LAMPIRAN B

PERANGKAT LUNAK
#INCLUDE "8051.H"

PORTSTEPPER .EQU P0
DATA7SEG .EQU P1
LEDMERAH .EQU P2.0
LEDHIJAU .EQU P2.1
SL1 .EQU P2.2
SL2 .EQU P2.3
SL3 .EQU P2.4
SL4 .EQU P2.5
SL5 .EQU P2.6
INPUTINFRA .EQU P3.2

.ORG $50
BUF1 .BLOCK 1
BUF2 .BLOCK 1
BUF3 .BLOCK 1
BUF4 .BLOCK 1
BUF5 .BLOCK 1
STLOK1 .BLOCK 1
STLOK2 .BLOCK 1
STLOK3 .BLOCK 1
STLOK4 .BLOCK 1
STLOK5 .BLOCK 1
STLOK6 .BLOCK 1
STLOK7 .BLOCK 1
STLOK8 .BLOCK 1
STLOK9 .BLOCK 1
STLOK10 .BLOCK 1
JUMMOBIL .BLOCK 1
.ORG $0
LJMP MULAI

.ORG $100
MULAI:
   MOV SP,#$20
   LCALL INITSERIAL
   MOV STLOK1,#$30
   MOV STLOK2,#$30
   MOV STLOK3,#$30
   MOV STLOK4,#$30
   MOV STLOK5,#$30
   MOV STLOK6,#$30
   MOV STLOK7,#$30
   MOV STLOK8,#$30
   MOV STLOK9,#$30
   MOV STLOK10,#$30
   MOV BUF1,#$C0
   MOV BUF2,#$C0
   MOV BUF3,#$C0
   MOV BUF4,#$C0
   MOV BUF5,#$C0
   SETB LEDMERAH
   CLR LEDHIJAU
   MOV R3,#$0A

LOOP:
   MOV SP,#$20
   MOV R4,#$FF
LCALL CEKJUMMOBIL

SCANLAGI1:
    LCALL SCANNING
    DJNZ R4,SCANLAGI1

;--------------------------------------------------------------------
; SCANNING POSISI MOBIL DAN MENCATATNYA
;--------------------------------------------------------------------
    MOV R3,#$0A
    MOV R4,#$4F

SCANMOBIL1:
    LCALL PUTARMOTORKR
    DJNZ R4,SCANMOBIL1
    JB INPUTINFRA,SCANMOBIL2
    MOV STLOK1,#$31
    DEC R3
    LJMP SCANMOBIL21

SCANMOBIL2: MOV STLOK1,#$30

SCANMOBIL21: LCALL PENGIRIMANDATA
    MOV R4,#$4F

SCANMOBIL22:
    LCALL PUTARMOTORKR
    DJNZ R4,SCANMOBIL22
    JB INPUTINFRA,SCANMOBIL3
    MOV STLOK2,#$31
    DEC R3
    LJMP SCANMOBIL31

SCANMOBIL3: MOV STLOK2,#$30

SCANMOBIL31: LCALL PENGIRIMANDATA
    MOV R4,#$4F
SCANMOBIL32:
  LCALL PUTARMOTORKR
  DJNZ R4,SCANMOBIL32
  JB INPUTINFRA,SCANMOBIL4
  MOV STLOK3,#$31
  DEC R3
  LJMP SCANMOBIL41
SCANMOBIL4:  MOV STLOK3,#$30
SCANMOBIL41:  LCALL PENGIRIMANDATA
  MOV R4,#$4F
SCANMOBIL42:
  LCALL PUTARMOTORKR
  DJNZ R4,SCANMOBIL42
  JB INPUTINFRA,SCANMOBIL5
  MOV STLOK4,#$31
  DEC R3
  LJMP SCANMOBIL51
SCANMOBIL5:  MOV STLOK4,#$30
SCANMOBIL51:  LCALL PENGIRIMANDATA
  MOV R4,#$4F
SCANMOBIL52:
  LCALL PUTARMOTORKR
  DJNZ R4,SCANMOBIL52
  JB INPUTINFRA,SCANMOBIL6
  MOV STLOK5,#$31
  DEC R3
  LJMP SCANMOBIL61
SCANMOBIL6:  MOV STLOK5,#$30
SCANMOBIL61:  LCALL PENGIRIMANDATA
  MOV R4,#$4F
SCANMOBIL62:
  LCALL PUTARMOTORKR
  DJNZ R4,SCANMOBIL62
  JB INPUTINFRA,SCANMOBIL7
  MOV STLOK6,#$31
  DEC R3
  LJMP SCANMOBIL71
SCANMOBIL7:  MOV STLOK6,#$30
SCANMOBIL71:  LCALL PENGIRIMANDATA
    MOV R4,#$4F
SCANMOBIL72:
  LCALL PUTARMOTORKR
  DJNZ R4,SCANMOBIL72
  JB INPUTINFRA,SCANMOBIL8
  MOV STLOK7,#$31
  DEC R3
  LJMP SCANMOBIL81
SCANMOBIL8:  MOV STLOK7,#$30
SCANMOBIL81:  LCALL PENGIRIMANDATA
    MOV R4,#$4F
SCANMOBIL82:
  LCALL PUTARMOTORKR
  DJNZ R4,SCANMOBIL82
  JB INPUTINFRA,SCANMOBIL9
  MOV STLOK8,#$31
  DEC R3
  LJMP SCANMOBIL91
SCANMOBIL9:  MOV STLOK8,#$30
SCANMOBIL91:  LCALL PENGIRIMANDATA
    MOV R4,#$4F
SCANMOBIL92:
    LCALL PUTARMOTORKR
    DJNZ R4,SCANMOBIL92
    JB INPUTINFRA,SCANMOBIL10
    MOV STLOK9,#$31
    DEC R3
    LJMP SCANMOBIL101
SCANMOBIL10:  MOV STLOK9,#$30
SCANMOBIL101:  LCALL PENGIRIMANDATA
    MOV R4,#$4F
SCANMOBIL102:
    LCALL PUTARMOTORKR
    DJNZ R4,SCANMOBIL102
    JB INPUTINFRA,SCANMOBILEND
    MOV STLOK10,#$31
    DEC R3
    LJMP SCANMOBILEND1
SCANMOBILEND:  MOV STLOK10,#$30
SCANMOBILEND1:  LCALL PENGIRIMANDATA

;------------- SCANNING PERTAMA SELESAI -----------
    MOV R4,#$FF
    LCALL CEKJUMMOBIL
SCANLAGI2:  LCALL SCANNING
    DJNZ R4,SCANLAGI2

;------------- SCANNING BALIK ---------------------
    MOV R3,#$0A
    JB INPUTINFRA,BSCANMOBIL90
    MOV STLOK10,#$31
    LJMP BSCANMOBIL91
BSCANMOBIL90: MOV STLOK10,#$30
BSCANMOBIL91: LCALL PENGIRIMANDATA
          MOV R4,#$4F
BSCANMOBIL9:
          LCALL PUTARMOTORKN
          DJNZ R4,BSCANMOBIL9
          JB INPUTINFRA,BSCANMOBIL8
          MOV STLOK9,#$31
          DEC R3
          LJMP BSCANMOBIL81
BSCANMOBIL8: MOV STLOK9,#$30
BSCANMOBIL81: LCALL PENGIRIMANDATA
          MOV R4,#$4F
BSCANMOBIL82:
          LCALL PUTARMOTORKN
          DJNZ R4,BSCANMOBIL82
          JB INPUTINFRA,BSCANMOBIL7
          MOV STLOK8,#$31
          DEC R3
          LJMP BSCANMOBIL71
BSCANMOBIL7: MOV STLOK8,#$30
BSCANMOBIL71: LCALL PENGIRIMANDATA
          MOV R4,#$4F
BSCANMOBIL72:
          LCALL PUTARMOTORKN
          DJNZ R4,BSCANMOBIL72
          JB INPUTINFRA,BSCANMOBIL6
          MOV STLOK7,#$31
          DEC R3
          LJMP BSCANMOBIL61
BSCANMOBIL6: MOV STLOK7,#$30
BSCANMOBIL61: LCALL PENGIRIMANDATA
       MOV R4,#$4F
BSCANMOBIL62:
       LCALL PUTARMOTORKN
       DJNZ R4,BSCANMOBIL62
       JB INPUTINFRA,BSCANMOBIL5
       MOV STLOK6,#$31
       DEC R3
       LJMP BSCANMOBIL51
BSCANMOBIL5: MOV STLOK6,#$30
BSCANMOBIL51: LCALL PENGIRIMANDATA
       MOV R4,#$4F
BSCANMOBIL52:
       LCALL PUTARMOTORKN
       DJNZ R4,BSCANMOBIL52
       JB INPUTINFRA,BSCANMOBIL4
       MOV STLOK5,#$31
       DEC R3
       LJMP BSCANMOBIL41
BSCANMOBIL4: MOV STLOK5,#$30
BSCANMOBIL41: LCALL PENGIRIMANDATA
       MOV R4,#$4F
BSCANMOBIL42:
       LCALL PUTARMOTORKN
       DJNZ R4,BSCANMOBIL42
       JB INPUTINFRA,BSCANMOBIL3
       MOV STLOK4,#$31
       DEC R3
       LJMP BSCANMOBIL31
BSCANMOBIL3: MOV STLOK4,#$30
BSCANMOBIL31: LCALL PENGIRIMANDATA
    MOV R4,#$4F
BSCANMOBIL32:
    LCALL PUTARMOTORKN
    DJNZ R4,BSCANMOBIL32
    JB INPUTINFRA,BSCANMOBIL2
    MOV STLOK3,#$31
    DEC R3
    LJMP BSCANMOBIL21
BSCANMOBIL2: MOV STLOK3,#$30
BSCANMOBIL21: LCALL PENGIRIMANDATA
    MOV R4,#$4F
BSCANMOBIL22:
    LCALL PUTARMOTORKN
    DJNZ R4,BSCANMOBIL22
    JB INPUTINFRA,BSCANMOBIL1
    MOV STLOK2,#$31
    DEC R3
    LJMP BSCANMOBIL11
BSCANMOBIL1: MOV STLOK2,#$30
BSCANMOBIL11: LCALL PENGIRIMANDATA
    MOV R4,#$4F
BSCANMOBIL12:
    LCALL PUTARMOTORKN
    DJNZ R4,BSCANMOBIL12
    JB INPUTINFRA,BSCANMOBIL10
    MOV STLOK1,#$31
    DEC R3
    LJMP BSCANMOBIL101
BSCANMOBIL10: MOV STLOK1,#$30
BSCANMOBIL101: LCALL PENGIRIMANDATA
          LCALL PUTARMOTORKN
          LJMP LOOP

;---------------------------------------------
; PEMUTARAN STEPPER MOTOR
;---------------------------------------------
PUTARMOTORKN: MOV DPTR,#DATASTEPPER1
PUTARMOTORKN1: CLR A
          MOVC A,@A+DPTR
          CJNE A,#0,PUTARMOTORKN2
          RET
PUTARMOTORKN2: MOV PORTSTEPPER,A
          LCALL DELAYMOTOR
          NOP
          NOP
          NOP
          INC DPTR
          LJMP PUTARMOTORKN1

PUTARMOTORKR: MOV DPTR,#DATASTEPPER2
PUTARMOTORKR1: CLR A
          MOVC A,@A+DPTR
          CJNE A,#0,PUTARMOTORKR2
          RET
PUTARMOTORKR2: MOV PORTSTEPPER,A
          LCALL DELAYMOTOR
NOP
NOP
NOP
INC  DPTR
LJMP  PUTARMOTORKR1

;--------------------------------------------------------
;PENGIRIMAN DATA KE KOMPUTER
;--------------------------------------------------------
PENGIRIMANDATA:
  MOV  A,STLOK1
  LCALL SENDCHR
  MOV  A,STLOK2
  LCALL SENDCHR
  MOV  A,STLOK3
  LCALL SENDCHR
  MOV  A,STLOK4
  LCALL SENDCHR
  MOV  A,STLOK5
  LCALL SENDCHR
  MOV  A,STLOK6
  LCALL SENDCHR
  MOV  A,STLOK7
  LCALL SENDCHR
  MOV  A,STLOK8
  LCALL SENDCHR
  MOV  A,STLOK9
  LCALL SENDCHR
  MOV  A,STLOK10
  LCALL SENDCHR
MOV     A,#$0D ;ENDOFFDATA
LCALL   SENDCHR
RET

;---------------------------------------------------
;RUTIN MENJALANAN STEPPER MOTOR
;---------------------------------------------------
JALANKANMOTOR:
    MOV     DPTR,#DATASTEPPER1
PUTARKAN1:
    CLR     A
    MOVCA   A,@A+DPTR
    CJNE    A,#0,PUTARKAN2
    RET

PUTARKAN2: MOV PORTSTEPPER,A
           LJMP PUTARKAN1

CEKJUMMOBIL:
    MOV     A,R3
    JNZ     TTG1
    MOV     BUF1,#$8C
    MOV     BUF2,#$86
    MOV     BUF3,#$C8
    MOV     BUF4,#$C1
    MOV     BUF5,#$89
    CLR     LEDMERAH
    SETB    LEDHIJAU
RET

TTG1: SETB LEDMERAH
CLR LEDHIJAU
MOV BUF1,#$C0
MOV BUF2,#$C0
MOV BUF3,#$C0
CJNE R3,#$01,TTG2
MOV BUF4,#$C0
MOV BUF5,#$F9
RET

TTG2: CJNE R3,#$02,TTG3
MOV BUF4,#$C0
MOV BUF5,#$A4
RET

TTG3: CJNE R3,#$03,TTG4
MOV BUF4,#$C0
MOV BUF5,#$B0
RET

TTG4: CJNE R3,#$04,TTG5
MOV BUF4,#$C0
MOV BUF5,#$99
RET

TTG5: CJNE R3,#$05,TTG6
MOV BUF4,#$C0
MOV BUF5,#$92
RET

TTG6: CJNE R3,#$06,TTG7
MOV BUF4,#$C0
MOV BUF5,#$82
RET

TTG7: CJNE R3,#$07,TTG8
      MOV BUF4,#$C0
      MOV BUF5,#$F8
      RET

TTG8: CJNE R3,#$08,TTG9
      MOV BUF4,#$C0
      MOV BUF5,#$80
      RET

TTG9: CJNE R3,#$09,TTG10
      MOV BUF4,#$C0
      MOV BUF5,#$90
      RET

TTG10: CJNE R3,#$0A,TTG2
       MOV BUF4,#$F9
       MOV BUF5,#$C0
       RET

;---------------------------------------------------
; RUTIN SCANNING DISPLAY
;---------------------------------------------------

SCANNING:
SCANW1: MOV DATA7SEG,BUF1
      CLR SL1
      SETB SL2
      SETB SL3
      SETB SL4
      SETB SL5
LCALL  DELAYDISPONW
MOV     DATA7SEG,#$FF
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
SCANW2: MOV     DATA7SEG,BUF2
    SETB SL1
    CLR SL2
    SETB SL3
    SETB SL4
    SETB SL5
LCALL  DELAYDISPONW
MOV     DATA7SEG,#$FF
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
B-16
SCANW3:       MOV     DATA7SEG,BUF3
              SETB    SL1
              SETB    SL2
              CLR     SL3
              SETB    SL4
              SETB    SL5
              LCALL   DELAYDISPONW
              MOV     DATA7SEG,#$FF
              NOP
              NOP
              NOP
              NOP
              NOP
              NOP
              NOP
              NOP

SCANW4:       MOV     DATA7SEG,BUF4
              SETB    SL1
              SETB    SL2
              SETB    SL3
              CLR     SL4
              SETB    SL5
              LCALL   DELAYDISPONW
              MOV     DATA7SEG,#$FF
              NOP
              NOP
              NOP
              NOP
              NOP
              NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
NOP
SCANW5:       MOV     DATA7SEG,BUF5
   SETB    SL1
   SETB    SL2
   SETB    SL3
   SETB    SL4
   CLR     SL5
   LCALL   DELAYDISPONW
   MOV     DATA7SEG,#$FF
   NOP
   NOP
   NOP
   NOP
   NOP
   NOP
   NOP
   NOP
   NOP
   NOP
   NOP
   NOP
   NOP
   NOP
   NOP
   NOP
   NOP
   RET

;-------------------------------------------------
; PROC RUTIN SERIAL UNTUK KIRIM DATA
;----------------------------------------------------------------------------------
SENDCHR:  CLR  ES
          CLR  TI
          MOV  SBUF,A
TXLOOP:
          JNB  TI,TXLOOP
          CLR  TI
          SETB  ES
          RET

;------------------------------------------------------------------
; INISIALISASI KOMUNIKASI SERIAL 9600BPS
;------------------------------------------------------------------
INITSERIAL:
          MOV  TMOD,#20H
          MOV  TCON,#41H
          MOV  TH1,#0FDH
          MOV  SCON,#50H
          SETB  TR1
          RET

;------ ROUTINE KONVERSI ANGKA KE DALAM FORMAT 7 SEGMENT -----

CONV7SEG:
          MOV  DPTR,#SEG
          MOV  DPL,#0
LOADC:    MOVC  A,@A+DPTR
          RET
DELAYDISPONW:
    MOV  R6,#$02
DELAY0ONW:  MOV  R7,#$FF
DELAY1ONW:  DJNZ    R7,DELAY1ONW
            DJNZ    R6,DELAY0ONW
            RET

DELAYMOTOR: MOV  R6,#$0F           ;2f         ;4F
DELAYMOTOR1: MOV  R7,#$FF
DELAYMOTOR2: DJNZ    R7,DELAYMOTOR2
            DJNZ    R6,DELAYMOTOR1
            RET

;                         0    1    2    3    4   5   6   7   8   9
SEG:            .BYTE   $C0,$F9,$A4,$B0,$99,$92,$82,$F8,$80,$90,$C0,$BF,$BF
KATAPENUH       .BYTE   $8C,$86,$C8,$C1,$89
DATASTEPPER1    .BYTE   $11,$22,$44,$88,$0
DATASTEPPER2    .BYTE   $88,$44,$22,$11,$0
.END
unit FUTAMA;

interface

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

type
    TForm1 = class(TForm)
        Panel1: TPanel;
        pmobil1: TPanel;
        pmobil2: TPanel;
        pmobil3: TPanel;
        pmobil4: TPanel;
        pmobil5: TPanel;
        pmobil6: TPanel;
        pmobil7: TPanel;
        pmobil8: TPanel;
        pmobil9: TPanel;
        pmobil10: TPanel;
        Label1: TLabel;
        Label2: TLabel;
        Enomor: TEdit;
        Label3: TLabel;
        Label4: TLabel;
        Label5: TLabel;
        Label6: TLabel;
        Label7: TLabel;
    end;
procedure Timer1Timer(Sender: TObject);
procedure FormCreate(Sender: TObject);
procedure BmasukClick(Sender: TObject);
private
  { Private declarations }
public
{ Public declarations }
end;

var
Form1: TForm1;
datars232:string;
stlok1,
stlok2,
stlok3,
stlok4,
stlok5,
stlok6,
stlok7,
stlok8,
stlok9,
stlok10 :boolean;
stisi:boolean;
lokasiparkir:integer;
implementation

{$R *.dfm}$

procedure TForm1.Timer1Timer(Sender: TObject);

begin
ptanggal.caption:=formatdatetime('dd/mm/yyyy',DATE);
pjam.caption:=formatdatetime('hh:mm:ss',time);
datars232:=com.read;
if length(datars232)>10 then
begin
  if copy(datars232,1,1)='1' then stlok1:=true else stlok1:=false;
  if copy(datars232,2,1)='1' then stlok2:=true else stlok2:=false;
  if copy(datars232,3,1)='1' then stlok3:=true else stlok3:=false;
  if copy(datars232,4,1)='1' then stlok4:=true else stlok4:=false;
  if copy(datars232,5,1)='1' then stlok5:=true else stlok5:=false;
  if copy(datars232,6,1)='1' then stlok6:=true else stlok6:=false;
  if copy(datars232,7,1)='1' then stlok7:=true else stlok7:=false;
  if copy(datars232,8,1)='1' then stlok8:=true else stlok8:=false;
  if copy(datars232,9,1)='1' then stlok9:=true else stlok9:=false;
  if copy(datars232,10,1)='1' then stlok10:=true else stlok10:=false;
end;

if stlok1 then pmobil1.color:=clred else pmobil1.Color:=clteal;
if stlok2 then pmobil2.color:=clred else pmobil2.Color:=clteal;
if stlok3 then pmobil3.color:=clred else pmobil3.Color:=clteal;
if stlok4 then pmobil4.color:=clred else pmobil4.Color:=clteal;
if stlok5 then pmobil5.color:=clred else pmobil5.Color:=clteal;
if stlok6 then pmobil6.color:=clred else pmobil6.Color:=clteal;
if stlok7 then pmobil7.color:=clred else pmobil7.Color:=clteal;
if stlok8 then pmobil8.color:=clred else pmobil8.Color:=clteal;
if stlok9 then pmobil9.color:=clred else pmobil9.Color:=clteal;
if stlok10 then pmobil10.color:=clred else pmobil10.Color:=clteal;
end;

procedure TForm1.FormCreate(Sender: TObject);
begin
  stlok1:=false;
  stlok2:=false;
  stlok3:=false;
end;
stlok4:=false;
stlok5:=false;
stlok6:=false;
stlok7:=false;
stlok8:=false;
stlok9:=false;
stlok10:=false;
lokasiparkir:=0;
stisi:=true;
end;

procedure TForm1.BmasukClick(Sender: TObject);
begin
if (not STLOK1) and stisi then begin lokasiparkir:=1;stisi:=false;end;
if (not STLOK2) and stisi then begin lokasiparkir:=2;stisi:=false;end;
if (not STLOK3) and stisi then begin lokasiparkir:=3;stisi:=false;end;
if (not STLOK4) and stisi then begin lokasiparkir:=4;stisi:=false;end;
if (not STLOK5) and stisi then begin lokasiparkir:=5;stisi:=false;end;
if (not STLOK6) and stisi then begin lokasiparkir:=6;stisi:=false;end;
if (not STLOK7) and stisi then begin lokasiparkir:=7;stisi:=false;end;
if (not STLOK8) and stisi then begin lokasiparkir:=8;stisi:=false;end;
if (not STLOK9) and stisi then begin lokasiparkir:=9;stisi:=false;end;
if (not STLOK10) and stisi then begin lokasiparkir:=10;stisi:=false;end;

stisi:=true;

plokasip.caption:=inttostr(lokasiparkir);
table1.Refresh;
table1.Last;
with table1 do
begin
  Insert;
  fieldbyname('tanggal').asstring:=ptanggal.caption;
  fieldbyname('jam').asstring:=pjam.caption;
  fieldbyname('no_polisi').asstring:=enomor.Text;
  fieldbyname('lok_parkir').AsString:=inttostr(lokasiparkir);
end;

with Printer do
begin
  BeginDoc;
  canvas.Textout(320,10, '====PARKING SYSTEM====');
  canvas.textout(320,80, '--------------------------------------------');
  canvas.TextOut(320,150, 'Tanggal:   '+ptanggal.caption);
  canvas.TextOut(320,220,'Jam        :   '+pjam.caption);
  canvas.TextOut(320,290,'No Kendaraan:  '+enomor.text);
  canvas.TextOut(320,360,'Lokasi Parkir:     '+inttostr(lokasiparkir));
  canvas.textout(320,430,'**********************************');
  canvas.textout(320,500,'            Terima kasih');
  EndDoc;
end;
end;
end.
LAMPIRAN C

FOTO ALAT
Gambar 1 Sensor TX

Gambar 2 Sensor RX
Gambar 3 Bagian Pengontrol

Gambar 4 Proses Scanning
LAMPIRAN D

DATA KOMPONEN
Features
- Compatible with MCS-51™ Products
- 4K Bytes of In-System Reprogrammable Flash Memory
  - Endurance: 1,000 Write/Erase Cycles
- Fully Static Operation: 0 Hz to 24 MHz
- Three-Level Program Memory Lock
- 128 x 8-Bit Internal RAM
- 32 Programmable I/O Lines
- Two 16-Bit Timer/Counters
- Six Interrupt Sources
- Programmable Serial Channel
- Low Power Idle and Power Down Modes

Description
The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash Programmable and Erasable Read Only Memory (FPEROM). The device is manufactured using Atmel's high density nonvolatile memory technology and is compatible with the industry standard MCS-51™ instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer which provides a highly flexible and cost effective solution to many embedded control applications.

Pin Configurations

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D-2
The AT89C51 provides the following standard features: 4K bytes of Flash, 128 bytes of RAM, 32 I/O lines, two 16-bit timers/counters, a five-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator and clock circuitry. In addition, the AT89C51 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The Power Down Mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.

**Pin Description**

**Vcc**
Supply voltage.

**GND**
Ground.

**Port 0**
Port 0 is an 8-bit open drain bidirectional I/O port. As an output port each pin can sink eight TTL inputs. When 1's are written to port 0 pins, the pins can be used as high-impedance inputs.

Port 0 may also be configured to be the multiplexed lower address/data bus during accesses to external program and data memory. In this mode P0 has internal pull-ups.

Port 0 also receives the code bytes during Flash programming, and outputs the code bytes during program verification. External pull-ups are required during program verification.

**Port 1**
Port 1 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 1 output buffers can sink/source four TTL inputs. When 1's are written to Port 1 pins they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (I_L) because of the internal pull-ups.

Port 1 also receives the lower lower address bytes during Flash programming and verification.

**Port 2**
Port 2 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 2 output buffers can sink/source four TTL inputs. When 1's are written to Port 2 pins they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current (I_L) because of the internal pull-ups.

Port 2 also receives the high-order address byte during fetches from external program memory and during accesses to external data memory that use 16-bit addresses (MOVX @ DPTR). In this application it uses strong internal pull-ups when emitting 1s. During accesses to external data memory that use 8-bit addresses (MOVX @ RI), Port 2 emits the contents of the P2 Special Function Register.

Port 2 also receives the high-order address bits and some control signals during Flash programming and verification.

**Port 3**
Port 3 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 3 output buffers can sink/source four TTL inputs. When 1's are written to Port 3 pins they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (I_L) because of the pull-ups.

Port 3 also serves the functions of various special features of the AT89C51 as listed below:

<table>
<thead>
<tr>
<th>Port Pin</th>
<th>Alternate Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>P3.0</td>
<td>RXD (serial input port)</td>
</tr>
<tr>
<td>P3.1</td>
<td>TXD (serial output port)</td>
</tr>
<tr>
<td>P3.2</td>
<td>INT0 (external interrupt 0)</td>
</tr>
<tr>
<td>P3.3</td>
<td>INT1 (external interrupt 1)</td>
</tr>
<tr>
<td>P3.4</td>
<td>T0 (timer 0 external output)</td>
</tr>
<tr>
<td>P3.5</td>
<td>T1 (timer 1 external input)</td>
</tr>
<tr>
<td>P3.6</td>
<td>WR (external data memory write strobe)</td>
</tr>
<tr>
<td>P3.7</td>
<td>RE (external data memory read strobe)</td>
</tr>
</tbody>
</table>

Port 3 also receives some control signals for Flash programming and verification.

**RST**
Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

**ALE**
Address Latch Enable output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming.

In normal operation ALE is emitted at a constant rate of 1/6 the oscillator frequency, and may be used for external timing or clocking purposes. Note, however, that once ALE pulse is skipped during access to external Data Memory.

If desired, ALE operation can be disabled by setting bit 0 of SFR location 8EH. With the bit set, ALE is active only during a MOVX or MOVC instruction. Otherwise, the pin is weakly pulled high. Setting the ALE-disable bit has no effect if the microcontroller is in external execution mode.

**PSEN**
Program Store Enable is the read strobe to external program memory.
When the AT89C51 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

E/A/Vpp
External Access Enable. E/A must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH. Note, however, that if bit 1 is programmed, E/A will be internally latched on reset.

E/A should be strapped to VCC for internal program executions.
This pin also receives the 12-volt programming enable voltage (Vpp) during Flash programming, for parts that require 12-volt Vpp.

XTAL1
Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

XTAL2
Output from the inverting oscillator amplifier.

Oscillator Characteristics
XTAL1 and XTAL2 are the input and output, respectively, of an inverting amplifier which can be configured for use as an on-chip oscillator, as shown in Figure 1. Either a quartz crystal or ceramic resonator may be used. To drive the device from an external clock source, XTAL2 should be left unconnected while XTAL1 is driven as shown in Figure 2.
There are no requirements on the duty cycle of the external clock signal, since the input to the internal clocking circuitry is through a divide-by-two flip-flop, but minimum and maximum voltage levels must be observed.

Idle Mode
In idle mode, the CPU puts itself to sleep while all the on-chip peripherals remain active. The mode is invoked by software. The context of the on-chip RAM and all the special functions registers remain unchanged during this mode. The idle mode can be terminated by any enabled interrupt or by a hardware reset.

Status of External Pins During Idle and Power Down Modes

<table>
<thead>
<tr>
<th>Mode</th>
<th>Program Memory</th>
<th>ALE</th>
<th>PSEN</th>
<th>PORT0</th>
<th>PORT1</th>
<th>PORT2</th>
<th>PORT3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idle</td>
<td>Internal</td>
<td>1</td>
<td>1</td>
<td>Data</td>
<td>Data</td>
<td>Data</td>
<td>Data</td>
</tr>
<tr>
<td>Idle</td>
<td>External</td>
<td>1</td>
<td>1</td>
<td>Float</td>
<td>Data</td>
<td>Data</td>
<td>Data</td>
</tr>
<tr>
<td>Power Down</td>
<td>Internal</td>
<td>0</td>
<td>0</td>
<td>Data</td>
<td>Data</td>
<td>Address</td>
<td>Data</td>
</tr>
<tr>
<td>Power Down</td>
<td>External</td>
<td>0</td>
<td>0</td>
<td>Float</td>
<td>Data</td>
<td>Data</td>
<td>Data</td>
</tr>
</tbody>
</table>
Power Down Mode

In the power down mode the oscillator is stopped, and the instruction that invokes power down is the last instruction executed. The on-chip RAM and Special Function Registers retain their values until the power down mode is terminated. The only exit from power down is a hardware reset. Reset redefines the SFRs but does not change the on-chip RAM. The reset should not be activated before \( V_{CC} \) is restored to its normal operating level and must be held active long enough to allow the oscillator to restart and stabilize.

Program Memory Lock Bits

On the chip are three lock bits which can be left unprogrammed (U) or can be programmed (P) to obtain the additional features listed in the table below:

When lock bit 1 is programmed, the logic level at the \( EA \) pin is sampled and latched during reset. If the device is powered up without a reset, the latch initializes to a random value, and holds that value until reset is activated. It is necessary that the latched value of \( EA \) be in agreement with the current logic level at that pin in order for the device to function properly.

Lock Bit Protection Modes

<table>
<thead>
<tr>
<th>Program Lock Bits</th>
<th>Protection Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB1</td>
<td>LB2</td>
</tr>
<tr>
<td>1</td>
<td>U</td>
</tr>
<tr>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>3</td>
<td>P</td>
</tr>
<tr>
<td>4</td>
<td>P</td>
</tr>
</tbody>
</table>

Programming the Flash

The AT89C51 is normally shipped with the on-chip Flash memory array in the erased state (that is, contents = FFH) and ready to be programmed. The programming interface accepts either a high-voltage (12-Volt) or a low-voltage (\( V_{PP} \)) program enable signal. The low voltage programming mode provides a convenient way to program the AT89C51 inside the user’s system, while the high-voltage programming mode is compatible with conventional third party Flash or EPROM programmers.

The AT89C51 is shipped with either the high-voltage or low-voltage programming mode enabled. The respective top-side marking and device signature codes are listed in the following table.

<table>
<thead>
<tr>
<th>( V_{PP} = 12V )</th>
<th>( V_{PP} = 5V )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Top-Side Mark</strong></td>
<td>AT89C51</td>
</tr>
<tr>
<td></td>
<td>xxxx</td>
</tr>
<tr>
<td></td>
<td>yyyy</td>
</tr>
<tr>
<td><strong>Signature</strong></td>
<td>(03H)=IEH</td>
</tr>
<tr>
<td></td>
<td>(03H)=I1H</td>
</tr>
<tr>
<td></td>
<td>(03H)=FFH</td>
</tr>
</tbody>
</table>

The AT89C51 code memory array is programmed byte-by-byte in either programming mode. To program any non-blank byte in the on-chip Flash Memory, the entire memory must be erased using the Chip Erase Mode.

Programming Algorithm: Before programming the AT89C51, the address, data and control signals should be set up according to the Flash programming mode table and Figures 3 and 4. To program the AT89C51, take the following steps:

1. Input the desired memory location on the address lines.
2. Input the appropriate data byte on the data lines.
3. Activate the correct combination of control signals.
4. Raise \( EA/V_{PP} \) to 12V for the high-voltage programming mode.
5. Pulse ALE/PROG once to program a byte in the Flash array or the lock bits. The byte-write cycle is self-timed and typically takes no more than 1.5 ms. Repeat steps 1 through 5, changing the address and data for the entire array or until the end of the object file is reached.

Data Polling: The AT89C51 features Data Polling to indicate the end of a write cycle. During a write cycle, an attempted read of the last byte written will result in the complement of the written datum on P0.7. Once the write cycle has been completed, true data are valid on all outputs, and the next cycle may begin. Data Polling may begin any time after a write cycle has been initiated.

Ready/Busy: The progress of byte programming can also be monitored by the RDY/BSTY output signal. P3.4 is pulled low after ALE goes high during programming to indicate BUSY. P3.4 is pulled high again when programming is done to indicate READY.
Program Verify: If lock bits LB1 and LB2 have not been programmed, the programmed code data can be read back via the address and data lines for verification. The lock bits cannot be verified directly. Verification of the lock bits is achieved by observing that their features are enabled.

Chip Erase: The entire Flash array is erased electrically by using the proper combination of control signals and by holding ALE/PROG low for 10 ms. The code array is written with all “1”s. The chip erase operation must be executed before the code memory can be re-programmed.

Reading the Signature Bytes: The signature bytes are read by the same procedure as a normal verification of locations 030H, 031H, and 032H, except that P3.6 and P3.7 must be pulled to a logic low. The values returned are as follows.

(030H) = 1EH indicates manufactured by Atmel
(031H) = 81H indicates 89C51
(032H) = FFH indicates 12V programming
(032H) = 06H indicates 3V programming

Programming Interface

Every code byte in the Flash array can be written and the entire array can be erased by using the appropriate combination of control signals. The write operation cycle is self-timed and once initiated, will automatically time itself to completion.

All major programming vendors offer worldwide support for the Atmel microcontroller series. Please contact your local programming vendor for the appropriate software revision.

### Flash Programming Modes

<table>
<thead>
<tr>
<th>Mode</th>
<th>RST</th>
<th>PSEN</th>
<th>ALE/PROG</th>
<th>EA/Vpp</th>
<th>P2.6</th>
<th>P2.7</th>
<th>P3.6</th>
<th>P3.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write Code Data</td>
<td>H</td>
<td>L</td>
<td></td>
<td>H/12V</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Read Code Data</td>
<td>H</td>
<td>L</td>
<td></td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Write Lock</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bit - 1</td>
<td>H</td>
<td>L</td>
<td></td>
<td>H/12V</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Bit - 2</td>
<td>H</td>
<td>L</td>
<td></td>
<td>H/12V</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Bit - 3</td>
<td>H</td>
<td>L</td>
<td></td>
<td>H/12V</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Chip Erase</td>
<td></td>
<td></td>
<td></td>
<td>H/12V</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Read Signature Byte</td>
<td>H</td>
<td>L</td>
<td></td>
<td></td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

Note: 1. Chip Erase requires a 10 ms PROG pulse.
Flash Programming and Verification Characteristics

$T_A = 0\degree C$ to $70\degree C$, $V_{CC} = 5.0 \pm 10\%$

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{PP}$</td>
<td>Programming Enable Voltage</td>
<td>11.5</td>
<td>12.5</td>
<td>V</td>
</tr>
<tr>
<td>$I_{PP}$</td>
<td>Programming Enable Current</td>
<td>1.0</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>$f_{CLL}$</td>
<td>Oscillator Frequency</td>
<td>3</td>
<td>24</td>
<td>MHz</td>
</tr>
<tr>
<td>$I_{SSL}$</td>
<td>Address Setup to PROG Low</td>
<td>$48f_{CLL}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{SHH}$</td>
<td>Address Hold After PROG</td>
<td>$48f_{CLL}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{CLL}$</td>
<td>Data Setup to PROG Low</td>
<td>$48f_{CLL}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{CHH}$</td>
<td>Data Hold After PROG</td>
<td>$48f_{CLL}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{SSH}$</td>
<td>Vpp Setup to PROG Low</td>
<td>10</td>
<td></td>
<td>\mu s</td>
</tr>
<tr>
<td>$I_{HHL}$</td>
<td>Vpp Hold After PROG</td>
<td>10</td>
<td></td>
<td>\mu s</td>
</tr>
<tr>
<td>$I_{SL}$</td>
<td>PROG Width</td>
<td>1</td>
<td>110</td>
<td>\mu s</td>
</tr>
<tr>
<td>$I_{AVV}$</td>
<td>Address to Data Valid</td>
<td>$48f_{CLL}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{LLO}$</td>
<td>ENABLow to Data Valid</td>
<td>$48f_{CLL}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{LHI}$</td>
<td>ENABH to BUSY Low to Data Valid</td>
<td>0</td>
<td>$48f_{CLL}$</td>
<td></td>
</tr>
<tr>
<td>$I_{BBL}$</td>
<td>BUSY High to BUSY Low</td>
<td>1.0</td>
<td></td>
<td>\mu s</td>
</tr>
<tr>
<td>$t_{BC}$</td>
<td>Byte Write Cycle Time</td>
<td>2.0</td>
<td></td>
<td>ms</td>
</tr>
</tbody>
</table>

Note: 1. Only used in 12-volt programming mode.
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Condition</th>
<th>Min</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIL</td>
<td>Input Low Voltage</td>
<td>(Storage SE)</td>
<td>-0.5</td>
<td>0.2 VCC + 0.1 V</td>
<td></td>
</tr>
<tr>
<td>VIH</td>
<td>Input High Voltage</td>
<td>(Except XTAL, RST)</td>
<td>0.2 VCC + 0.9 V</td>
<td>VCC + 0.5 V</td>
<td></td>
</tr>
<tr>
<td>VILH</td>
<td>Input Low Voltage(1)</td>
<td>(Port 1, 2, 3)</td>
<td>0.7 VCC</td>
<td>VCC + 0.5 V</td>
<td></td>
</tr>
<tr>
<td>VILH</td>
<td>Output Low Voltage(1)</td>
<td>(Port 0, ALE, PSEN)</td>
<td>0.45</td>
<td>0.45 V</td>
<td></td>
</tr>
<tr>
<td>VOH</td>
<td>Output High Voltage (Ports 1, 2, 3, ALE, PSEN)</td>
<td>IOLH = 60 μA, VCC = 5V ± 10%</td>
<td>2.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>VOH</td>
<td>Output High Voltage (Ports 1, 2, 3, ALE, PSEN)</td>
<td>IOHI = 25 μA</td>
<td>0.75 VCC</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>VOH</td>
<td>Output High Voltage (Ports 1, 2, 3, ALE, PSEN)</td>
<td>IOHI = 10 μA</td>
<td>0.9 VCC</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>VOH</td>
<td>Output High Voltage (Ports 0 in External Bus Mode)</td>
<td>IOOH = 880 μA, VCC = 5V ± 10%</td>
<td>2.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>VOH</td>
<td>Output High Voltage (Ports 0 in External Bus Mode)</td>
<td>IOOH = 300 μA</td>
<td>0.75 VCC</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>VOH</td>
<td>Output High Voltage (Ports 0 in External Bus Mode)</td>
<td>IOOH = 80 μA</td>
<td>0.9 VCC</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>IOH</td>
<td>Logical 0 Input Current (Ports 1, 2, 3)</td>
<td>VN = 0.45V</td>
<td>-50 μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOH</td>
<td>Logical 0 to 1 Transition Current (Ports 1, 2, 3)</td>
<td>VN = 2V, VCC = 5V ± 10%</td>
<td>-650 μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOH</td>
<td>Input Leakage Current (Port 0, EA)</td>
<td>0.45 &lt; VIL &lt; VCC</td>
<td>±10 μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIO</td>
<td>Input Output Capacitance</td>
<td>Test Freq. = 1 MHz, Ta = 25°C</td>
<td>10 pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIDD</td>
<td>Power Supply Current (Active Mode, 12 MHz)</td>
<td>VCC = 5V</td>
<td>40 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIDD</td>
<td>Power Supply Current (Idle Mode, 12 MHz)</td>
<td>VCC = 5V</td>
<td>100 μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIDD</td>
<td>Power Down Mode(2)</td>
<td>VCC = 5V</td>
<td>40 μA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

### DC Characteristics

\[ T_A = -40^\circ C \text{ to } 85^\circ C, \quad V_{CC} = 5.0V \pm 20\% \text{ (unless otherwise noted)} \]

## Notes
1. Under steady state (non-transition) conditions, IOH must be externally limited as follows:
   - Maximum IOH per pin: 10 mA
   - Maximum IOH per 8-bit port: Port 0: 2.5 mA, Port 1, 2, 3: 1.5 mA
   - Maximum total IOH for all output pins: 71 mA
   - If IOH exceeds the test condition, VCC may exceed the related specification. Pins are not guaranteed to sink current greater than the listed test conditions.
2. Minimum VCC for Power Down is 2V.
### AC Characteristics

(Under Operating Conditions: Load Capacitance for Port 0, ALE, PROG, and PSEN = 100 pF; Load Capacitance for all other outputs = 60 pF)

#### External Program and Data Memory Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>12 MHz Oscillator</th>
<th>16 to 24 MHz Oscillator</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>t1CCL</td>
<td>Oscillator Frequency</td>
<td>0</td>
<td>24</td>
<td>MHz</td>
</tr>
<tr>
<td>t1AFL</td>
<td>ALE Pulse Width</td>
<td>127</td>
<td>2tCCL-40</td>
<td>ns</td>
</tr>
<tr>
<td>t1ALM</td>
<td>Address Valid to ALE Low</td>
<td>43</td>
<td>tCCL-13</td>
<td>ns</td>
</tr>
<tr>
<td>t1AHL</td>
<td>Address Hold After ALE Low</td>
<td>48</td>
<td>tCCL-20</td>
<td>ns</td>
</tr>
<tr>
<td>t1LUV</td>
<td>ALE Low to Valid Instruction In</td>
<td>233</td>
<td>4tCCL-55</td>
<td>ns</td>
</tr>
<tr>
<td>t1LUL</td>
<td>ALE Low to PSEN Low</td>
<td>43</td>
<td>tCCL-13</td>
<td>ns</td>
</tr>
<tr>
<td>t1LPL</td>
<td>PSEN Pulse Width</td>
<td>205</td>
<td>3tCCL-20</td>
<td>ns</td>
</tr>
<tr>
<td>t1LUV</td>
<td>PSEN Low to Valid Instruction In</td>
<td>146</td>
<td>3tCCL-45</td>
<td>ns</td>
</tr>
<tr>
<td>t1RIX</td>
<td>Input Instruction Hold After PSEN</td>
<td>0</td>
<td>0</td>
<td>ns</td>
</tr>
<tr>
<td>t1RIZ</td>
<td>Input Instruction Float After PSEN</td>
<td>0</td>
<td>0</td>
<td>ns</td>
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<tr>
<td>t1PUL</td>
<td>PSEN to Address Valid</td>
<td>75</td>
<td>tCCL-8</td>
<td>ns</td>
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<tr>
<td>t1PUL</td>
<td>Address to Valid Instruction In</td>
<td>342</td>
<td>8tCCL-55</td>
<td>ns</td>
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<tr>
<td>t1PUL</td>
<td>PSEN Low to Address Float</td>
<td>10</td>
<td>10</td>
<td>ns</td>
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<tr>
<td>t1RSH</td>
<td>RD Pulse Width</td>
<td>400</td>
<td>8tCCL-100</td>
<td>ns</td>
</tr>
<tr>
<td>t1RSH</td>
<td>WR Pulse Width</td>
<td>400</td>
<td>8tCCL-100</td>
<td>ns</td>
</tr>
<tr>
<td>t1LUV</td>
<td>RD Low to Valid Data In</td>
<td>252</td>
<td>8tCCL-90</td>
<td>ns</td>
</tr>
<tr>
<td>t1AHi</td>
<td>Data Hold After RD</td>
<td>0</td>
<td>0</td>
<td>ns</td>
</tr>
<tr>
<td>t1AHi</td>
<td>Data Float After RD</td>
<td>97</td>
<td>2tCCL-28</td>
<td>ns</td>
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<tr>
<td>t1LUV</td>
<td>ALE Low to Valid Data In</td>
<td>517</td>
<td>8tCCL-150</td>
<td>ns</td>
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<td>t1LUV</td>
<td>Address to Valid Data In</td>
<td>585</td>
<td>9tCCL-405</td>
<td>ns</td>
</tr>
<tr>
<td>t1LUL</td>
<td>ALE Low to RD or WR Low</td>
<td>200</td>
<td>3tCCL-50</td>
<td>ns</td>
</tr>
<tr>
<td>t1LUL</td>
<td>Address to RD or WR Low</td>
<td>203</td>
<td>4tCCL-75</td>
<td>ns</td>
</tr>
<tr>
<td>t1LUL</td>
<td>Data Valid to WR Transition</td>
<td>23</td>
<td>tCCL-20</td>
<td>ns</td>
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<tr>
<td>t1LUL</td>
<td>Data Valid to WR High</td>
<td>433</td>
<td>7tCCL-129</td>
<td>ns</td>
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<tr>
<td>t1LUL</td>
<td>Data Valid After WR</td>
<td>33</td>
<td>tCCL-20</td>
<td>ns</td>
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<tr>
<td>t1LUL</td>
<td>RD Low to Address Float</td>
<td>0</td>
<td>0</td>
<td>ns</td>
</tr>
<tr>
<td>t1LUL</td>
<td>RD or WR High to ALE High</td>
<td>43</td>
<td>123</td>
<td>tCCL-20</td>
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External Data Memory Write Cycle

External Clock Drive Waveforms

External Clock Drive

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min</th>
<th>Max</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>fOCLC</td>
<td>Oscillator Frequency</td>
<td>0</td>
<td>24</td>
<td>kHz</td>
</tr>
<tr>
<td>tCLOCC</td>
<td>Clock Period</td>
<td>41.6</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>tCHCX</td>
<td>High Time</td>
<td>15</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>tCLOCLX</td>
<td>Low Time</td>
<td>15</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>tCLOCH</td>
<td>Rise Time</td>
<td>20</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>tCHCL</td>
<td>Fall Time</td>
<td>20</td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>
Serial Port Timing: Shift Register Mode Test Conditions

\[ (V_{CC} = 5.0 \, V \pm 20\%; \, \text{Load capacitance} = 80 \, \text{pF}) \]

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>12 MHz Osc</th>
<th>Variable Oscillator</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>hCLC</td>
<td>Serial Port Clock Cycle Time</td>
<td>1.0</td>
<td>12CLC</td>
<td>µs</td>
</tr>
<tr>
<td>tS0K</td>
<td>Output Data Setup to Clock Rising Edge</td>
<td>700</td>
<td>10CLC-123</td>
<td>ns</td>
</tr>
<tr>
<td>tX0K</td>
<td>Output Data Hold After Clock Rising Edge</td>
<td>50</td>
<td>2CLC-117</td>
<td>ns</td>
</tr>
<tr>
<td>tS1X</td>
<td>Input Data Hold After Clock Rising Edge</td>
<td>0</td>
<td>0</td>
<td>ns</td>
</tr>
<tr>
<td>tX1C</td>
<td>Clock Rising Edge to Input Data Valid</td>
<td>700</td>
<td>10CLC-123</td>
<td>ns</td>
</tr>
</tbody>
</table>

Shift Register Mode Timing Waveforms

AC Testing Input/Output Waveforms\(^{(1)}\) Float Waveforms\(^{(1)}\)

\[ V_{CC} = 0.5 V \]
\[ 0.2 \, V_{CC} - 0.9 V \]
\[ 0.2 \, V_{CC} - 0.1 V \]

Note: 1. AC inputs during testing are driven at \( V_{CC} = 0.5 V \) for a logic 1 and \( 0.45V \) for a logic 0. Timing measurements are made at \( V_{CC \, \text{min}} \), for a logic 1 and \( V_{IL \, \text{max}} \), for a logic 0.

Note: 1. For timing purposes, a port pin is no longer floating when a 100 mV change from load voltage occurs. A port pin becomes floating when 100 nV change from the load voltage \( V_{OH} \) level occurs.
## Ordering Information

<table>
<thead>
<tr>
<th>Speed (MHz)</th>
<th>Power Supply</th>
<th>Ordering Code</th>
<th>Package</th>
<th>Operation Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>5V ± 20%</td>
<td>AT89C51-12AC</td>
<td>44A</td>
<td>Commercial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-12JC</td>
<td>44J</td>
<td>(0°C to 70°C)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-12PC</td>
<td>44P6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-12QC</td>
<td>44Q</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-12AI</td>
<td>44A</td>
<td>Industrial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-12AI</td>
<td>44J</td>
<td>(-40°C to 85°C)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-12PI</td>
<td>44P6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-12QI</td>
<td>44Q</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-12AA</td>
<td>44A</td>
<td>Automotive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-12UA</td>
<td>44J</td>
<td>(-40°C to 105°C)</td>
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<td></td>
<td></td>
<td>AT89C51-12PA</td>
<td>44P6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-12QA</td>
<td>44Q</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>5V ± 20%</td>
<td>AT89C51-16AC</td>
<td>44A</td>
<td>Commercial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-16JC</td>
<td>44J</td>
<td>(0°C to 70°C)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-16PC</td>
<td>44P6</td>
<td></td>
</tr>
<tr>
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<td></td>
<td>AT89C51-16QC</td>
<td>44Q</td>
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</tr>
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<td></td>
<td>AT89C51-16AI</td>
<td>44A</td>
<td>Industrial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-16AI</td>
<td>44J</td>
<td>(-40°C to 85°C)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-16PI</td>
<td>44P6</td>
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<td>AT89C51-16QI</td>
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<td>44A</td>
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</tr>
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<td>AT89C51-16UA</td>
<td>44J</td>
<td>(-40°C to 105°C)</td>
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<tr>
<td></td>
<td></td>
<td>AT89C51-16PA</td>
<td>44P6</td>
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<td>AT89C51-16QA</td>
<td>44Q</td>
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<tr>
<td>20</td>
<td>5V ± 20%</td>
<td>AT89C51-20AC</td>
<td>44A</td>
<td>Commercial</td>
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<td></td>
<td></td>
<td>AT89C51-20UC</td>
<td>44J</td>
<td>(0°C to 70°C)</td>
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<td></td>
<td></td>
<td>AT89C51-20PC</td>
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<td>AT89C51-20QC</td>
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<td></td>
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<td></td>
<td></td>
<td>AT89C51-20AI</td>
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</tr>
<tr>
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<td></td>
<td>AT89C51-20UI</td>
<td>44J</td>
<td>(-40°C to 85°C)</td>
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<tr>
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<td></td>
<td>AT89C51-20PI</td>
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<tr>
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<td>AT89C51-20QI</td>
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## Ordering Information

<table>
<thead>
<tr>
<th>Speed (MHz)</th>
<th>Power Supply</th>
<th>Ordering Code</th>
<th>Package</th>
<th>Operation Range</th>
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<tbody>
<tr>
<td>24</td>
<td>5V ± 20%</td>
<td>AT89C51-24AC</td>
<td>44A</td>
<td>Commercial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-24JC</td>
<td>44J</td>
<td>(0°C to 70°C)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-24PC</td>
<td>44P6</td>
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<td>AT89C51-24QC</td>
<td>44Q</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-24AI</td>
<td>44A</td>
<td>Industrial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-24JI</td>
<td>44J</td>
<td>(-40°C to 85°C)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-24PI</td>
<td>44P6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT89C51-24QI</td>
<td>44Q</td>
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</tbody>
</table>

### Package Type

- **44A**: 44 Lead, Thin Plastic Gull Wing Quad Flatpack (TQFP)
- **44J**: 44 Lead, Plastic Leaded Chip Carrier (PLCC)
- **40P6**: 40 Lead, 0.600” Wide, Plastic Dual Inline Package (PDIP)
- **44Q**: 44 Lead, Plastic Gull Wing Quad Flatpack (PGFP)
DS75176B/DS75176BT
Multipoint RS-485/RS-422 Transceivers

General Description
The DS75176B is a high speed differential TRI-STATE® busline transceiver designed to meet the requirements of EIA standard RS485 with extended common mode range (+12V to -7V), for multipoint data transmission. In addition, it is compatible with RS-422.

The driver and receiver outputs feature TRI-STATE capability, for the driver outputs over the entire common mode range of +12V to -7V. Bus contention or fault situations that cause excessive power dissipation within the device are handled by a thermal shutdown circuit, which forces the driver outputs into the high-impedance state.

DC specifications are guaranteed over the 0 to 70°C temperature range and 4.75V to 5.25V supply voltage range.

Features
- Meets EIA standard RS485 for multipoint bus transmission and is compatible with RS-422
- Small Outline (SO) package option available for minimum board space.
- 22 ns driver propagation delays.
- Single +5V supply.
- -7V to +12V bus common mode range permits ±7V ground difference between devices on the bus.
- Thermal shutdown protection.
- High impedance to bus with driver in TRI-STATE or with power off, over the entire common mode range allows the unused devices on the bus to be powered down.
- Pin out compatible with DS3615A and SN75176A/B.
- Combined impedance of a driver output and receiver input is less than one 5KΩ, allowing up to 32 transceivers on the bus.
- 70 mV typical receiver hysteresis.

Connection and Logic Diagram

Top View
Order Number DS75176B, DS75176BT, DS75176BM or DS75176BTM
See NS Package Number M05E or M18A

TRI-STATE is a registered trademark of National Semiconductor Corp.
## Absolute Maximum Ratings (Note 1)

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage, ( V_{CC} )</td>
<td>7V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Input Voltage</td>
<td>7V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driver Input Voltage</td>
<td>7V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driver Output Voltage</td>
<td>+15V</td>
<td>-10V</td>
<td></td>
</tr>
<tr>
<td>Receiver Input Voltage (DS75176D)</td>
<td>+15V</td>
<td>-10V</td>
<td></td>
</tr>
<tr>
<td>Receiver Output Voltage</td>
<td>0.0V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous Power Dissipation @ 25°C</td>
<td>675 mW (Note 5)</td>
<td>910 mW (Note 4)</td>
<td></td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>-65°C to +150°C</td>
<td></td>
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</tr>
<tr>
<td>Lead Temperature (Soldering, 4 seconds)</td>
<td>263°C</td>
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</tr>
</tbody>
</table>

## Electrical Characteristics (Notes 2, 3)

0°C ≤ \( T_J \) ≤ 70°C, 4.15V ≤ \( V_{CC} \) ≤ 5.25V unless otherwise specified.

### Symbol | Parameter | Conditions | Min | Typ | Max | Units |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CC} )</td>
<td>Differential Driver Output Voltage (Unloaded)</td>
<td>0°C</td>
<td>5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{CC} )</td>
<td>Differential Driver Output Voltage (with Lead)</td>
<td>(Figure 1)</td>
<td>2</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{iD} )</td>
<td>Change in Magnitude of Driver Differential Output Voltage For Complementary Output Stares</td>
<td>(Figure 1)</td>
<td>0.2</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{CC} )</td>
<td>Driver Common Mode Output Voltage</td>
<td>R = 27Ω</td>
<td>3.0</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{CC} )</td>
<td>Change in Magnitude of Driver Common Mode Output Voltage For Complementary Output Stares</td>
<td>0.2</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{IH} )</td>
<td>Input High Voltage</td>
<td>DI, DE, RE</td>
<td>2</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{IL} )</td>
<td>Input Low Voltage</td>
<td>DI, DE, RE</td>
<td>0.8</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{CL} )</td>
<td>Input Clamp Voltage</td>
<td>( I_{CL} = -18 \text{ mA} )</td>
<td>-1.5</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{L} )</td>
<td>Input Low Current</td>
<td>( V_{CC} = 0.4V )</td>
<td>-500</td>
<td>\mu A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{H} )</td>
<td>Input High Current</td>
<td>( V_{CC} = 2.4V )</td>
<td>20</td>
<td>\mu A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{N} )</td>
<td>Input Current</td>
<td>DGRI, DGRI</td>
<td>( V_{CC} = 0V ) or 5.28V</td>
<td>( V_{IN} = 12V )</td>
<td>+1.0</td>
<td>mA</td>
</tr>
<tr>
<td>( V_{TH} )</td>
<td>Differential Input Threshold Voltage for Receiver</td>
<td>( -7V ≤ V_{IN} &lt; +12V )</td>
<td>-0.2</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta V_{IN} )</td>
<td>Receiver Input Hysteresis</td>
<td>( V_{CC} = 0V )</td>
<td>70</td>
<td>mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{OC} )</td>
<td>Receiver Output High Voltage</td>
<td>( I_{OH} = 400 \mu A )</td>
<td>27</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{ON} )</td>
<td>Output Low Voltage</td>
<td>( I_{OL} = 16 \text{ mA} ) (Note 7)</td>
<td>0.5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{CM} )</td>
<td>OFF-State (High Impedance)</td>
<td>( V_{OC} = \text{Max} )</td>
<td>±200</td>
<td>\mu A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{CM} )</td>
<td>Output Current at Receiver</td>
<td>3.4V ≤ ( V_{OC} ≤ 2.4V )</td>
<td>12</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R_{IN} )</td>
<td>Receiver input resistance</td>
<td>( -7V ≤ V_{IN} ≤ +12V )</td>
<td>12</td>
<td>kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{CC} )</td>
<td>Supply Current</td>
<td>NoLoad</td>
<td>55</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{CC} )</td>
<td>Driver Outputs Enabled</td>
<td>(Note 7)</td>
<td>35</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{CC} )</td>
<td>Driver Outputs Disabled</td>
<td>55</td>
<td>mA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{CC} )</td>
<td>Driver Short-Circuit</td>
<td>( V_{CC} = -7V ) (Note 7)</td>
<td>-250</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{CC} )</td>
<td>Output Current</td>
<td>( V_{CC} = -12V ) (Note 7)</td>
<td>-250</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Electrical Characteristics (Notes 2, 3) (Continued)

0°C ≤ T_A ≤ 70°C, 4.75V ≤ V_{CC} ≤ 5.25V unless otherwise specified

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{OS}</td>
<td>Receiver Short-Circuit Output Current</td>
<td>V_{CC} = 0V</td>
<td>-15</td>
<td>-6</td>
<td>nA</td>
<td></td>
</tr>
</tbody>
</table>

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

Note 2: All currents into device pins are positive; all currents out of device pins are negative. All voltages are referenced to device ground unless otherwise specified.  

Note 3: All typicals are given for V_{CC} = 5V and T_A = 25°C.  

Note 4: Emits linearly at 8.5mW/°C to 65mW at 70°C.  

Note 5: Datasheet listings are linearly 1.1mW/°C to 400mW at 70°C.  

Note 6: Differential - Input/output low voltage is referenced to the noninverting terminal A with respect to the inverting terminal G.  

Note 7: All worst case parameters for which note 7 is applied, must be increased by 10% for 25°C > T_A > 0°C. The other parameters remain valid for -40°C < T_A < 85°C.

### Switching Characteristics

V_{CC} = 5.0V, T_A = 25°C

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{OL}</td>
<td>Driver Input to Output</td>
<td>R_{DFF} = 60Ω</td>
<td>12</td>
<td>22</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>I_{OH}</td>
<td>Driver Input to Output</td>
<td>C_{1} = C_{2} = 100 pF</td>
<td>17</td>
<td>22</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>t_{R}</td>
<td>Driver Rise Time</td>
<td>R_{DFF} = 60Ω</td>
<td>18</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>t_{F}</td>
<td>Driver Fall Time</td>
<td>C_{1} = C_{2} = 100 pF (Figure 3 and Figure 5)</td>
<td>19</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>t_{EH}</td>
<td>Driver Enable to Output High</td>
<td>C_{1} = 100 pF (Figure 4 and Figure 6) S1 Open</td>
<td>29</td>
<td>100</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>t_{EL}</td>
<td>Driver Enable to Output Low</td>
<td>C_{1} = 100 pF (Figure 4 and Figure 6) S2 Open</td>
<td>31</td>
<td>50</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>t_{LZ}</td>
<td>Driver Disable Time from Low</td>
<td>C_{1} = 15 pF (Figure 4 and Figure 8) S2 Open</td>
<td>13</td>
<td>30</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>t_{HZ}</td>
<td>Driver Disable Time from High</td>
<td>C_{1} = 15 pF (Figure 4 and Figure 8) S1 Open</td>
<td>19</td>
<td>200</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>t_{LS}</td>
<td>Receiver Input to Output</td>
<td>C_{1} = 15 pF (Figure 2 and Figure 7) S1 and S2 Closed</td>
<td>39</td>
<td>37</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>t_{RE}</td>
<td>Receiver Enable to Output Low</td>
<td>C_{1} = 15 pF (Figure 2 and Figure 8) S2 Open</td>
<td>15</td>
<td>20</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>t_{RH}</td>
<td>Receiver Enable to Output High</td>
<td>C_{1} = 15 pF (Figure 2 and Figure 8) S1 Open</td>
<td>11</td>
<td>20</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>t_{LZ}</td>
<td>Receiver Disable from Low</td>
<td>C_{1} = 15 pF (Figure 2 and Figure 8) S2 Open</td>
<td>28</td>
<td>32</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>t_{LH}</td>
<td>Receiver Disable from High</td>
<td>C_{1} = 15 pF (Figure 2 and Figure 8) S1 Open</td>
<td>13</td>
<td>35</td>
<td>nA</td>
<td></td>
</tr>
</tbody>
</table>
AC Test Circuits

Note:  S1 and S2 of test circuit are closed except as otherwise mentioned.

FIGURE 2.

FIGURE 3.

Note: Unless otherwise specified, the switches are closed.

FIGURE 4.

Switching Time Waveforms

FIGURE 5. Driver Propagation Delays and Transition Times
Function Tables

**DS75176B Transmitting**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Line Condition</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>RE</td>
<td>DE</td>
<td>DI</td>
</tr>
<tr>
<td>X 1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>X 1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>X 0</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X 1</td>
<td>X</td>
<td>Fault</td>
</tr>
</tbody>
</table>
**Function Tables (Continued)**

**DS75176B Receiving**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>RE</td>
<td>DE</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

X — Don't care condition
Z — High impedance state
Fault — Improper line conditions causing excessive power dissipation in the driver, such as shorts or bus contention situations
**This is a fail safe condition**

**Typical Application**

![Typical Application Diagram](image-url)
Physical Dimensions  inches (millimeters) unless otherwise noted

Lit. # 103560

Molded Dual-In-Line Package (N)
Order Number DS75176BN or DS75176BTN
NS Package Number N09E
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Photo Modules for PCM Remote Control Systems

Available types for different carrier frequencies

<table>
<thead>
<tr>
<th>Type</th>
<th>fo</th>
<th>Type</th>
<th>fo</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSOP1730</td>
<td>30 kHz</td>
<td>TSOP1733</td>
<td>33 kHz</td>
</tr>
<tr>
<td>TSOP1736</td>
<td>36 kHz</td>
<td>TSOP1737</td>
<td>36.7 kHz</td>
</tr>
<tr>
<td>TSOP1738</td>
<td>38 kHz</td>
<td>TSOP1740</td>
<td>40 kHz</td>
</tr>
<tr>
<td>TSOP1756</td>
<td>56 kHz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Description

The TSOP17.. - series are miniaturized receivers for infrared remote control systems. PIN diode and preamplifier are assembled on lead frame, the epoxy package is designed as IR filter. The demodulated output signal can directly be decoded by a microprocessor. TSOP17.. is the standard IR remote control receiver series, supporting all major transmission codes.

Features

- Photo detector and preamplifier in one package
- Internal filter for PCM frequency
- Improved shielding against electrical field disturbance
- TTL and CMOS compatibility
- Output active low

- Low power consumption
- High immunity against ambient light
- Continuous data transmission possible (up to 2400 bps)
- Suitable burst length ≥ 10 cycles/burst

Block Diagram

![Block Diagram Image]
Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>(Pin 2)</td>
<td>$V_S$</td>
<td>-0.3...8.0</td>
<td>V</td>
</tr>
<tr>
<td>Supply Current</td>
<td>(Pin 2)</td>
<td>$I_S$</td>
<td>5</td>
<td>mA</td>
</tr>
<tr>
<td>Output Voltage</td>
<td>(Pin 3)</td>
<td>$V_O$</td>
<td>-0.3...8.0</td>
<td>V</td>
</tr>
<tr>
<td>Output Current</td>
<td>(Pin 3)</td>
<td>$I_O$</td>
<td>5</td>
<td>mA</td>
</tr>
<tr>
<td>Junction Temperature</td>
<td></td>
<td>$T_J$</td>
<td>100</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td></td>
<td>$T_{sta}$</td>
<td>-25...+85</td>
<td>°C</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td></td>
<td>$T_{amb}$</td>
<td>-25...+85</td>
<td>°C</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>(Tamb = 25 °C)</td>
<td>$P_{tot}$</td>
<td>50</td>
<td>mW</td>
</tr>
<tr>
<td>Soldering Temperature</td>
<td></td>
<td>$T_{sd}$</td>
<td>260</td>
<td>°C</td>
</tr>
</tbody>
</table>

Basic Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Current (Pin 2)</td>
<td>$V_N = 5 , V, , E_N = 0$</td>
<td>$I_{S0}$</td>
<td>0.4</td>
<td>0.6</td>
<td>1.5</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>$V_N = 5 , V, , E_N = 40 , kV, , sunlight$</td>
<td>$I_{SIT}$</td>
<td>1.0</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>Supply Voltage (Pin 2)</td>
<td>$V_N$</td>
<td>$V_S$</td>
<td>4.5</td>
<td>5.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Transmission Distance</td>
<td>$E_N = 0$, test signal see fig 7, IR diode TSAL6200, $I_T = 400 , mA$</td>
<td>$d$</td>
<td>35</td>
<td></td>
<td>m</td>
<td></td>
</tr>
<tr>
<td>Output Voltage Low (Pin 3)</td>
<td>$I_{SS} = 0.5 , mA, E_N = 0.7 , mW/m^2, f = 10 , kHz, I_T = 0.4$</td>
<td>$V_{OSL}$</td>
<td>250</td>
<td></td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>Irradiance (30 – 40 kHz)</td>
<td>$E_{min}$</td>
<td>0.35</td>
<td>0.5</td>
<td></td>
<td>mW/m^2</td>
<td></td>
</tr>
<tr>
<td>Irradiance (50 kHz)</td>
<td>$E_{min}$</td>
<td>0.4</td>
<td>0.6</td>
<td></td>
<td>mW/m^2</td>
<td></td>
</tr>
<tr>
<td>Directivity</td>
<td>$E_{max}$</td>
<td>30</td>
<td></td>
<td></td>
<td>W/m^2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Angle of half transmission distance</td>
<td>$e_{1/2}$</td>
<td>±45</td>
<td></td>
<td>deg</td>
<td></td>
</tr>
</tbody>
</table>

Application Circuit

*) recommended to suppress power supply disturbances

**) The output voltage should not be held continuously at a voltage below 3.3 V by the external circuit.
Suitable Data Format

The circuit of the TSOP17.. is designed in such a way that unexpected output pulses due to noise or disturbance signals are avoided. A bandpass filter, an integrator stage and an automatic gain control are used to suppress such disturbances.

The distinguishing mark between data signal and disturbance signal are carrier frequency, burst length and duty cycle.

The data signal should fulfill the following condition:

- Carrier frequency should be close to center frequency of the bandpass (e.g. 38kHz).
- Burst length should be 10 cycles/burst or longer.
- After each burst which is between 10 cycles and 70 cycles a gap time of at least 14 cycles is necessary.
- For each burst which is longer than 1.8ms a corresponding gap time is necessary at some time in the data stream. This gap time should have at least same length as the burst.
- Up to 1400 short bursts per second can be received continuously.

Some examples for suitable data format are:

When a disturbance signal is applied to the TSOP 17.. it can still receive the data signal. However the sensitivity is reduced to that level that no unexpected pulses will occur.

Some examples for such disturbance signals which are suppressed by the TSOP17.. are:

- DC light (e.g. from tungsten bulb or sunlight)
- Continuous signal at 38kHz or at any other frequency
- Signals from fluorescent lamps with electronic ballast (an example of the signal modulation is in the figure below).
Typical Characteristics \( (T_{amb} = 25^\circ C \text{ unless otherwise specified}) \)

Figure 1. Frequency Dependence of Responsivity

Figure 2. Sensitivity in Dark Ambient

Figure 3. Sensitivity in Bright Ambient

Figure 4. Sensitivity vs. Electric Field Disturbances

Figure 5. Sensitivity vs. Supply Voltage Disturbances

Figure 6. Sensitivity vs. Ambient Temperature
Figure 13. Vertical Directivity $\phi_Y$

Figure 14. Horizontal Directivity $\phi_X$

Dimensions in mm

[Diagram showing dimensions and annotations]
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It is the policy of Vishay Semiconductor GmbH to

1. Meet all present and future national and international statutory requirements.

2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

It is particular concern to control or eliminate releases of these substances into the atmosphere which are known as ozone depleting substances (ODSs).

The Montreal Protocol (1987) and its London Amendments (1990) intend to severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

Vishay Semiconductor GmbH has been able to use its policy of continuous improvements to eliminate the use of ODSs listed in the following documents.


2. Class I and II ozone depleting substances in the Clean Air Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA.


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