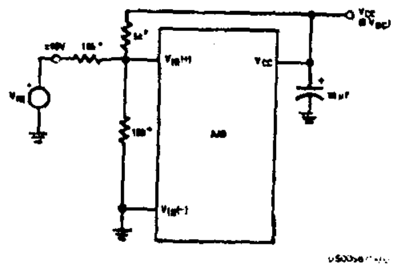
*See Figure 5 to select R value

DB7="1" for $V_{IN}(+) > V_{IN}(-) + (V_{REF}/2)$

Omit circuitry within the dotted area if hysteresis is not needed

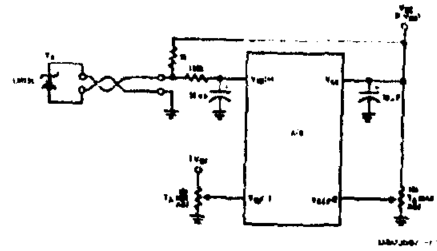
Typical Applications (Continued)

Handling ±10V Analog Inputs

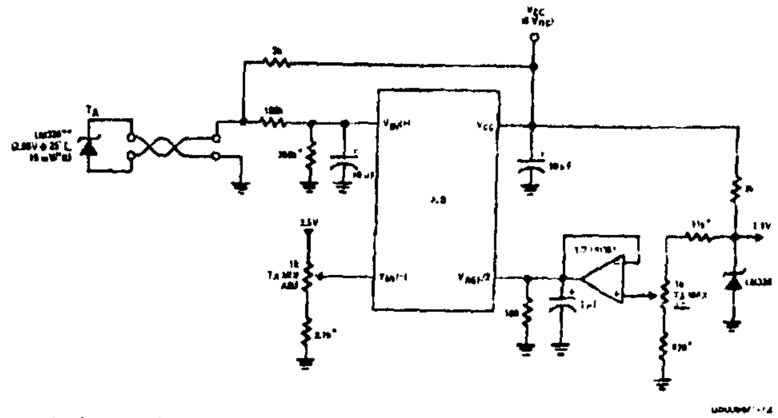


*Beckman Instruments #694-3-R10K resistor array

Low-Cost, µP Interfaced, Temperature-to-Digital Converter



µP Interfaced Temperature-to-Digital Converter

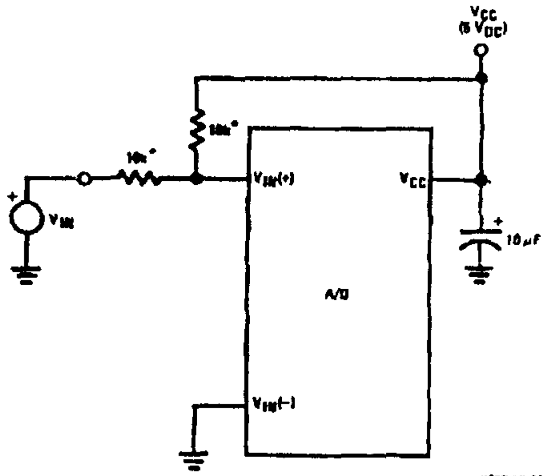


*Circuit values shown are for 0°C≤T_A≤+128°C

**Can calibrate each sensor to allow easy replacement, then A/D can be calibrated with a pre-set input voltage

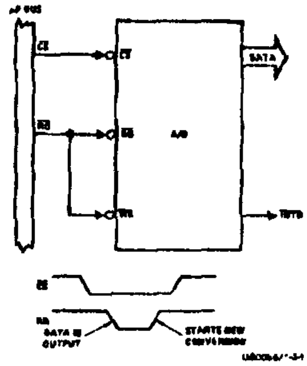
Typical Applications (Continued)

Handling ±5V Analog Inputs

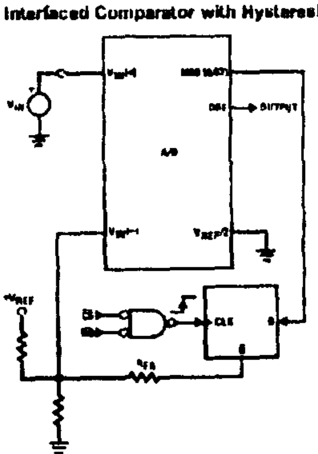


*Beckman Instruments #694-3-R10K resistor array

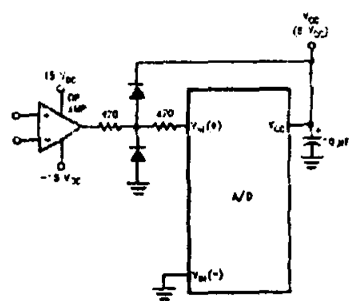
Read-Only Interface



µP Interfaced Comparator with Hysteresis



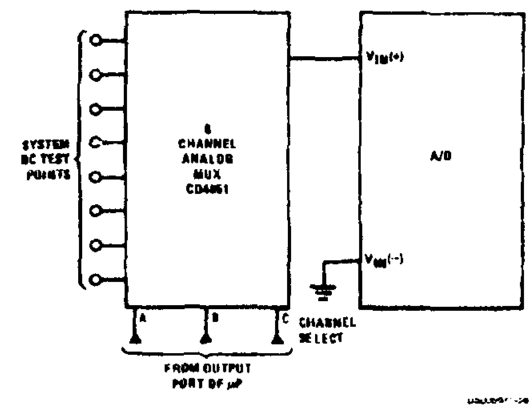
Protecting the Input



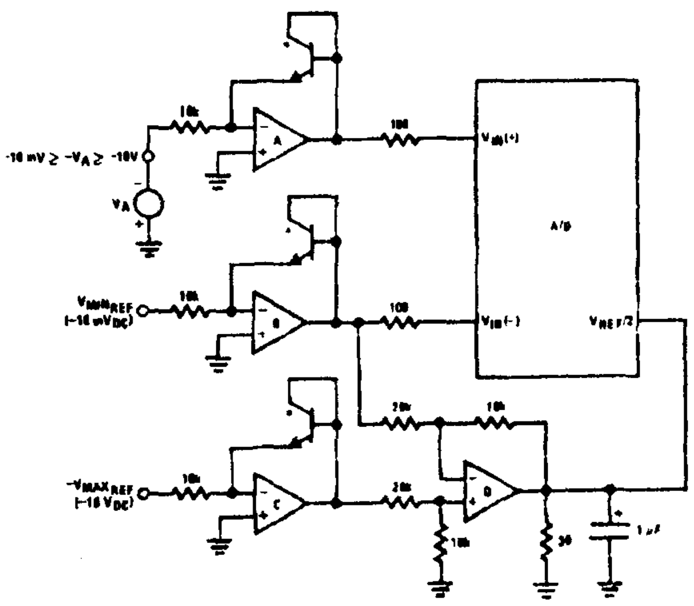
Diodes are 1N914

Typical Applications (Continued)

Analog Self-Test for a System

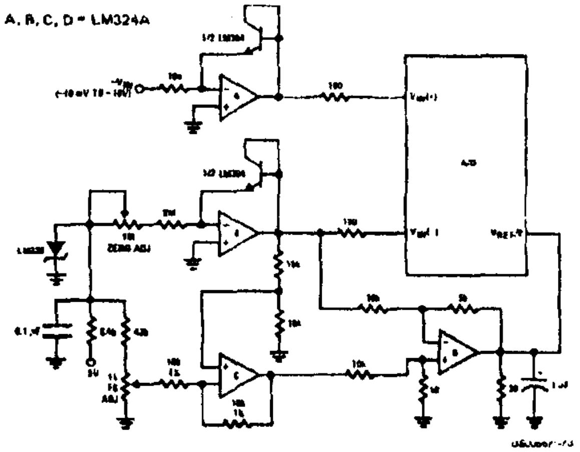


A Low-Cost, 3-Decade Logarithmic Converter

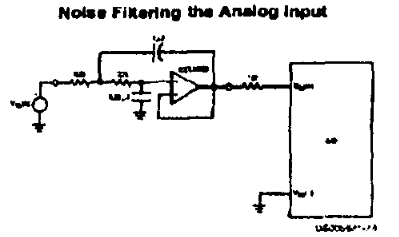


*LM389 transistors
A, B, C, D = LM324A quad op amp

3-Decade Logarithmic A/D Converter

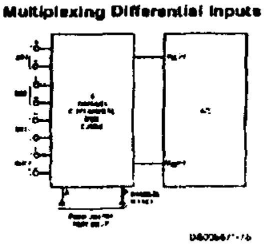


Noise Filtering the Analog Input

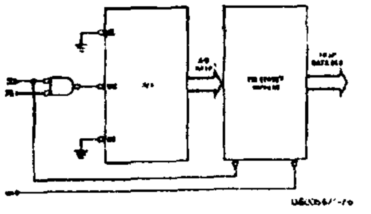


f_C = 20 Hz
Uses Chebyshev implementation for steeper roll-off unity-gain, 2nd order, low pass filter
Adding a separate filter for each channel increases system response time if an analog multiplexer is used

Multiplexing Differential Inputs

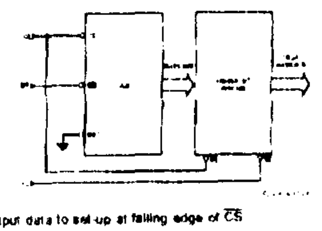


Output Buffers with A/D Data Enabled



*A/D output data is updated 1 CLK period prior to assertion of $\overline{INTR}$

Increasing Bus Drive and/or Reducing Time on Bus



*Allows output data to set-up at falling edge of $\overline{CS}$

National Semiconductor

LM741
Operational Amplifier

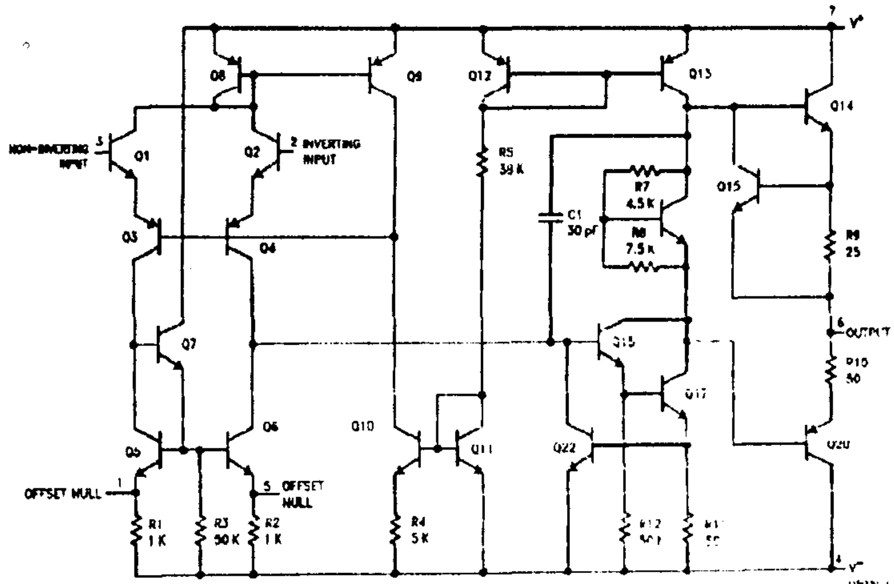
General Description

The LM741 series are general purpose operational amplifiers which feature improved performance over industry standards like the LM709. They are direct, plug-in replacements for the 709C, LM201, MC1439 and 748 in most applications.

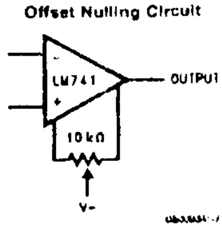
The amplifiers offer many features which make their application nearly foolproof: overload protection on the input and output, no latch-up when the common mode range is exceeded, as well as freedom from oscillations.

The LM741C/LM741E are identical to the LM741/LM741A except that the LM741C/LM741E have their performance guaranteed over a 0°C to +70°C temperature range, instead of −55°C to +125°C.

Schematic Diagram



Offset Nulling Circuit



 DS009341

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

(Note 6)

	LM741A	LM741E	LM741	LM741C
Supply Voltage	±22V	±22V	±22V	±18V
Power Dissipation (Note 2)	500 mW	500 mW	500 mW	500 mW
Differential Input Voltage	±30V	±30V	±30V	±30V
Input Voltage (Note 3)	±15V	±15V	±15V	±15V
Output Short Circuit Duration	Continuous	Continuous	Continuous	Continuous
Operating Temperature Range	−55°C to +125°C	0°C to +70°C	−55°C to +125°C	0°C to +70°C
Storage Temperature Range	−65°C to +150°C	−65°C to +150°C	−65°C to +150°C	−65°C to +150°C
Junction Temperature	150°C	100°C	150°C	100°C
Soldering Information				
N-Package (10 seconds)	260°C	260°C	260°C	260°C
J- or H-Package (10 seconds)	300°C	300°C	300°C	300°C
M-Package				
Vapor Phase (60 seconds)	215°C	215°C	215°C	215°C
Infrared (15 seconds)	215°C	215°C	215°C	215°C

See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.

	LM741A	LM741E	LM741	LM741C
ESD Tolerance (Note 7)	400V	400V	400V	400V

Electrical Characteristics (Note 4)

Parameter	Conditions	LM741A/LM741E			LM741			LM741C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	$T_A = 25°C$										
	$R_S \le 10\ k\Omega$					1.0	5.0		2.0	6.0	mV
	$R_S \le 50\Omega$		0.8	3.0							mV
	$T_{AMIN} \le T_A \le T_{AMAX}$										
	$R_S \le 50\Omega$			4.0							mV
	$R_S \le 10\ k\Omega$						6.0			7.5	mV
Average Input Offset Voltage Drift				15							μV/°C
Input Offset Voltage Adjustment Range	$T_A = 25°C, V_S = \pm 20V$	±10				±15			±15		mV
Input Offset Current	$T_A = 25°C$		3.0	30		20	200		20	200	nA
	$T_{AMIN} \le T_A \le T_{AMAX}$			70		85	500			300	nA
Average Input Offset Current Drift				0.5							nA/°C
Input Bias Current	$T_A = 25°C$		30	80		80	500		80	500	nA
	$T_{AMIN} \le T_A \le T_{AMAX}$			0.210			1.5			0.8	μA
Input Resistance	$T_A = 25°C, V_S = \pm 20V$	1.0	6.0		0.3	2.0		0.3	2.0		MΩ
	$T_{AMIN} \le T_A \le T_{AMAX}$, $V_S = \pm 20V$	0.5									MΩ
Input Voltage Range	$T_A = 25°C$							±12	±13		V
	$T_{AMIN} \le T_A \le T_{AMAX}$				±12	±13					V

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

(Note 6)

	LM741A	LM741E	LM741	LM741C
Supply Voltage	±22V	±22V	±22V	±18V
Power Dissipation (Note 2)	500 mW	500 mW	500 mW	500 mW
Differential Input Voltage	±30V	±30V	±30V	±30V
Input Voltage (Note 3)	±15V	±15V	±15V	±15V
Output Short Circuit Duration	Continuous	Continuous	Continuous	Continuous
Operating Temperature Range	−55°C to +125°C	0°C to +70°C	−55°C to +125°C	0°C to +70°C
Storage Temperature Range	−65°C to +150°C	−65°C to +150°C	−65°C to +150°C	−65°C to +150°C
Junction Temperature	150°C	100°C	150°C	100°C
Soldering Information				
N-Package (10 seconds)	260°C	260°C	260°C	260°C
J- or H-Package (10 seconds)	300°C	300°C	300°C	300°C
M-Package				
Vapor Phase (60 seconds)	215°C	215°C	215°C	215°C
Infrared (15 seconds)	215°C	215°C	215°C	215°C

See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.

ESD Tolerance (Note 7)	400V	400V	400V	400V

Electrical Characteristics (Note 4)

Parameter	Conditions	LM741A/LM741E			LM741			LM741C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	$T_A = 25°C$										
	$R_S \leq 10\ k\Omega$					1.0	5.0		2.0	6.0	mV
	$R_S \leq 50\Omega$		0.8	3.0							mV
	$T_{AMIN} \leq T_A \leq T_{AMAX}$										
	$R_S \leq 50\Omega$			4.0							mV
	$R_S \leq 10\ k\Omega$						6.0			7.5	mV
Average Input Offset Voltage Drift				15							μV/°C
Input Offset Voltage Adjustment Range	$T_A = 25°C, V_S = \pm 20V$	±10				±15			±15		mV
Input Offset Current	$T_A = 25°C$		3.0	30		20	200		20	200	nA
	$T_{AMIN} \leq T_A \leq T_{AMAX}$			70		85	500			300	nA
Average Input Offset Current Drift				0.5							nA/°C
Input Bias Current	$T_A = 25°C$		30	80		80	500		80	500	nA
	$T_{AMIN} \leq T_A \leq T_{AMAX}$			0.210			1.5			0.8	μA
Input Resistance	$T_A = 25°C, V_S = \pm 20V$	1.0	6.0		0.3	2.0		0.3	2.0		MΩ
	$T_{AMIN} \leq T_A \leq T_{AMAX}$, $V_S = \pm 20V$	0.5									MΩ
Input Voltage Range	$T_A = 25°C$							±12	±13		V
	$T_{AMIN} \leq T_A \leq T_{AMAX}$				±12	±13					V

Electrical Characteristics (Note 4) (Continued)

Note 2: For operation at elevated temperatures, these devices must be derated based on thermal resistance, and T_j max. (listed under "Absolute Maximum Ratings"). $T_j = T_A + (\theta_{jA} P_D)$.

Thermal Resistance	Cerdip (J)	DIP (N)	HO8 (H)	SO-8 (M)
θ_{jA} (Junction to Ambient)	100°C/W	100°C/W	170°C/W	195°C/W
θ_{jC} (Junction to Case)	N/A	N/A	25°C/W	N/A

Note 3: For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

Note 4: Unless otherwise specified, these specifications apply for $V_S = \pm 15V$, $-55°C \le T_A \le +125°C$ (LM741/LM741A). For the LM741C/LM741E, these specifications are limited to $0°C \le T_A \le +70°C$.

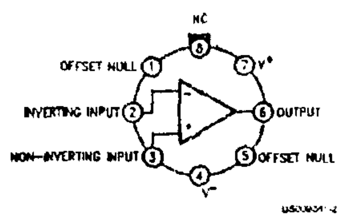
Note 5: Calculated value from: BW (MHz) = 0.35/Rise Time(µs).

Note 6: For military specifications see RETS741X for LM741 and RETS741AX for LM741A.

Note 7: Human body model, 1.5 kΩ in series with 100 pF.

Connection Diagram

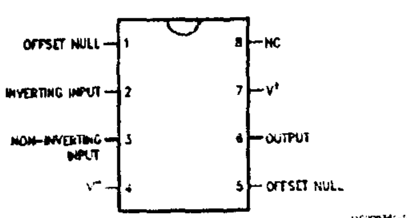
Metal Can Package



Note 8: LM741H is available per JM38510/10101

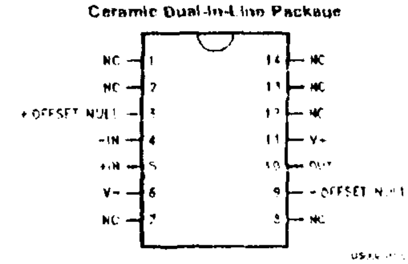
Order Number LM741H, LM741H/883 (Note 8), LM741AH/883 or LM741CH
See NS Package Number H08C

Dual-In-Line or S.O. Package



Order Number LM741J, LM741J/883, LM741CM, LM741CN or LM741EN
See NS Package Number J08A, M08A or N08E

Ceramic Dual-In-Line Package

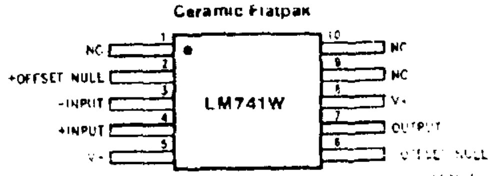


Note 9: also available per JM38510/10101

Note 10: also available per JM38510/10102

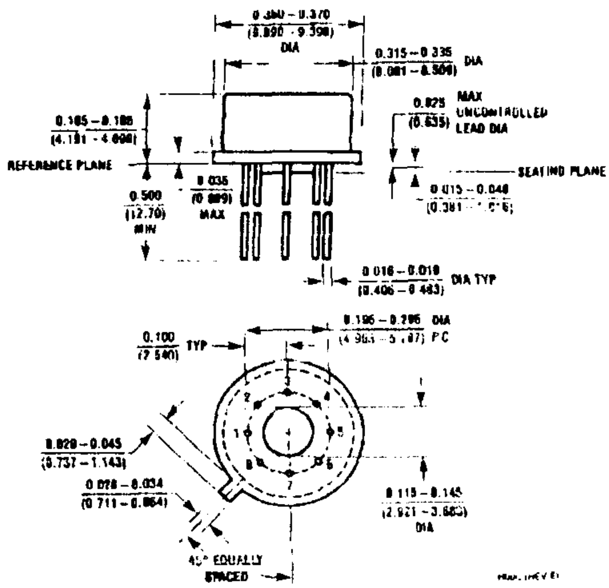
Order Number LM741J-14/883 (Note 9), LM741AJ-14/883 (Note 10)
See NS Package Number J14A

Ceramic Flatpak

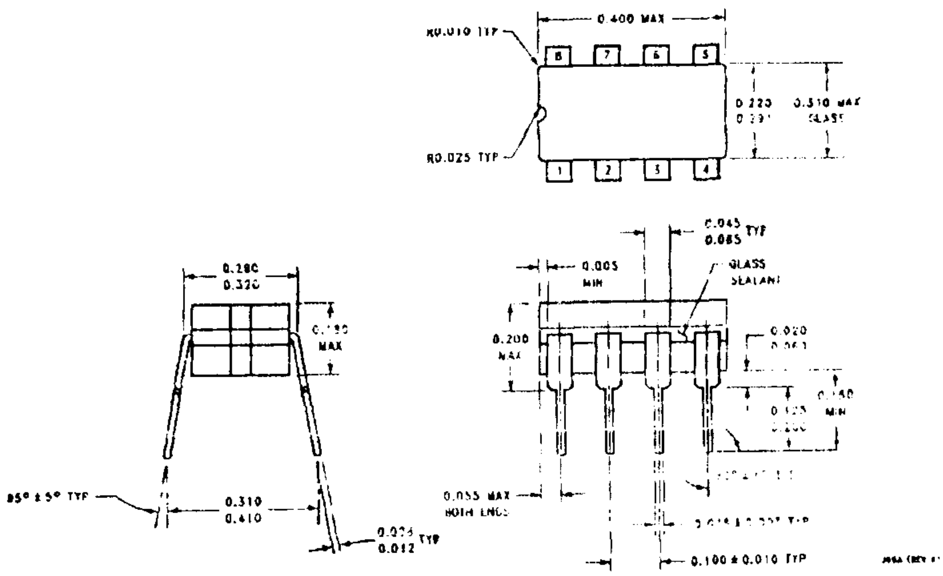


Order Number LM741W/883
See NS Package Number W10A

Physical Dimensions inches (millimeters) unless otherwise noted

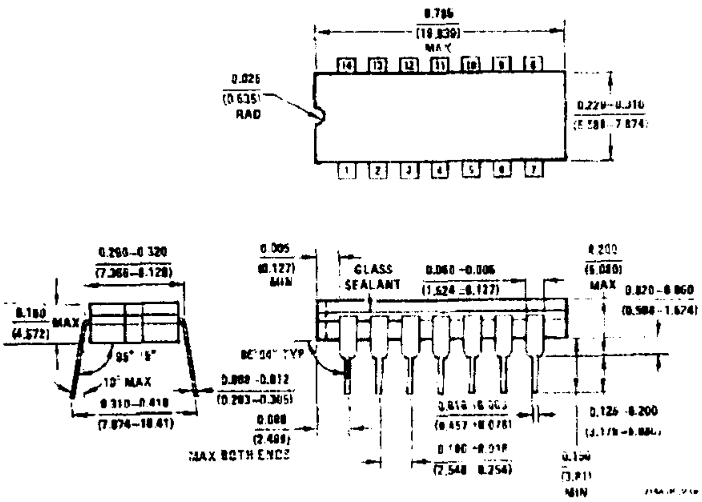


Metal Can Package (H)
Order Number LM741H, LM741H/883, LM741AH/883, LM741CH or LM741EH
NS Package Number H08C

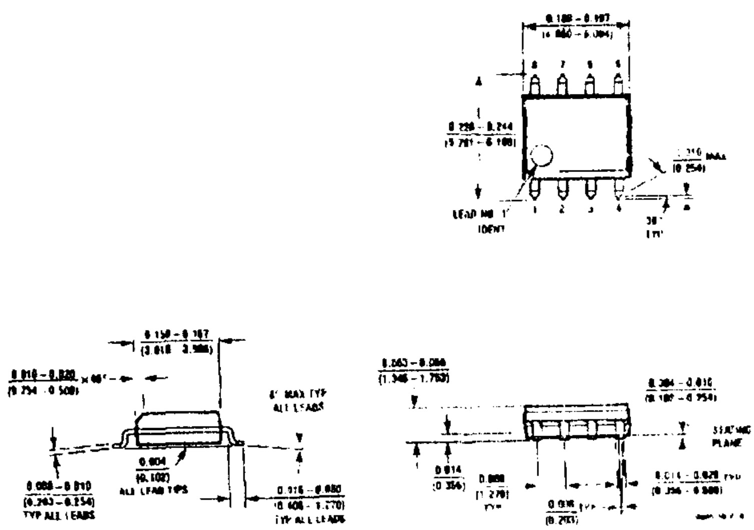


Ceramic Dual-In-Line Package (J)
Order Number LM741CJ or LM741J/883
NS Package Number J08A

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

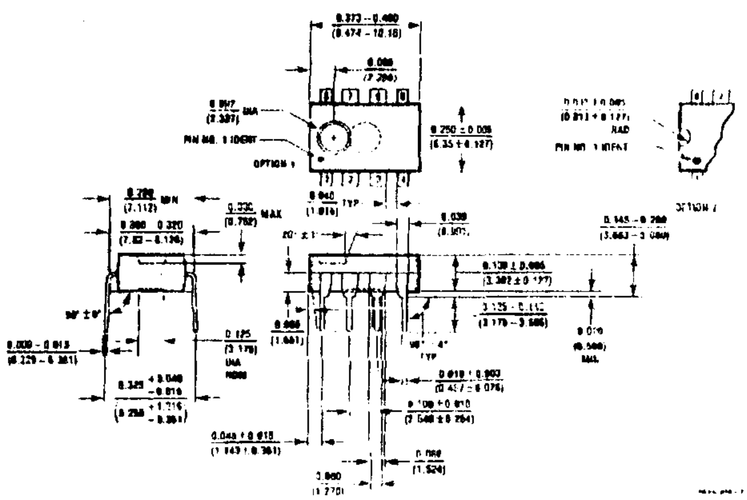


Ceramic Dual-In-Line Package (J)
Order Number LM741J-14/883 or LM741AJ-14/883
NS Package Number J14A



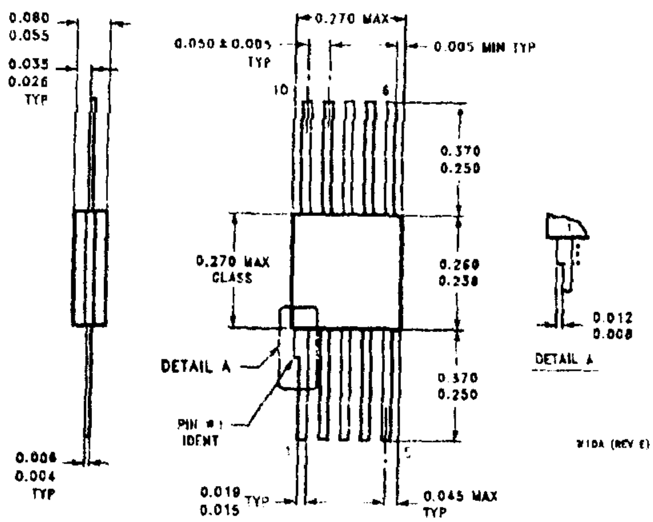
Small Outline Package (M)
Order Number LM741CM
NS Package Number M08A

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



Dual-In-Line Package (N)
Order Number LM741CN or LM741EN
NS Package Number N08E

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



10-Lead Ceramic Flatpak (W)
Order Number LM741W/883
NS Package Number W10A

National Semiconductor Corporation
Americas
Tel: 1-800-272-9959
Fax: 1-800-737-7018
Email: support@nsc.com

www.national.com

National Semiconductor Europe
Fax: +49 (0) 1 80-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 1 80-530 85 85
English Tel: +49 (0) 1 80-532 78 32
Français Tel: +49 (0) 1 80-532 93 58
Italiano Tel: +49 (0) 1 80-534 16 80

National Semiconductor Asia Pacific Customer Response Group
Tel: 65-2544466
Fax: 65-2504466
Email: ap.support@nsc.com

National Semiconductor Japan Ltd.
Tel: 81-3-5639-7560
Fax: 81-3-5639-7507

BIODATA

Nama	: ATAN
NRP	: 5103096036
NIRM	: 96.7.003.31073.58595
Alamat	: Kali Kepiting Jaya IX/51 A
Tempat /Tanggal Lahir	: Bengkalis, 5 Maret 1976
Agama	: Katolik

Riwayat Pendidikan :

1. Lulus SD Katolik DON BOSKO IV, Kupang, Tahun 1990.
2. Lulus SMP Katolik FRATER, Kupang, Tahun 1993.
3. Lulus SMA Katolik GIOVANNI, Kupang, Tahun 1996.
4. Mahasiswa Universitas Katolik WIDYA MANDALA, Fakultas Teknik Jurusan Elektro, Surabaya, Angkatan 1996.