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LAMPIRAN

Listing Program pada Arduino Uno

```
//----------------------------------------------------------------//
#include <SPI.h>
#include <SD.h>
#include <Wire.h>                  // Include Wire library (required for I2C devices)
#include <LiquidCrystal_I2C.h>     // Include LiquidCrystal_I2C library

LiquidCrystal_I2C lcd(0x3F, 16, 2);  // Configure LiquidCrystal_I2C library with 0x27 address,
16 columns and 2 rows
char filename[16];
int datapb=0;
int a =0;
int data[36];
int x=0;
int yangdikirim=1;
int bocor=1;
char buffer[50];
String dataString = "";
 /* SD card module pin configurations
 ** MOSI - pin 11
 ** MISO - pin 12
 ** CLK - pin 13
 ** CS - pin 10
 */
const int chipSelect = 10;

String lagiapa="Diam bae...";

int ledState = LOW;             // ledState used to set the LED
unsigned long previousMillis= 0;        // will store last time LED was updated
unsigned long mulai=0;
unsigned long berhenti=0;
//debounce variable needed
int buttonState, buttonState2, buttonState3;             // the current reading from the input pin
int lastButtonState, lastButtonState2, lastButtonState3 = LOW;   // the previous reading from the
input pin
long lastDebounceTime, lastDebounceTime2, lastDebounceTime3 = 0;  // the last time the output
pin was toggled
long debounceDelay, debounceDelay2, debounceDelay3 = 50;    // the debounce time; increase if
the output flickers
//end
```

```
int dataADC=0;
float tekanan=0;
float adcrata2=0;
bool pbEvent=0;
bool pbNewFile=0;
bool pbClear=0;

#define dashboard 0
#define measure1 1
#define measure2 2
#define measure3 3
#define measure4 4
#define measure5 5
#define measure6 6
#define bikinfilebaru 7
#define debugmode 8 //kebocoran
#define checksd 9

uint8_t machine_state = dashboard;
//----------------------------------------------------------------------//
void setup() {
  pinMode(5,  INPUT_PULLUP);
  pinMode(6,  INPUT_PULLUP);
  pinMode(7, INPUT_PULLUP);

  pinMode(8,  OUTPUT);
  pinMode(9,  OUTPUT);
  Serial.begin(9600);
  // set up the LCD lcd.begin(colomn, row)
  lcd.init();                          // Initialize I2C LCD module

  lcd.backlight();
  // Print a message to the LCD.
  analogReference(EXTERNAL);
  if (!SD.begin(chipSelect)) {
    Serial.println("Card failed, or not present");
    lcd.print("No SD Card X");
    return;
  }
  Serial.println("card initialized.");
  lcd.print("SD Card Good");
  delay(2000);
}
//----------------------------------------------------------------------//
void blinkblueLED() {
  unsigned long currentMillis = millis();
```

```
  if (currentMillis - previousMillis >= 250) {
    previousMillis = currentMillis;
    if (ledState == LOW) {
    ledState = HIGH;
    } else {
      ledState = LOW;
    }
    digitalWrite(8, ledState);
  }
}
void blinkgreenLED() {
  unsigned long currentMillis = millis();
  if (currentMillis - previousMillis >= 250) {
    previousMillis = currentMillis;
    if (ledState == LOW) {
    ledState = HIGH;
    } else {
      ledState = LOW;
    }
    digitalWrite(9, ledState);
  }
}
void eventbtn() {
  int reading = digitalRead(7);
  if (reading != lastButtonState) {
    lastDebounceTime = millis();
  }

  if ((millis() - lastDebounceTime) > debounceDelay) {
    if (reading != buttonState) {
      buttonState = reading;
      if (buttonState == LOW) {
        pbEvent=1;
      }
    }
  }
  lastButtonState = reading;
}
void newbtn() {
  int reading2 = digitalRead(6);
  if (reading2 != lastButtonState2) {
    lastDebounceTime2 = millis();
  }

  if ((millis() - lastDebounceTime2) > debounceDelay2) {
    if (reading2 != buttonState2) {
```

```
      buttonState2 = reading2;
      if (buttonState2 == LOW) {
        pbNewFile=1;
      }
    }
  }
  lastButtonState2 = reading2;
}
void clearbtn() {
  int reading3 = digitalRead(5);
  if (reading3 != lastButtonState3) {
    lastDebounceTime3 = millis();
  }

  if ((millis() - lastDebounceTime3) > debounceDelay3) {
    if (reading3 != buttonState3) {
      buttonState3 = reading3;
      if (buttonState3 == LOW) {
        pbClear=1;
      }
    }
  }
  lastButtonState3 = reading3;
}
//void beep() {
//  digitalWrite(A5, HIGH);
//  delay(100);
//  digitalWrite(A5, LOW);
//  return;
//}
void convertadcketekanan(){
  dataADC=analogRead(0);
  adcrata2=0.85*adcrata2+0.15*dataADC;
  tekanan=0.2762*adcrata2-32.281;
//=0.3178*adcrata2 - 29.626;
//tekanan=0.3158*adcrata2 - 29.537;
//tekanan=0.3162*adcrata2 - 33.667;
//tekanan=0.3155*adcrata2 - 35;
}
void (*resetFunc)(void)=0;
void loop() {
  switch (machine_state){
    case dashboard:
      x=0; //array cursor di awal
      digitalWrite(8, HIGH);// green
      digitalWrite(9, HIGH);//blue
```

```
    newbtn();
    clearbtn();
    eventbtn();
    if(pbNewFile==1){
      digitalWrite(8, LOW);//green
      //beep();
      machine_state=measure1;
      pbNewFile=0;
    }
    if(pbClear==1&&pbEvent==1){//tekan kedua pb masuk ke debug serial
      //beep();
      machine_state=debugmode;
      pbEvent=0;
      pbClear=0;
    }
    convertadcketekanan();
    lcd.clear();
    lcd.setCursor(0,
0);lcd.print("T");lcd.setCursor(1,0);lcd.print(":");lcd.setCursor(2,0);lcd.print(millis()/1000);
    lcd.setCursor(0,
1);lcd.print("A");lcd.setCursor(1,1);lcd.print(":");lcd.setCursor(2,1);lcd.print(dataADC);
    lcd.setCursor(7,
0);lcd.print("Ps");lcd.setCursor(9,0);lcd.print(":");lcd.setCursor(10,0);lcd.print(tekanan);
    lcd.setCursor(7,
1);lcd.print("As");lcd.setCursor(9,1);lcd.print(":");lcd.setCursor(10,1);lcd.print(adcrata2);
    delay(200);
  break;
  //-----------------------------------debug mode here----------------------------------//
  case debugmode:
    convertadcketekanan();
    newbtn();
    clearbtn();
    mulai=millis();
    if (pbClear==1){
      //beep(); bocor=-1;
      Serial.println(bocor);
      berhenti=mulai;
      delay(100);
      pbClear=0;
    }

    if(bocor==-1){
      lagiapa="Ngukur...";
      Serial.println(mulai-berhenti);
      if(mulai-berhenti>=60000){
```

```
        Serial.print("Selesai:");
        Serial.println(tekanan);
        bocor=2;
      }
    }

    if(bocor==2||bocor==1){
      berhenti=mulai;
    } if(bocor==2){
    lagiapa="Selesai...";
    } if(pbNewFile==1){
     digitalWrite(8, LOW);//green
      //beep();
      machine_state=dashboard;
      pbNewFile=0;
    }

    lcd.clear();
    lcd.setCursor(0,
0);lcd.print("T");lcd.setCursor(1,0);lcd.print(":");lcd.setCursor(2,0);lcd.print((mulai-
berhenti)/1000);
    lcd.setCursor(7,
0);lcd.print("Ps");lcd.setCursor(9,0);lcd.print(":");lcd.setCursor(10,0);lcd.print(tekanan);
    lcd.setCursor(0, 1);lcd.print(lagiapa);
    delay(200);
   break;
   //------------------------------------------------------------------------------------------//
  /* case debugmode:
    newbtn();
    clearbtn();
    if(pbNewFile==1){
      digitalWrite(8, LOW);//green
      //beep();
      machine_state=measure1;
      pbNewFile=0;
    }
    if (pbClear==1){
      //beep();
      yangdikirim=yangdikirim*-1;
      pbClear=0;
    } lcd.clear();
    convertadcketekanan();
    if(yangdikirim==1){
```

```
    sprintf(buffer, "%d", dataADC);
  }
  if(yangdikirim==-1){
    sprintf(buffer, "%d", adcrata2);
  }
  Serial.println(buffer);
  delay(25);
break;
*/
//--------------------------------------------------------------------------------------------//
case measure1:
  blinkblueLED();
  digitalWrite(9, HIGH);//green
  digitalWrite(A5, LOW);//turn buzzer off
  eventbtn();
  clearbtn();

  if(pbEvent==1){
    data[x]=tekanan;
    x++;
    a=a+50;
    pbEvent=0;
    //beep();
    if(x==6){
      digitalWrite(8, LOW);//green
      delay(250);
      a=250;
      machine_state=measure2;
    }
  }
  if(pbClear==1){
    x--;
    a=a-50;
    if(x<=0&&a<=0){
    a=0;
      x=0;
    }
    pbClear=0;
    //beep();
  }
  convertadcketekanan();
  lcd.clear();
  lcd.setCursor(0, 0);lcd.print("*NI*");
  lcd.setCursor(0, 1);lcd.print("SP:");lcd.setCursor(3,1);lcd.print(a);
  lcd.setCursor(8, 1);lcd.print("Ps:");lcd.setCursor(11,1);lcd.print(tekanan);
  lcd.setCursor(8, 0);lcd.print("Dt:");lcd.setCursor(11,0);lcd.print(x);
```

```
  delay(100);
break;
//------------------------------------------------------------------------------//
case measure2:
  blinkgreenLED();
  digitalWrite(8, HIGH);
  eventbtn();
  clearbtn();
  if(pbEvent==1){
  data[x]=tekanan;
  x++;
    a=a-50;
    pbEvent=0;
    //beep();
    if(x==12){
      digitalWrite(8, LOW);//red
      delay(100);
      a=0;
      machine_state=measure3;
    }//event button ditekan
  }
  if(pbClear==1){
  x--;
    a=a+50;
    if(x==5&&a>250){
    x=5;
      a=250;
      machine_state=measure1;
    }
    pbClear=0;
    //beep();
  }
  convertadcketekanan();
  lcd.clear();
  lcd.setCursor(0, 0);lcd.print("*TI*");
  lcd.setCursor(0, 1);lcd.print("SP:");lcd.setCursor(3,1);lcd.print(a);
  lcd.setCursor(8, 1);lcd.print("Ps:");lcd.setCursor(11,1);lcd.print(tekanan);
  lcd.setCursor(8, 0);lcd.print("Dt:");lcd.setCursor(11,0);lcd.print(x);
  delay(100);
break;
//-----------------------------------------------//
case measure3:
  blinkblueLED();
  digitalWrite(9, HIGH);
  eventbtn();
  clearbtn();
```

```
  if(pbEvent==1){
    data[x]=tekanan;
    x++;
    a=a+50;
    pbEvent=0;
    //beep();
    if(x==18){
      digitalWrite(8, LOW);//red
      delay(250);
      a=250;
      machine_state=measure4;
    }//event button pressed
  }
   if(pbClear==1){
   x--;
    a=a-50;
    if(x==11&&a<0){
    x=11;
      a=0;
      machine_state=measure2;
    }
    pbClear=0;
    //beep();
  }
  convertadcketekanan();
  lcd.clear();
  lcd.setCursor(0, 0);lcd.print("*NII*");
  lcd.setCursor(0, 1);lcd.print("SP:");lcd.setCursor(3,1);lcd.print(a);
  lcd.setCursor(8, 1);lcd.print("Ps:");lcd.setCursor(11,1);lcd.print(tekanan);
  lcd.setCursor(8, 0);lcd.print("Dt:");lcd.setCursor(11,0);lcd.print(x);
  delay(100);
break;
//-----------------------------------------------//
case measure4:
  blinkgreenLED();
  digitalWrite(8, HIGH);
  eventbtn();
  clearbtn();
  if(pbEvent==1){
  data[x]=tekanan;
  x++;
    a=a-50;
    pbEvent=0;
    //beep();
    if (x==24){
      digitalWrite(8, LOW);//red
```

```
    delay(250); a=0;
    machine_state=measure5;
   } //Event Button Pressed
  }
   if(pbClear==1){
   x--; a=a+50;
   if(x==17&&a>250){
   x=17;
    a=250;
    machine_state=measure3;
   }
   pbClear=0;
   //beep();
  }
  convertadcketekanan();
  lcd.clear();
  lcd.setCursor(0, 0);lcd.print("*TII*");
  lcd.setCursor(0, 1);lcd.print("SP:");lcd.setCursor(3,1);lcd.print(a);
  lcd.setCursor(8, 1);lcd.print("Ps:");lcd.setCursor(11,1);lcd.print(tekanan);
  lcd.setCursor(8, 0);lcd.print("Dt:");lcd.setCursor(11,0);lcd.print(x);
  delay(100);
  break;
//----------------------------------------------------//
case measure5:
  blinkblueLED();
  digitalWrite(9, HIGH);
  eventbtn();
  clearbtn();
  if(pbEvent==1){
  data[x]=tekanan;
  x++;
   a=a+50;
   pbEvent=0;
   //beep();
   if (x==30){
    digitalWrite(8, LOW);//red
    delay(250);
    a=250;
    machine_state=measure6;
   }
  }
   if(pbClear==1){
   x--;
   a=a-50;
```

```
    if(x==23&&a<0){
      x=23; a=0;
      machine_state=measure4;
    }
    pbClear=0;
    //beep();
  }
  convertadcketekanan();
  lcd.clear();
  lcd.setCursor(0, 0);lcd.print("*NIII*");
  lcd.setCursor(0, 1);lcd.print("SP:");lcd.setCursor(3,1);lcd.print(a);
  lcd.setCursor(8, 1);lcd.print("Ps:");lcd.setCursor(11,1);lcd.print(tekanan);
  lcd.setCursor(8, 0);lcd.print("Dt:");lcd.setCursor(11,0);lcd.print(x);
  delay(100);
break;
//-----------------------------------------------------------------//
case measure6:
  blinkgreenLED();
  digitalWrite(8, HIGH);
  eventbtn();
  clearbtn();
  if(pbEvent==1){
  data[x]=tekanan;
  x++;
    a=a-50;
    pbEvent=0;
    //beep();
    if (x==36){
      digitalWrite(8, LOW);//red
      delay(250);
      a=0;
      machine_state=bikinfilebaru;
    }
  }
   if(pbClear==1){
    x--; a=a+50;
    if(x==29&&a>250){
    x=29;
      a=250;
      machine_state=measure5;
    }
    pbClear=0;
    //beep();
  }
```

```
    convertadcketekanan();
    lcd.clear();
    lcd.setCursor(0, 0);lcd.print("*TIII*");
    lcd.setCursor(0, 1);lcd.print("SP:");lcd.setCursor(3,1);lcd.print(a);
    lcd.setCursor(8, 1);lcd.print("Ps:");lcd.setCursor(11,1);lcd.print(tekanan);
    lcd.setCursor(8, 0);lcd.print("Dt:");lcd.setCursor(11,0);lcd.print(x);
    delay(100);
   break;
   //------------------------------------------------------------------//
   case bikinfilebaru:
    //check and generate new file name
    int n = 0;
    snprintf(filename, sizeof(filename), "tensi%03d.csv", n); // includes a three-digit sequence
number in the file name
    while(SD.exists(filename)) {
      n++;
      snprintf(filename, sizeof(filename), "tensi%03d.csv", n);
    }
    //write into a new file name
    File dataFile = SD.open(filename, FILE_WRITE);
    if (dataFile) { x=0;
        for(x=0;x<36;x++){
        if(x==35){
            dataString+=String(data[x]);
          } else{
          dataString+=String(data[x])+",";
          }
          Serial.println(x);
          delay(25);
        }
        dataFile.print(dataString);
        dataFile.close();
        lcd.clear();
        lcd.setCursor(0, 0);lcd.print(filename);
        delay(2000); resetFunc();
        machine_state=dashboard;
      }
    else {
      Serial.println("error");
    }
   break;
  }
}
```

Listing Program pada Visual Code Setting

```
from PyQt5 import QtWidgets,uic
import openpyxl
import csv
i=list()

#create function
def convert():
    data=call.lineEdit.text() #input data
    output=call.lineEdit_2.text() #output data
    print("text: ",data)
    #read csv and extract value to i
    with open(data+'.csv') as csvfile:
        readCSV = csv.reader(csvfile, delimiter=',')
        for row in readCSV:
            i.append(row)

    #read template file
    xfile = openpyxl.load_workbook('LK Tekanan.xlsx')
    sheet = xfile.get_sheet_by_name('Tensimeter')

    #write to cell
    sheet['B22'] = int(i[0][0])
    sheet['B23'] = int(i[0][1])
    sheet['B24'] = int(i[0][2])
    sheet['B25'] = int(i[0][3])
    sheet['B26'] = int(i[0][4])
    sheet['B27'] = int(i[0][5])

    sheet['C27']  =  int(i[0][6])
    sheet['C26']  =  int(i[0][7])
    sheet['C25']  =  int(i[0][8])
    sheet['C24']  =  int(i[0][9])
    sheet['C23'] = int(i[0][10])
    sheet['C22'] = int(i[0][11])

    sheet['D22'] = int(i[0][12])
    sheet['D23'] = int(i[0][13])
    sheet['D24'] = int(i[0][14])
    sheet['D25'] = int(i[0][15])
    sheet['D26'] = int(i[0][16])
    sheet['D27'] = int(i[0][17])

    sheet['E27'] = int(i[0][18])
```

```
    sheet['E26'] = int(i[0][19])
    sheet['E25'] = int(i[0][20])
    sheet['E24'] = int(i[0][21])
    sheet['E23'] = int(i[0][22])
    sheet['E22'] = int(i[0][23])

    sheet['F22'] = int(i[0][24])
    sheet['F23'] = int(i[0][25])
    sheet['F24'] = int(i[0][26])
    sheet['F25'] = int(i[0][27])
    sheet['F26'] = int(i[0][28])
    sheet['F27'] = int(i[0][29])

    sheet['G27'] = int(i[0][30])
    sheet['G26'] = int(i[0][31])
    sheet['G25'] = int(i[0][32])
    sheet['G24'] = int(i[0][33])
    sheet['G23'] = int(i[0][34])
    sheet['G22'] = int(i[0][35])


    #save to new file
    xfile.save(str(output)+'.xlsx')
    print("----------------------- Saved as : "+str(output)+'.xlsx'+" -----------
----------------")

#setup gui
app=QtWidgets.QApplication([])
call=uic.loadUi("baru.ui")

#button callback function
call.pushButton.clicked.connect(convert)

#show and execute
call.show()
app.exec()
```

Standar Operasional Prosedur (SOP) Penggunaan Alat "Kalibrator Tensimeter Dilengkapi dengan Pengolahan Data Otomatis"

"Mode Kebocoran"

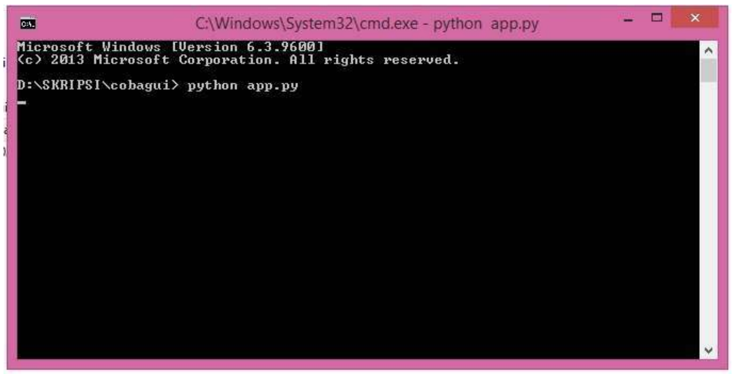
1. Pastikan micro SD Card telah terpasang pada alat
2. Pasang selang manset dan bola tensi pada alat (selang 3 way) yang telah tersedia.
3. Pastikan tensimeter menunjukkan titik 0 mmHg, jika belum maka nol-kan. Apabila tidak dapat di-nol-kan, maka tidak dapat dilakukan kalibrasi pada tensimeter tersebut.
4. Tekan tombol ***On*** satu kali untuk menyalakan alat, tunggu sampai alat selesai melakukan inisialisasi SD Card.
5. Untuk melakukan pemilihan "mode kebocoran" tekan tombol *New* dan *Event* secara bersamaan selama ± 2 detik sampai tampilan pada lcd berubah menjadi tampilan mode kebocoran.
6. Pompa tensimeter sampai pada titik 200 mmHg, kunci bola tensi dan catat hasil tekanan awal yang tampil pada lcd, kemudian tekan tombol *New* untuk memulai pengukuran.
7. Waktu pengukuran akan berjalan selama 60 detik dengan ditunjukkan pada T yang melakukan counter up selama 60 detik dan lcd menampilkan tulisan "Ngukur".
8. Ketika telah mencapai 60 detik, waktu akan berhenti, lcd menampilkan tulisan "Selesai" dan tekanan akhir akan ditampilkan pada lcd, catat tekanan akhir tersebut.
9. Tekan tombol *Hold* untuk kembali pada tampilan awal setelah inisialisasi micro SD Card.

“Mode Akurasi Tekanan”

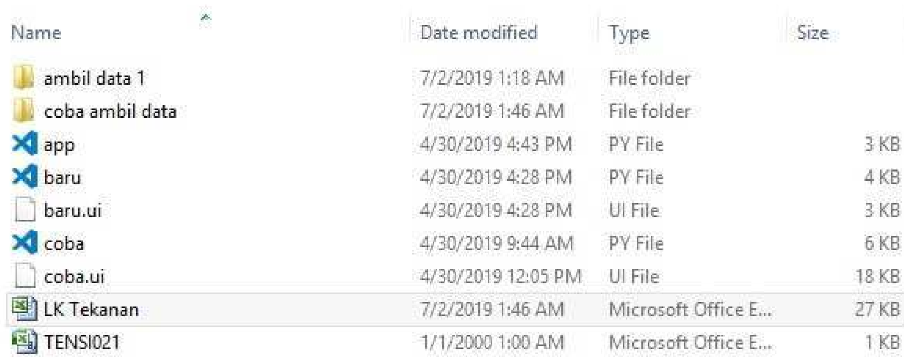
1. Download dan install aplikasi Visual Studio Code Setting Up pada *personal computer* (PC)

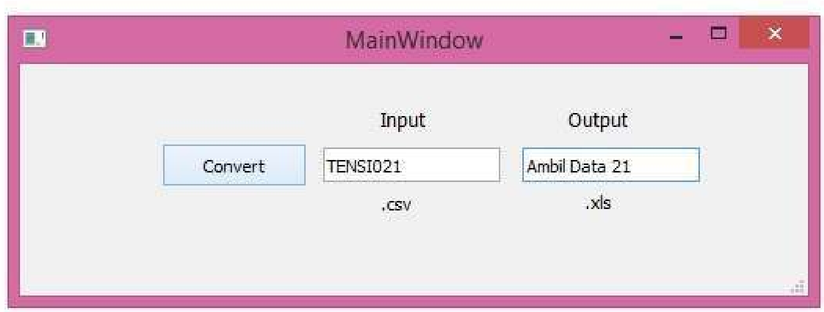
2. Pastikan micro SD Card telah terpasang pada alat.
3. Pasang selang manset dan bola tensi pada alat (selang *3-way*) yang telah tersedia.
4. Pastikan tensimeter menunjukkan titik 0 mmHg, jika belum maka nol-kan. Apabila tidak dapat di-nol-kan, maka tidak dapat dilakukan kalibrasi pada tensimeter tersebut.
5. Tekan tombol ***On*** satu kali untuk menyalakan alat, tunggu sampai alat selesai melakukan inisialisasi *SD Card*.
6. Untuk melakukan pemilihan “mode akurasi tekanan” tekan tombol *Hold* selama ± 2 detik sampai tampilan pada lcd berubah menjadi tampilan mode akurasi tekanan.
7. Tekan tombol *Event* untuk meng-enter data naik dan turun.
8. Pada data NI (Naik I) tekan tombol *Event* pada saat tensimeter menunjukkan 0 mmHg, kemudian pompa tensimeter sampai titik 50 mmHg dan tekan tombol *Event* untuk menginput data tekanan pada titik tersebut dan menuju ke titik berikutnya. Ulangi langkah tersebut pada titik 100 mmHg, 150 mmHg, 200 mmHg dan 250 mmHg.
9. Pada data TI (Turun I), pompa tensimeter sampai melebihi 250 mmHg, kemudian buka kuncian pada bola tensi agar tekanan pada tensimeter turun. Pada saat titik 250 mmHg tekan tombol *Event* untuk menginput data tekanan pada titik tersebut dan menuju ke titik berikutnya. Ulangi langkah tersebut pada titik 200 mmHg, 150 mmHg, 100 mmHg, 50 mmHg dan 0 mmHg.
10. Ulangi langkah-langkah pada nomor 8 dan 9 sebanyak 3 kali, yaitu pada data N II, T II, N III dan T III.
11. Pada saat data terakhir T III pada titik 0 mmHg, tekan tombol *Event* lagi untuk mengirim data yang tersimpan tersebut pada *micro SD Card*. Maka lcd akan menampilkan nama file pada lcd misalnya “**tensi021.csv**”.
12. Kemudian buka file csv yang telah terkirim pada *micro SD Card* tersebut pada PC dengan menggunakan *card reader*.
13. Buka folder yang berisi aplikasi Visual Studio Code Setting Up yang digunakan untuk pemrosesan data, pastikan di dalam folder tersebut terdapat file lembar kerja yang akan digunakan untuk menyalin data dari file csv.
14. Copy file dari *micro SD Card* tersebut ke dalam folder yang berisi aplikasi Visual Studio Code Setting Up.
15. Ketik “cmd” pada address bar tekan enter

16. Tunggu sampai muncul tampilan windows cmd, ketik “python app.py” kemudian tekan enter



17. Tunggu sampai muncul window untuk mengkonversi. Kemudian ketik nama file yang telah dicopy pada folder yang berisi aplikasi Visual Studio Code Setting Up, dan ketik nama file setelah dikonversi

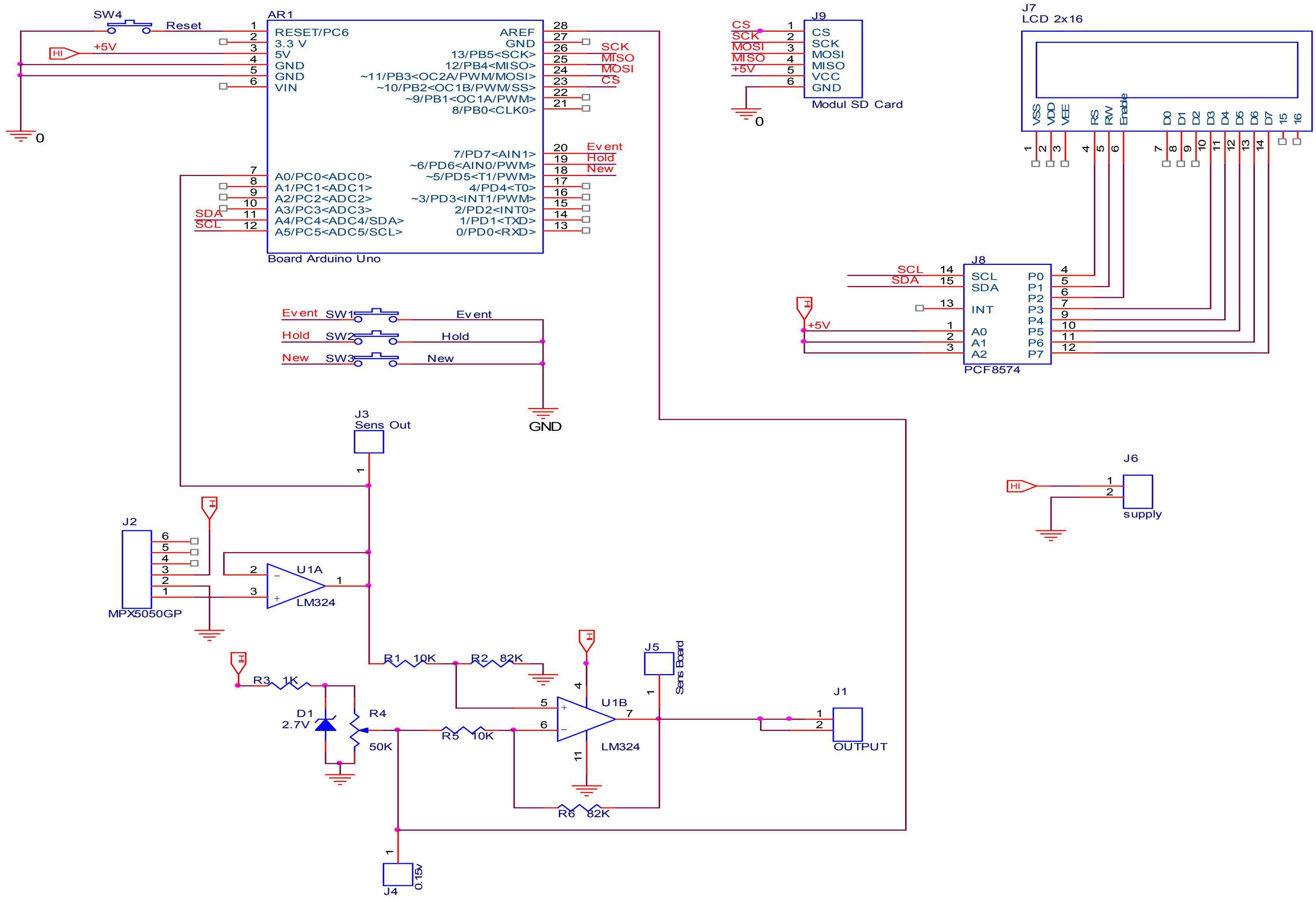




18. Tekan Convert pada MainWindow, maka selesai dilakukan konversi.
19. Data tersebut dapat dilihat pada Microsoft excel dengan nama file yang telah diubah.
20. Untuk mematikan alat, tekan tombol ***Off*** dua kali.

Foto pengambilan data

RANGKAIAN KESELURUHAN



Document Number: MPX5100
Rev. 14, 12/2018

MPX5100, 0 to 100 kPa, Differential, Gauge, and Absolute, Integrated, Pressure Sensors

MPX5100

The MPX5100 series piezoresistive transducer is a state-of-the-art monolithic silicon pressure sensor designed for a wide range of applications, but particularly those employing a microcontroller or microprocessor with A/D inputs. This patented, single element transducer combines advanced micromachining techniques, thin-film metallization, and bipolar processing to provide an accurate, high-level, analog output signal that is proportional to the applied pressure.

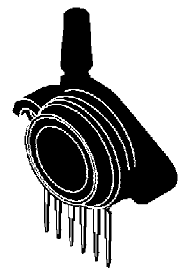
Features

- 2.5% maximum error over 0 to 85 °C
- Ideally suited for microprocessor or microcontroller-based systems
- Patented silicon shear stress strain gauge
- Available in absolute, differential and gauge configuration
- Durable epoxy unibody element
- Easy-to-use chip carrier option

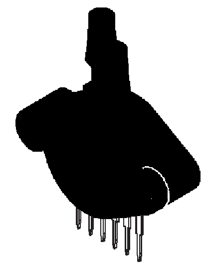
Typical applications

- Patient monitoring
- Process control
- Pump/motor control
- Pressure switching
- White goods

Unibody packages

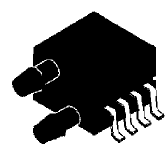


MPX5100AP/GP
98ASB42796B

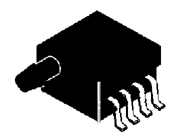


MPX5100DP
98ASA42797B

Small outline packages

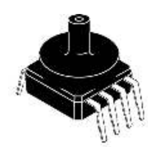


MPXV5100DP
98ASA99255D



MPXV5100GP
98ASA99303D

MPXV5100GC6U
98ASB17757C



MPXV5100GC7U
98ASB17759C

Ordering information

Device name	Shipping	Package	# of Ports			Pressure type			Device marking
			None	Single	Dual	Gauge	Differential	Absolute	
Unibody Package (MPX5100 Series)									
MPX5100AP	Tray	98ASB42796B		•				•	MPX5100AP
MPX5100DP	Tray	98ASB42797B			•		•		MPX5100DP
MPX5100GP	Tray	98ASB42796B		•		•			MPX5100GP
Small Outline Package (MPXV5100 Series)									
MPXV5100DP	Tray	98ASA99255D			•		•		MPXV5100DP
MPXV5100GC6U	Rail	98ASB17757C		•		•			MPXV5100G
MPXV5100GC7U	Rail	98ASB17759C		•		•			MPXV5100G
MPXV5100GP	Tray	98ASA99303D		•		•			MPXV5100GP

NXP reserves the right to change the detail specifications as may be required to permit improvements in the design of its products.

Contents

Related Documentation

The MPX5100 device features and operations are described in a variety of reference manuals, user guides, and application notes. To find the most-current versions of these documents:

1. Go to the NXP homepage at:

   http://www.nxp.com/

2. In the Keyword search box at the top of the page, enter the device number MPX5100.
3. In the Refine Your Result pane on the left, click on the Documentation link.

Sensors
NXP Semiconductors, B.V. 2

Sensors
NXP Semiconductors, B.3V.

1 General Description

1.1 MPX5100AP/DP/GP Block diagram

Figure 1 shows a block diagram of the internal circuitry integrated on a pressure sensor chip in a unibody package.

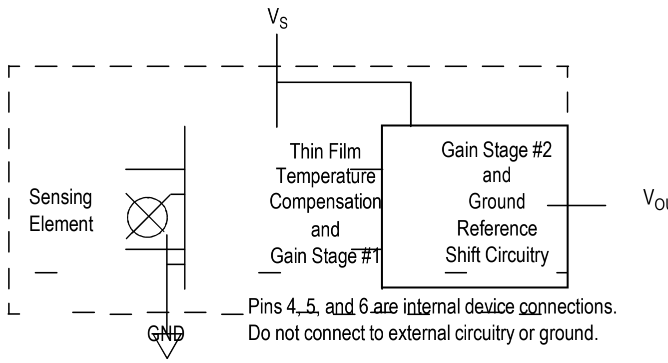


Figure 1. Integrated pressure sensor block diagram

1.2 MPX5100AP/DP/GP Pinout (Unibody)

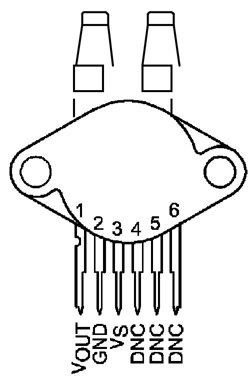


Figure 2. Device pinout (top view)

Table 1. Pin functions

Pin	Name	Function
1	V_{OUT}	Output voltage
2	GND	Ground
3	V_S	Voltage supply
4	DNC	Do not connect to external circuitry or ground.
5	DNC	Do not connect to external circuitry or ground.
6	DNC	Do not connect to external circuitry or ground.

1.3 MPXV5100DP/GC6U/GC7U/GP block diagram

Figure 1 shows a block diagram of the internal circuitry integrated on a pressure sensor chip in a small outline package.

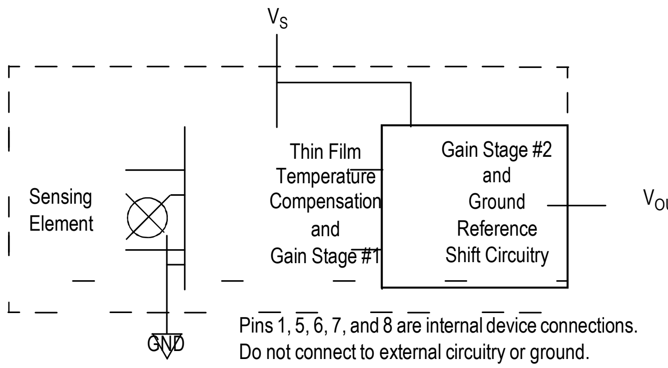


Figure 3. Integrated pressure sensor block diagram

1.4 MPXV5100DP/GC6U/GC7U/GP pinout (small outline package)

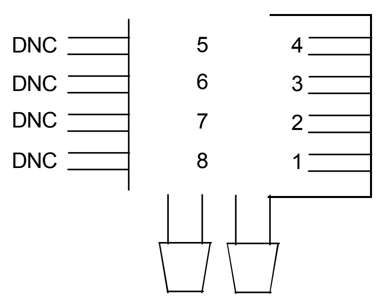


Figure 4. Device pinout (top view)

Table 2. Pin functions

Pin	Name	Function
1	DNC	Do not connect to external circuitry or ground.
2	V_S	Voltage supply
3	GND	Ground
4	V_{OUT}	Output voltage
5	DNC	Do not connect to external circuitry or ground.
6	DNC	Do not connect to external circuitry or ground.
7	DNC	Do not connect to external circuitry or ground.
8	DNC	Do not connect to external circuitry or ground.

2 Mechanical and Electrical Specifications

2.1 Maximum ratings

Table 3. Maximum ratings(1)

Rating	Symbol	Value	Unit
Maximum pressure	P_{max}	400	kPa
Storage temperature	T_{stg}	-40 to +125	°C
Operating temperature	T_A	-40 to +125	°C

1. Exposure beyond the specified limits may cause permanent damage or degradation to the device.

2.2 Operating characteristics

Table 4. Operating characteristics (V_S = 5 Vdc, T_A = 25 °C.)

Characteristic	Symbol	Min	Typ	Max	Unit
Pressure range(1) Gauge, differential: MPX5100G/MPXV5100G Absolute: MPX5100AP	P_{OP}	 0 15	 — —	 100 115	kPa
Supply voltage(2)	V_S	4.75	5.0	5.25	V_{DC}
Supply current	I_O	—	7.0	10	mAdc
Minimum pressure offset(3), (0 to 85 °C) @ V_S = 5.0 V	V_{OFF}	0.088	0.20	0.313	V_{DC}
Full-scale output(4), differential and absolute (0 to 85 °C) @ V_S = 5.0 V	V_{FSO}	4.587	4.700	4.813	V_{DC}
Full-scale Span(5), differential and absolute (0 to 85 °C) @ V_S = 5.0 V	V_{FSS}	—	4.500	—	V_{DC}
Accuracy(6)	—	—	—	±2.5	$\%V_{FSS}$
Sensitivity	V/P	—	45	—	mV/kPa
Response time(7)	t_R	—	1.0	—	ms
Output source current at full-scale output	I_{O+}	—	0.1	—	mAdc
Warm-up time(8)	—	—	20	—	ms
Offset stability(9)	—	—	±0.5	—	$\%V_{FSS}$

1. 1.0 kPa (kiloPascal) equals 0.145 psi.
2. Device is ratiometric within this specified excitation range.
3. Offset (V_{OFF}) is defined as the output voltage at the minimum rated pressure.
4. Full-scale output (V_{FSO}) is defined as the output voltage at the maximum or full-rated pressure.
5. Full-scale span (V_{FSS}) is defined as the algebraic difference between the output voltage at full-rated pressure and the output voltage at the minimum rated pressure.
6. Accuracy (error budget) consists of the following:
   - Linearity: Output deviation from a straight line relationship with pressure over the specified pressure range.
   - Temperature hysteresis: Output deviation at any temperature within the operating temperature range, after the temperature is cycled to and from the minimum or maximum operating temperature points, with zero differential pressure applied.
   - Pressure hysteresis: Output deviation at any pressure within the specified range, when this pressure is cycled to and from minimum or maximum rated pressure at 25 °C.
   - TcSpan: Output deviation over the temperature range of 0 to 85 °C, relative to 25 °C.
   - TcOffset: Output deviation with minimum pressure applied over the temperature range of 0 to 85 °C, relative to 25 °C.
   - Variation from nominal: The variation from nominal values, for offset or full-scale span, as a percent of V_{FSS} at 25 °C.
7. Response time is defined as the time for the incremental changed in the output to go from 10% to 90% of its final value when subjected to a specified step change in pressure.
8. Warm-up time is defined as the time required for the product to meet the specified output voltage after the pressure has been stabilized.
9. Offset stability is the product's output deviation when subjected to 1000 hours of pulsed pressure, temperature cycling with bias test.

3 On-chip Temperature Compensation and Calibration

Figure 5 shows the sensor output signal relative to pressure input. Typical, minimum, and maximum output curves are shown for operation over a temperature range of 0 to 85 °C using the decoupling circuit shown in Figure 7. The output will saturate outside of the specified pressure range.

Figure 6 illustrates both the Differential/Gauge and the Absolute Sensing Chip in the basic chip carrier. A fluorosilicone gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the sensor diaphragm.

The MPX5100 series pressure sensor operating characteristics, and internal reliability and qualification tests are based on use of dry air as the pressure media. Media, other than dry air, may have adverse effects on sensor performance and long-term reliability. Contact the factory for information regarding media compatibility in your application.

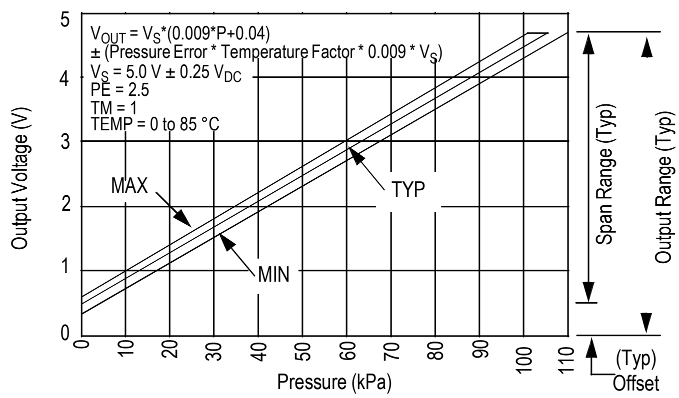


Figure 5. Output versus pressure differential

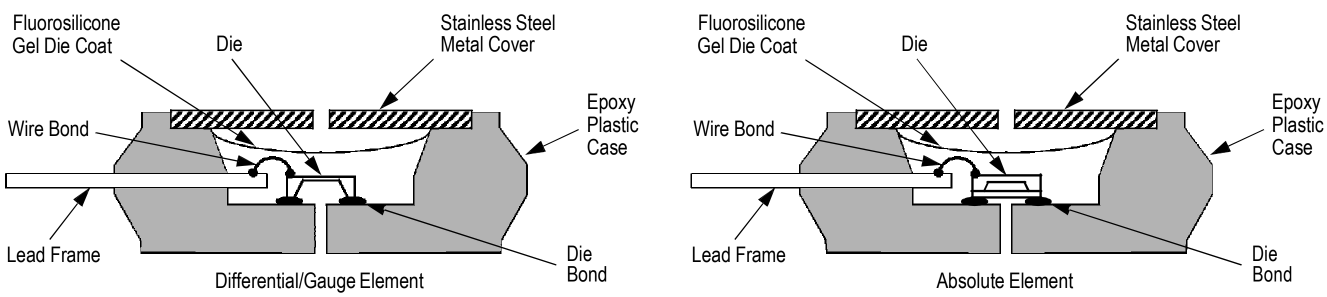


Figure 6. Cross-sectional diagrams (not-to-scale)

Figure 7 shows the recommended decoupling circuit for interfacing the output of the integrated sensor to the A/D input of a microprocessor or microcontroller. Proper decoupling of the power supply is recommended.

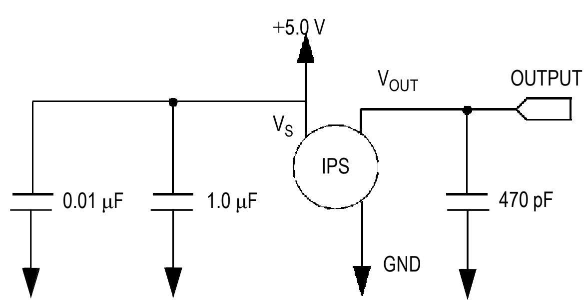


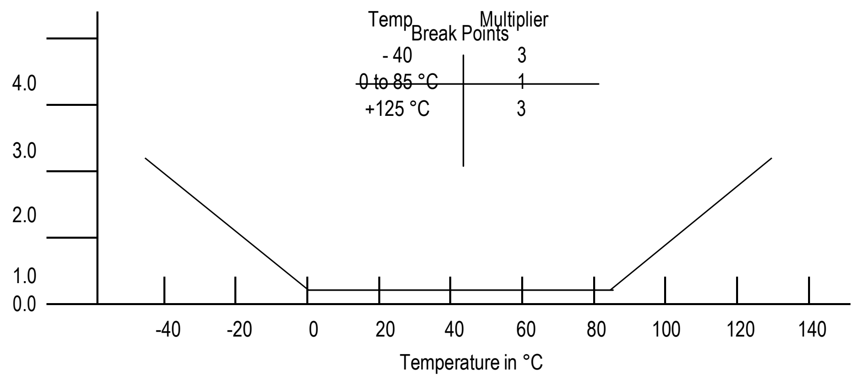
Figure 7. Recommended power supply decoupling and output filtering

(For additional output filtering, please refer to application note AN1646.)

The following figures show the nominal transfer function, temperature and pressure error over the operating range for the MPX5100D,MPX5100G and MPXV5100G devices.

Nominal Transfer Value: $V_{OUT} = V_S (P \times 0.009 + 0.04)$
$\pm$ (Pressure Error x Temp. Mult. x $0.009 \times V_S$)
$V_S = 5.0\ V \pm 0.25\ V$

Figure 8. Transfer function (MPX5100D, MPX5100G, MPXV5100G)



Note: The Temperature Multiplier is a linear response from 0 to -40 °C and from 85 to 125 °C.

Figure 9. Temperature error multiplier (MPX5100D, MPX5100G, MPXV5100G)

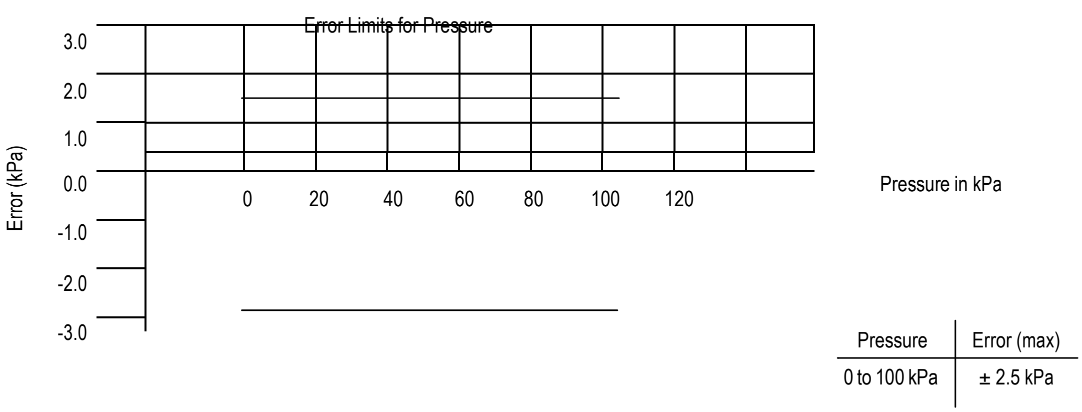
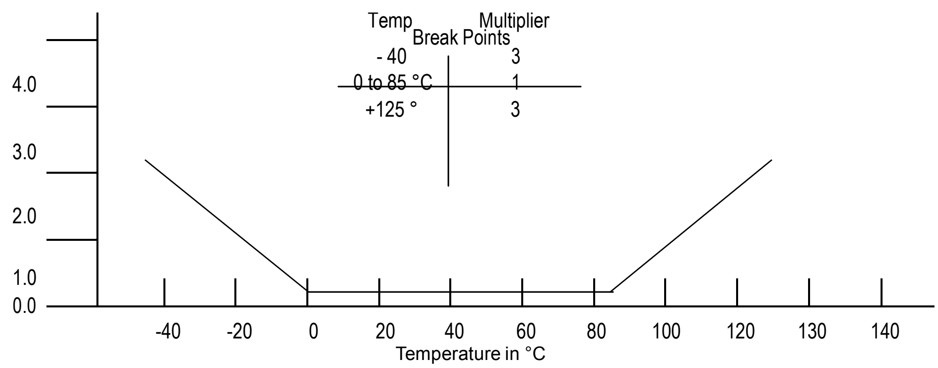


Figure 10. Pressure error band (MPX5100D, MPX5100G, MPXV5100G)

The following figures show the nominal transfer function, temperature and pressure error over the operating range for the MPX5100AP device.

Nominal Transfer Value: $V_{OUT} = V_S\ (P \times 0.009 - 0.095)$
$\pm$ (Pressure Error x Temp. Mult. x 0.009 x V_S)
$V_S = 5.0\ V \pm 0.25\ V$

Figure 11. Transfer function (MPX5100AP)



Note: The Temperature Multiplier is a linear response from 0 to -40 °C and from 85 to 125 °C.

Figure 12. Temperature error multiplier (MPX5100AP)

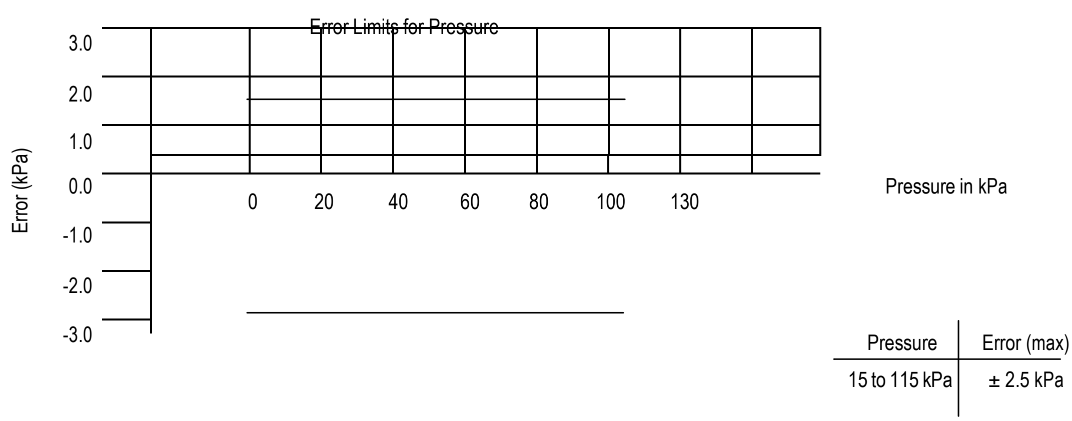


Figure 13. Pressure error band (MPX5100AP)

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4 Package Information

4.1 Pressure (P1)/Gauge (P2) side identification table

NXP designates the two sides of the pressure sensor as the Pressure (P1) side and the Gauge (P2) side. The Pressure (P1) side is the side containing fluoro-silicone gel which protects the die from harsh media. The MPX pressure sensor is designed to operate with positive differential pressure applied, P1 > P2.

The Pressure (P1) side may be identified by using the table below.

Part number	Package	Pressure (P1) side identifier
MPX5100AP, MPX5100GP	98ASB42796B	Side with port attached
MPX5100DP	98ASB42797B	Side with part marking
MPXV5100DP	98ASA99255D	Side with part marking
MPXV5100GC6U	98ASB17757C	Side with port attached
MPXV5100GC7U	98ASB17759C	Side with port attached
MPXV5100GP	98ASA99303D	Side with port attached

4.2 Minimum recommended footprint for surface mounted applications

Surface mount board layout is a critical portion of the total design. The footprint for the surface mount packages must be the correct size to ensure proper solder connection interface between the board and the package. With the correct footprint, the packages will self align when subjected to a solder reflow process. It is always recommended to design boards with a solder mask layer to avoid bridging and shorting between solder

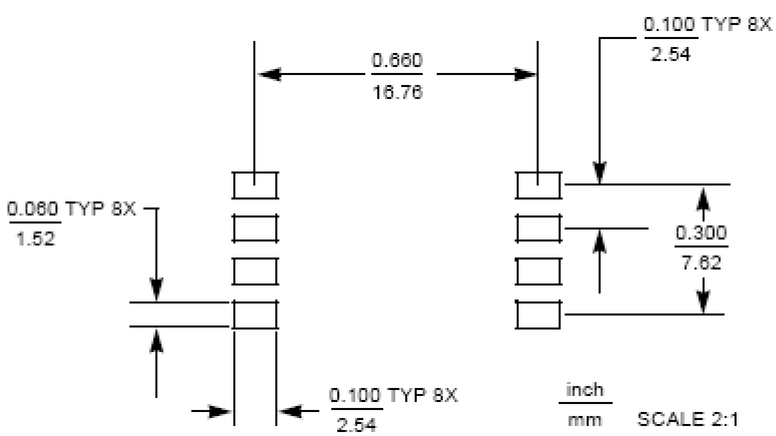

Figure 14. Small outline package footprint

4.3 Package dimensions

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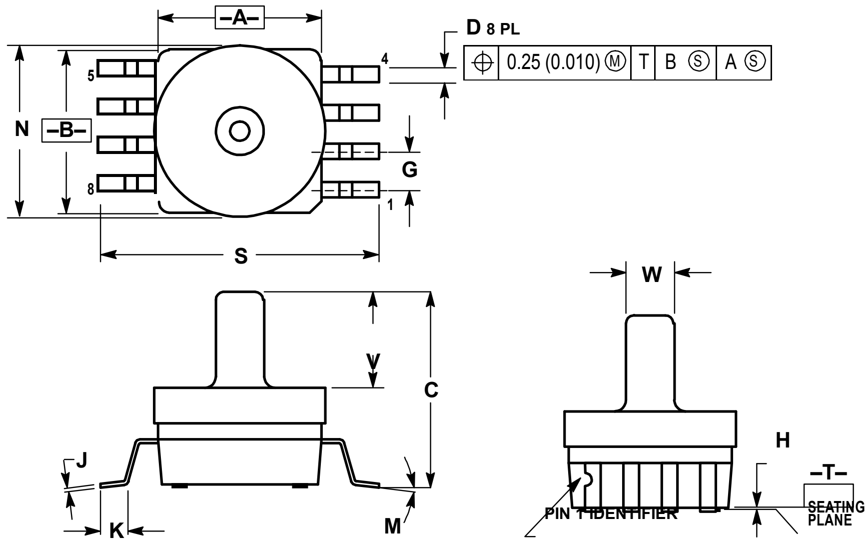

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
5. ALL VERTICAL SURFACES 5 TYPICAL DRAFT.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.415	0.425	10.54	10.79
B	0.415	0.425	10.54	10.79
C	0.500	0.520	12.70	13.21
D	0.038	0.042	0.96	1.07
G	0.100 BSC		2.54 BSC	
H	0.002	0.010	0.05	0.25
J	0.009	0.011	0.23	0.28
K	0.061	0.071	1.55	1.80
M	0	7	0	7
N	0.444	0.448	11.28	11.38
S	0.709	0.725	18.01	18.41
V	0.245	0.255	6.22	6.48
W	0.115	0.125	2.92	3.17

Case 98ASB17757C, 8-lead small outline package

This drawing is located at http://cache.NXP.com/files/shared/doc/package_info/98ASB17759C.pdf.

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		PAGE 482C	
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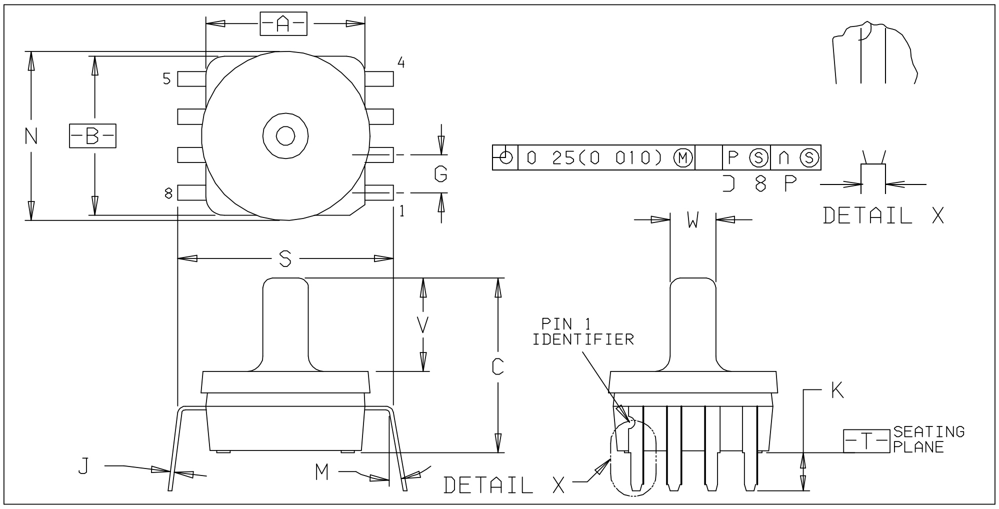

DIM	MILLIMCICPS MIN	MAX	INCIICS MIN	MAX
Ո	10 5	10 79	0 15	0 25
P	10 5	10 79	0 15	0 25
C	12 70	13 21	0 500	0 520
D	0 66	0 86	0 026	0 03
G	2 5	PSC	0 100	PSC
J	0 23	0 28	0 009	011
I	2 5	3 05	0 100	0 120
M	0	15	0	15
N	11 28	11 38	0	0 8
S	13 72	1 22	0 5 0	0 560
V	6 22	6 8	0 2 5	0 255
W	2 92	3 17	11	125

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION 'A' AND 'B' DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15(0.006).
5. ALL VERTICAL SURFACES - TYPICAL -
6. DIMENSION ' TO OF LEAD WHEN FORMED
7. 482C-01 -02 OBSOLETE. STANDARD

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Case 98ASB17759C, 8-lead small outline package

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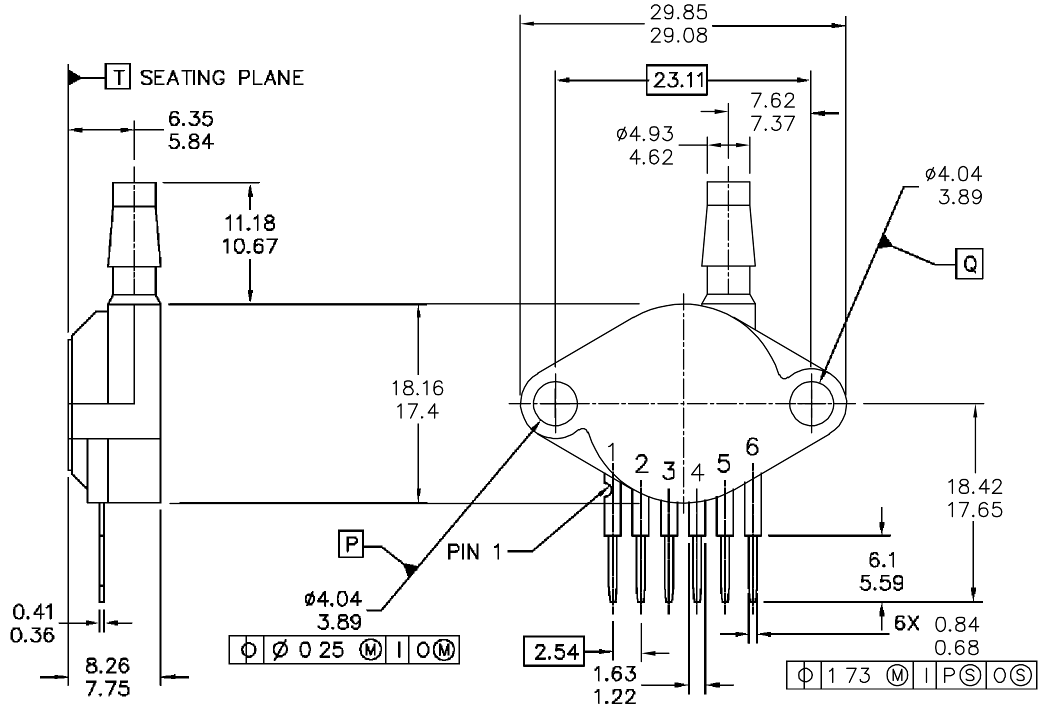

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TITLE: SENSOR, 6 LEAD UNIBODY CELL, AP & GP 01ASB09087B	DOCUMENT NO: 98ASB42796B		REV: G
	CASE NUMBER: 867B-04		28 JUL 2005
	STANDARD: NON-JEDEC		

Case 98ASB42796B, 6-lead unibody package

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NOTES:

1. DIMENSIONS ARE IN MILLIMETERS.

2. DIMENSIONS AND TOLERANCES PER ASME Y14.5M−1994.

3. 867B−01 THRU −3 OBSOLETE, NEW STANDARD 867B−04.

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TITLE: SENSOR, 6 LEAD UNIBODY CELL, AP & GP 01ASB09087B	DOCUMENT NO: 98ASB42796B		REV: G
	CASE NUMBER: 867B−04		28 JUL 2005
	STANDARD: NON−JEDEC		

Case 98ASB42796B, 6-lead unibody package

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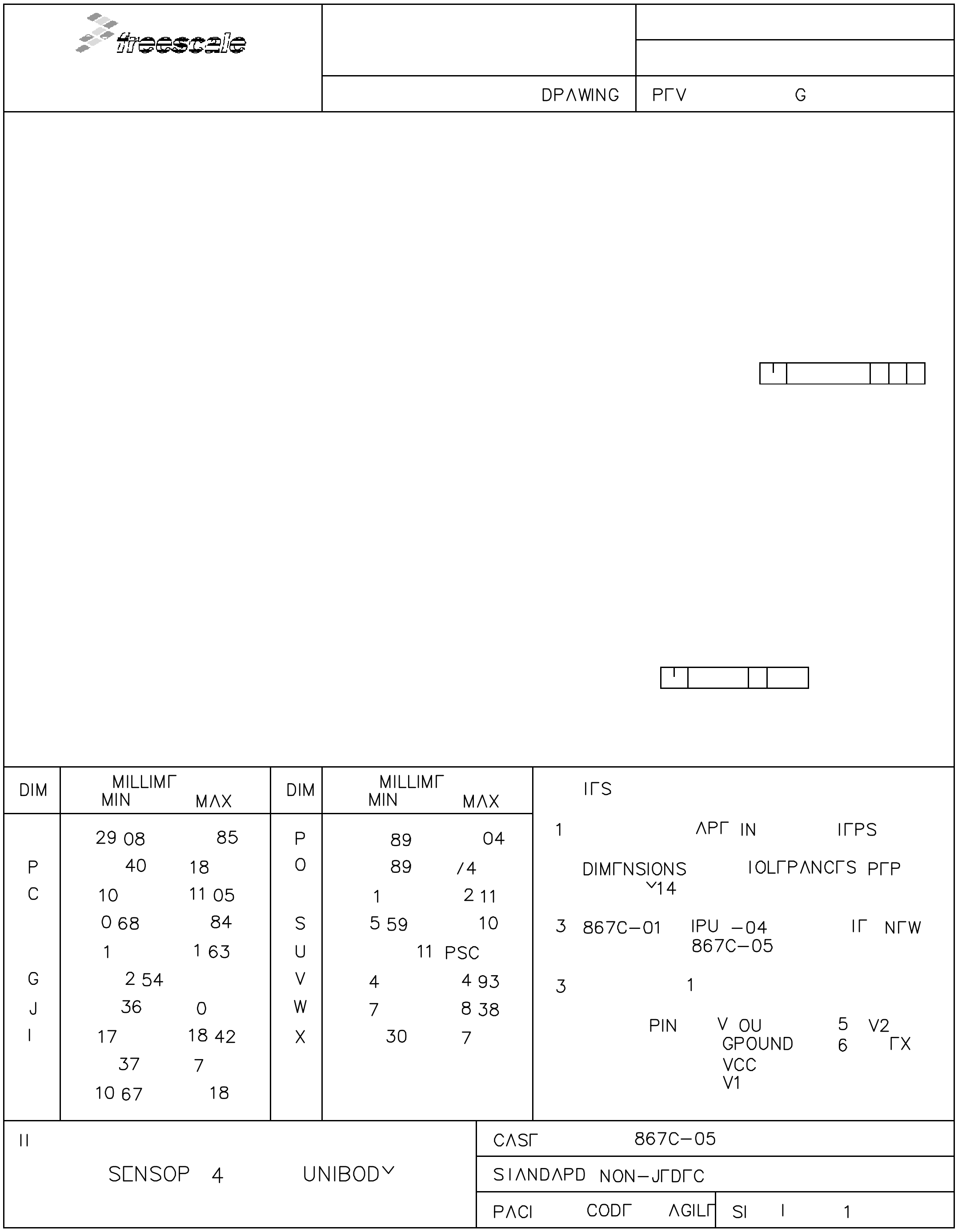
This drawing is located at http://cache.NXP.com/files/shared/doc/package_info/98ASB42797B.pdf.



Case 98ASB42797B, 6-lead unibody package

ΛSMΓ

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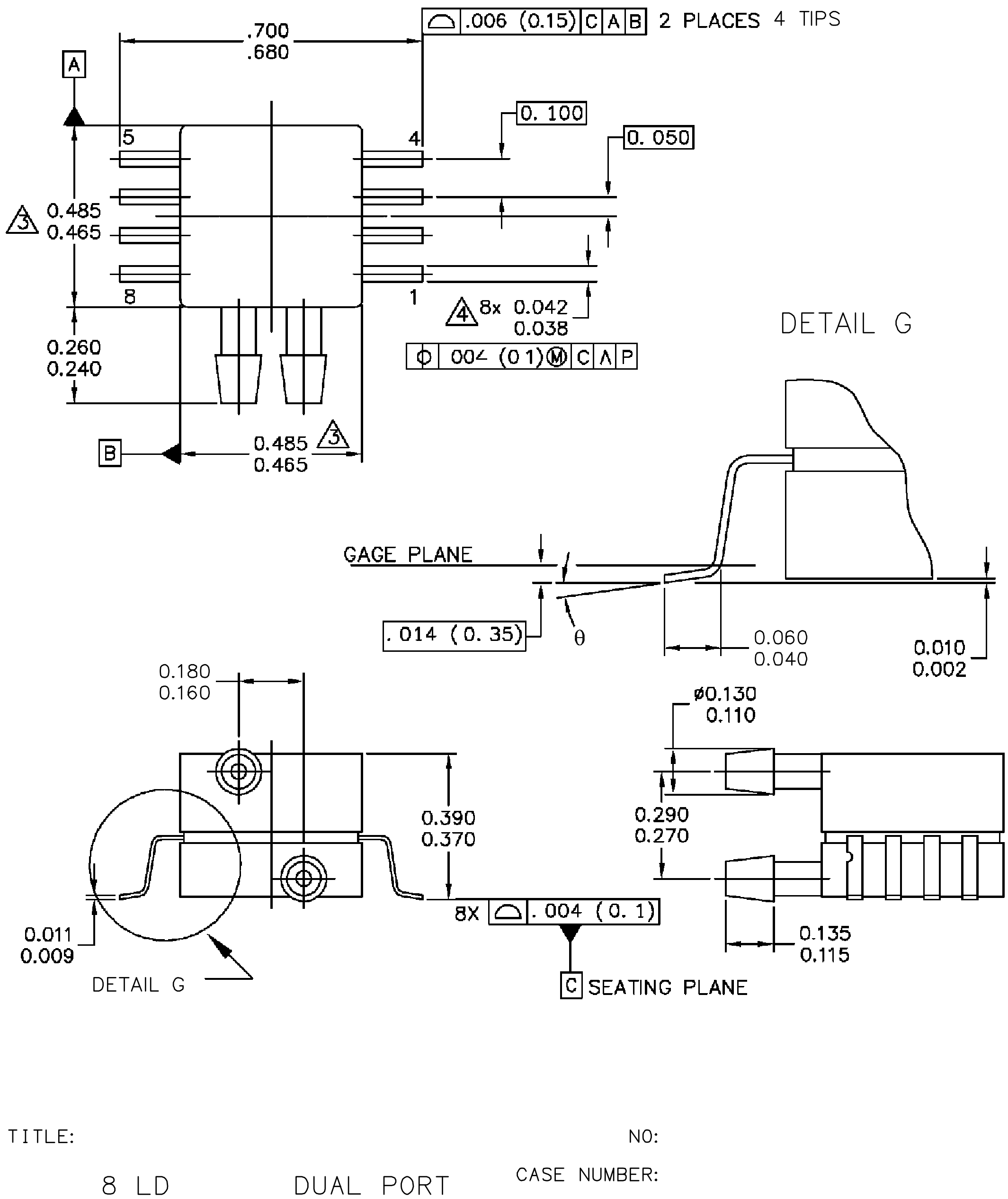
This drawing is located at http://cache.NXP.com/files/shared/doc/package_info/98ASA99255D.pdf.



Case 98ASA99255D, 8-lead, dual port, small outline package

SNSR,

NOTES:

1. CONTROLLING DIMENSION: INCH

2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.

3. (△) DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PPROTRUSIONS. MOLD FLASH AND PROTRUSIONS SHALL NOT EXCEED .006 PER SIDE.

4. (△) DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 MAXIMUM.

	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE
TITLE: 8 LD SNSR, DUAL PORT	DOCUMENT NO: 98ASA99255D	REV: A
	CASE NUMBER: 1351–01	27 JUL 2005
	STANDARD: NON–JEDEC	

Case 98ASA99255D, 8-lead, dual port, small outline package

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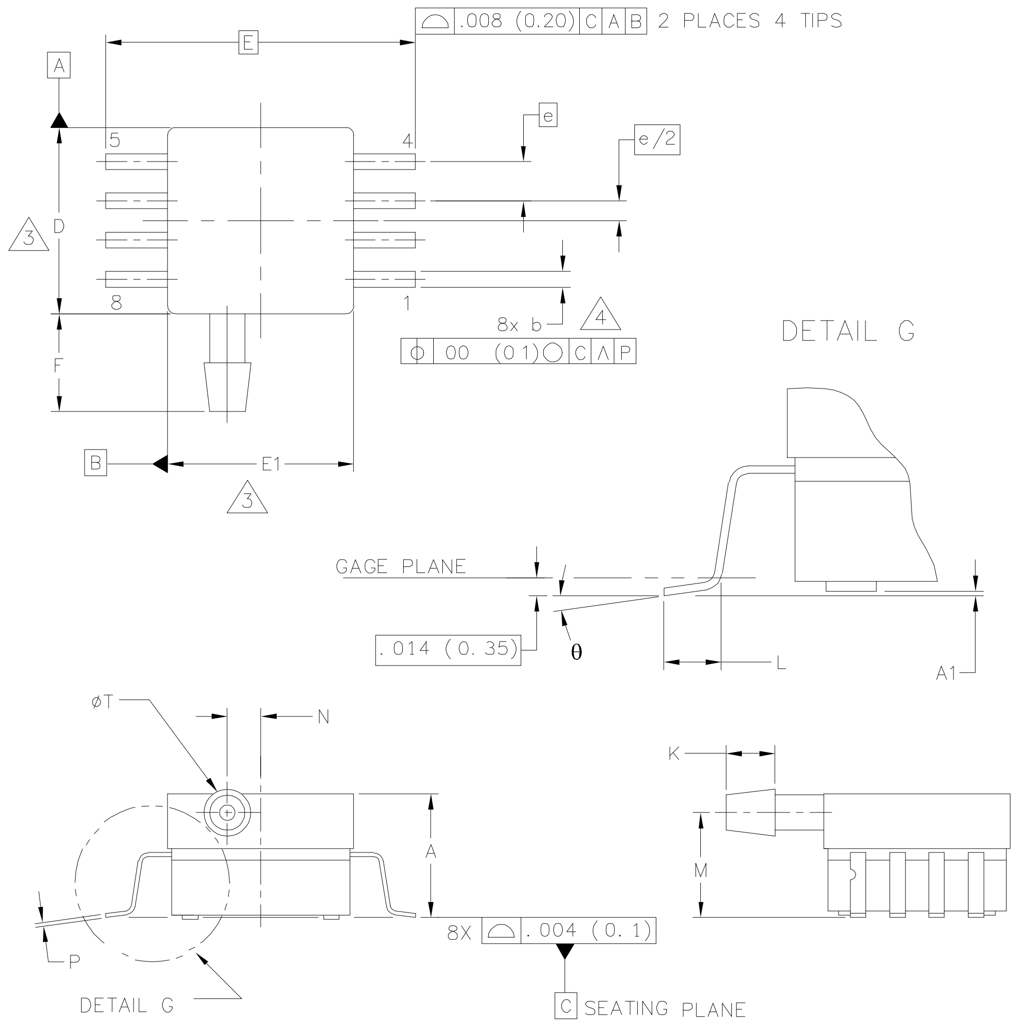
NXP Semiconductors, B.V.
25

This drawing is located at http://cache.NXP.com/files/shared/doc/package_info/98ASA99303D.pdf.



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TITLE: 8 LD SOP, SIDE PORT	DOCUMENT NO: 98ASA99303D	REV: D
	CASE NUMBER: 1369-01	13 DEC 2010
	STANDARD: NON-JEDEC	

PAGE 1 OF 2

Case 98ASA99303D, 8-lead, side port, small outline package

Sensors
NXP Semiconductors, B.V. 27

NOTES:

1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M—1994.
3. DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH AND PROTRUSIONS SHALL NOT EXCEED .006 (0.152) PER SIDE.
4. DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 (0.203) MAXIMUM.

	INCHES		MILLIMETERS			INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX	DIM	MIN	MAX	MIN	MAX
A	.300	.330	7.62	8.38	θ	0°	7°	0°	7°
A1	.002	.010	0.05	0.25	–	---	---	---	---
b	.038	.042	0.96	1.07	–	---	---	---	---
D	.465	.485	11.81	12.32	–	---	---	---	---
E	.717 BSC		18.21 BSC		–	---	---	---	---
E1	.465	.485	11.81	12.32	–	---	---	---	---
e	.100 BSC		2.54 BSC		–	---	---	---	---
F	.245	.255	6.22	6.47	–	---	---	---	---
K	.120	.130	3.05	3.30	–	---	---	---	---
L	.061	.071	1.55	1.80	–	---	---	---	---
M	.270	.290	6.86	7.36	–	---	---	---	---
N	.080	.090	2.03	2.28	–	---	---	---	---
P	.009	.011	0.23	0.28	–	---	---	---	---
T	.115	.125	2.92	3.17	–	---	---	---	---

	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE
TITLE: 8 LD SOP, SIDE PORT	DOCUMENT NO: 98ASA99303D	REV: D
	CASE NUMBER: 1369–01	13 DEC 2010
	STANDARD: NON–JEDEC	

Case 98ASA99303D, 8-lead, side port, small outline package

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NXP Semiconductors, B.V. 29

5 Revision History

Table 5. Revision history

Revision number	Revision date	Description of changes
14	12/2018	• Deleted obsolete part numbers MPX5100A and MPX5100D. • Changed format to new corporate format. • Added pinout for MPX5100AP/DP/GP in Figure 2. • Added pin functions for MPX5100AP/DP/GP as Table 1. • Added pinout for MPXV5100DP/GC6U/GC7U/GP as Figure 4. • Added pin functions for MPXV5100DP/GC6U/GC7U/GP as Table 2. • Moved section 5.1, Package dimensions to Section 4.3. • Deleted section 5, duplicate Package Information information section. • Added revision history as Table 5.

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How to Reach Us:

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Document Number: MPX5100
Rev. 14
12/2018

Low power quad op amps

LM124/224/324/324A/ SA534/LM2902

DESCRIPTION

The LM124/SA534/LM2902 series consists of four independent, high-gain, internally frequency-compensated operational amplifiers designed specifically to operate from a single power supply over a wide range of voltages.

UNIQUE FEATURES

In the linear mode, the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.

The unity gain crossover frequency and the input bias current are temperature-compensated.

FEATURES

- Internally frequency-compensated for unity gain
- Large DC voltage gain: 100dB
- Wide bandwidth (unity gain): 1MHz (temperature-compensated)
- Wide power supply range Single supply: $3V_{DC}$ to $30V_{DC}$ or dual supplies: $1.5V_{DC}$ to $15V_{DC}$
- Very low supply current drain: essentially independent of supply voltage (1mW/op amp at $+5V_{DC}$)
- Low input biasing current: $45nA_{DC}$ (temperature-compensated)
- Low input offset voltage: $2mV_{DC}$ and offset current: $5nA_{DC}$
- Differential input voltage range equal to the power supply voltage
- Large output voltage: $0V_{DC}$ to V_{CC}-$1.5V_{DC}$ swing

PIN CONFIGURATION

D, F, N Packages

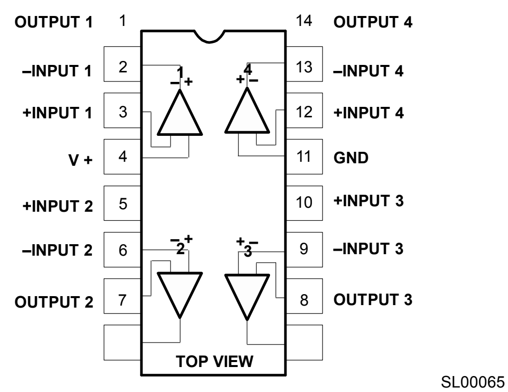

Figure 1. Pin Configuration

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
14-Pin Plastic Dual In-Line Package (DIP)	-55C to +125C	LM124N	SOT27-1
14-Pin Ceramic Dual In-Line Package (CERDIP)	-55C to +125C	LM124F	0581B
14-Pin Plastic Dual In-Line Package (DIP)	-25C to +85C	LM224N	SOT27-1
14-Pin Ceramic Dual In-Line Package (CERDIP)	-25C to +85C	LM224F	0581B
14-Pin Plastic Small Outline (SO) Package	-25C to +85C	LM224D	SOT108-1
14-Pin Plastic Dual In-Line Package (DIP)	0C to +70C	LM324N	SOT27-1
14-Pin Ceramic Dual In-Line Package (CERDIP)	0C to +70C	LM324F	0581B
14-Pin Plastic Small Outline (SO) Package	0C to +70C	LM324D	SOT108-1
14-Pin Plastic Dual In-Line Package (DIP)	0C to +70C	LM324AN	SOT27-1
14-Pin Plastic Small Outline (SO) Package	0C to +70C	LM324AD	SOT108-1
14-Pin Plastic Dual In-Line Package (DIP)	-40C to +85C	SA534N	SOT27-1
14-Pin Ceramic Dual In-Line Package (CERDIP)	-40C to +85C	SA534F	0581B
14-Pin Plastic Small Outline (SO) Package	-40C to +85C	SA534D	SOT108-1
14-Pin Plastic Small Outline (SO) Package	-40C to +125C	LM2902D	SOT108-1
14-Pin Plastic Dual In-Line Package (DIP)	-40C to +125C	LM2902N	SOT27-1

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_{CC}	Supply voltage	32 or 16	V_{DC}
V_{IN}	Differential input voltage	32	V_{DC}
V_{IN}	Input voltage	-0.3 to +32	V_{DC}
P_D	Maximum power dissipation, T_A=25C (still-air)[1]		
	N package	1420	mW
	F package	1190	mW
	D package	1040	mW
	Output short-circuit to GND one amplifier[2] V_{CC}<15V_{DC} and T_A=25C	Continuous	
I_{IN}	Input current (V_{IN}<-0.3V)[3]	50	mA
T_A	Operating ambient temperature range		
	LM324/A	0 to +70	C
	LM224	-25 to +85	C
	SA534	-40 to +85	C
	LM2902	-40 to +125	C
	LM124	-55 to +125	C
T_{STG}	Storage temperature range	-65 to +150	C
T_{SOLD}	Lead soldering temperature (10sec max)	300	C

NOTES:

1. Derate above 25C at the following rates:
   F package at 9.5mW/C
   N package at 11.4mW/C
   D package at 8.3mW/C
2. Short-circuits from the output to V_{CC}+ can cause excessive heating and eventual destruction. The maximum output current is approximately 40mA, independent of the magnitude of V_{CC}. At values of supply voltage in excess of +15V_{DC} continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction.
3. This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistors becoming forward biased and thereby acting as input bias clamps. In addition, there is also lateral NPN parasitic transistor action on the IC chip. This action can cause the output voltages of the op amps to go to the V+ rail (or to ground for a large overdrive) during the time that the input is driven negative.

DC ELECTRICAL CHARACTERISTICS

V_{CC}=5V, T_A=25C unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM124/LM224			LM324/SA534/LM2902			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Offset voltage[1]	R_S=0		2	5		2	7	mV
		R_S=0 , over temp.			7			9	
V_{OS}/ T	Temperature drift	R_S=0 , over temp.		7			7		V/C
I_{BIAS}	Input current[2]	I_{IN}(+) or I_{IN}(-)		45	150		45	250	nA
		I_{IN}(+) or I_{IN}(-), over temp.		40	300		40	500	
I_{BIAS}/ T	Temperature drift	Over temp.		50			50		pA/C
I_{OS}	Offset current	I_{IN}(+)-I_{IN}(-)		3	30		5	50	nA
		I_{IN}(+)-I_{IN}(-), over temp.			100			150	
I_{OS}/ T	Temperature drift	Over temp.		10			10		pA/C
V_{CM}	Common-mode voltage range[3]	V_{CC}30V	0		V_{CC}-1.5	0		V_{CC}-1.5	V
		V_{CC}30V, over temp.	0		V_{CC}-2	0		V_{CC}-2	
CMRR	Common-mode rejection ratio	V_{CC}=30V	70	85		65	70		dB
V_{OUT}	Output voltage swing	R_L=2k , V_{CC}=30V, over temp.	26			26			V
V_{OH}	Output voltage high	R_L10k , V_{CC}=30V, over temp.	27	28		27	28		V
V_{OL}	Output voltage low	R_L10k , over temp.		5	20		5	20	mV
I_{CC}	Supply current	R_L=, V_{CC}=30V, over temp.		1.5	3		1.5	3	mA
		R_L =, over temp.		0.7	1.2		0.7	1.2	
A_{VOL}	Large-signal voltage gain	V_{CC}=15V (for large V_O swing), R_L2k	50	100		25	100		V/mV
		V_{CC}=15V (for large V_O swing), R_L2k , over temp.	25			15			
	Amplifier-to-amplifier coupling[5]	f=1kHz to 20kHz, input referred		-120			-120		dB
PSRR	Power supply rejection ratio	R_S0	65	100		65	100		dB
I_{OUT}	Output current source	V_{IN}+=+1V, V_{IN}-=0V, V_{CC}=15V	20	40		20	40		mA
		V_{IN}+=+1V, V_{IN}-=0V, V_{CC}=15V, over temp.	10	20		10	20		mA
	Output current sink	V_{IN}-=+1V, V_{IN}+=0V, V_{CC}=15V	10	20		10	20		mA
		V_{IN}-=+1V, V_{IN}+=0V, V_{CC}=15V, over temp.	5	8		5	8		mA
		V_{IN}-=+1V, V_{IN}+=0V, V_O=200mV	12	50		12	50		A
I_{SC}	Short-circuit current[4]		10	40	60	10	40	60	mA
GBW	Unity gain bandwidth			1			1		MHz
SR	Slew rate			0.3			0.3		V/ s
V_{NOISE}	Input noise voltage	f=1kHz		40			40		nV/Hz
V_{DIFF}	Differential input voltage[3]				V_{CC}			V_{CC}	V

DC ELECTRICAL CHARACTERISTICS (Continued)

V_{CC}=5V, T_A=25C unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM324A			UNIT
			Min	Typ	Max	
V_{OS}	Offset voltage[1]	R_S=0		2	3	mV
		R_S=0 , over temp.			5	
V_{OS}/ T	Temperature drift	R_S=0 , over temp.		7	30	V/C
I_{BIAS}	Input current[2]	I_{IN}(+) or I_{IN}(-)		45	100	nA
		I_{IN}(+) or I_{IN}(-), over temp.		40	200	
I_{BIAS}/ T	Temperature drift	Over temp.		50		pA/C
I_{OS}	Offset current	I_{IN}(+)-I_{IN}(-)		5	30	nA
		I_{IN}(+)-I_{IN}(-), over temp.			75	
I_{OS}/ T	Temperature drift	Over temp.		10	300	pA/C
V_{CM}	Common-mode voltage range[3]	V_{CC}30V	0		V_{CC}-1.5	V
		V_{CC}30V, over temp.	0		V_{CC}-2	V
CMRR	Common-mode rejection ratio	V_{CC}=30V	65	85		dB
V_{OUT}	Output voltage swing	R_L=2k , V_{CC}=30V, over temp.	26			V
V_{OH}	Output voltage high	R_L10k , V_{CC}=30V, over temp.	27	28		V
V_{OL}	Output voltage low	R_L10k , over temp.		5	20	mV
I_{CC}	Supply current	R_L=, V_{CC}=30V, over temp.		1.5	3	mA
		R_L=, over temp.		0.7	1.2	mA
A_{VOL}	Large-signal voltage gain	V_{CC}=15V (for large V_O swing), R_L2k	25	100		V/mV
		V_{CC}=15V (for large V_O swing), R_L2k , over temp.	15			V/mV
	Amplifier-to-amplifier coupling[5]	f=1kHz to 20kHz, input referred		-120		dB
PSRR	Power supply rejection ratio	R_S0	65	100		dB
I_{OUT}	Output current source	V_{IN}+=+1V, V_{IN}-=0V, V_{CC}=15V	20	40		mA
		V_{IN}+=+1V, V_{IN}-=0V, V_{CC}=15V, over temp.	10	20		mA
	Output current sink	V_{IN}-=+1V, V_{IN}+=0V, V_{CC}=15V	10	20		mA
		V_{IN}-=+1V, V_{IN}+=0V, V_{CC}=15V, over temp.	5	8		mA
		V_{IN}-=+1V, V_{IN}+=0V, V_O=200mV	12	50		A
I_{SC}	Short-circuit current[4]		10	40	60	mA
V_{DIFF}	Differential input voltage[3]				V_{CC}	V
GBW	Unity gain bandwidth			1		MHz
SR	Slew rate			0.3		V/ s
V_{NOISE}	Input noise voltage	f=1kHz		40		nV/Hz

NOTES:
1. V_O 1.4V_{DC}, R_S=0 with V_{CC} from 5V to 30V and over full input common-mode range (0V_{DC}+ to V_{CC} -1.5V).
2. The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.
3. The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is V_{CC} -1.5, but either or both inputs can go to +32V without damage.
4. Short-circuits from the output to V_{CC} can cause excessive heating and eventual destruction. The maximum output current is approximately 40mA independent of the magnitude of V_{CC}. At values of supply voltage in excess of +15V_{DC}, continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers.
5. Due to proximity of external components, insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of coupling increases at higher frequencies.

EQUIVALENT CIRCUIT

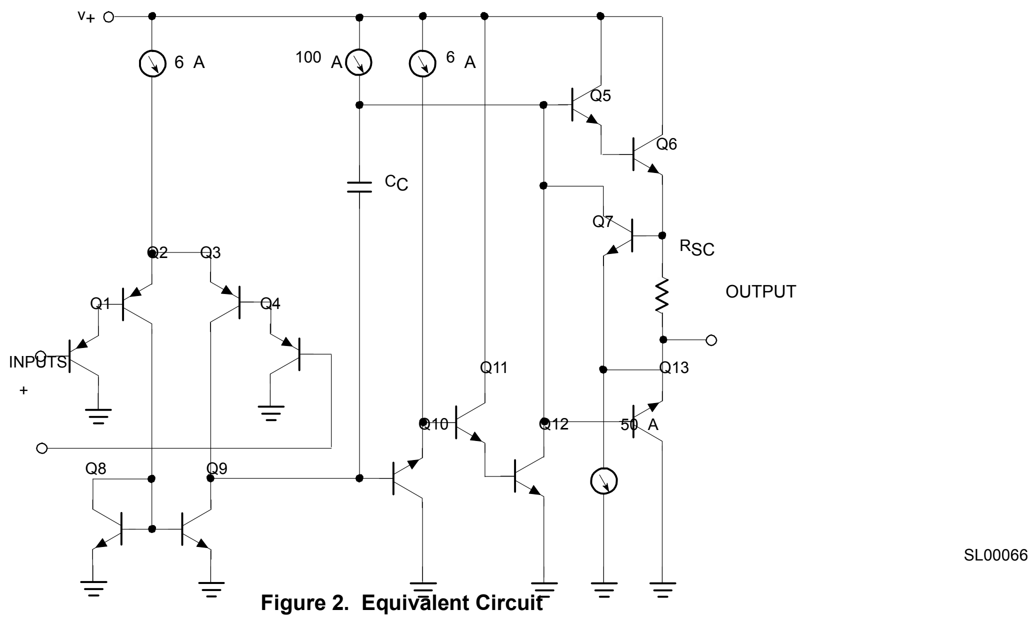

Figure 2. Equivalent Circuit

TYPICAL PERFORMANCE CHARACTERISTICS

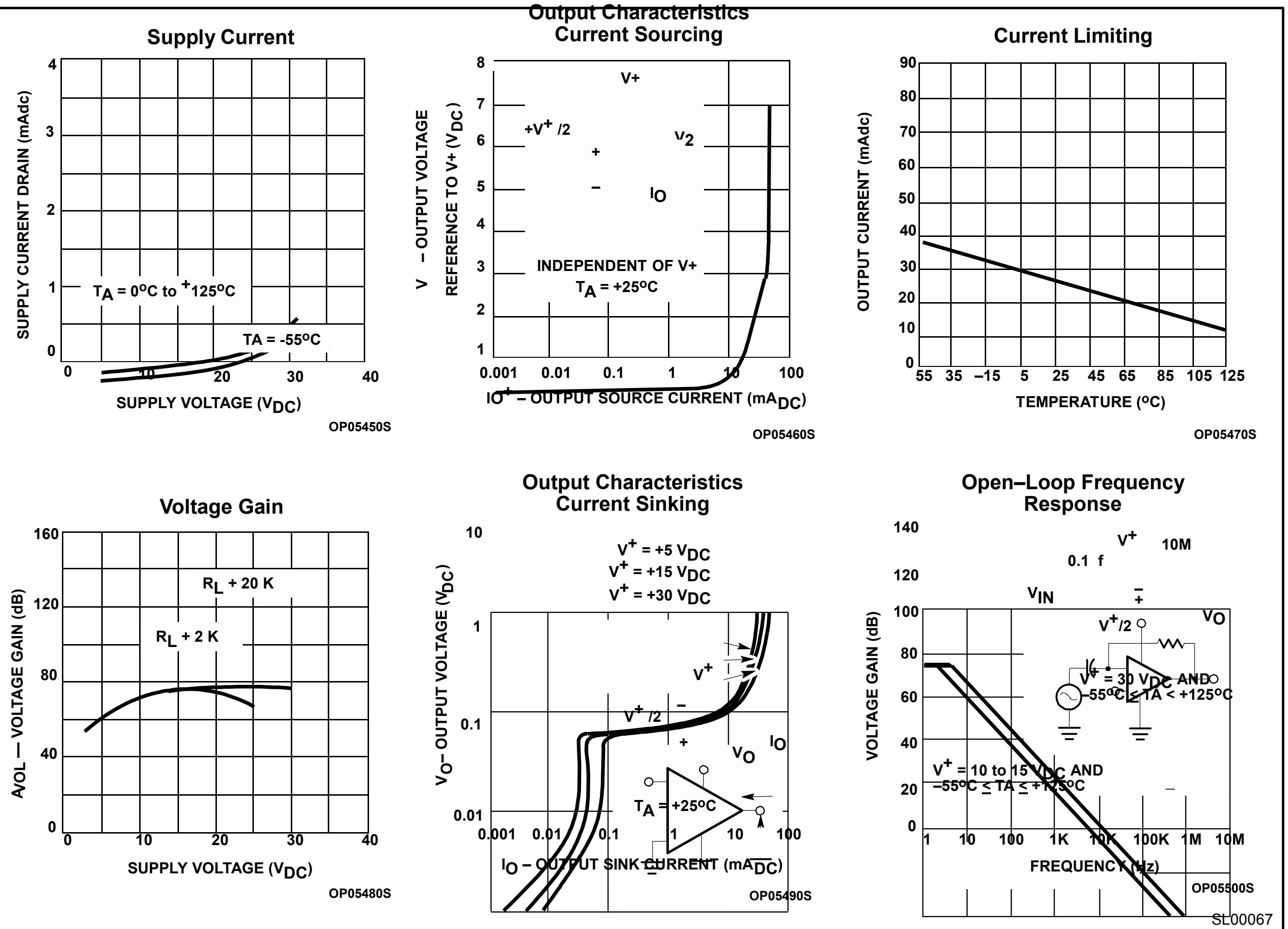

Figure 3. Typical Performance Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

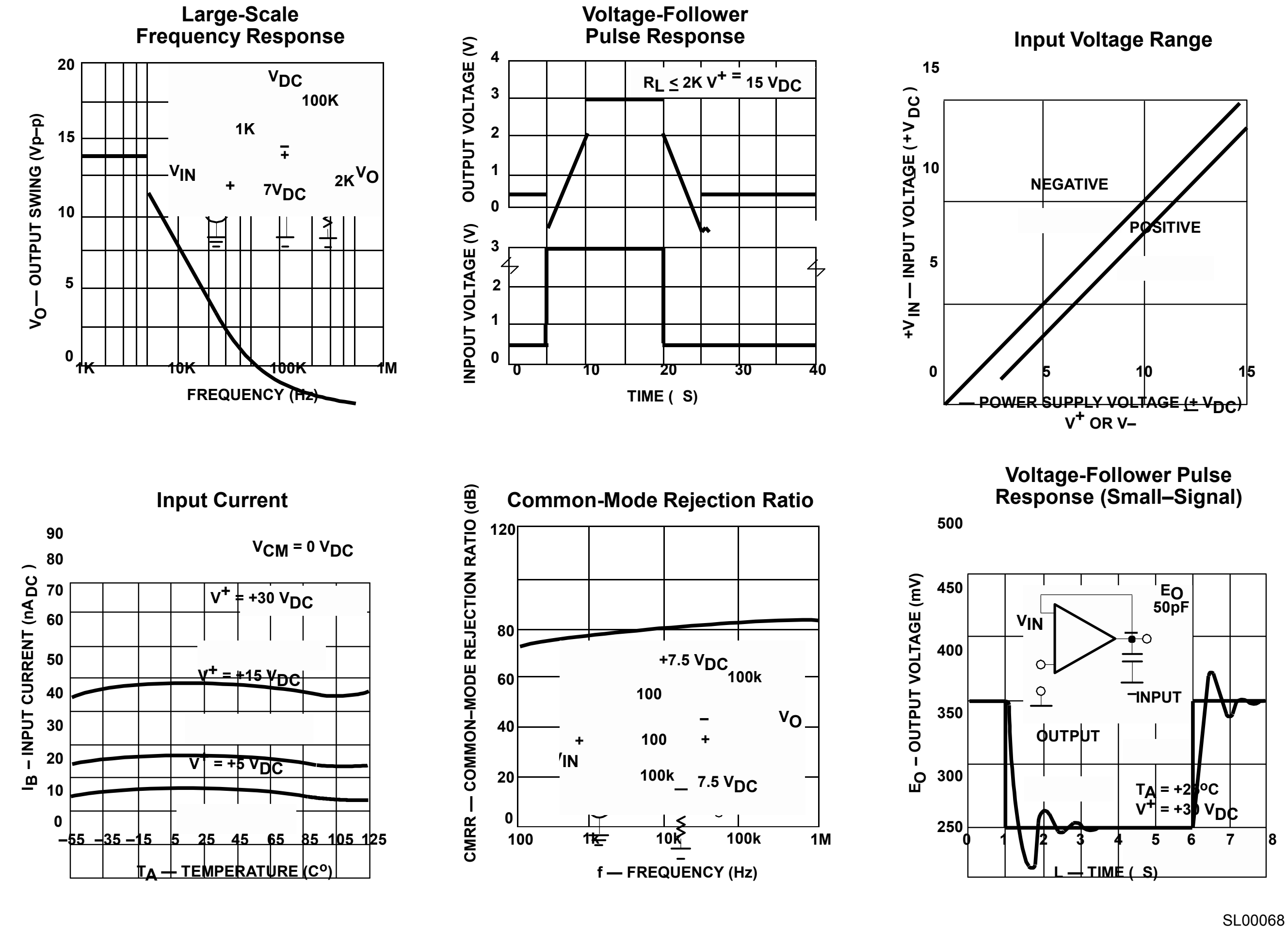

Figure 4. Typical Performance Characteristics (cont.)

TYPICAL APPLICATIONS

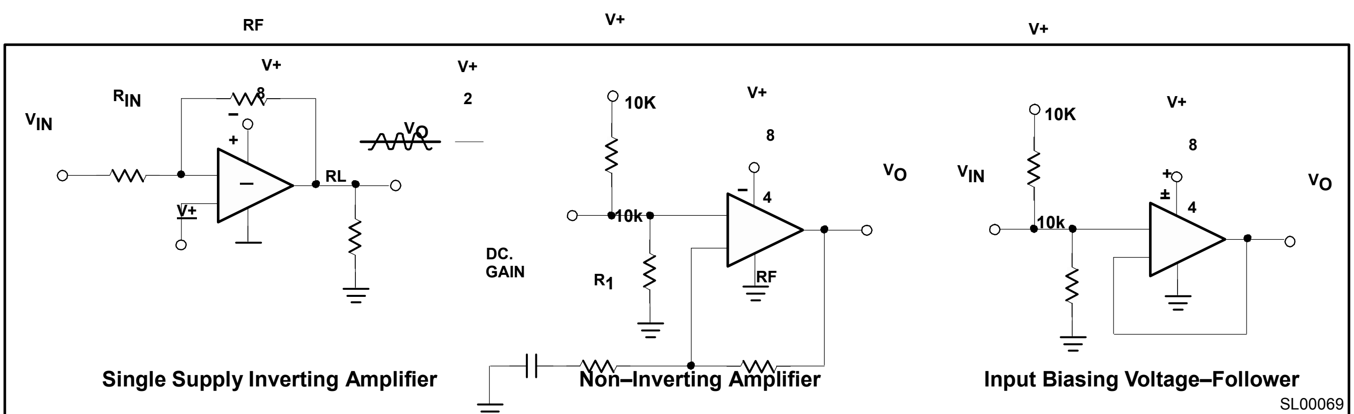

Figure 5. Typical Applications

FORM REVISI TUGAS AKHIR

Nama Mahasiswa : RATNA DINAR PURWANINGRUM

NIM : 163609024

Fakultas / Progdi : Fakultas Teknologi Industri / S1 Teknik Elektro

Judul Tugas Akhir : Kalibrator Tensimeter Dilengkapi Dengan Pengolahan Data Otomatis

Ujian Tanggal : 06 Juli 2019

No Bab.	Tanggal	Materi Konsultasi	Keterangan Catatan	Tanda Tangan Penguji
I	15 Juli 2019	Penambahan tentang kelebihan dan kekurangan dari modul	Acc	
II	15 Juli 2019	Pada saran ditambahkan tentang kekurangan modul untuk dikembangkan		
III	15 Juli 2019	Pembetulan penulisan pada ABSTRAK		
IV	15 Juli 2019	Pembetulan penulisan nomor urutan pada kesimpulan 3 saran		
V		Penambahan lampiran-lampiran yang sesuai	Acc	

Disetujui Dosen Penguji
Pada Tanggal,..15 Juli 2019......

Penguji I,

(Atmiasri , ST, MT)

Penguji II,

(Ir. Rony HPF , MT)

1. a. Penyelesaian Revisi paling lambat 2 minggu dari pelaksanaan Ujian Tugas Akhir.
   b. Pengetikan, penjilidan, penandatangani Tugas Akhir dan mengumpulkan Tugas Akhir paling lambat 2 minggu dari revisi.
2. Apabila sampai batas waktu tersebut (point 1,a dan b) mahasiswa belum menyelesaikan revisi dan tanda tangan, maka **Ujian dinyatakan Gugur**.
3. a. Foto copy Form Revisi diserahkan ke Program Studi.
   b. Tugas Akhir yang sudah direvisi diserahkan ke Fakultas 3 (Tiga) eksemplar untuk dijilid.