Lampiran 1
Gambar Alat Secara Keseluruhan
Lampiran 2
Program Arduino Uno
#include <EEPROM.h>
#include <DHT.h>

//Constants
#define DHTPIN 4
#define DHTTYPE DHT22
//DHT dht(DHTPIN, DHTTYPE);

//Variables
int LDR= A2;
int pirPin = 6;
int redLED= 13;
int greenLED=12;
int nilaiLDR= 0;
int buzzerPin = 11;
int pirState = LOW;
float hum;
float temp;
int MQ2 = A3;
int MQ2Value = 0;
int address = 0;
int startAddress = 60;

void setup() {
  Serial.begin(9600);
  Serial.println("DHT22 Temperature dan Humidity ke EEPROM");
  Serial.print("Data dimulai pada lokasi EEPROM ");
  Serial.println(startAddress);
  pinMode(redLED, OUTPUT);
  pinMode(greenLED, OUTPUT);
  pinMode(buzzerPin, OUTPUT);
  pinMode(LDR, INPUT);
pinMode(pirPin, INPUT);
pinMode (MQ2, INPUT);
dht.begin();
}

void loop()
{
  //SENSOR TEMPERATUR DAN KELEMBABAN (DHT22)
  //hum = dht.readHumidity();
  //temp= dht.readTemperature();
  Serial.print("Humidity: ");
  Serial.print(hum);
  Serial.print(" RH, Temp: ");
  Serial.print(temp);
  Serial.println("C");
  if (temp >= 32){
    tone(buzzerPin, 956, 200);
    delay (500);
    tone(buzzerPin, 956, 200);
    delay (500);
    tone(buzzerPin, 956, 200);
    delay (500);
    tone(buzzerPin, 956, 200);
    delay (500);
    Serial.println ("OVER HEAT");
  }else if (temp <= 28){
    digitalWrite (greenLED, HIGH);
    Serial.println("LOW TEMPERATURE");
  }else if (temp = 29, temp = 31){
    digitalWrite (greenLED, LOW);
    Serial.println (" DO NOTHING! TEMPERATURE IS NORMAL");
  delay(2000);
// SENSOR PERGERAKAN (PASSIVE INFRARED)

Val = digitalRead (pirPin);
if(Val == HIGH) {
    if (pirState == LOW) {
        Serial.println("Motion Detected");
        pirState = HIGH;
        tone(buzzerPin, 956, 200);
        delay (500);
        tone(buzzerPin, 956, 200);
        delay (500);
        tone(buzzerPin, 956, 200);
        delay (500);
        tone(buzzerPin, 956, 200);
        delay (500);
        tone(buzzerPin, 956, 200);
        delay (500);
    }
}
else {
    if (pirState == HIGH){
        noTone(buzzerPin);
        Serial.println("Motion Ended");
        pirState = LOW;                   }
}
delay (2000);

//SENSOR CAHAYA (LDR)
{
    nilaiLDR= analogRead(LDR);
    Serial.print("NilaiLDR= ");
    Serial.println ("Cd");
    Serial.println(nilaiLDR);
    if(nilaiLDR < 500) {
        digitalWrite(redLED, HIGH); }
    else  {

digitalWrite(redLED, LOW);
delay (2000);
}}

// Sensor Asap dan Gas
{
MQ2Value = analogRead (MQ2);
Serial.print ("NilaiMQ2= ");
Serial.println (MQ2Value);
if (MQ2Value >= 300 ) {
tone(buzzerPin, 956, 200);
delay (500);
tone(buzzerPin, 956, 200);
delay (500);
tone(buzzerPin, 956, 200);
delay (500);
tone(buzzerPin, 956, 200);
delay (500);
tone(buzzerPin, 956, 200);
delay (500);
tone(buzzerPin, 956, 200);
delay (500);
tone(buzzerPin, 956, 200);
delay (500);
Serial.println ("Status Asap : YES ");
} else
Serial.println ("Status Asap : NO"); noTone(buzzerPin);
delay (2000); // delay 2 sec
} }
Lampiran 3
Tampilan Hasil Pengujian Alat pada Soket Test
Your specialist in innovating humidity & temperature sensors

Digital-output relative humidity & temperature sensor/module

DHT22 (DHT22 also named as AM2302)

Capacitive-type humidity and temperature module/sensor

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1. Feature & Application:
- Full range temperature compensated
- Relative humidity and temperature measurement
- Calibrated digital signal
- Outstanding long-term stability
- Extra components not needed
- Long transmission distance
- Low power consumption
- 4 pins packaged and fully interchangeable

2. Description:

DHT22 output calibrated digital signal. It utilizes exclusive digital-signal-collecting-technique and humidity sensing technology, assuring its reliability and stability. Its sensing elements is connected with 8-bit single-chip computer.

Every sensor of this model is temperature compensated and calibrated in accurate calibration chamber and the calibration-coefficient is saved in type of programme in OTP memory, when the sensor is detecting, it will cite coefficient from memory.

Small size & low consumption & long transmission distance (20m) enable DHT22 to be suited in all kinds of harsh application occasions.

Single-row packaged with four pins, making the connection very convenient.

3. Technical Specification:

<table>
<thead>
<tr>
<th>Model</th>
<th>DHT22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>3.3-6V DC</td>
</tr>
<tr>
<td>Output signal</td>
<td>digital signal via single-bus</td>
</tr>
<tr>
<td>Sensing element</td>
<td>Polymer capacitor</td>
</tr>
<tr>
<td>Operating range</td>
<td>humidity 0-100%RH; temperature -40~80Celsius</td>
</tr>
<tr>
<td>Accuracy</td>
<td>humidity ±2%RH(Max ±5%RH); temperature ±0.5Celsius</td>
</tr>
<tr>
<td>Resolution or sensitivity</td>
<td>humidity ±0.1%RH; temperature 0.1Celsius</td>
</tr>
<tr>
<td>Repeatability</td>
<td>humidity ±1%RH; temperature ±0.2Celsius</td>
</tr>
<tr>
<td>Humidity hysteresis</td>
<td>±0.3%RH</td>
</tr>
<tr>
<td>Long-term Stability</td>
<td>±0.5%RH/year</td>
</tr>
<tr>
<td>Sensing period</td>
<td>Average: 2s</td>
</tr>
<tr>
<td>Interchangeability</td>
<td>fully interchangeable</td>
</tr>
<tr>
<td>Dimensions</td>
<td>small size 14<em>18</em>5.5mm; big size 22<em>28</em>5mm</td>
</tr>
</tbody>
</table>

4. Dimensions: (unit----mm)

1) Small size dimensions: (unit----mm)

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Pin sequence number:  1 2 3 4 (from left to right direction).

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VDD—power supply</td>
</tr>
<tr>
<td>2</td>
<td>DATA—signal</td>
</tr>
<tr>
<td>3</td>
<td>NULL</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
</tr>
</tbody>
</table>

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5. Electrical connection diagram:

3Pin---NC, AM2302 is another name for DHT22

6. Operating specifications:

(1) Power and Pins
Power's voltage should be 3.3-6V DC. When power is supplied to sensor, don't send any instruction to the sensor within one second to pass unstable status. One capacitor valued 100nF can be added between VDD and GND for wave filtering.

(2) Communication and signal
Single-bus data is used for communication between MCU and DHT22, it costs 5mS for single time communication.

Data is comprised of integral and decimal part, the following is the formula for data.

DHT22 send out higher data bit firstly!
DATA=8 bit integral RH data+8 bit decimal RH data+8 bit integral T data+8 bit decimal T data+8 bit check-sum
If the data transmission is right, check-sum should be the last 8 bit of "8 bit integral RH data+8 bit decimal RH data+8 bit integral T data+8 bit decimal T data".

When MCU send start signal, DHT22 change from low-power-consumption-mode to running-mode. When MCU finishes sending the start signal, DHT22 will send response signal of 40-bit data that reflect the relative humidity

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and temperature information to MCU. Without start signal from MCU, DHT22 will not give response signal to
MCU. One start signal for one time's response data that reflect the relative humidity and temperature information
from DHT22. DHT22 will change to low-power-consumption-mode when data collecting finish if it don't receive
start signal from MCU again.

1) Check bellow picture for overall communication process:

2) Step 1: MCU send out start signal to DHT22

Data-bus's free status is high voltage level. When communication between MCU and DHT22 begin, program of
MCU will transform data-bus's voltage level from high to low level and this process must beyond at least 1ms to
ensure DHT22 could detect MCU's signal, then MCU will wait 20-40us for DHT22's response.

Check bellow picture for step 1:

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Step 2: DHT22 send response signal to MCU

When DHT22 detect the start signal, DHT22 will send out low-voltage-level signal and this signal last 80us as response signal, then program of DHT22 transform data-bus's voltage level from low to high level and last 80us for DHT22's preparation to send data.

Check bellow picture for step 2:
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---

Start transmit 1 bit data

Start transmit next bit data

26-28us voltage-length means data "0"

---

Step 3: DHT22 send data to MCU

When DHT22 is sending data to MCU, every bit's transmission begin with low-voltage-level that last 50us, the following high-voltage-level signal's length decide the bit is "1" or "0".

Check below picture for step 3:

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---
70us voltage-length means 1bit data "1"

Start transmit 1bit data

Start transmit next bit data

If signal from DHT22 is always high-voltage-level, it means DHT22 is not working properly, please check the electrical connection status.

7. Electrical Characteristics:

<table>
<thead>
<tr>
<th>Item</th>
<th>Condition</th>
<th>Min</th>
<th>Typical</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>DC</td>
<td>3.3</td>
<td>5</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>Current supply</td>
<td>Measuring</td>
<td>1</td>
<td>1.5</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>Stand-by</td>
<td>40</td>
<td>Null</td>
<td>50</td>
<td>uA</td>
</tr>
<tr>
<td>Collecting period</td>
<td>Second</td>
<td></td>
<td>2</td>
<td></td>
<td>Second</td>
</tr>
</tbody>
</table>

*Collecting period should be: >2 second.

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8. Attentions of application:

(1) Operating and storage conditions
   We don't recommend the applying RH-range beyond the range stated in this specification. The DHT22 sensor can recover after working in non-normal operating condition to calibrated status, but will accelerate sensors' aging.

(2) Attentions to chemical materials
   Vapor from chemical materials may interfere DHT22's sensitive-elements and debase DHT22's sensitivity.

(3) Disposal when (1) & (2) happens
   Step one: Keep the DHT22 sensor at condition of Temperature 50~60Celsius, humidity <10%RH for 2 hours;
   Step two: After step one, keep the DHT22 sensor at condition of Temperature 20~30Celsius, humidity >70%RH for 5 hours.

(4) Attention to temperature's affection
   Relative humidity strongly depend on temperature, that is why we use temperature compensation technology to ensure accurate measurement of RH. But it's still be much better to keep the sensor at same temperature when sensing.
   DHT22 should be mounted at the place as far as possible from parts that may cause change to temperature.

(5) Attentions to light
   Long time exposure to strong light and ultraviolet may debase DHT22's performance.

(6) Attentions to connection wires
   The connection wires' quality will effect communication's quality and distance, high quality shielding-wire is recommended.

(7) Other attentions
   * Welding temperature should be bellow 260Celsius.
   * Avoid using the sensor under dew condition.
   * Don't use this product in safety or emergency stop devices or any other occasion that failure of DHT22 may cause personal injury.

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Light Dependent Resistor - LDR

Two cadmium sulphide (cds) photoconductive cells with spectral responses similar to that of the human eye. The cell resistance falls with increasing light intensity. Applications include smoke detection, automatic lighting control, batch counting and burglar alarm systems.

Applications

Photoconductive cells are used in many different types of circuits and applications.

Analog Applications
- Camera Exposure Control
- Auto Slide Focus - dual cell
- Photocopy Machines - density of toner
- Colorimetric Test Equipment
- Densitometer
- Electronic Scales - dual cell
- Automatic Gain Control – modulated light source
- Automated Rear View Mirror

Digital Applications
- Automatic Headlight Dimmer
- Night Light Control
- Oil Burner Flame Out
- Street Light Control
- Absence / Presence (beam breaker)
- Position Sensor

Electrical Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell resistance</td>
<td>1000 LUX</td>
<td>-</td>
<td>400</td>
<td>-</td>
<td>Ohm</td>
</tr>
<tr>
<td></td>
<td>10 LUX</td>
<td>-</td>
<td>9</td>
<td>-</td>
<td>K Ohm</td>
</tr>
<tr>
<td>Dark Resistance</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>M Ohm</td>
</tr>
<tr>
<td>Dark Capacitance</td>
<td>-</td>
<td>-</td>
<td>3.5</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>Rise Time</td>
<td>1000 LUX</td>
<td>-</td>
<td>2.8</td>
<td>-</td>
<td>ms</td>
</tr>
<tr>
<td></td>
<td>10 LUX</td>
<td>-</td>
<td>18</td>
<td>-</td>
<td>ms</td>
</tr>
<tr>
<td>Fall Time</td>
<td>1000 LUX</td>
<td>-</td>
<td>48</td>
<td>-</td>
<td>ms</td>
</tr>
<tr>
<td></td>
<td>10 LUX</td>
<td>-</td>
<td>120</td>
<td>-</td>
<td>ms</td>
</tr>
<tr>
<td>Voltage AC/DC Peak</td>
<td>-</td>
<td>-</td>
<td>320</td>
<td>V</td>
<td>max</td>
</tr>
<tr>
<td>Current</td>
<td>-</td>
<td>-</td>
<td>75</td>
<td>mA</td>
<td>max</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>mW</td>
<td>max</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-60</td>
<td>-</td>
<td>+75</td>
<td>Deg. C</td>
<td></td>
</tr>
</tbody>
</table>
Guide to source illuminations

<table>
<thead>
<tr>
<th>Light source Illumination</th>
<th>LUX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moonlight</td>
<td>0.1</td>
</tr>
<tr>
<td>60W Bulb at 1m</td>
<td>50</td>
</tr>
<tr>
<td>1W MES Bulb at 0.1m</td>
<td>100</td>
</tr>
<tr>
<td>Fluorescent Lighting</td>
<td>500</td>
</tr>
<tr>
<td>Bright Sunlight</td>
<td>30,000</td>
</tr>
</tbody>
</table>

Sensitivity

The sensitivity of a photodetector is the relationship between the light falling on the device and the resulting output signal. In the case of a photocell, one is dealing with the relationship between the incident light and the corresponding resistance of the cell.

**Figure 2 Resistance as function of illumination**

Spectral Response

**Figure 3 Spectral response**

Like the human eye, the relative sensitivity of a photoconductive cell is dependent on the wavelength (color) of the incident light. Each photoconductor material type has its own unique spectral response curve or plot of the relative response of the photocell versus wavelength of light.
**Dimensions**

<table>
<thead>
<tr>
<th></th>
<th>(   )</th>
<th></th>
<th>(   )</th>
</tr>
</thead>
<tbody>
<tr>
<td>.144</td>
<td>3.66</td>
<td>.070</td>
<td>1.78</td>
</tr>
<tr>
<td>.164</td>
<td>4.17</td>
<td>.090</td>
<td>2.29</td>
</tr>
<tr>
<td>1.38</td>
<td>35.05</td>
<td>1.62</td>
<td>41.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Typical Application Circuits**

**Figure 6** Sensitive light operated relay

![Sensitive light operated relay diagram]

Relay energised when light level increases above the level set by VR1.

**Figure 9** Logarithmic law photographic light meter

![Logarithmic law photographic light meter diagram]

Typical value R1 = 100kΩ
R2 = 200kΩ preset to give two overlapping ranges.
(Calendaration should be made against an accurate meter.)
Figure 7  Light interruption detector

As Figure 6 relay energised when light level drops below the level set by VR1.

Figure 8  Automatic light circuit

Figure 10  Extremely sensitive light operated relay

(Relay energised when light exceeds preset level.)
Incorporates a balancing bridge and op-amp. R1 and NORP12 may be interchanged for the reverse function.
MAX232x Dual EIA-232 Drivers/ Receivers

1 Features
- Meets or Exceeds TIA/EIA-232-F and ITU Recommendation V.28
- Operates From a Single 5-V Power Supply With 1.0-µF Charge-Pump Capacitors
- Operates up to 120 kbit/s
- Two Drivers and Two Receivers
- ±30-V Input Levels
- Low Supply Current: 8 mA Typical
- ESD Protection Exceeds JESD 22
  – 2000-V Human-Body Model (A114-A)
- Upgrade With Improved ESD (15-kV HBM) and 0.1-µF Charge-Pump Capacitors is Available With the MAX202 Device

2 Applications
- TIA/EIA-232-F
- Battery-Powered Systems
- Terminals
- Modems
- Computers

3 Description
The MAX232 device is a dual driver/receiver that includes a capacitive voltage generator to supply TIA/EIA-232-F voltage levels from a single 5-V supply. Each receiver converts TIA/EIA-232-F inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V, a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into TIA/EIA-232-F levels.

4 Simplified Schematic

---

An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.
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5 Revision History

Changes from Revision L (March 2004) to Revision M

• Removed Ordering Information table. ........................................... 1
• Added Handling Rating table, Feature Description section, Device Functional Modes, Application and Implementation section, Power Supply Recommendations section, Layout section, Device and Documentation Support section, and Mechanical, Packaging, and Orderable Information section........................................... 1
• Moved $T_{\text{stg}}$ to Handling Ratings table. ........................................... 4
### 6 Pin Configuration and Functions

#### Pin Functions

<table>
<thead>
<tr>
<th>PIN NAME, NUMBER</th>
<th>TYPE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1+ 1</td>
<td>—</td>
<td>Positive lead of C1 capacitor</td>
</tr>
<tr>
<td>VS+ 2</td>
<td>O</td>
<td>Positive charge pump output for storage capacitor only</td>
</tr>
<tr>
<td>C1- 3</td>
<td>—</td>
<td>Negative lead of C1 capacitor</td>
</tr>
<tr>
<td>C2+ 4</td>
<td>—</td>
<td>Positive lead of C2 capacitor</td>
</tr>
<tr>
<td>C2- 5</td>
<td>—</td>
<td>Negative lead of C2 capacitor</td>
</tr>
<tr>
<td>VS- 6</td>
<td>O</td>
<td>Negative charge pump output for storage capacitor only</td>
</tr>
<tr>
<td>T2OUT, T1OUT 7, 14</td>
<td>O</td>
<td>RS232 line data output (to remote RS232 system)</td>
</tr>
<tr>
<td>R2IN, R1IN 8, 13</td>
<td>I</td>
<td>RS232 line data input (from remote RS232 system)</td>
</tr>
<tr>
<td>R2OUT, R1OUT 9, 12</td>
<td>O</td>
<td>Logic data output (to UART)</td>
</tr>
<tr>
<td>T2IN, T1IN 10, 11</td>
<td>I</td>
<td>Logic data input (from UART)</td>
</tr>
<tr>
<td>GND 15</td>
<td>—</td>
<td>Ground</td>
</tr>
<tr>
<td>VCC 16</td>
<td>—</td>
<td>Supply Voltage, Connect to external 5V power supply</td>
</tr>
</tbody>
</table>
7 Specifications

7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MIN</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CC}</td>
<td>-0.3</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>V_{S+}</td>
<td>V_{CC} - 0.3</td>
<td>15</td>
<td>V</td>
</tr>
<tr>
<td>V_{S-}</td>
<td>-0.3</td>
<td>-15</td>
<td>V</td>
</tr>
<tr>
<td>V_{I}</td>
<td>-0.3</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td>V_{O}</td>
<td>V_{S-} - 0.3</td>
<td>V_{S+} + 0.3</td>
<td>V</td>
</tr>
<tr>
<td>T_{1IN}, T_{2IN}</td>
<td>-0.3</td>
<td>V_{CC} + 0.3</td>
<td>V</td>
</tr>
<tr>
<td>R_{1IN}, R_{2IN}</td>
<td>±30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T_{1OUT}, T_{2OUT}</td>
<td>-0.3</td>
<td>V_{CC} + 0.3</td>
<td>V</td>
</tr>
<tr>
<td>T_{J}</td>
<td>150</td>
<td></td>
<td>°C</td>
</tr>
</tbody>
</table>

(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) All voltages are with respect to network GND.

7.2 Handling Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MIN</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>T_{STG}</td>
<td>-65</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>V_{(ESD)}</td>
<td></td>
<td></td>
<td>V</td>
</tr>
</tbody>
</table>

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

7.3 Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MIN</th>
<th>NOM</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CC}</td>
<td>4.5</td>
<td>5</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>V_{IH}</td>
<td>2</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{IL}</td>
<td></td>
<td>0.8</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>R_{1IN}, R_{2IN}</td>
<td></td>
<td>±30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T_{A}</td>
<td>MAX232</td>
<td>0</td>
<td>70</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td>MAX232I</td>
<td>-40</td>
<td>85</td>
<td></td>
</tr>
</tbody>
</table>

7.4 Thermal Information

<table>
<thead>
<tr>
<th>THERMAL METRIC(1)</th>
<th>MAX232xD</th>
<th>MAX232xDW</th>
<th>MAX232xN</th>
<th>MAX232xNS</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>R_{UA}</td>
<td>73</td>
<td>57</td>
<td>64</td>
<td>64</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

(1) For more information about traditional and new thermal metrics, see the IC Package Thermal Metrics application report (SPRA953).

7.5 Electrical Characteristics — Device

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 6)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>TEST CONDITIONS(1)</th>
<th>MIN</th>
<th>TYP(2)</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{CC}</td>
<td>V_{CC} = 5.5V, all outputs open, T_{A} = 25°C</td>
<td>8</td>
<td>10</td>
<td>mA</td>
<td></td>
</tr>
</tbody>
</table>

(1) Test conditions are C1–C4 = 1 μF at V_{CC} = 5 V ± 0.5 V

(2) All typical values are at V_{CC} = 5 V, and T_{A} = 25°C.
### 7.6 Electrical Characteristics — Driver

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{OH}$</td>
<td>High-level output voltage T1OUT, T2OUT $R_L = 3 , k\Omega$ to GND</td>
<td>5</td>
<td>7</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{OL}$</td>
<td>Low-level output voltage $^{(3)}$ T1OUT, T2OUT $R_L = 3 , k\Omega$ to GND</td>
<td>–7</td>
<td>–5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$I_O$</td>
<td>Output resistance T1OUT, T2OUT $V_{SV} = V_{SO} = 0$, $V_O = \pm 2 , V$</td>
<td>300</td>
<td></td>
<td></td>
<td>$\Omega$</td>
</tr>
<tr>
<td>$I_{OS}^{(4)}$</td>
<td>Short-circuit output current T1OUT, T2OUT $V_{CC} = 5.5 , V$, $V_O = 0 , V$</td>
<td></td>
<td></td>
<td>±10</td>
<td>mA</td>
</tr>
<tr>
<td>$I_{IS}$</td>
<td>Short-circuit input current T1IN, T2IN $V_I = 0$</td>
<td></td>
<td></td>
<td>200</td>
<td>$\mu A$</td>
</tr>
</tbody>
</table>

(1) Test conditions are $C1–C4 = 1 \, \mu F$ at $V_{CC} = 5 \, V \pm 0.5 \, V$.
(2) All typical values are at $V_{CC} = 5 \, V$, $T_A = 25^\circ C$.
(3) The algebraic convention, in which the least-positive (most negative) value is designated minimum, is used in this data sheet for logic voltage levels only.
(4) Not more than one output should be shorted at a time.

### 7.7 Electrical Characteristics — Receiver

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{OH}$</td>
<td>High-level output voltage R1OUT, R2OUT $I_{OH} = –1 , mA$</td>
<td>3.5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{OL}$</td>
<td>Low-level output voltage $^{(3)}$ R1OUT, R2OUT $I_{OL} = 3.2 , mA$</td>
<td></td>
<td>0.4</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{IT+}$</td>
<td>Receiver positive-going input threshold voltage R1IN, R2IN $V_{CC} = 5 , V$, $T_A = 25^\circ C$</td>
<td>1.7</td>
<td>2.4</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{IT–}$</td>
<td>Receiver negative-going input threshold voltage R1IN, R2IN $V_{CC} = 5 , V$, $T_A = 25^\circ C$</td>
<td>0.8</td>
<td>1.2</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{hys}$</td>
<td>Input hysteresis voltage R1IN, R2IN $V_{CC} = 5 , V$</td>
<td>0.2</td>
<td>0.5</td>
<td>1</td>
<td>V</td>
</tr>
<tr>
<td>$r$</td>
<td>Receiver input resistance R1IN, R2IN $V_{CC} = 5 , V$, $T_A = 25^\circ C$</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>$k\Omega$</td>
</tr>
</tbody>
</table>

(1) Test conditions are $C1–C4 = 1 \, \mu F$ at $V_{CC} = 5 \, V \pm 0.5 \, V$.
(2) All typical values are at $V_{CC} = 5 \, V$, $T_A = 25^\circ C$.
(3) The algebraic convention, in which the least-positive (most negative) value is designated minimum, is used in this data sheet for logic voltage levels only.

### 7.8 Switching Characteristics

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR</td>
<td>Driver slew rate $RL = 3 , k\Omega$ to $7 , k\Omega$, see Figure 4</td>
<td></td>
<td>30</td>
<td></td>
<td>$V/\mu s$</td>
</tr>
<tr>
<td>SR(t)</td>
<td>Driver transition region slew rate see Figure 5</td>
<td></td>
<td>3</td>
<td></td>
<td>$V/\mu s$</td>
</tr>
<tr>
<td>Data rate</td>
<td>One TOUT switching</td>
<td>120</td>
<td></td>
<td></td>
<td>$kbit/s$</td>
</tr>
<tr>
<td>$t_{PLH(R)}$</td>
<td>Receiver propagation delay time, low- to high-level output TTL load, see Figure 3</td>
<td>500</td>
<td></td>
<td></td>
<td>$ns$</td>
</tr>
<tr>
<td>$t_{PHL(R)}$</td>
<td>Receiver propagation delay time, high- to low-level output TTL load, see Figure 3</td>
<td>500</td>
<td></td>
<td></td>
<td>$ns$</td>
</tr>
</tbody>
</table>

(1) Test conditions are $C1–C4 = 1 \, \mu F$ at $V_{CC} = 5 \, V \pm 0.5 \, V$. 
7.9 Typical Characteristics

Figure 1. TOUT VOH & VOL vs Load Resistance, Both Drivers Loaded

Figure 2. Driver to Receiver Loopback Timing Waveform
8 Parameter Measurement Information

Figure 3. Receiver Test Circuit and Waveforms for t_{PHL} and t_{PLH} Measurements

A. The pulse generator has the following characteristics: Z_{O} = 50 Ω, duty cycle ≤ 50%.
B. C_{L} includes probe and jig capacitance.
C. All diodes are 1N3064 or equivalent.
Parameter Measurement Information (continued)

$\text{Pulse Generator (see Note A)}$
\begin{align*}
T1\text{IN or T2\text{IN}} & \rightarrow T1\text{OUT or T2\text{OUT}} \\
& \rightarrow \text{EIA-232 Output}
\end{align*}

$RL$

$CL = 10 \text{ pF (see Note B)}$

**WAVEFORMS**

- $\leq 10 \text{ ns}$
- $10\%$
- $90\%$
- $50\%$
- $V_{OL}$
- $V_{OH}$
- $t_{THL}$
- $t_{TLH}$
- $SR = \frac{0.8 \left( V_{OH} - V_{OL} \right)}{t_{THL}}$ or $\frac{0.8 \left( V_{OL} - V_{OH} \right)}{t_{TLH}}$

**TEST CIRCUIT**

---

**Figure 4. Driver Test Circuit and Waveforms for $t_{PHL}$ and $t_{PLH}$ Measurements (5-μs Input)**

---

A. The pulse generator has the following characteristics: $Z_O = 50 \text{ Ω}$, duty cycle $\leq 50\%$.

B. $C_L$ includes probe and jig capacitance.

---

$\text{Pulse Generator (see Note A)}$
\begin{align*}
& \rightarrow \text{EIA-232 Output}
\end{align*}

$3 \text{ kΩ}$

$CL = 2.5 \text{ nF (see Note B)}$

**WAVEFORMS**

- $\leq 10 \text{ ns}$
- $10\%$
- $90\%$
- $50\%$
- $3 \text{ V}$
- $-3 \text{ V}$
- $V_{OL}$
- $V_{OH}$
- $t_{THL}$
- $t_{TLH}$
- $SR = \frac{6 \text{ V}}{t_{THL} \text{ or } t_{TLH}}$

**TEST CIRCUIT**

---

**Figure 5. Test Circuit and Waveforms for $t_{THL}$ and $t_{TLH}$ Measurements (20-μs Input)**

---

A. The pulse generator has the following characteristics: $Z_O = 50 \text{ Ω}$, duty cycle $\leq 50\%$.
9 Detailed Description

9.1 Overview

The MAX232 device is a dual driver/receiver that includes a capacitive voltage generator using four capacitors to supply TIA/EIA-232-F voltage levels from a single 5-V supply. Each receiver converts TIA/EIA-232-F inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V, a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into TIA/EIA-232-F levels. The driver, receiver, and voltage-generator functions are available as cells in the Texas Instruments LinASIC™ library. Outputs are protected against shorts to ground.

9.2 Functional Block Diagram

![Functional Block Diagram]

9.3 Feature Description

9.3.1 Power

The power block increases and inverts the 5V supply for the RS232 driver using a charge pump that requires four 1-µF external capacitors.

9.3.2 RS232 Driver

Two drivers interface standard logic level to RS232 levels. Internal pull up resistors on TIN inputs ensures a high input when the line is high impedance.

9.3.3 RS232 Receiver

Two receivers interface RS232 levels to standard logic levels. An open input will result in a high output on ROUT.

9.4 Device Functional Modes

9.4.1 \( V_{CC} \) powered by 5V

The device will be in normal operation.

9.4.2 \( V_{CC} \) unpowered

When MAX232 is unpowered, it can be safely connected to an active remote RS232 device.

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIN</td>
<td>TOUT</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
</tbody>
</table>

(1) \( H = \) high level, \( L = \) low level, \( X = \) irrelevant, \( Z = \) high impedance
Table 2. Function Table Each Receiver

<table>
<thead>
<tr>
<th>INPUTS RIN</th>
<th>OUTPUT ROUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>Open</td>
<td>H</td>
</tr>
</tbody>
</table>

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off),
Open = disconnected input or connected driver off

10 Application and Implementation

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI’s customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

10.1 Application Information

For proper operation add capacitors as shown in Figure 6. Pins 9 through 12 connect to UART or general purpose logic lines. EIA-232 lines will connect to a connector or cable.

10.2 Typical Application

![Figure 6. Typical Operating Circuit](image)

† C3 can be connected to VCC or GND.

NOTES:
A. Resistor values shown are nominal.
B. Nonpolarized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown. In addition to the 1-µF capacitors shown, the MAX202 can operate with 0.1-µF capacitors.

10.2.1 Design Requirements

- $V_{CC}$ minimum is 4.5 V and maximum is 5.5 V.
- Maximum recommended bit rate is 120 kbps.

10.2.2 Detailed Design Procedure

Use 1 µF tantalum or ceramic capacitors.
Typical Application (continued)

10.2.3 Application Curves

11 Power Supply Recommendations

The $V_{CC}$ voltage should be connected to the same power source used for logic device connected to TIN pins. $V_{CC}$ should be between 4.5V and 5.5V.

12 Layout

12.1 Layout Guidelines

Keep the external capacitor traces short. This is more important on C1 and C2 nodes that have the fastest rise and fall times.

12.2 Layout Example
13 Device and Documentation Support

13.1 Related Links
The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

<table>
<thead>
<tr>
<th>PARTS</th>
<th>PRODUCT FOLDER</th>
<th>SAMPLE &amp; BUY</th>
<th>TECHNICAL DOCUMENTS</th>
<th>TOOLS &amp; SOFTWARE</th>
<th>SUPPORT &amp; COMMUNITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX232</td>
<td>Click here</td>
<td>Click here</td>
<td>Click here</td>
<td>Click here</td>
<td>Click here</td>
</tr>
<tr>
<td>MAX232I</td>
<td>Click here</td>
<td>Click here</td>
<td>Click here</td>
<td>Click here</td>
<td>Click here</td>
</tr>
</tbody>
</table>

13.2 Trademarks
All trademarks are the property of their respective owners.

13.3 Electrostatic Discharge Caution
⚠️ These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

13.4 Glossary
SLYZ022 — Ti Glossary.
This glossary lists and explains terms, acronyms and definitions.

14 Mechanical, Packaging, and Orderable Information
The following pages include mechanical packaging and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser based versions of this data sheet, refer to the left hand navigation.
### PACKAGING INFORMATION

<table>
<thead>
<tr>
<th>Orderable Device</th>
<th>Status</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>Package Qty</th>
<th>Eco Plan</th>
<th>Lead/Ball Finish</th>
<th>MSL Peak Temp</th>
<th>Op Temp (°C)</th>
<th>Device Marking</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX232D</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>0 to 70</td>
<td>MAX232</td>
<td></td>
</tr>
<tr>
<td>MAX232DE4</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>0 to 70</td>
<td>MAX232</td>
<td></td>
</tr>
<tr>
<td>MAX232DG4</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
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<td>MAX232</td>
<td></td>
</tr>
<tr>
<td>MAX232DR</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>2500</td>
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<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>0 to 70</td>
<td>MAX232</td>
<td></td>
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<td>MAX232DRE4</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>2500</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>0 to 70</td>
<td>MAX232</td>
<td></td>
</tr>
<tr>
<td>MAX232DRG4</td>
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<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>2500</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>0 to 70</td>
<td>MAX232</td>
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<tr>
<td>MAX232DW</td>
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<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
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<td>D</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
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<td>MAX232</td>
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<td>MAX232DWG4</td>
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<td>DW</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>0 to 70</td>
<td>MAX232</td>
<td></td>
</tr>
<tr>
<td>MAX232DWE4</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>DW</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>0 to 70</td>
<td>MAX232</td>
<td></td>
</tr>
<tr>
<td>MAX232DWG4</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>DW</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>0 to 70</td>
<td>MAX232</td>
<td></td>
</tr>
<tr>
<td>MAX232DWR</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>0 to 70</td>
<td>MAX232</td>
<td></td>
</tr>
<tr>
<td>MAX232DWE4</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>0 to 70</td>
<td>MAX232</td>
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<td>D</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
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<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>-40 to 85</td>
<td>MAX232I</td>
<td></td>
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<tr>
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<td>MSL Peak Temp (3)</td>
<td>Op Temp (°C)</td>
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(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBsolete:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check [http://www.ti.com/productcontent](http://www.ti.com/productcontent) for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material).
(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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# TAPE AND REEL INFORMATION

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<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>SPQ</th>
<th>Reel Diameter (mm)</th>
<th>Reel Width W1 (mm)</th>
<th>A0  (mm)</th>
<th>B0  (mm)</th>
<th>K0  (mm)</th>
<th>P1  (mm)</th>
<th>W    (mm)</th>
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<td>12.0</td>
<td>16.0</td>
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</table>

*A all dimensions are nominal.

---

**TAPE DIMENSIONS**

A0 Dimension designed to accommodate the component width
B0 Dimension designed to accommodate the component length
K0 Dimension designed to accommodate the component thickness
W Overall width of the carrier tape
P1 Pitch between successive cavity centers

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**

Pocket Quadrants

Sprocket Holes

User Direction of Feed

---

*All dimensions are nominal.*
# TAPE AND REEL BOX DIMENSIONS

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*All dimensions are nominal*
PLASTIC DUAL-IN-LINE PACKAGE

N (R-PDIP-T**)

16 PINS SHOWN

PMNS ** | 14 | 16 | 18 | 20
---------|----|----|----|----
A MAX    | 0.775 (19.69) | 0.775 (19.69) | 0.920 (23.37) | 1.060 (26.92)
A MIN    | 0.745 (18.92) | 0.745 (18.92) | 0.850 (21.59) | 0.940 (23.88)

MS-001 VARIATION | AA | BB | AC | AD

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.
MECHANICAL DATA

D (R-PDSO-G16)  PLASTIC SMALL OUTLINE

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
   △ Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0.15) each side.
   △ Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0.43) each side.
E. Reference JEDEC MS-012 variation AC.
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC-7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.
NOTES:
A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0.15).
D. Falls within JEDEC MS–013 variation AA.
NOTES:  
A. All linear dimensions are in millimeters.  
B. This drawing is subject to change without notice.  
C. Body dimensions do not include mold flash or protrusion, not to exceed 0.15.

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TECHNICAL DATA

MQ-2 GAS SENSOR

FEATURES
- Wide detecting scope
- Fast response and High sensitivity
- Stable and long life
- Simple drive circuit

APPLICATION
- They are used in gas leakage detecting equipments in family and industry, are suitable for detecting of LPG, i-butane, propane, methane, alcohol, Hydrogen, smoke.

SPECIFICATIONS

A. Standard work condition

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<th>Parameter name</th>
<th>Technical condition</th>
<th>Remarks</th>
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<td>Vh</td>
<td>Heating voltage</td>
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B. Environment condition

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<td></td>
</tr>
<tr>
<td>O2</td>
<td>Oxygen concentration</td>
<td>21%(standard condition)/Oxygen concentration can affect sensitivity, minimum value is over 2%</td>
<td></td>
</tr>
</tbody>
</table>

C. Sensitivity characteristic

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter name</th>
<th>Technical parameter</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rs</td>
<td>Sensing Resistance</td>
<td>3KΩ-30KΩ (1000ppm iso-butane)</td>
<td>Detection concentration scope: 200ppm-5000ppm LPG and propane 300ppm-5000ppm butane 5000ppm-20000ppm methane 300ppm-5000ppm H2 100ppm-2000ppm Alcohol</td>
</tr>
<tr>
<td>α</td>
<td>Concentration Slope rate</td>
<td>≤0.6</td>
<td></td>
</tr>
</tbody>
</table>

D. Structure and configuration, basic measuring circuit

Structure and configuration of MQ-2 gas sensor is shown as Fig. 1 (Configuration A or B), sensor composed by micro Al2O3 ceramic tube, Tin Dioxide (SnO2) sensitive layer, measuring electrode and heater are fixed into a
crust made by plastic and stainless steel net. The heater provides necessary work conditions for work of sensitive components. The enveloped MQ-2 have 6 pin, 4 of them are used to fetch signals, and other 2 are used for providing heating current.

Electric parameter measurement circuit is shown as Fig.2

E. Sensitivity characteristic curve

Fig.3 is shows the typical sensitivity characteristics of the MQ-2 for several gases. In their: Temp: 20℃, Humidity: 65%, O₂ concentration 21% RL=5kΩ Ro: sensor resistance at 1000ppm of H₂ in the clean air. Rs: sensor resistance at various concentrations of gases.

Fig.4 is shows the typical dependence of the MQ-2 on temperature and humidity. Ro: sensor resistance at 1000ppm of H₂ in air at 33%RH and 20 degree. Rs: sensor resistance at 1000ppm of H₂ at different temperatures and humidities.

SENSITIVITY ADJUSTMENT

Resistance value of MQ-2 is difference to various kinds and various concentration gases. So, when using this components, sensitivity adjustment is very necessary. We recommend that you calibrate the detector for 1000ppm liquifided petroleum gas<LPG> or 1000ppm iso-butane<i-C₄H₁₀> concentration in air and use value of Load resistance that(R₁) about 20 KΩ (5KΩ to 47 KΩ).

When accurately measuring, the proper alarm point for the gas detector should be determined after considering the temperature and humidity influence.