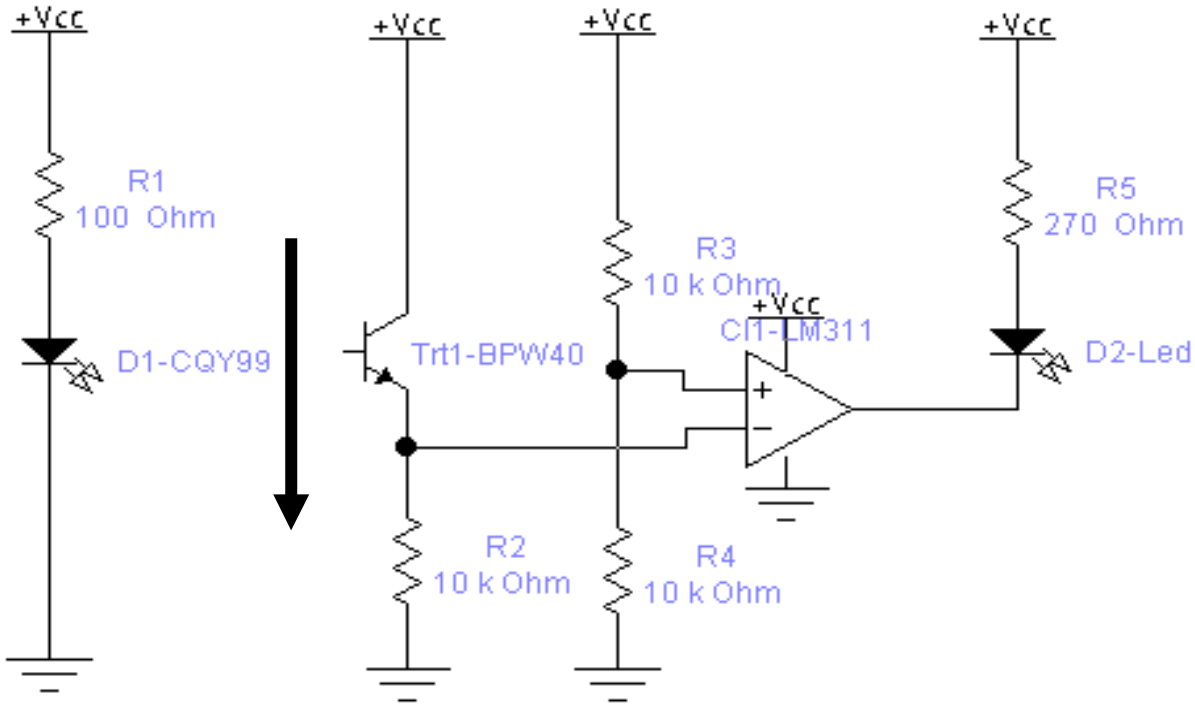
## 5. Praktika: Fotoigorleak - Fototransistoreak

Hesi fotoelektriko baten muntaia egingo da, fotoigorle bat eta fototransistore (foto-hargailu) baten bidez, biak espektro infragorrian lan egingo dute. Praktika hau, *protoboard*ak muntatzeko maletan muntatuko da, osagai fisikoekin.
Osagai berria dugu, LM311a, seinale elektrikoen konparatzailea hain zuzen ere. Konparatzaile honek objektuak antzemango ditu, argi infragorria eteterakoan.

Tentsioen eta korronteen kalkulu teoriko eta praktikoak egingo dira. Horretarako, polimetroa erabiliko da.




Kalkulu eta neurketak:

**1.** D1 diodoan zehar doan korrontea kalkulatu eta neurtu.
**2.** Trt1 transistorearen igorlean dagoen tentsioa neurtu, hesia zabalik eta itxita dagoenean.
**3.** R3 eta R4k sortzen duten korapiloan tentsioa neurtu eta kalkulatu.
**4.** IC1eko irteerako tentsioa kalkulatu.
**5.** D2 diodoan zehar doan korrontea kalkulatu eta neurtu.

Osagaien zerrenda:

| **Erresistoreak** | **Osagaia** |
|---|---|
| 100 Ω | R1 |
| 10 KΩ | R2,R3,R4 |
| 270 Ω | R5 |
| **Fotodiodoak** | |
| L53F3C (gardena) | D1 |
| **Fototransistoreak** | |
| L53P3C (gardena) | Trt1 |
| **Led diodoak** | |
| Gorria | D2 |
| **Zirkuitu Integratuak** | |
| LM311 | CI1 |

**Fotoigorlea:**
Infragorriko espektroko argia igortzen du kitzikatuta dagoenean. Igorritako argia hobeto fokalizatzeko lente bat dauka.

**Fototransistorea:**
Argi ikuskorreko eta argi infragorriko erradiazioetara sentikorra da. Bere fokua hobetzeko lentea dauka baita ere..

**Konparatzailea:**
Bi sarreren arteko konparaketa egiten du. (+) hankatxoko tentsioa, balio absolutuan (-) hankatxoko tentsioa baino handiagoa bada, irteera inpedantzia altuko egoeran jartzen da, kolektore irekia izanagatik. $V^- > V^+$ balio absolutuan, irteera, 0 da.

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**T-1 3/4 (5mm) INFRA-RED EMITTING DIODE**

| | |
|---|---|
| L-53F3C | L-53F3BT |
| L-53SF4C | L-53SF4BT |
| L-53SF6C | L-53SF6BT |
| L-53SF7C | L-53SF7BT |

### Features

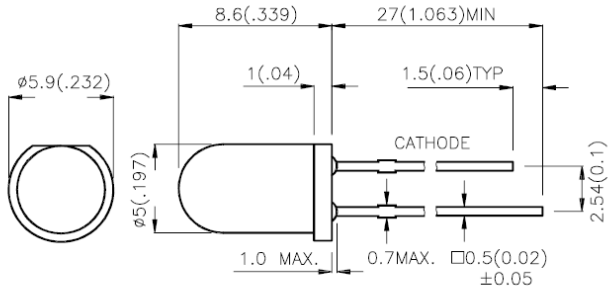
- MECHANICALLY AND SPECTRALLY MATCHED TO THE L-51P3C PHOTOTRANSISTOR.
- BOTH WATER CLEAR LENS AND BLUE TRANSPARENT LENS AVAILABLE HIGH POWER OUTPUT.

### Description

F3 Made with Gallium Arsenide Infrared Emitting diodes.

SF4 and SF6 and SF7 Made with Gallium Aluminum Arsenide Infrared Emitting diodes.

### Package Dimensions




Notes:
1. All dimensions are in millimeters (inches).
2. Tolerance is ±0.25(0.01") unless otherwise noted.
3. Lead spacing is measured where the lead emerge package.
4. Specifications are subject to change without notice.

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## Selection Guide

| Part No. | Dice | Lens Type | Po (mW/sr) @20mA | | Po (mW/sr) @50mA | | Viewing Angle |
|---|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Min. | Typ. | 2θ1/2 |
| L-53F3C | GaAs | WATER CLEAR | 8 | 20 | 12 | 30 | 30° |
| L-53F3BT | GaAs | BLUE TRANS. | 5 | 20 | 8 | 30 | 30° |
| L-53SF4C | GaAlAs | WATER CLEAR | 8 | 20 | 12 | 30 | 30° |
| L-53SF4BT | GaAlAs | BLUE TRANS. | 5 | 20 | 8 | 30 | 30° |
| L-53SF6C | GaAlAs | WATER CLEAR | 10 | 40 | 50 | 100 | 30° |
| L-53SF6BT | GaAlAs | BLUE TRANS. | 10 | 40 | 50 | 100 | 30° |
| L-53SF7C | GaAlAs | WATER CLEAR | 10 | 40 | 50 | 100 | 30° |
| L-53SF7BT | GaAlAs | BLUE TRANS. | 10 | 40 | 50 | 100 | 30° |

Note:
1. θ1/2 is the angle from optical centerline where the luminous intensity is 1/2 the optical centerline value.

## Electrical / Optical Characteristics at $T_A$=25°C

| Item | P/N | Symbol | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|---|
| Forward Voltage | F3<br>SF4<br>SF6<br>SF7 | $V_F$ | 1.2<br>1.3<br>1.35<br>1.4 | 1.5<br>1.7<br>1.6<br>1.8 | V | IF=20mA |
| Reverse Current | F3<br>SF4<br>SF6<br>SF7 | $I_R$ | - | 10<br>10<br>10<br>10 | uA | VR=5V |
| Junction Capacitance | F3<br>SF4<br>SF6<br>SF7 | C | 90<br>90<br>30<br>30 | - | pF | V=0 f=1MHz |
| Peak Spectral Wavelength | F3<br>SF4<br>SF6<br>SF7 | λP | 940<br>880<br>860<br>850 | - | nm | IF=20mA |
| Spectral Bandwidth | F3<br>SF4<br>SF6<br>SF7 | Δλ | 50<br>50<br>50<br>41 | - | nm | IF=20mA |

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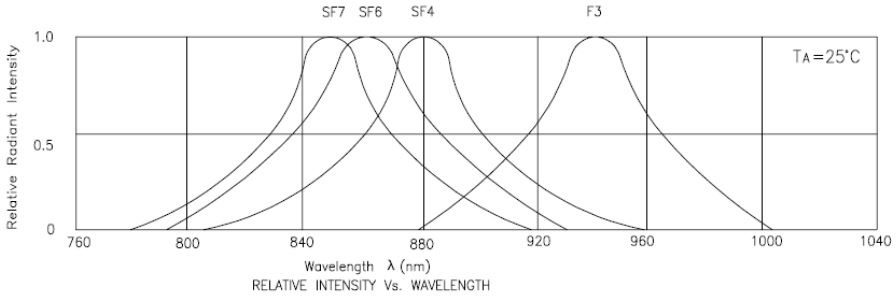
## Absolute Maximum Ratings at $T_A$=25°C

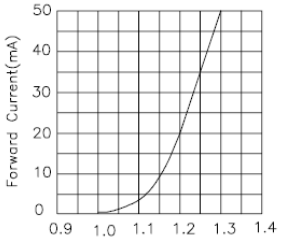
| Item | Symbol | F3&SF4 | SF6&SF7 | Units |
|---|---|---|---|---|
| Power Dissipation | Pd | 100 | 100 | mW |
| Forward Current | $I_F$ | 50 | 50 | mA |
| Peak Forward Current | $I_P$ | 1.2 | 1 | A |
| Reverse Voltage | $V_R$ | 5 | 5 | V |
| Operating Temperature | Topr | -40~ +85 | -40~ +85 | °C |
| Storage Temperature | Tstg | -40~ +85 | -40~ +85 | °C |

Notes:
1. 1/10 Duty Cycle, 0.1ms Pulse Width.
2. 4mm below package base.

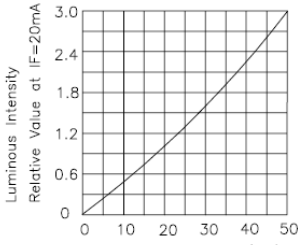


RELATIVE INTENSITY Vs. WAVELENGTH

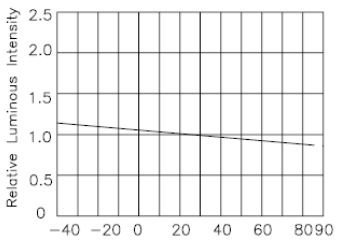
### L-53F3C, L-53F3BT



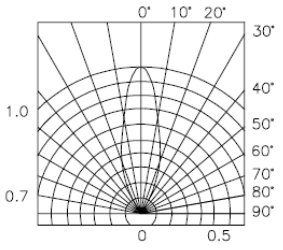
FORWARD CURRENT Vs
FORWARD VOLTAGE



LUMINOUS INTENSITY Vs.
FORWARD CURRENT



LUMINOUS INTENSITY Vs.
AMBIENT TEMPERATURE



SPATIAL DISTRIBUTION

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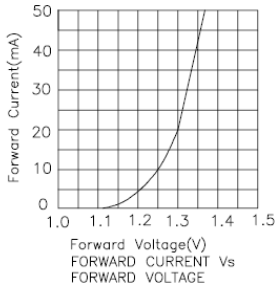
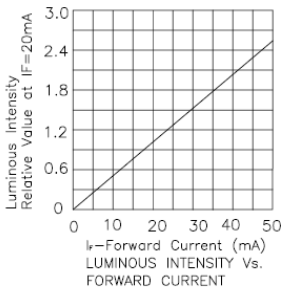
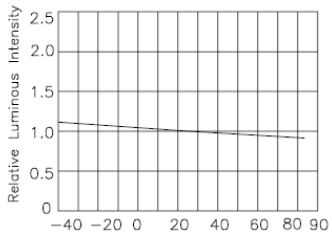
## L-53SF4C, L-53SF4BT



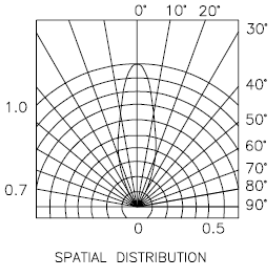

FORWARD CURRENT Vs
FORWARD VOLTAGE




LUMINOUS INTENSITY Vs.
FORWARD CURRENT

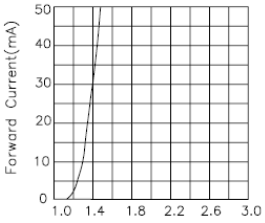



LUMINOUS INTENSITY Vs.
AMBIENT TEMPERATURE

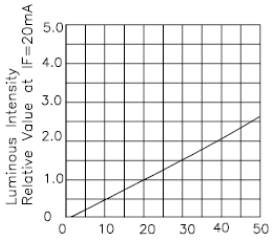



SPATIAL DISTRIBUTION

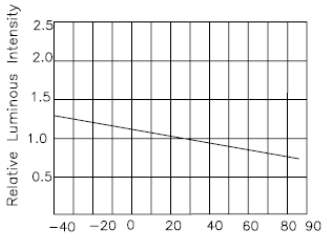
## L-53SF6C, L-53SF6BT



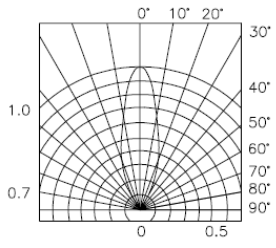

FORDWARD CURRENT Vs
FORWARD VOLTAGE




LUMINOUS INTENSITY Vs.
FORWARD CURRENT

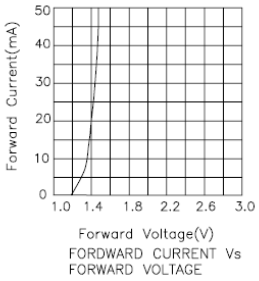



LUMINOUS INTENSITY Vs.
AMBIENT TEMPERATURE

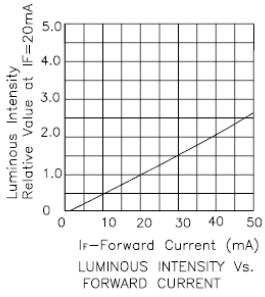



SPATIAL DISTRIBUTION

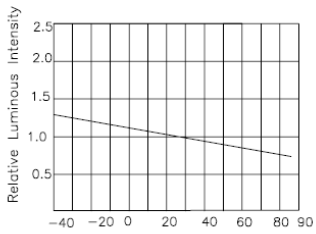
**L-53SF7C, L-53SF7BT**



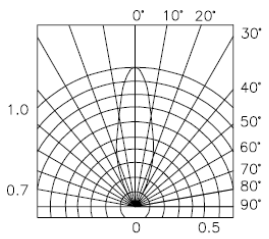

FORDWARD CURRENT Vs
FORWARD VOLTAGE




LUMINOUS INTENSITY Vs.
FORWARD CURRENT




LUMINOUS INTENSITY Vs.
AMBIENT TEMPERATURE




SPATIAL DISTRIBUTION

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**PHOTOTRANSISTOR**

L-53P3C

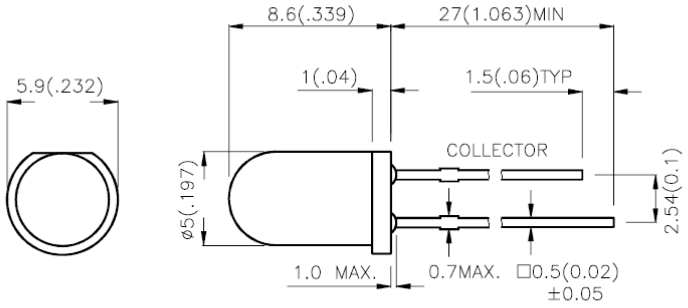
### Features

- MECHANICALLY AND SPECTRALLY MATCHED TO THE L-53 SERIES INFRARED EMITTING LED LAMP.
- WATER CLEAR LENS.

### Description

Made with NPN silicon phototransistor chips.

### Package Dimensions




Notes:
1. All dimensions are in millimeters (inches).
2. Tolerance is ±0.25(0.01") unless otherwise noted.
3. Lead spacing is measured where the lead emerge package.
4. Specifications are subject to change without notice.

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## Electrical / Optical Characteristics at $T_A$=25°C

| Symbol | Parameter | Min. | Typ. | Max. | Unit | Test Condiction |
|---|---|---|---|---|---|---|
| $V_{BR\ CEO}$ | Collector-to-Emitter Breakdown Voltage | 30 | - | - | V | $I_C$=100uA<br>$E_e$=0mW/cm$^2$ |
| $V_{BR\ ECO}$ | Emitter-to-Collector Breakdown Voltage | 5 | - | - | V | $I_E$=100uA<br>$E_e$=0mW/cm$^2$ |
| $V_{CE\ (SAT)}$ | Collector-to-Emitter Saturation Voltage | - | - | 0.8 | V | $I_C$=2mA<br>$E_e$=20mW/cm$^2$ |
| $I_{CEO}$ | Collector Dark Current | - | - | 100 | nA | $V_{CE}$=10V<br>$E_e$=0mW/cm$^2$ |
| $T_R$ | Rise Time (10% to 90%) | - | 3 | - | us | $V_{CE}$=5V<br>$I_C$=1mA<br>$R_L$=1000Ω |
| $T_F$ | Fall Time (90% to 10%) | - | 3 | - | us | |
| $I_{(ON)}$ | On State Collector Current | 0.1 | 0.5 | - | mA | $V_{CE}$=5V<br>Ee=1mW/cm$^2$<br>λ=940nm |

## Absolute Maximum Ratings at $T_A$=25°C

| Parameter | Maximum Rating |
|---|---|
| Collector-to-Emitter Breakdown Voltage | 30V |
| Emitter-to-Collector Breakdown Voltage | 5V |
| Power Dissipation at (or below) 25°C Free Air Temperature | 100mW |
| Operating Temperature Range | -40°C ~ +85°C |
| Storage Temperature Range | -40°C ~ +85°C |
| Lead soldering Temperature<br>(>5mm for 5sec) | 260°C |

# DATA SHEET

## LM111/211/311/311B
Voltage comparator

Product data
Supersedes data of 1994 Aug 31
File under Integrated Circuits, IC11 Handbook

2001 Aug 03

Philips
Semiconductors

PHILIPS

# Voltage comparator LM111/211/311/311B

## DESCRIPTION

The LM111 series are voltage comparators that have input currents approximately a hundred times lower than devices like the µA710. They are designed to operate over a wider range of supply voltages; from standard ±15 V op amp supplies down to a single 3 V supply. Their output is compatible with RTL, DTL, and TTL as well as MOS circuits. Further, they can drive lamps or relays, switching voltages up to 50 V at currents as high as 50mA.

Both the inputs and the outputs of the LM111 series can be isolated from system ground, and the output can drive loads referred to ground, the positive supply, or the negative supply. Offset balancing and strobe capability are provided and outputs can be wire-ORed.

Although slower than the µA710 (200 ns response time versus 40 ns), the devices are also much less prone to spurious oscillations. The LM111 series has the same pin configuration as the µA710 series.

## FEATURES

- Operates from single 3 V supply (LM311B)
- Maximum input bias current: 150 nA (LM311: 250 nA)
- Maximum offset current: 20 nA (LM311: 50 nA)
- Differential input voltage range: ±30 V
- Power consumption: 135 mW at ±15 V
- High sensitivity: 200 V/mV
- Zero crossing detector

## PIN CONFIGURATION

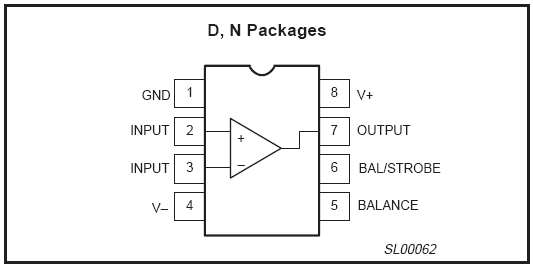



**Figure 1. Pin Configuration**

## APPLICATIONS

- Precision squarer
- Positive/negative peak detector
- Low voltage adjustable reference supply
- Switching power amplifier

## ORDERING INFORMATION

| DESCRIPTION | TEMPERATURE RANGE | ORDER CODE | DWG # |
|---|---|---|---|
| 8-Pin Plastic Small Outline Package (SO) | –55 °C to +125 °C | LM111D | SOT96-1 |
| 8-Pin Plastic Dual In-Line Package (DIP) | –55 °C to +125 °C | LM111N | SOT97-1 |
| 8-Pin Plastic Small Outline Package (SO) | –25 °C to +85 °C | LM211D | SOT96-1 |
| 8-Pin Plastic Dual In-Line Package (DIP) | –25 °C to +85 °C | LM211N | SOT97-1 |
| 8-Pin Plastic Small Outline Package (SO) | 0 °C to +70 °C | LM311D | SOT96-1 |
| 8-Pin Plastic Dual In-Line Package (DIP) | 0 °C to +70 °C | LM311N | SOT97-1 |
| 8-Pin Plastic Small Outline Package (SO) | 0 °C to +70 °C | LM311BD | SOT96-1 |
| 8-Pin Plastic Dual In-Line Package (DIP) | 0 °C to +70 °C | LM311BN | SOT97-1 |

## EQUIVALENT SCHEMATIC

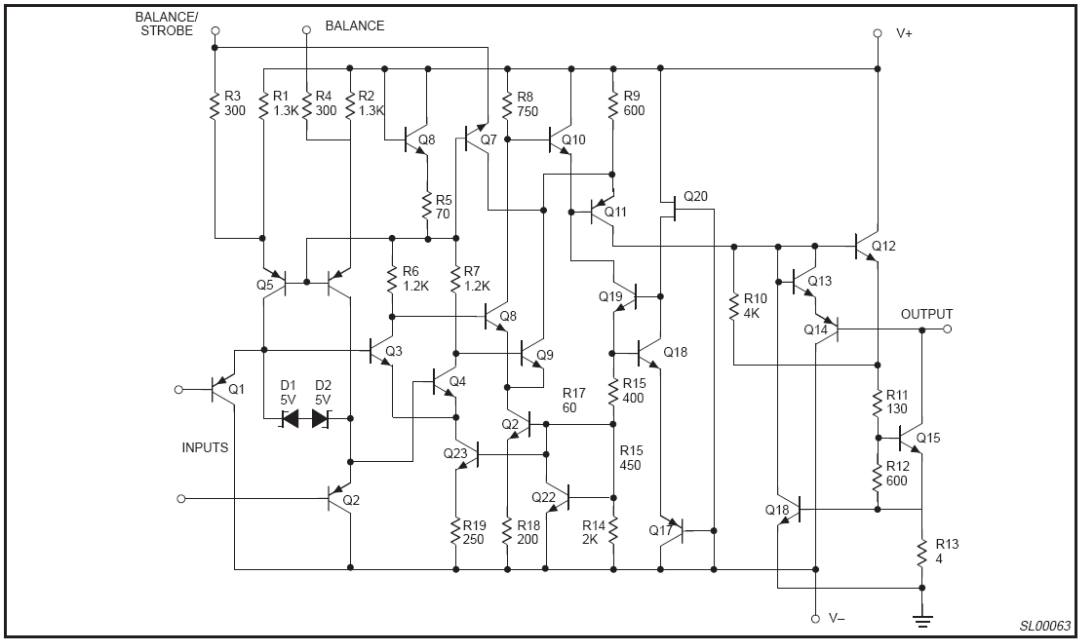



**Figure 2. Equivalent Schematic**

## ABSOLUTE MAXIMUM RATINGS

| SYMBOL | PARAMETER | RATING | UNIT |
|---|---|---|---|
| $V_S$ | Total supply voltage | 36 | V |
| | Output to negative supply voltage:<br>LM111/LM211<br>LM311/LM311B | <br>50<br>40 | <br>V<br>V |
| | Ground to negative supply voltage | 30 | V |
| | Differential input voltage | ±30 | V |
| $V_{IN}$ | Input voltage[1] | ±15 | V |
| $P_{D\ MAX}$ | Maximum power dissipation, $T_{amb}$ = 25 °C (still-air)[2]<br>N package<br>D package | <br>1190<br>780 | <br>mW<br>mW |
| I | Output short-circuit duration | 10 | sec |
| $T_{amb}$ | Operating ambient temperature range<br>LM111<br>LM211<br>LM311/LM311B | <br>–55 to +125<br>–25 to +85<br>0 to +70 | <br>°C<br>°C<br>°C |
| $T_{stg}$ | Storage temperature range | –65 to +150 | °C |
| $T_{sld}$ | Lead soldering temperature (10 sec max) | 230 | °C |

**NOTES:**

1. This rating applies for ±15 V supplies. The positive input voltage limit is 30 V above the negative supply. The negative input voltage limit is equal to the negative supply voltage or 30 V below the positive supply, whichever is less.
2. Derate above 25 °C, at the following rates:
   N package at 9.5 mW/°C
   D package at 6.2 m/W°C

## DC ELECTRICAL CHARACTERISTICS[1, 2, 3, 6]

Over temperature range unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | LM111/LM211 | | | LM311 | | | LM311B | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| $V_{OS}$ | Input offset voltage[3] | $T_{amb}$ = 25 °C; $R_S \leq 50$ kΩ | | 0.7 | 3.0 | | 2.0 | 7.5 | | 2.0 | 7.5 | mV |
| $I_{OS}$ | Input offset current[3] | $T_{amb}$ = 25 °C | | 4.0 | 10 | | 6.0 | 50 | | 6 | 25 | nA |
| $I_{BIAS}$ | Input bias current | $T_{amb}$ = 25 °C | | 60 | 100 | | 100 | 250 | | 100 | 200 | nA |
| $A_V$ | Voltage gain | $T_{amb}$ = 25 °C | | 200 | | | 200 | | | 200 | | V/mV |
| | Response time[4] | $T_{amb}$ = 25 °C | | 200 | | | 200 | | | 500 | | ns |
| $V_{SAT}$ | Saturation voltage | LM111/211 $V_{IN} \leq -5$mV; $I_{OUT}$ = 50 mA LM311/B $V_{IN} \leq -10$ mV; $I_{OUT}$ = 50 mA $T_{amb}$ = 25 °C | | 0.75 | 1.5 | | 0.75 | 1.5 | | 0.75 | 1.5 | V |
| $I_{BAL/STR}$ | Strobe on current | $T_{amb}$ = 25 °C | | 3.0 | | | 3.0 | | | 3.0 | | mA |
| $I_{LEAKAGE}$ | Output leakage current[6] | LM111/211 $V_{IN} \geq 5$ mV; $V_{OUT}$ = 35 V LM311/B $V_{IN} \geq 10$ mV; $V_{OUT}$ = 35 V $T_{amb}$ = 25 °C, $I_{STROBE}$ = 3 mA (V– = $V_{GND}$ = –5 V) | | 0.2 | 10 | | 0.2 | 50 | | 0.2 | 50 | nA |
| $V_{OS}$ | Input offset voltage[3] | $R_S \leq 50$ kΩ | | | 4.0 | | | 10 | | | 10 | mV |
| $I_{OS}$ | Input offset current[3] | | | | 20 | | | 70 | | | 50 | nA |
| $I_{BIAS}$ | Input bias current | | | | 150 | | | 300 | | | 250 | nA |
| $V_{IN}$ | Input voltage range | V = ±15 V (Pin 7 may go to 5 V) | –14.5 | 13.8 to –14.7 | 13.0 | –14.5 | 13.8 to –14.7 | 13.0 | V– +0.5 | | V+ –1.5 | V |
| $V_{OL}$ | Saturation voltage[6] | V+ ≥ 4.5 V, V– = 0 V LM111/211 $V_{IN} \leq -6$ mV; $I_{SINK} \leq 8$ mA LM311/B $V_{IN} \leq -10$ mV; $I_{SINK} \leq 8$ mA | | 0.23 | 0.4 | | 0.23 | 0.4 | | 0.23 | 0.4 | V |
| $I_{OH}$ | Output leakage current | $V_{IN} \geq 5$ mV; $V_{OUT}$ = 35 V | | 0.1 | 0.5 | | | | | | | µA |
| $I_{CC}$ | Positive supply current | $T_{amb}$ = 25 °C | | 5.1 | 6.0 | | 5.1 | 7.5 | | 1.6 | 3.5 | mA |
| $I_{EE}$ | Negative supply voltage | $T_{amb}$ = 25 °C | | 4.1 | 5.0 | | 4.1 | 5.0 | | | | mA |

**NOTES:**

1. This rating applies for ±15 V supplies. The positive input voltage limit is 30 V above the negative supply. The negative input voltage limit is equal to the negative supply voltage or 30 V below the positive supply, whichever is less.
2. These specifications apply for $V_S$ = ±15 V and 0 °C < $T_{amb}$ < 70 °C unless otherwise specified. With the LM211, however, all temperature specifications are limited to –25 °C ≤ $T_{amb}$ ≤ +85 °C, and for the LM111 is limited to –55 °C < $T_{amb}$ < +125 °C. The offset voltage, offset current, and bias current specifications apply for any supply voltage from a single 5 V supply up to ±15 V supplies.
3. The offset voltages and offset currents given are the maximum values required to drive the output within a volt of either supply with 1 mA load. Thus, these parameters define an error band and take into account the worst case effects of voltage gain and input impedance.
4. The response time specified is for a 100 mV input step with 5 mV over-drive.
5. Do not short the strobe pin to ground; it should be current driven at 3 mA to 5 mA.
6. LM311B, all parameters are at V+ = 3 V ±10%; V– = GND = 0 V.

## TYPICAL APPLICATIONS

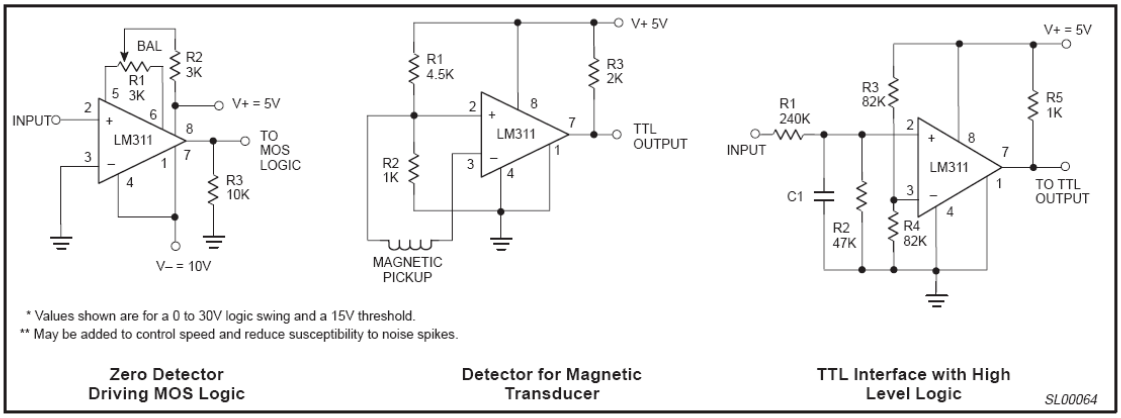
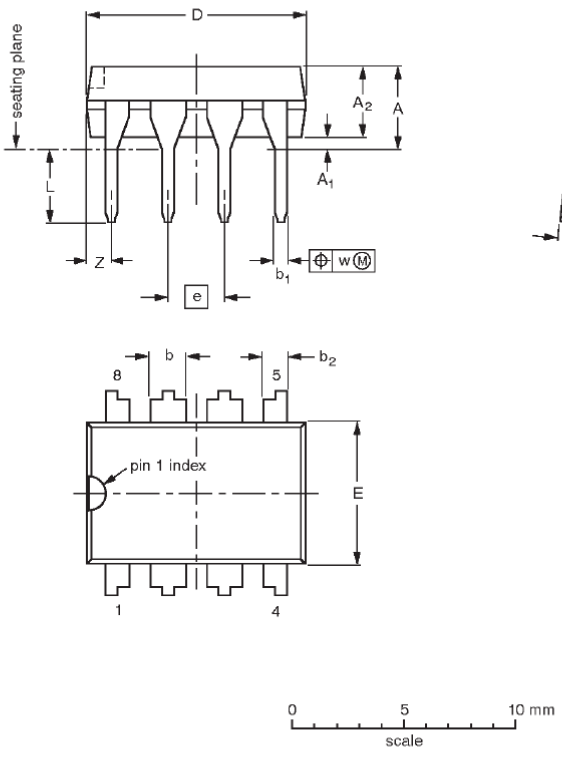



**Figure 3. Typical Applications**

**DIP8: plastic dual in-line package; 8 leads (300 mil)** **SOT97-1**




**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

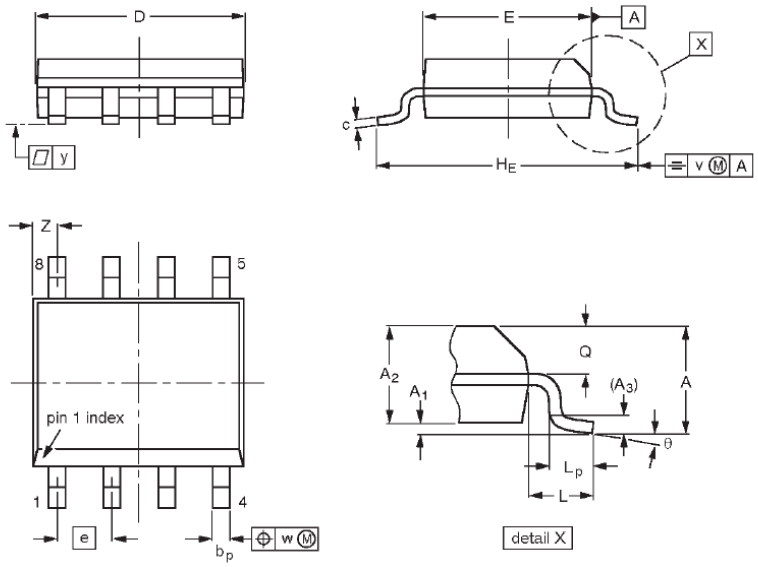
| UNIT | A max. | $A_1$ min. | $A_2$ max. | b | $b_1$ | $b_2$ | c | $D^{(1)}$ | $E^{(1)}$ | e | $e_1$ | L | $M_E$ | $M_H$ | w | $Z^{(1)}$ max. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 4.2 | 0.51 | 3.2 | 1.73<br>1.14 | 0.53<br>0.38 | 1.07<br>0.89 | 0.36<br>0.23 | 9.8<br>9.2 | 6.48<br>6.20 | 2.54 | 7.62 | 3.60<br>3.05 | 8.25<br>7.80 | 10.0<br>8.3 | 0.254 | 1.15 |
| inches | 0.17 | 0.020 | 0.13 | 0.068<br>0.045 | 0.021<br>0.015 | 0.042<br>0.035 | 0.014<br>0.009 | 0.39<br>0.36 | 0.26<br>0.24 | 0.10 | 0.30 | 0.14<br>0.12 | 0.32<br>0.31 | 0.39<br>0.33 | 0.01 | 0.045 |

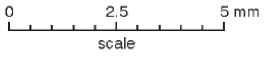
**Note**

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT97-1 | 050G01 | MO-001 | SC-504-8 | | | ~~95-02-04~~<br>99-12-27 |

**SO8: plastic small outline package; 8 leads; body width 3.9 mm** **SOT96-1**




**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | $D^{(1)}$ | $E^{(2)}$ | e | $H_E$ | L | $L_p$ | Q | v | w | y | $Z^{(1)}$ | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.75 | 0.25<br>0.10 | 1.45<br>1.25 | 0.25 | 0.49<br>0.36 | 0.25<br>0.19 | 5.0<br>4.8 | 4.0<br>3.8 | 1.27 | 6.2<br>5.8 | 1.05 | 1.0<br>0.4 | 0.7<br>0.6 | 0.25 | 0.25 | 0.1 | 0.7<br>0.3 | $8^o$<br>$0^o$ |
| inches | 0.069 | 0.010<br>0.004 | 0.057<br>0.049 | 0.01 | 0.019<br>0.014 | 0.0100<br>0.0075 | 0.20<br>0.19 | 0.16<br>0.15 | 0.050 | 0.244<br>0.228 | 0.041 | 0.039<br>0.016 | 0.028<br>0.024 | 0.01 | 0.01 | 0.004 | 0.028<br>0.012 | |

**Notes**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT96-1 | 076E03 | MS-012 | | | | ~~97-05-22~~<br>99-12-27 |

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|---|---|---|
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