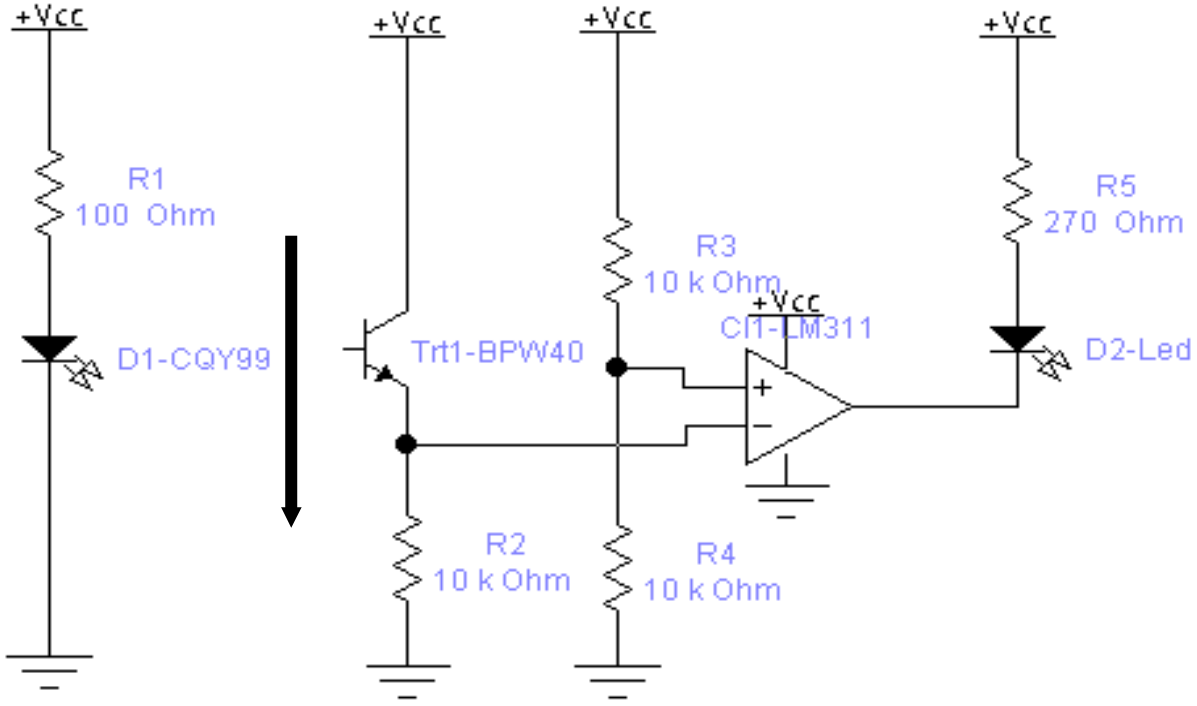
FUNDAMENTOS DE TECNOLOGÍA DE COMPUTADORES
PRÁCTICAS DE LABORATORIO

Fotoemisores – Fototransistores

Se realizará el montaje de una barrera fotoeléctrica por medio de un fotoemisor y un fototransistor (fotorreceptor), ambos trabajando en el espectro infrarrojo. Esta práctica se realizará utilizando la maleta de montaje de prototipos y con componentes físicos de inserción. Nos encontramos con un componente nuevo que es un comparador de señales eléctricas (LM311). Este comparador detecta la presencia o no de un objeto interrumpiendo el haz de luz infrarroja.

Se realizarán los cálculos teóricos de las tensiones y corrientes así como las medidas físicas de corriente y tensión. Para esto ultimo, utilizaremos el polímetro como instrumento de medida.



Rellenad con los valores observados mediante los instrumentos de que disponemos, los valores de la siguiente tabla (por favor, indicad claramente las unidades):

	Con barrera entre D_1 y Trt1	**Sin barrera entre D1 y Trt1**
Intensidad a través del diodo D1		
Tensión en el emisor de Trt1 (En R2)		
Tensión en entrada + al comparador (En R4)		
Tensión en la salida del comparador		
Intensidad a través del diodo D2		

La lista de componentes es la siguiente:

Resistencias	**Componente**
100 Ω	R1
10 KΩ	R2,R3,R4
270 Ω	R5
Fotodiodos	
L53F3C	D1
Fototransistores	
L53P3C	Trt1
Diodos Led	
Rojo	D2
Circuitos Integrados	
LM311	CI1

Fotoemisor:
Diodo emisor de luz en el entorno del infrarrojo provisto de una lente para focalizar mejor la luz emitida.

Fototransistor:
Sensible en un espectro más amplio que comprende tanto el infrarrojo como la luz visible. Está también provisto de una lente para mejorar el enfoque.

Comparador:
Realiza la comparación entre las dos entradas, cuando el terminal (+) es mayor en valor absoluto que el terminal (-), la salida presenta un estado de alta impedancia por ser un colector abierto. Cuando el terminal (-) es mayor en valor absoluto que el terminal (+) la salida será un 0 V.

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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

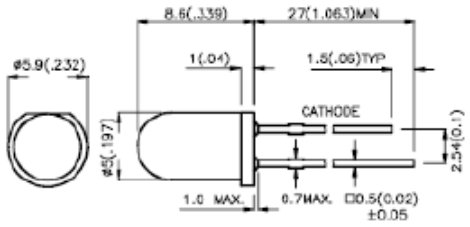
- MECHANICALLY AND SPECTRALLY MATCHED TO THE L-51P3C PHOTOTRANSISTOR.
- BOTH WATER CLEAR LENS AND BLUE TRANSPARENT LENS AVAILABLE HIGH POWER OUTPUT.

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 SF4 SF6 SF7	V_F	1.2 1.3 1.35 1.4	1.5 1.7 1.6 1.8	V	IF=20mA
Reverse Current	F3 SF4 SF6 SF7	I_R	-	10 10 10 10	uA	VR=5V
Junction Capacitance	F3 SF4 SF6 SF7	C	90 90 30 30	-	pF	V=0 f=1MHz
Peak Spectral Wavelength	F3 SF4 SF6 SF7	λP	940 880 860 850	-	nm	IF=20mA
Spectral Bandwidth	F3 SF4 SF6 SF7	Δλ	50 50 50 41	-	nm	IF=20mA

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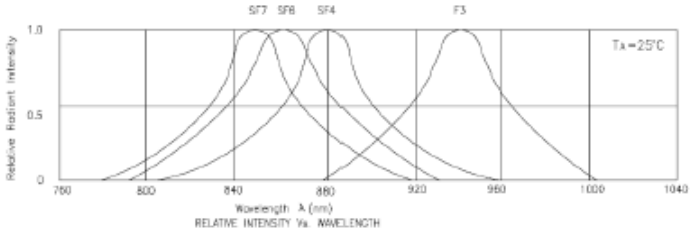
Absolute Maximum Ratings at T_A=25°C

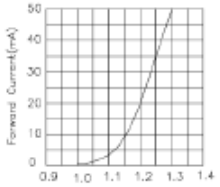
Item	Symbol	F3&SF4	SF6&SF7	Units
Power Dissipation	Pd	100	100	mW
Forward Current	I_F	50	50	mA
Peak Forward Current	I_P	1.2	1	A
Reverse Voltage	V_R	5	5	V
Operating Temperature	Topr	-40~ +85	-40~ +85	°C
Storage Temperature	Tstg	-40~ +85	-40~ +85	°C

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

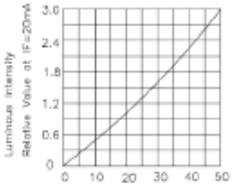


RELATIVE INTENSITY Vs. WAVELENGTH

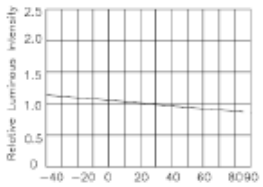
L-53F3C, L-53F3BT



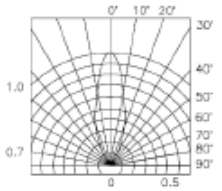
FORWARD CURRENT Vs. FORWARD VOLTAGE



LUMINOUS INTENSITY Vs. FORWARD CURRENT



LUMINOUS INTENSITY Vs. AMBIENT TEMPERATURE



SPATIAL DISTRIBUTION

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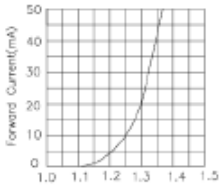
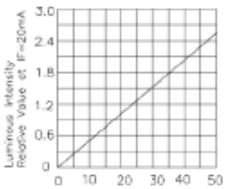
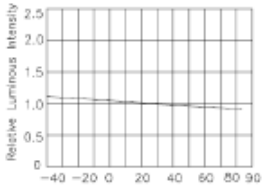
L-53SF4C, L-53SF4BT



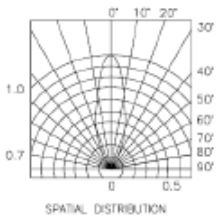
FORWARD CURRENT Vs
FORWARD VOLTAGE



LUMINOUS INTENSITY Vs.
FORWARD CURRENT

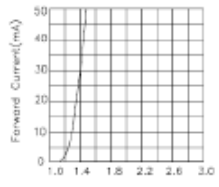


LUMINOUS INTENSITY Vs.
AMBIENT TEMPERATURE

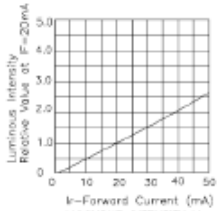


SPATIAL DISTRIBUTION

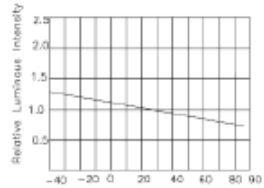
L-53SF6C, L-53SF6BT



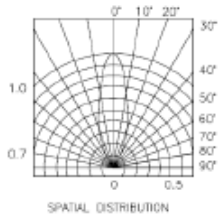
FORWARD CURRENT Vs
FORWARD VOLTAGE



LUMINOUS INTENSITY Vs.
FORWARD CURRENT

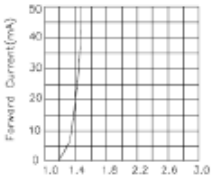


LUMINOUS INTENSITY Vs.
AMBIENT TEMPERATURE

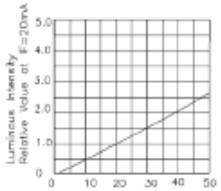


SPATIAL DISTRIBUTION

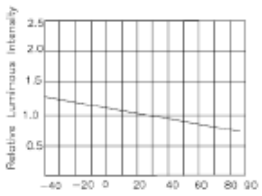
L-53SF7C, L-53SF7BT



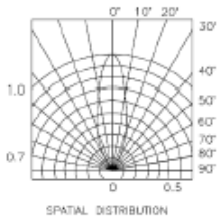
FORWARD CURRENT Vs
FORWARD VOLTAGE



LUMINOUS INTENSITY Vs.
FORWARD CURRENT



LUMINOUS INTENSITY Vs.
AMBIENT TEMPERATURE



SPATIAL DISTRIBUTION

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PHOTOTRANSISTOR

L-53P3C

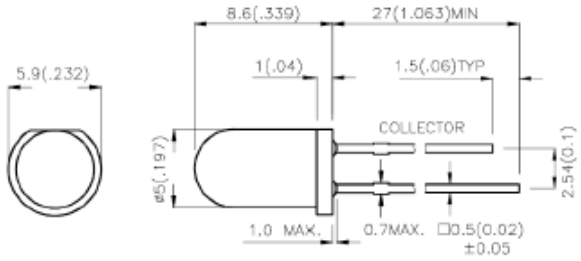
Features

- 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 E_e=0mW/cm²
$V_{BR\ ECO}$	Emitter-to-Collector Breakdown Voltage	5	-	-	V	I_E=100uA E_e=0mW/cm²
$V_{CE\ (SAT)}$	Collector-to-Emitter Saturation Voltage	-	-	0.8	V	I_C=2mA E_e=20mW/cm²
I_{CEO}	Collector Dark Current	-	-	100	nA	V_{CE}=10V E_e=0mW/cm²
T_R	Rise Time (10% to 90%)	-	3	-	us	V_{CE}=5V I_C=1mA 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 E_e=1mW/cm² 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 (>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.

PIN CONFIGURATION

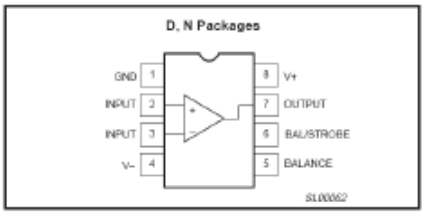


Figure 1. Pin Configuration

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

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

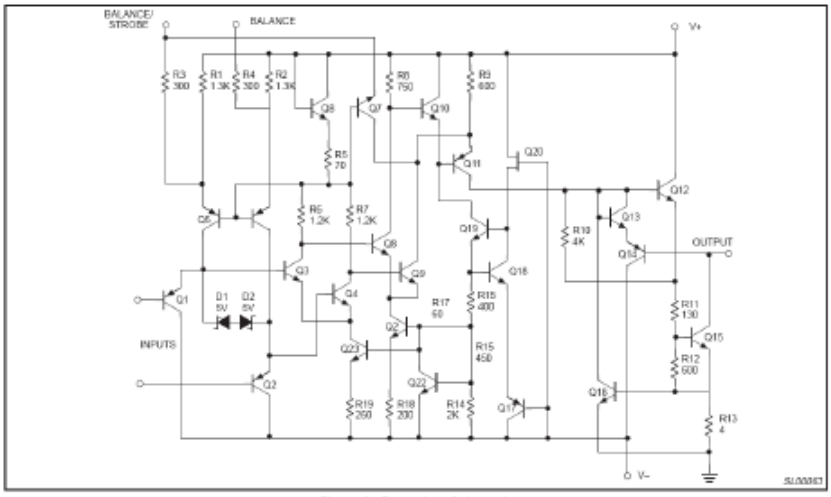


Figure 2. Equivalent Schematic

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_S	Total supply voltage	36	V
	Output to negative supply voltage: LM111/LM211 LM311/LM311B	 50 40	 V 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] N package D package	 1190 780	 mW mW
t	Output short-circuit duration	10	sec
T_{amb}	Operating ambient temperature range LM111 LM211 LM311/LM311B	 –55 to +125 –25 to +85 0 to +70	 °C °C °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[5]	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		1.8	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

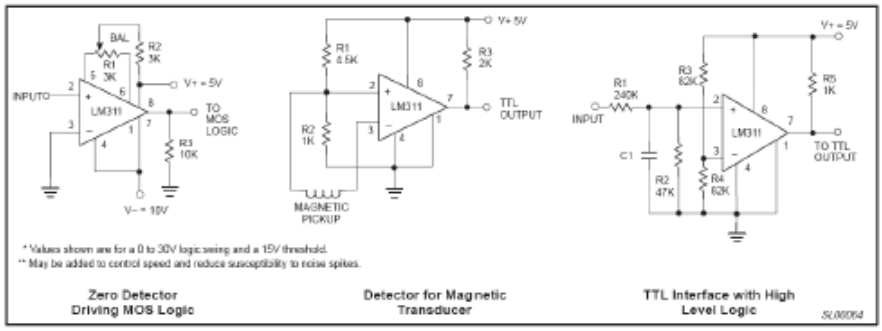
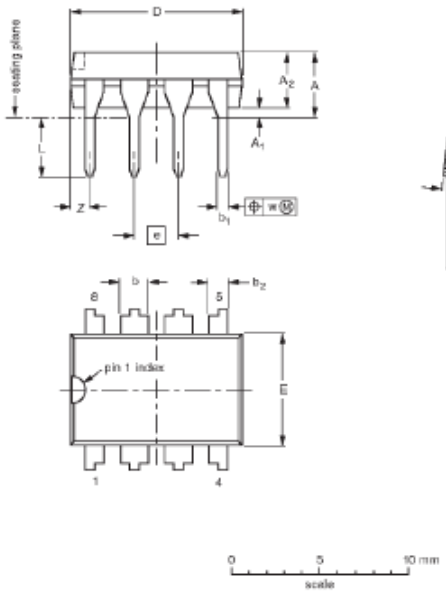


Figure 3. Typical Applications

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



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

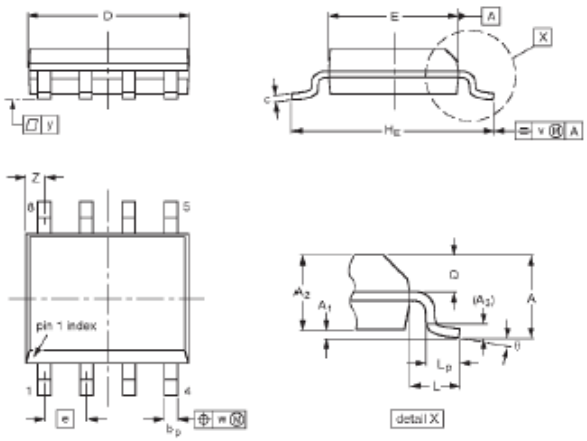
UNIT	A max.	A_1 min.	A_2 max.	b	b_1	b_2	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.2	0.51	3.2	1.73 1.14	0.53 0.38	1.07 0.89	0.36 0.23	9.8 9.2	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	1.15
inches	0.17	0.020	0.13	0.068 0.045	0.021 0.015	0.042 0.035	0.014 0.009	0.39 0.36	0.26 0.24	0.10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

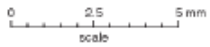
Note

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~~ 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 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	5.0 4.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.20 0.19	0.16 0.15	0.050	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 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~~ 99-12-27

Data sheet status

Data sheet status [1]	Product status [2]	Definitions
Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
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Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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