NEC Electronics Inc.

NEC

# OPTOELECTRONIC PRODUCTS

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DATA BOOK

NEC

OPTOELECTRONIC PRODUCTS

# 1985 OPTOELECTRONICS DATA BOOK

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NEC

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# GENERAL INFORMATION 1

**Section 1 — General Information**

### Introduction

The Optoelectronics Catalog illustrates the broad line of devices that NEC offers to designers and manufacturers. The variety of components gives greater design alternatives and the ability to choose the part that truly fits the product needs. NEC's componets are designed to satisfy industrial, communication, instrumentation, and consumer applications.

Designed for easy reference, the catalog is divided into the following sections.

**General Information** — Selection guides, cross reference, ordering information and handling precautions.

**Quality and Reliability** — Detailed specifications of Q and R product testing.

**Standard LED's and Fashion LED's** — Light Emitting Diodes are available in red, green, amber, and infrared wavelengths. Standard shapes and sizes, as well as NEC designed fashion lamps are also available.

**Photo Couplers** — NEC's photo couplers come in standard configurations, as well as proprietary high-performance devices.

**Photo Interrupters** — These devices are available in standard and unique NEC sizes. All have superior efficiency, stability and operating characteristics.

**Photo Transistors and Photo Diodes** — NEC has a wide variety of components available to meet a majority of design applications.

### Ordering Information

NEC Electronics offers a broad line of optoelectronic products in the NEPOC series, giving the designer flexibility and the latest in semiconductor technology.

NEC has maintained technological leadership in all facets of optoelectronics, including visible LEDs, infrared (IR) LEDs, photo interrupters, photo sensors, and photo couplers. These devices are designed to cover industrial, communication, instrumentation, and consumer applications with NEC's high quality and reliability.

### Numbering System

S Y 4 03 D A

**Type Code**

**Color Code**

R = Red
G = Green
Y = Yellow or Amber
E = Infrared

**Color and Material**

1 = Red, GaAsP/GaAs λ = 660 nm
2 = Green, GaP/GaP λ = 565 nm
3 = Infrared, GaAs λ = 940 nm
4 = Yellow, GaAsP/GaP λ = 585 nm
5 = Red, GaP/GaP λ = 695 nm
6 = Red, GaAsP/GaP λ = 630 nm
10 = Infrared, GaAlAs λ = 950 nm

**Style Codes**

03, 13 = T1¾, 5 mm Lamp
05, 15 = T1, 3 mm Lamp
3X, 4X, 6X = Fashion Flat Top LED

**Lens Type**

D = Diffused, Tinted
T = Transparent, Tinted
C = Clear, Colorless
W = White, Diffused

**Revision**

The letters A to J are designated for changes in parameter or production process.

## SELECTION GUIDES

### Red — Light Emitting Diodes

| NEC Part Number | MAX $P_D$ (mW) | MAX $I_F$ (mA) | Typical $V_F$ (V) | Typical $I_R$ (μA) | Typical $I_V$ (mcd) | Typical Wavelength (nm) |
|---|---|---|---|---|---|---|
| SR106D/C | 80 | 40 | 1.6 | 0.01 | 1.5/2.5 | 660 |
| SR503D/C/W | 60 | 30 | 2.0 | 0.01 | 5/10/5 | 695 |
| SR505D/C/W | 60 | 30 | 2.0 | 0.01 | 3.5/6/3.5 | 695 |
| SR506D/C | 60 | 30 | 2.0 | 0.01 | 1/2 | 695 |
| SR513D/C/W | 60 | 30 | 2.0 | 0.01 | 5/10/5 | 695 |
| SR531D | 60 | 30 | 2.0 | 0.01 | 0.5 | 695 |
| SR533D | 60 | 30 | 2.0 | 0.01 | 0.5 | 695 |
| SR535D | 60 | 30 | 2.0 | 0.01 | 0.5 | 695 |
| SR536D | 60 | 30 | 2.0 | 0.01 | 0.5 | 695 |
| SR537D | 60 | 30 | 2.0 | 0.01 | 0.5 | 695 |
| SR538D | 60 | 30 | 2.0 | 0.01 | 0.5 | 695 |
| SR539D | 60 | 30 | 2.0 | 0.01 | 0.5 | 695 |
| SR540D | 60 | 30 | 2.0 | 0.01 | 0.7 | 695 |
| SR603D/C/W | 100 | 50 | 2.0 | 0.01 | 3/6/3 | 630 |
| SR605D/C/W | 80 | 40 | 2.0 | 0.01 | 5/10/5 | 630 |
| SR613D/C/W | 100 | 50 | 2.0 | 0.01 | 7/20/7 | 630 |
| SR615D/C/W | 100 | 50 | 2.0 | 0.01 | 8/16/8 | 630 |
| SR632D | 100 | 40 | 2.0 | 0.01 | 1.2 | 630 |
| SR661D | 100 | 40 | 2.0 | 0.01 | 1.0 | 630 |

**Note:** $V_F$ ..... Measured at $I_F$=10 mA, except SR106 $I_F$=20 mA.
$I_R$ ..... Measured at $V_R$=4.5V, except SR106 $V_R$=3V.
$I_V$ ..... Measured at $I_F$=10 mA, except SR106 $I_F$=20 mA.
Wavelength measured at $I_F$=10 mA.

### Green—Light Emitting Diodes

| NEC Part Number | MAX $P_D$ (mW) | MAX $I_F$ (mA) | Typical $V_F$ (V) | Typical $I_R$ (μA) | Typical $I_V$ (mcd) | Typical Wavelength (nm) |
|---|---|---|---|---|---|---|
| SG203DA/TA | 100 | 40 | 2.0 | 0.01 | 8/13 | 565 |
| SG205D/T | 100 | 40 | 2.0 | 0.01 | 3/5 | 565 |
| SG206D/T | 100 | 40 | 2.0 | 0.01 | 1.5/3 | 565 |
| SG213D/T | 100 | 40 | 2.0 | 0.01 | 15/45 | 565 |
| SG215D/T | 100 | 40 | 2.0 | 0.01 | 10/20 | 565 |
| SG231D | 100 | 40 | 2.0 | 0.01 | 1.0 | 565 |
| SG233D | 100 | 40 | 2.0 | 0.01 | 1.0 | 565 |
| SG235D | 100 | 40 | 2.0 | 0.01 | 1.0 | 565 |
| SG236D | 100 | 40 | 2.0 | 0.01 | 1.0 | 565 |
| SG237D | 100 | 40 | 2.0 | 0.01 | 1.0 | 565 |
| SG238D | 100 | 40 | 2.0 | 0.01 | 1.0 | 565 |
| SG239D | 100 | 40 | 2.0 | 0.01 | 1.0 | 565 |
| SG240D | 100 | 40 | 2.0 | 0.01 | 1.5 | 565 |
| SG261D | 100 | 40 | 2.0 | 0.01 | 1.5 | 565 |

**Note:** $V_F$ ..... Measured at $I_F$ = 10mA.
$I_R$ ..... Measured at $V_R$ = 4.5V.
$I_V$ ..... Measured at $I_F$ = 10mA.
Wavelength measured at $I_F$ = 10mA.

### Amber/Yellow — Light Emitting Diodes

| NEC Part Number | MAX $P_D$ (mW) | MAX $I_F$ (mA) | Typical $V_F$ (V) | Typical $I_R$ (μA) | Typical $I_V$ (mcd) | Typical Wavelength (nm) |
|---|---|---|---|---|---|---|
| SY403DA/TA | 100 | 40 | 2.0 | 0.01 | 10/30 | 590 |
| SY405D/T | 100 | 40 | 2.2 | 0.01 | 2/4 | 590 |
| SY406D/T | 100 | 40 | 2.0 | 0.01 | 3/4 | 590 |
| SY413D/T | 100 | 40 | 2.0 | 0.01 | 10/30 | 590 |
| SY415D/T | 100 | 40 | 2.0 | 0.01 | 10/20 | 590 |
| SY431D | 100 | 40 | 2.0 | 0.01 | 1.0 | 590 |
| SY432D | 100 | 40 | 2.0 | 0.01 | 1.2 | 590 |
| SY433D | 100 | 40 | 2.0 | 0.01 | 1.0 | 590 |
| SY435D | 100 | 40 | 2.0 | 0.01 | 1.0 | 590 |
| SY436D | 100 | 40 | 2.0 | 0.01 | 1.0 | 590 |
| SY437D | 100 | 40 | 2.0 | 0.01 | 1.0 | 590 |
| SY438D | 100 | 40 | 2.0 | 0.01 | 1.0 | 590 |
| SY439D | 100 | 40 | 2.0 | 0.01 | 1.0 | 590 |
| SY440D | 100 | 40 | 2.0 | 0.01 | 1.5 | 590 |
| SY461D | 100 | 40 | 2.0 | 0.01 | 1.5 | 590 |

**Note:** $V_F$ ..... Measured at $I_F$=10 mA
$I_R$ ..... Measured at $V_R$=4.5V
$I_V$ ..... Measured at $I_F$=10 mA
Wavelength measured at $I_F$=10 mA.

### Infrared Light Emitting Diodes (IR LEDs)

| NEC Part Number | MAX $P_D$ (mW) | MAX $I_F$ (mA) | Typical $V_F/I_F$ (V/mA) | Typical $I_R$ (μA) | Typical $P_O$ (mW) | Typical Wavelength |
|---|---|---|---|---|---|---|
| SE301A | 150 | 100 | 1.2 /50 | 0.01 | 6 | 940nm |
| SE302A | 75 | 50 | 1.2 /30 | 0.01 | 1.5 | 940nm |
| SE303A | 150 | 100 | 1.25/50 | 0.01 | 6.5 | 940nm |
| SE306 | 100 | 50 | 1.1 /10 | 10 | 0.5 | 940nm |
| SE307 | 150 | 100 | 1.45/50 | N/A | 15 | 940nm |
| SE308 | 100 | 50 | 1.14/20 | 10 | 0.85 | 940nm |
| SE1003 | 150 | 50 | 1.25/50 | 0.01 | 20 | 950nm |

**Note:** $I_R$ tested at ..... $V_R$=3V.
$P_O$ tested at ..... $I_F$=30 mA.
Wavelength tested at ..... $I_F$=30 mA.
$T_A$ = 25°C for all data.

## SELECTION GUIDES (Cont)

### Photo Couplers

| NEC Part Number | $I_F$ (mA) MAX | $I_C$ (mA) MAX | $V_{ISO}$ (VAC) MAX | $V_F/I_F$ (V/mA) MAX | $I_{CEO}$ (nA) MAX | CTR/$I_F$ (%/mA) MIN | $V_{CE}$(sat) (IC=2mA) MAX | $BV_{CEO}$ (V) MIN |
|---|---|---|---|---|---|---|---|---|
| 4N25 | 80 | 100 | 2500* | 1.4/10 | 50 | 20/20 | 0.3 | 30 |
| MCT2 | 80 | 100 | 2000 | 1.4/10 | 50 | 20/20 | 0.3 | 30 |
| PS2002B | 50 | 50 | 2500* | 1.9/5 | 400 | 100/5 | 1.2 | 40 |
| PS2004B | 50 | 200 | 2000 | 1.4/20 | 400 | 1300/5 | 1.2 | 30 |
| PS2005B | 150 | 50 | 2000 | 2.0/100 | 200 | 10/100 | 0.3 (4mA) | 30 |
| PS2006B | 25 | 8 | 3000* | 1.7/16 | N/A | 15 | N/A | |
| PS2007B | 10 | 50 | 3000* | 1.7/10 | TTL | 600 | TTL out | |
| PS2010 | 80 | 100 | 2000 | 1.4/10 | 50 | 20/20 | 0.3 | 30 |
| PS2021 | 80 | 100 | 4000 | 1.4/10 | 50 | 50/10 | 0.3 | 40 |
| PS2022 | 80 | 100 | 4000 | 1.4/10 | 100 | 200/10 | 1.0 | 40 |
| PS2031 | 80 | 100 | 2000 | 1.4/10 | 50 | 20/20 | 0.3 | 200 |
| PS2401A | 80 | 80 | 5000 | 1.4/10 | 100 | 80/5 | 0.3 | 40 |

Note: $I_{CEO}$ measured at $V_{CE}$=10V and $I_F$=0.
*Denotes DC volts; all others in AC volts.

### Photo Couplers—SCR Type

| NEC Part Number | $V_{DRM}$ (V) MAX | $I_T$ (mA) MAX | $V_{ISO}$ ($V_{RMS}$) MIN | $V_F/I_F$ (V/mA) MAX | $I_{DRM}$* (uA) MAX | $V_{TM}$ (V) MAX | $I_{FT}$* (mA) MAX |
|---|---|---|---|---|---|---|---|
| PS3001 | 200 | 300 | 2000 | 1.4/20 | 100 | 1.3 | 12 |
| PS3002 | 400 | 300 | 2000 | 1.4/20 | 100 | 1.3 | 12 |
| PS3001(1) | 200 | 300 | 2500 | 1.4/20 | 100 | 1.3 | 12 |
| PS3002(1) | 400 | 11 | 2500 | 1.4/20 | 100 | 1.3 | 12 |

Note: $I_{DRM}$ with $R_{GK}$ = 27kΩ and $T_A$ = 100°C.
$V_{TM}$ with $I_T$ = 300 mA.
$I_{FT}$ with $V_D$ = 6V and $R_{GK}$ = 27Ω.
*Maximum Value

### Photo Transistors

| NEC Part Number | $P_C$ (mW) MAX | $I_C$ (mA) MAX | $V_{CEO}$ (V) MAX | $I_{CEO}$ (nA) MAX | $V_{CE}$(sat) (V) MAX | $I_L$* (mA) MIN |
|---|---|---|---|---|---|---|
| PH101 | 100 | 50 | 20 | 500 | 1.5 | 4 |
| PH102 | 100 | 40 | 30 | 200 | 0.3 | .050 |
| PH103 | 100 | 50 | 30 | 400 | 1.5 | 2 |
| PH104 | 100 | 40 | 30 | 100 | 0.3 | .020 |
| PH106 | 100 | 40 | 30 | 100 | 0.3 | .060 |
| PH108 | 100 | 40 | 30 | 100 | 0.3 (IC=0.5mA) | 0.3 ($V_{CE}$=5V) |
| | | | | | (H=5.0mW/cm²) | (H=0.5mW/cm²) |

Note: $I_{CEO}$ tested at ..... $V_{CE}$=10V — L=0.
$V_{CE(sat)}$ tested at ..... L=1000lx.
$I_L$ tested at ..... $V_{CE}$=2V — L=100lx.
*Minimum Value

### Photo Interrupters

| NEC Part Number | $I_F$ (mA) MAX | $V_{CEO}$ (V) MAX | $I_C$ (mA) MAX | $V_F$ (V) MAX | $I_{CEO}$ (nA) MAX | $V_{CE}$(sat) (V) MAX | CTR (%) MIN |
|---|---|---|---|---|---|---|---|
| PS4001 | 50 | 30 | 50 | 1.1 | 400 | 1.2 | 20 |
| PS4003 | 50 | 30 | 50 | 1.1 | 400 | 1.2 | 15 |
| PS4005 | 50 | 30 | 50 | 1.1 | 400 | 1.2 | 20 |
| PS4007 | 50 | 30 | 50 | 1.1 | 400 | 1.2 | 20 |
| PS4008 | 50 | 30 | 40 | 1.1 | 100 | 0.3 | 0.5 |
| PS4009 | 50 | 30 | 50 | 1.1 | 400 | 1.2 | 20 |
| PS4010 | 50 | 30 | 50 | 1.1 | 400 | 1.2 | 20 |
| PS4011 | 50 | 30 | 50 | 1.1 | 400 | 1.2 | 20 |
| PS4014 | 50 | 30 | 40 | 1.1 | 100 | 0.3 | 0.5 |
| PS6001 | 50 | 30 | 40 | 1.4 | N/A | 0.3 | N/A |

Note: $V_F$ tested at ..... $I_F$=20mA, except PS6001A $I_F$=30mA.
$I_{CEO}$ tested at ..... $V_{CE}$=10V and $I_F$=0.
$V_{CE(sat)}$ tested at ..... $I_F$=10 mA—$I_C$=0.5 mA.
CTR tested at ..... $I_F$=10 mA—$V_{CE}$=2V.
PS4008/PS6001 $V_{CE(sat)}$ tested at ..... $I_F$=10 mA—$I_C$=50 μA.
The PS6001 is a photo reflective sensor.

### Photo Diodes

| NEC Part Number | $V_R$ (V) MAX | $P_C$ (mW) MAX | $I_F$ (mA) MAX | Sensitivity (nA)/lx MIN | $I_D$* (pA) MAX | $t_r$ (nS) MAX |
|---|---|---|---|---|---|---|
| PH201A | 5 | N/A | 1 | 90** | 3.0 | 150μS |
| PH302 | 32 | 150 | N/A | 50 | 30 | 50 |
| PH302B | 32 | 150 | N/A | 32 | 30 | 50 |
| PH305 | 20 | 150 | N/A | 30 | 10 | 30 |
| PH309 | 20 | 150 | N/A | 50 | 30 | 30 |

Note: $t_r$ tested at ..... $R_L$=1KΩ.
$I_D$ tested at ..... $V_R$=10V, except PH201 $V_R$=2.0V.
Sensitivity in units of nA/lx, except PH201 L=100lx.
Wavelength of maximum sensitivity is 940nm.
*Maximum Value
**Measured in nA

## CROSS REFERENCE GUIDE

### Photo Couplers

| Fairchild No. | NEC No. | Notes |
|---|---|---|
| FCD810 | PS2010 | 1 |
| FCD810C | PS2021 | 1 |
| FCD820 | PS2010 | 1 |
| FCD820C | PS2021 | 1 |
| FCD825 | PS2010L/K | 1 |
| FCD825C | PS2021 | 1 |
| FCD830 | PS2010 | 1 |
| FCD830C | PS2021 | 1 |
| FCD831 | PS2010 | 1 |
| FCD831C | PS2021 | 1 |
| FCD836 | PS2010 | 1 |
| FCD836C | PS2021 | 1 |

| General Electric No. | NEC No. | Notes |
|---|---|---|
| CNY17I | PS2021M | 2,3 |
| CNY17II | PS2021M | 2,3 |
| CNY17III | PS2021 | 2,3 |
| CNY17IV | PS2021 | 2,3 |
| CNY30 | PS3001 | 1 |
| CNY31 | PS2022 | 3 |
| CNY32 | PS2021 | 3 |
| CNY34 | PS3002L | 1 |
| CNY47 | PS2010M | 1 |
| CNY47A | PS2010L/K | 1 |
| CNY48 | PS2022L | 1 |
| CNY51 | PS2021K | 2,3 |
| H11A1 | PS2010L/K | 1 |
| H11A2 | PS2010 | 1 |
| H11A3 | PS2010 | 1 |
| H11A4 | PS2010 | 1 |
| H11A5 | PS2010 | 1 |
| H11A520 | PS2021L | 2,3 |
| H11A550 | PS2021L | 2,3 |
| H11A5100 | PS2021K | 2,3 |
| H11B1 | PS2022L/K | 1 |
| H11B2 | PS2022 | 1 |
| H11B255 | PS2022 | 4 |
| H11B3 | PS2022 | 1 |
| H11C1 | PS3001(1) | 1 |
| H11C2 | PS3001 | 1 |
| H11C3 | PS3001 | 1 |
| H11C4 | PS3002(1) | 1 |
| H11C5 | PS3002 | 1 |
| H11C6 | PS3002 | 1 |
| H15A1 | PS2021 | 3 |
| H15A2 | PS2021 | 3 |
| H15B1 | PS2022 | 3 |
| H15B2 | PS2022 | 3 |

| General Instrument No. | NEC No. | Notes |
|---|---|---|
| MCA230 | PS2022 | 3 |
| MCA231 | PS2022 | 3 |
| MCA255 | PS2022 | 2 |
| MCA8 | PS4001 | |
| MCA81 | PS4001 | |
| MCS2 | PS3001(1) | 1 |
| MCS2400 | PS3002(1) | 1 |
| MCT2 | PS2010 | 1 |
| MCT2E | PS2021 | 1 |
| MCT26 | PS2010 | 1 |
| MCT210 | PS2021K | 1 |
| MCT271 | PS2021M | 2 |
| MCT272 | PS2021L | 2 |
| MCT273 | PS2021K | 2 |
| MCT277 | PS2021K | 1 |
| MCT4 | PS1001 | 4 |
| MCT4R | PS1001 | 4 |
| MCT6 | PS2401A-2 | 4 |
| MCT66 | PS2401A-2 | 4 |
| MCT8 | PS4014 | |
| MCT81 | PS4014 | |

| Hewlett-Packard No. | NEC No. | Notes |
|---|---|---|
| 6N135 | PS2006B | 1 |
| 6N136 | PS2006B | 1 |
| 6N137 | PS2007B | 1 |
| HCPL-2502 | PS2006B | 2 |
| HCPL-2601 | PS2007B | 4 |

| Jedec No. | NEC No. | Notes |
|---|---|---|
| 4N25 | PS2021 | 1,3 |
| 4N25A | PS2010 | 1 |
| 4N26 | PS2010 | 1 |
| 4N27 | PS2010 | 1 |
| 4N28 | PS2010 | 1 |
| 4N29 | PS2022 | 2,3 |
| 4N29A | PS2022 | 2,3 |
| 4N30 | PS2022 | 2,3 |
| 4N31 | PS2022 | 2,3 |
| 4N32 | PS2022 | 2,3 |
| 4N32A | PS2022 | 2,3 |
| 4N33 | PS2022 | 2,3 |
| 4N35 | PS2021L | 1 |
| 4N36 | PS2010K | 1 |
| 4N37 | PS2010K | 1 |
| 4N39 | PS3001 | 1 |
| 4N40 | PS3002 | 1 |

| Litronics No. | NEC No. | Notes |
|---|---|---|
| IL-1 | PS2010 | 1 |
| IL-12 | PS2010 | 2 |
| IL-15 | PS2010 | 2 |
| IL-16 | PS2010 | 2 |
| IL-100 | PS2007B | 4 |
| IL-101 | PS2007B | 4 |
| IL-5 | PS2010M | 2 |
| ILA-30 | PS2022 | 1 |
| ILA-55 | PS2022 | 2,3 |

**Notes:** 1. Direct replacement.
2. Equivalent (minor electrical difference).
3. Equivalent (minor mechanical difference).
4. Different (significant difference, electrical or mechanical).

## CROSS REFERENCE GUIDE (Cont)

### Photo Couplers

| Litronics No. (cont.) | NEC No. | Notes |
|---|---|---|
| ILCA2-30 | PS2022 | 1 |
| ILCA2-55 | PS2022 | 2, 3 |
| ILCT-6 | PS2401A-2 | 4 |
| ILD-74 | PS2401A-2 | 4 |
| ILQ-74 | PS2401A-4 | 4 |
| **Siemens No.** | **NEC No.** | **Notes** |
| CNY17I | PS2021M | 2, 3 |
| CNY17II | PS2021L/M | 2, 3 |
| CNY17III | PS2021L | 2, 3 |
| CNY17IV | PS2021K | 2, 3 |
| CNY18II | PS1001 | 4 |
| CNY18III | PS1001 | 4 |
| CNY18IV | PS1001 | 4 |
| CNY18V | PS1001 | 4 |
| SFH600I | PS2010L | 2 |
| SFH600II | PS2010K | 2 |
| SFH600III | PS2021K | 2, 3 |
| SFH601-1 | PS2021M | 2, 3 |
| SFH601-2 | PS2021M | 2, 3 |
| SFH601-3 | PS2021L | 2, 3 |
| SFH601-4 | PS2021K | 2, 3 |
| **Spectronics No.** | **NEC No.** | **Notes** |
| SCD11B1 | PS2022 | 3 |
| SCD11B2 | PS2022 | 3 |
| SCD11B3 | PS2022 | 3 |
| SPX-103 | PS2021L/K | 2, 3 |
| SPX-2 | PS2021 | 3 |
| SPX-2E | PS2021 | 3 |
| SPX-26 | PS2021 | 3 |
| SPX-33 | PS2021 | 3 |
| SPX-35 | PS2021L/K | 2, 3 |
| SPX-4 | PS2021 | 3 |
| SPX-5 | PS2021 | 3 |
| SPX-53 | PS2021 | 3 |
| SPX-6 | PS2021 | 2, 3 |
| **Telefunken No.** | **NEC No.** | **Notes** |
| CQY-80 | PS2021L/K | 2 |
| **Texas Instrument No.** | **NEC No.** | **Notes** |
| TIL102 | PS1001 | 4 |
| TIL111 | PS2010 | 1 |
| TIL112 | PS2010 | 1 |
| TIL113 | PS2022 | 1 |
| TIL114 | PS2010 | 1 |
| TIL115 | PS2010 | 1 |
| TIL116 | PS2010 | 1 |
| TIL117 | PS2010L | 1 |
| TIL118 | PS2010 | 1 |
| TIL119 | PS2022 | 2 |

**Notes:** 1. Direct replacement.
2. Equivalent (minor electrical difference).
3. Equivalent (minor mechanical difference).
4. Different (significant difference, electrical or mechanical).

### Light Emitting Diode Lamps

| Hewlett-Packard No. | NEC No. | Notes |
|---|---|---|
| 5082-4650 | SR603D | |
| 5082-4655 | SR603D | |
| 5082-4657 | SR603C | |
| 5082-4658 | SR603C | |
| 5082-4684 | SR605D | |
| 5082-4160 | SR605D | |
| 5082-4550 | SY403DA | |
| 5082-4555 | SY403DA | |
| 5082-4557 | SY403TA | |
| 5082-4558 | SY403TA | |
| 5082-4584 | SY405D | |
| 5082-4150 | SY406D | |
| 5082-4950 | SG203DA | |
| 5082-4955 | SG203DA | |
| 5082-4957 | SG203TT | |
| 5082-4958 | SG203TT | |
| 5082-4984 | SG205D | |
| 5082-4190 | SG206D | |
| 5082-4850 | SR503D | |
| 5082-4855 | SR503D | |
| 5082-4484 | SR505D | |
| 5082-4494 | SR505D | |
| 5082-4480 | SR505D | |
| 5082-4483 | SR505W | |
| 5082-4486 | SR505C | |
| 5082-4880 | SR503D | |
| 5082-4881 | SR503D | |
| 5082-4882 | SR503D | |
| 5082-4883 | SR503C | |
| 5082-4884 | SR503C | |
| 5082-4885 | SR503C | |
| 5082-4886 | SR503W | |
| 5082-4887 | SR503W | |
| 5082-4888 | SR503W | |
| 5082-4420 | SR504W | |
| 5082-4620 | ——— | |
| 5082-4520 | SY404D | |
| 5082-4920 | SG204D | |
| **Dialight No.** | **NEC No.** | **Notes** |
| 521-9165 | SR503D | |
| 521-9166 | SR503C | |
| 521-9190 | SR503W | |
| 521-9179 | SR503D | |
| 521-9189 | SR503D | |
| 521-9186 | SR106D | |
| 521-9195 | SR505D | |
| 521-9200 | SR503D | |
| 521-9202 | SG203TA | |
| 521-9203 | SG203DA | |
| 521-9204 | SY403TA | |
| 521-9205 | SY403DA | |
| 521-9206 | SG205D | |
| 521-9207 | SY405D | |

## CROSS REFERENCE GUIDE (Cont)

### Light Emitting Diode Lamps

| Dialight No. (cont.) | NEC No. | Notes |
|---|---|---|
| 521-9217 | SR503D | |
| 521-9185 | SR106C | |

| Litronix No. | NEC No. | Notes |
|---|---|---|
| RL-20 | SR503D | |
| RL-20-02 | ——— | |
| RL-20-03 | SR503W | |
| RL-20-04 | SR503C | |
| RL-21 | SR505D | |
| RL-21-02 | ——— | |
| RL-21-04 | SR515C | |
| RL-50 | SR106V | |
| RL-50-01 | SR106D | |
| RL-50-02 | ——— | |
| RL-50-03 | ——— | |
| RL-209 | SR505D | |
| RL-209-02 | ——— | |
| RL-209-03 | SR505W | |
| RL-209-04 | SR505C | |
| RL-54 | SR106D | |
| RL-55 | SR106D | |
| RL-4484 | SR505D | |
| RL-2000 | SR503D | |
| RL-4403 | SR503D | |
| RL4440 | SR503D | |
| RL4850 | SR503D | |
| RL-5054-1 | SR503D | |
| RL-5054-2 | SR503D | |
| OL-30 | SY403D | |
| OL-31 | SY405D | |
| YL4850 | SY403DA | |
| YL4484 | SY405D | |
| YL56 | SY406D | |
| GL4850 | SG203DA | |
| GL4484 | SG205D | |
| GL56 | SG206D | |
| IRL40 | SE301A | |
| IRL60 | SE302A | |

| General Instrument No. | NEC No. | Notes |
|---|---|---|
| MV50 | SR106D | |
| MV54 | SR106D | |
| MV52 | SG206D | |
| MV53 | SY406D | |
| MV55 | SY106D | |
| MV5020 | SR503C | |
| MV5021 | SR503W | |
| MV5022 | ——— | |
| MV5023 | SR503D | |
| MV5024 | SR503D | |
| MV5025 | SR503D | |
| MV5026 | SR503D | |
| MV5050 | SR503C | |
| MV5051 | SR503W | |
| MV5052 | ——— | |
| MV5053 | SR503D | |
| MV5054-1 | SR503D | |
| MV5054-2 | SR503D | |
| MV5054-3 | SR503D | |
| MV5055 | SR503D | |
| MV5056 | SR503D | |
| MV5074B/C | SR505D | |
| MV5075B/C | SR505D | |
| MV5152 | SY403TA | |
| MV5153 | SY503DA | |
| MV5154 | SY403DA | |
| MV5252 | SG203TA | |
| MV5253 | SG203DA | |
| MV5254 | SG203DA | |
| MV5352 | SY403TA | |
| MV5353 | SY403DA | |
| MV5752 | SR603C | |
| MV5753 | SR603D | |
| MV5354 | SY403DA | |
| MV5274B/C | SG205D | |
| MV5374B/C | SY405D | |
| MV5774B/C | SR603D | |
| ME60 | SE302A | |
| ME61 | SE302A | |
| ME7161 | SE302A | |
| ME7021 | ——— | |
| ME7161 | ——— | |

| Motorola No. | NEC No. | Notes |
|---|---|---|
| MLED60 | SE302A | |
| MLED90 | SE302A | |
| MLED500 | ——— | |
| MLED630 | SR104D | |
| MLED650 | SR503D | |
| MLED750 | SG203DA | |

| Intermetall No. | NEC No. | Notes |
|---|---|---|
| CQY65 | SR105D | |

| Stanley No. | NEC No. | Notes |
|---|---|---|
| GD-2-301R | ——— | |
| GD-2-301C | SR106C | |
| GD-2-301G | SG206T | |
| GD-4-203 | ——— | |
| GD-4-204RD | SR503D | |
| GD-4-204CD | SR503W | |
| GD-4-204GD | SG203DA | |
| GD-4-204YD | SY403DA | |
| GD-4-205RD | SR503D | |
| GD-4-205CD | SR503W | |
| GD-4-205GD | SG203DA | |
| GD-4-205YD | SY403DA | |
| GD-4-505RD | SR505D | |

**Notes:** 1. Direct replacement.
2. Equivalent (minor electrical difference).
3. Equivalent (minor mechanical difference).
4. Different (significant difference, electrical or mechanical).

## CROSS REFERENCE GUIDE (Cont)

### Light Emitting Diode Lamps

| Stanley No. (cont.) | NEC No. | Notes |
|---|---|---|
| GD-4-505CD | SR505W | |
| GD-4-505GD | SG205D | |
| GD-4-505YD | SY405D | |
| SG2-01B | ——— | |
| SG2-02B | ——— | |
| SG2-03B | ——— | |
| SG2-04B | SR505D | |
| SG2-05B | SG205D | |
| SG2-06B | SY405D | |

| Texas Instrument No. | NEC No. | Notes |
|---|---|---|
| TIL203 | SR101C | |
| TIL204 | SR104D | |
| TIL209 | SR505D | |
| TIL210 | SE301A | |

| Siemens No. | NEC No. | Notes |
|---|---|---|
| CQY17 | SE301A | |
| CQY18 | SE301A | |
| LD261 | SE302A | |
| LD30B | SR505D | |
| LD30C | SR505C | |
| LD40I | SR503D | |
| LD40II | SR503D | |
| LD50I | SR503D | |
| LD50II | SR503D | |

| Telefunken No. | NEC No. | Notes |
|---|---|---|
| CQX10 | SR503D | |
| CQX40L | SR503D | |
| CQX40/5VL | SR503D | |
| CQX40/12VL | SR503D | |
| CQX41 | SR106D | |
| CQY85 | SR505D | |
| V136PL | SR503C | |
| V137PL | SR503W | |
| V138P | SR106C | |
| V139P | ——— | |
| V169P | SR503D | |
| V178P | SR105D | |
| CQX11 | SR203DA | |
| CQX40L | SR503D | |
| CQX40/5VL | SR503D | |
| CQX40/12VL | SR503D | |
| CQX41 | SR106D | |
| CQY85 | SR505D | |
| V137PL | SR503C | |
| V137PL | SR503W | |
| V138P | SR106C | |
| V139P | ——— | |
| V169 | SR503D | |
| V178P | SR105D | |
| CQX11 | SG203D | |
| CQY72L | SG203DA | |
| V169P | SG203DA | |
| CQY73 | SG206D | |
| CQY86 | SG205D | |
| V179P | SG205D | |
| CQX12 | SY403DA | |
| CQY74L | SY403DA | |
| V170P | SY403DA | |
| CQY75 | SY406D | |
| CQY87 | SY405D | |
| V180P | SY405D | |
| CQY32 | SE301A | |
| CQY35 | SE301A | |
| CQY34 | SE301A | |
| CQY37 | SE302A | |

| Matsushita No. | NEC No. | Notes |
|---|---|---|
| LN21 | SR503D | |
| LN21W | SR503W | |
| LN21RP | SR503D | |
| LN22 | ——— | |
| LN23 | ——— | |
| LN23S | SR505W | |
| LN23S(R) | ——— | |
| LN25 | ——— | |
| LN25D | ——— | |
| LN26D | ——— | |
| LN31 | SG203DA | |
| LN32 | SG205D | |
| LN35 | ——— | |
| LN35D | ——— | |
| LN45 | ——— | |
| LN45D | ——— | |
| LN322M | ——— | |
| LN322S | SR505D | |
| LN51F/51FT | SE301A | |
| LN51L/51LT | SE301A | |
| LN52 | ——— | |
| LN55 | SE301A | |
| LN60 | SE301A | |
| LN70 | ——— | |
| LN71 | ——— | |

| OKI No. | NEC No. | Notes |
|---|---|---|
| OLD414 | SR104D, SR104DA | |
| OLD414DG | SR104D, SR104DA | |
| OLD415 | SR505C | |
| OLD415C | ——— | |
| OLD415T | SR505C | |
| OLD416 | SR106C | |
| OLD416LC | ——— | |
| OLD416LD | SR106D | |
| OLD416LT | SR106C | |
| OLD419 | ——— | |
| OLD419C | ——— | |
| OLD4101C | ——— | |

**Notes:** 1. Direct replacement.
2. Equivalent (minor electrical difference).
3. Equivalent (minor mechanical difference).
4. Different (significant difference, electrical or mechanical).

## CROSS REFERENCE GUIDE (Cont)

### Light Emitting Diode Lamps

| OKI No. (cont.) | NEC No. | Notes |
|---|---|---|
| OLD4101D | SR503D | |
| OLD41011 | SR503C | |
| OLD314D | SG204D | |
| OLD314DG | SG204D | |
| OLD315C | ——— | |
| OLD315D | SG205D | |
| OLD316LC | SG206T | |
| OLD316LT | ——— | |
| OLD319C | ——— | |
| OLD319D | ——— | |
| OLD3101C | SG203TA | |
| OLD3101D | SG203DA | |
| OLD31011T | ——— | |
| OLD714D | SY404D | |
| OLD714DG | SY404D | |
| OLD715D | SY405D | |
| OLD716LC | SY406T | |
| OLD716LT | ——— | |
| OLD719D | ——— | |
| OLD7101C | SY403TA | |
| OLD7101D | SY403DA | |
| OLD7101T | ——— | |
| OLD122 | SE301A | |
| OLD124 | SE301A | |

| Sharp No. | NEC No. | Notes |
|---|---|---|
| GL-3PR1 | SR505D | |
| GL-3PR2 | SR505D | |
| GL-5PR1 | SR503D | |
| GL-5PR2 | SR503D | |
| GL30PR | SR505D | |
| GL-30PR3 | SE505W | |
| GL-30PR8 | SR505C | |
| GL-40PR | ——— | |
| GL-40PR3 | ——— | |
| GL-31AR | SR505D | |
| GL-31AR8 | SR505C | |
| GL-32AR | SR505D | |
| GL-41AR | ——— | |
| GL-41AR3 | ——— | |
| GL-51AR | SR104D | |
| GL-30PG | SG203DA | |
| GL-30PG8 | ——— | |
| GL-40PG | ——— | |
| GL-40PG3 | ——— | |
| GL-50PG | SG204D | |
| GL50PG1 | ——— | |
| GL32PG | SG205D | |
| GL52PG | SG203DA | |
| GL52AY | SY403DA | |
| GL503 | SE301A | |
| GL504 | SE301A | |
| GL50G | SE301A | |
| GLE503 | SE301A | |
| GLE503F | SE301A | |

| Toshiba No. | NEC No. | Notes |
|---|---|---|
| TLR101 | SR104D | |
| TLR102 | SR505D | |
| TLR103 | ——— | |
| TLR104 | SR503D | |
| TLR105 | ——— | |
| TLR106 | SR503W | |
| TLR107 | ——— | |
| TLR108 | SR505C | |
| TLR109 | SR505W | |
| TLR110 | SR503C | |
| TLR113 | SR503C | |
| TLR114 | SR503D | |
| TLR115 | ——— | |
| TLR116 | SR504D | |
| TLR120 | SR503C | |
| TLR202 | ——— | |
| TLG102 | SG205D | |
| TLG103 | SG203TA | |
| TLG105 | ——— | |
| TLG107 | ——— | |
| TLG108 | SG205T | |
| TLG113 | SG203T | |
| TLG115 | ——— | |
| TLG202 | ——— | |
| TLN101 | SE301A | |
| TLN103 | SE301A | |

**Notes:** 1. Direct replacement.
2. Equivalent (minor electrical difference).
3. Equivalent (minor mechanical difference).
4. Different (significant difference, electrical or mechanical).

**Handling Precautions:**

1. Full resin-molded LED lamps generally have slightly lower mechanical and thermal strength than other resin-molded semiconductor devices, as they have less additives. Therefore, please note the following.
   (a) Leads should be soldered at a point 5mm or more from the root of the leads at 260°C and within 5s.
   (b) If the temperature of the molded portion rises, in addition to the residual stress between leads, the possibility of open or short circuiting due to deformation or breakdown of the resin will increase.
2. On cleaning the device:
   (a) Cleaning with unsuitable solvent may damage the resin of the package. The following solvents should be used at a temperature of less than 45°C with an immersion time of less than 3 min:

       Freon TE, Freon TF, ethanol, methanol
       Difron-solvent, isopropyl-alcohol

   (b) Ultrasonic cleaning will place stress on the devices. The degree of stress varies with the output power, the size of the PCB, and the mounting methods. It therefore should be confirmed experimentally, under actual conditions, that such cleaning does not have an adverse effect on the devices.

# QUALITY AND RELIABILITY 2

**Section 2 — Quality and Reliability**

### Quality and Reliability

When it comes to quality and reliability, NEC is totally committed. Our "zero defects" goal is woven into the very fabric of the company.

Our Quality and Reliability Department is one of the most powerful departments in NEC. Products are not only tested upon completion, they are tested at every phase of production — from the earliest design, to manufacturing production.

This is NEC's TQC concept — Total Quality Control. It guarantees our customers the highest possible quality performance of NEC products.

Our optoelectronic components are guaranteed to an AQL of 0.1%. At least 9,999 of every 10,000 devices will pass stringent electrical tests.



While zero defects may be an impossible goal, NEC comes closer to it than anyone else in the industry. And we're well on our way to an even higher quality standard of only one defect per every 100,000 parts produced.

NEC takes pride in offering the broadest variety of components to fit your product needs. And all with the highest quality and reliability available.

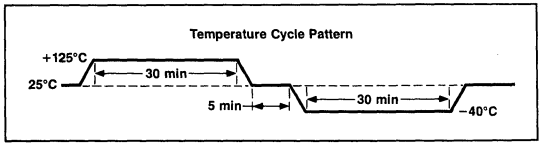
## Photo Couplers — Plastic Dip

| Sub Group | Inspection Item | LTPD |
|---|---|---|
| 1 | Major Defects (Open, Short Visual, etc.) | 1% |
| 2 | Reliability Parameters ($V_F$, $I_R$, $I_{CEO}$) | 3% |
| 3 | Operating Parameters (CTR, $V_{CE}$(sat), R1-2) | 5% |
| 4 | Minor Defects (Visual and Mechanical, etc.) | 5% |

## Process Reliability Conformance Test

| Sub Group | Test | Method MIL750B | Size Sample | Test Condition |
|---|---|---|---|---|
| 1 | External Appearance | 2066 | 11 | ———— |
| 2 | Soldering Temperature | 2301.1 | | 260 + 5°C for 10 + s once. |
| | Temperature Cycling | 1051.1 | 22 | –40 to +125°C for 5 cycles. |
| | Thermal Shock | 1056.1 | | 0 to 100°C for 5 cycles. |
| 3 | Shock | 2016.1 | | 1500g for 0.5ms, Axis X, Y, and Z, 5 cycles |
| | Vibration Var. Freq. | 2056.1 | 22 | 20G at 100Hz to 2kHz, Axis X, Y, and Z, 4min. |
| | Constant Acceleration | 2006 | | 20 kG, X, Y, and Z axis 1min/4 cycles. |
| 4 | Terminal Strength (Lead Fatigue) | 2036.1 | 11 | 227g, 90°, 3 times. |
| 5 | Salt Atmosphere | 1046.1 | 11 | 35°C, 24hr 10 to 50g/m2/day. |
| 6* | D.C. Operating Life | 1026.1 | 22 | If:Absolute maximum current $V_{CE}$=5V, for 1000 hours. |
| 7* | High Temperature Storage Life | 1031.1 | 22 | 125°C for 1 khr |
| 8* | Low Temperature Storage | 1031.1 | 22 | –40°C for 1khr |
| 9* | High Temp. and High Humidity Storage | 1021.1 | 22 | 80°C at 90% R.H. for 1khr |
| 10* | High Temp. Biased | 1031.1 | 22 | 125°C, $V_{CE}$ = 30V for 1khr |
| 11* | Temperature Cycle | 1051.1 | 100 | –40 to +125°C 50, 100, 200 cycles (see diag.) |

*Testing frequency is once every month.




## Acceptance Criteria After Reliability Conformance Test

| Item | Minimum | Maximum | Test Conditions |
|---|---|---|---|
| $V_F$ (LED) | —— | U × 1.2 | Refer to data book |
| $I_R$ (LED) | —— | U × 2.0 | Refer to data book |
| $I_{CEO}$ | —— | U × 4.0 | Refer to data book |
| CTR* | –30%L | +30%U | Refer to data book |

**Note:** U = Upper limit specified on data sheet. L = Lower limit specified on data sheet.
* Checked at 168 hours with –15%L, +15%U as acceptance criteria.

Table 2-1
An Example of Manufacturing Process Flow Chart for Light Emitting Diode (Plastic Molded Package)

| Process | Control Item | Frequency | Remarks |
|---|---|---|---|
| Materials | | | |
| LED Wafer → Diffusion | Resistivity<br>Sheet Resistance<br>Breakdown Voltage<br>Appearance | Every Lot | Magnification (40-400) |
| Acceptance Inspection | | | |
| Aluminum → Metallization | Al Thickness<br>Appearance | Every Lot | Magnification (40-400) |
| Wafer Sorting | Electrical Characteristics | 100% | |
| Pelletizing | Appearance | 100% | Magnification (40-100) |
| Lead Frame → Die Mounting | Appearance | Every Lot | Magnification (20-40) |
| Gold Bond Wire → Wire Bonding | Appearance<br>Bond Strength | Every Shift<br>Every Shift | Magnification (20-40) |
| Molding Compound → Molding | Appearance | Every Lot | Magnification (1) |
| Thermal Aging | Temperature<br>Duration | Every Day | |
| Lead Solder Plating | Appearance | Every Lot | Magnification (1) |
| Lead Shearing | Appearance | Every Lot | Magnification (1) |
| Electrical Sorting | Electrical Characteristics (100% Sorting) | 100% | |
| Reliability Verification Test | Life Test<br>Environmental Test | Every Test Lot | |
| Incoming Warehouse Inspection | Electrical Characteristics<br>Appearance | LTPD 1~3%<br>LTPD 1~5% | Magnification (1) |
| Storage | | | |
| Shipment | | | |

**Note:** LTPD is according to MIL-S-19500 sampling plan.

**Table 2-2**
**An Example of Initial Characteristics Test (Incoming Warehouse Inspection) for Light Emitting Diode (Plastic Molded Package)**

| | | Sampling Inspection Plan* | | |
|---|---|---|---|---|
| Group | Item | LTPD | Sample Size | Acceptance Number |
| Open and Short | Open, Short | 1% | 231 | 0 |
| Cutoff Current, Forward Voltage and Light Current | $I_R$, $I_L$, $V_F$ | 3% | 129 | 1 |
| Appearance (Major Defect) | Molded Body Breakage/Crack Lead Breakage | 1% | 231 | 0 |
| Appearance (Minor Defect) | Molded Body Damage/Bubble Dirtiness, Lead Bent | 5% | 77 | 1 |

*LTPD is according to MIL-S-19500's LTPD Sampling Plan.

**Table 2-3**
**Acceptance for Light Emitting Diode (Plastic Molded Package) After Reliability Test**

| | Failure Criteria | | | |
|---|---|---|---|---|
| Test Item | Item | Minimum | Maximum | Unit |
| Resistance to Soldering Heat | Reverse Current ($I_R$) | — | U x 2 | μA |
| Temperature Cycling | Forward Voltage ($V_F$) | — | U x 1.1 | V |
| Thermal Shock | Lighting Current ($I_L$) | −50 | — | % |
| Mechanical Shock | | | | |
| Vibration, Variable Frequency | | | | |
| Constant Acceleration | | | | |
| Salt Atmosphere | | | | |
| Intermittent Life | | | | |
| High-Temperaure Storage | | | | |
| Low-Temperaure Storage | | | | |
| High-Temperature High-Humidity Storage | | | | |
| Terminal Strength (Fatigue) | Terminal's Appearance | No Breaking and No Loosening | | — |
| Salt Atmosphere | Terminal's Appearance | No Extreme Rust and No Corrosion | | — |

**Note:** U = Upper limit specified on data sheet.

Table 2-4
An Example of Reliability Test for Light Emitting Diode (Plastic Molded Package)

| Test Item | Equivalent Test Method JIS-C -7021 | MIL-STD -202 | MIL-STD -750 | LEC PUB 68 | Test Condition | Sample Size | Acceptance Number |
|---|---|---|---|---|---|---|---|
| Resistance to Soldering | A-1 Cond. A | 210 Cond. B | 2031 | Tb Method A | 260°C, 10s, once without flux | | |
| Temperature Cycling | A-6 | 107 | 1051 | Na | $T_{STG\ MIN}$ ~ $T_{STG\ MAX}$, 30 cycles (30 min) (air) | 22 | 0 |
| Thermal Shock | A-3 Method II | — | 1056 Cond. B | Nc | 100°C ~C, 5 cycles (5 min) (liquid) | | |
| Mechanical Shock | A-7 Cond. F | 213 | 2016 | Ea | 1500G, 0.5ms X, Y, Z, 5 times each | | |
| Vibration, Variable Frequency | A-10 Cond. D | — | 2056 | Fc | 20G, 100 ~ 2000 ~ 100Hz 4 min, X, Y, Z, 4 times each | 22 | 0 |
| Constant Acceleration | A-9 Cond. A | 212 | 2006 | Ga | 20,000G, 1 min, X, Y, Z | | |
| Terminal Strength Lead Fatigue | — | 211 Cond. C | 2036 Cond.E | Ub | At the specified weight, 90°, 3 times | 11 | 0 |
| Salt Atmosphere | A-12 Cond. B | 101 | 1041 | Ka | $T_A$ = 35°C, concentration 5% 0.5 ~ 3.0ml/80cm$^2$/hr, 24 hr | 11 | 0 |
| Intermittent Life | — | — | 1026 | — | $T_A$ = 25°C, specified current, specified cycle, 1000 hr | 20 | 1 |
| High-Temperature Storage | B-10 | 108 | 1031 | Ba | $T_{STG\ MAX}$, 1000 hr | 20 | 1 |
| Low-Temperature Storage | B-12 | — | — | Aa | $T_{STG\ MIN}$, 1000 hr | 20 | 1 |
| High-Temperature, High-Humidity Storage | B-11 Cond, B-C | 103 | — | Ca | $T_A$ = 60°C, RH = 90% 1000 hr | 20 | 0 |

2

# STANDARD LEDs 3

**Section 3 — Standard LEDs**

NEC Electronics Inc.

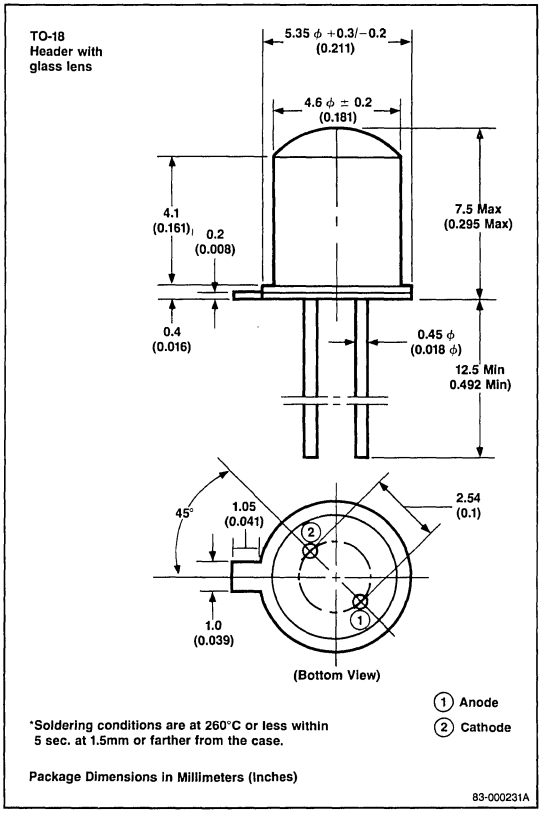
# SE301A GaAs INFRARED EMITTING DIODE INDUSTRIAL USE

*NEPCO SERIES*

## Description

The SE301A is a GaAs (Gallium Arsenide) infrared emitting diode which is mounted on a TO-18 hermetically sealed header with a glass lens. On forward bias, it emits a spectrally narrow band of radiation peaking at 940nm. The close wavelength match of this device to silicon sensors makes it ideally suited for all source-sense applications. Its low cost and volume producibility opens new areas of use anywhere an infrared source is desirable.

## Package Dimensions




*Soldering conditions are at 260°C or less within 5 sec. at 1.5mm or farther from the case.

Package Dimensions in Millimeters (Inches)

83-000231A

## Features

- ☐ Low cost
- ☐ High output power — 3mW min
- ☐ Fast switching time
- ☐ Long life-solid state reliability
- ☐ Compact, rugged, lightweight
- ☐ Spectrally matched to silicon sensors

## Applications

- ☐ Paper tape and punch card readers
- ☐ Optical encoders
- ☐ Photo choppers
- ☐ High speed optoelectronic data links

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 150mW |
| Forward Current, $I_F$ | 100mA |
| Peak Forward Current, $I_{PEAK}$[1] | 1000mA |
| Reverse Voltage, $V_R$ | 5.0V |
| Junction Temperature, $T_J$ | +125°C |
| Storage Temperature, $T_{STG}$ | −65°C ~ +125°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | | 1.45 | V | $I_F$ = 50mA |
| Pulse Forward Voltage | $V_F$ | | | 5.0 | V | $I_F$ = 1.0A |
| Capacitance | C | | 100 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 940 | | nm | $I_F$ = 50mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 60 | | nm | $I_F$ = 50mA |
| Output Power | $P_O$ | 3.0 | | | mW | $I_F$ = 50mA |
| Peak Output Power | $P_{PEAK}$[1] | 15 | | | mW | $I_F$ = 1.0mA |
| Light Turn-On and Turn-Off | $t_{ON}$, $t_{OFF}$ | | 1 | | μs | |

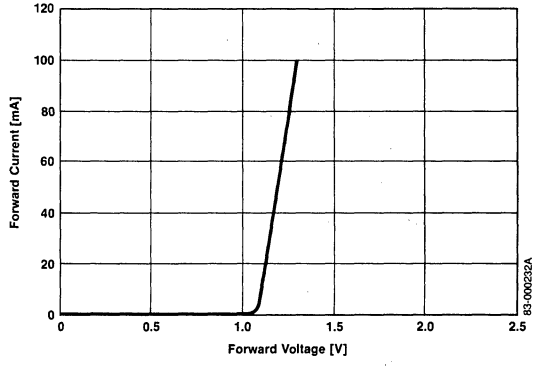
**Note:** 1. f = 1.0kHz, duty cycle 1%.

3

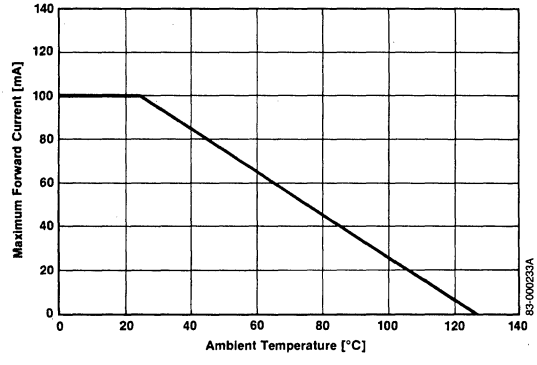
## Typical Characteristics (cont)

$T_A$ = +25°C

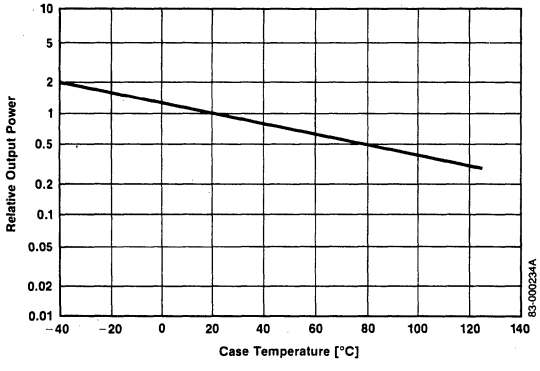
Forward Current vs Forward Voltage



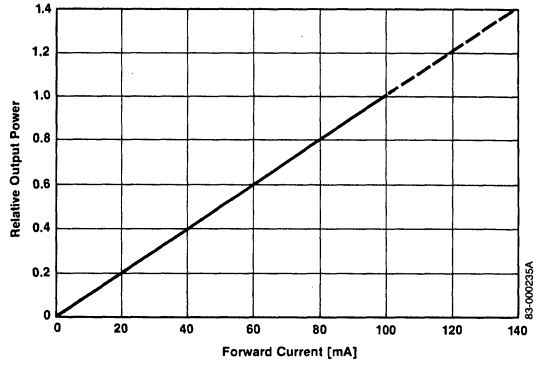

Maximum Forward Current vs Ambient Temperature



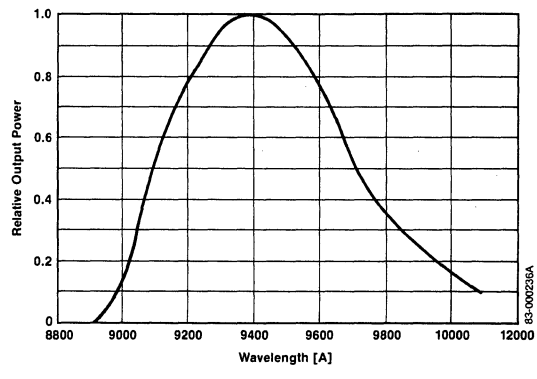

Relative Output Power vs Case Temperature



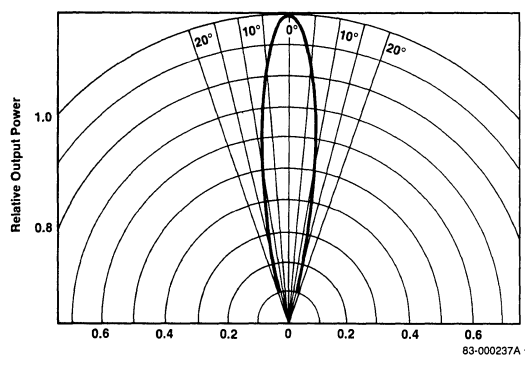

Relative Output Power vs Forward Current




Spectral Distribution




Spatial Distribution



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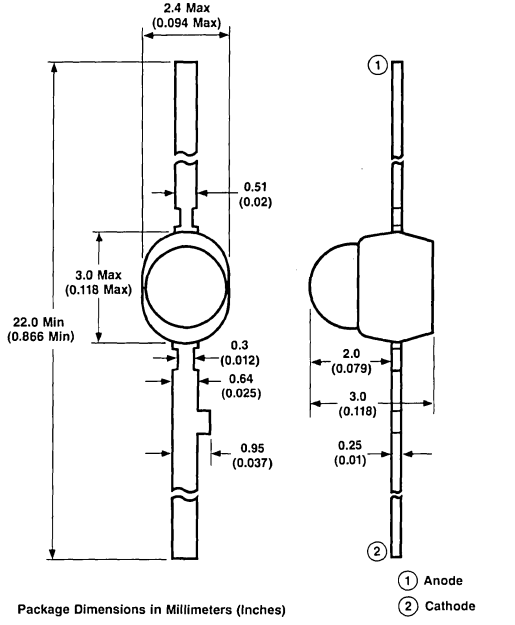
# SE302A
# GaAs INFRARED EMITTING DIODE INDUSTRIAL USE

*NEPCO SERIES*

## Description

The SE302A is a GaAs (Gallium Arsenide) infrared emitting diode which is mounted on a lead frame and molded in a clear plastic lens. On forward bias, it emits a spectrally narrow band of radiation peaking at 940nm. The close wavelength match of this device to silicon sensors makes it ideally suited for all source-sense applications. Its low cost and volume producibility open new areas of use anywhere an infrared source is desirable.

## Package Dimensions




Package Dimensions in Millimeters (Inches)

*Soldering conditions are at 260°C or less within 5 sec. at 3mm or farther from the case.

83-000238A

## Features

- ☐ Low cost
- ☐ High output power
- ☐ Fast switching time
- ☐ Long life, solid state reliability
- ☐ Compact, rugged, lightweight
- ☐ Spectrally matched to silicon sensors (Good compatibility with Darlington photo transistor (PH101))
- ☐ Easily assembled in linear arrays
- ☐ Compatible with integrated circuits

## Applications

- ☐ Electro optical switches
- ☐ Card and tape reader sources
- ☐ Optical encoders
- ☐ Photo choppers, isolator
- ☐ High speed optoelectronic data links
- ☐ Photo coupler

3

## Absolute Maximum Ratings

$T_A = +25°C$

| | |
|---|---|
| Power Dissipation, $P_D$ | 75mW |
| Forward Current, $I_F$ | 50mA |
| Reverse Voltage, $V_R$ | 3.0V |
| Junction Temperature, $T_J$ | +80°C |
| Storage Temperature, $T_{STG}$ | −30°C ~ +80°C |

## Electro-Optical Characteristics

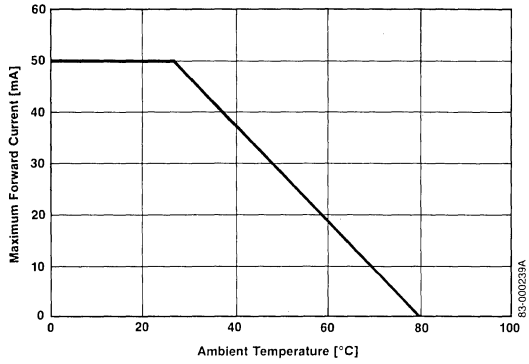
$T_A = +25°C$

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 1.2 | 1.4 | V | $I_F$ = 50mA |
| Reverse Current | $I_R$ | | | 5.0 | μV | $V_R$ = 3.0V |
| Capacitance | C | | 100 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 940 | | nm | $I_F$ = 50mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 60 | | nm | $I_F$ = 50mA |
| Output Power | $P_O$ | 1.0 | 1.5 | | mW | $I_F$ = 50mA |
| Light Turn-On and Turn-Off | $t_{ON}$, $t_{OFF}$ | | 1.0 | | μs | |

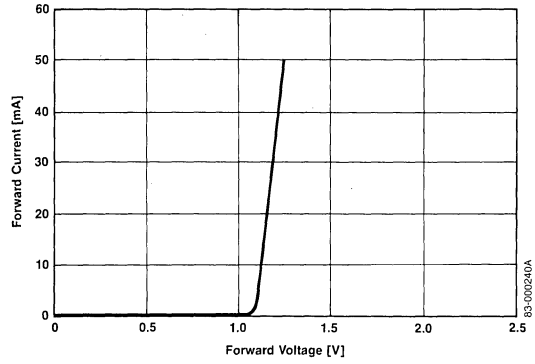
## Typical Characteristics

$T_A = +25°C$

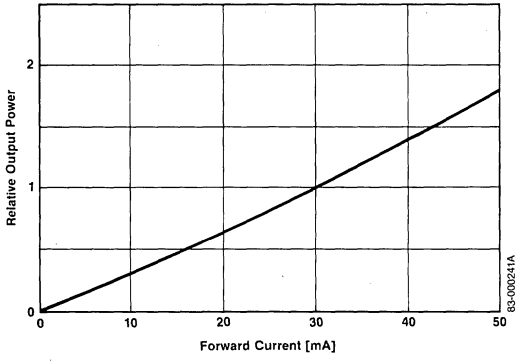
Maximum Forward Current vs Ambient Temperature



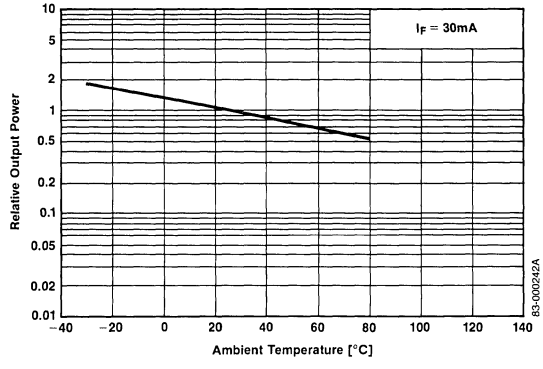

Forward Current vs Forward Voltage



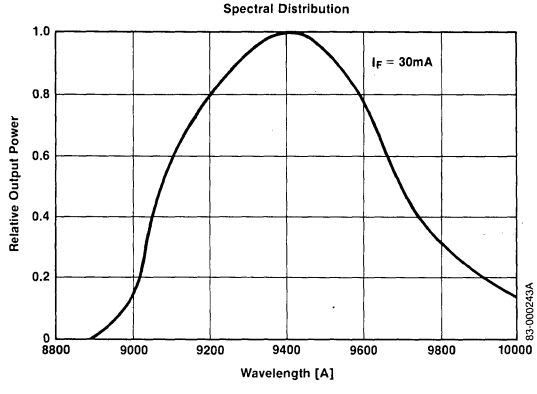

Relative Output Power vs Forward Current



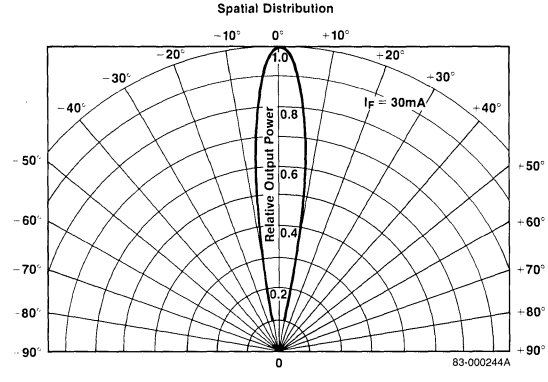

Relative Output Power vs Ambient Temperature




Spectral Distribution




Spatial Distribution



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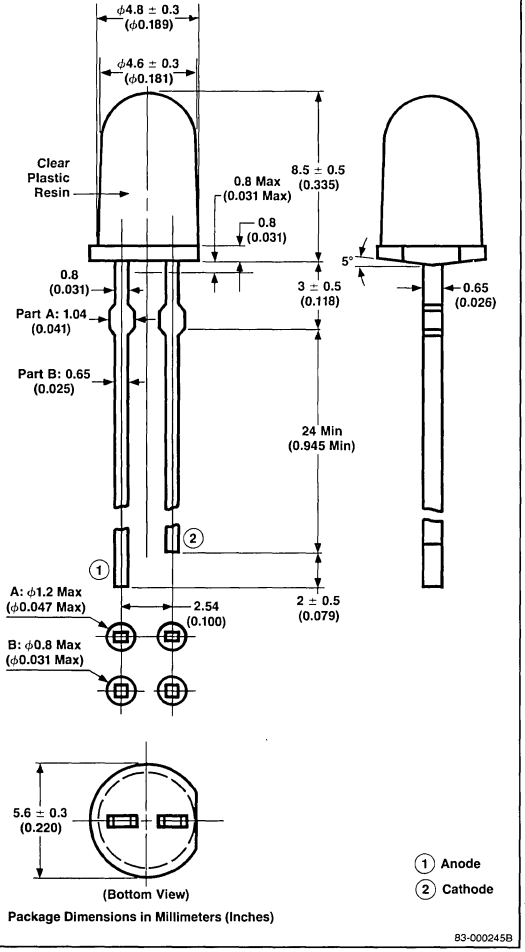
# SE303A
# GaAs INFRARED EMITTING DIODE

*NEPOC SERIES*

## Description

The SE303A is a GaAs (gallium arsenide) infrared emitting diode which is mounted on the lead frames and molded in plastic. On forward bias, it emits a spectrally narrow band of radiation peaking at 940nm.

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000245B

## Features

- ☐ Economical
- ☐ High output power
- ☐ Wide half angle
- ☐ Good linearity
- ☐ Spectrally matched to silicon sensors
- ☐ Long lead

## Applications

- ☐ Light source for TV remote control
- ☐ Light source for smoke detector
- ☐ Optical encoders
- ☐ Photo choppers, isolator

## Absolute Maximum Ratings

$T_A = +25°C$

| | |
|---|---|
| Power Dissipation, $P_D$ | 150mW |
| Forward Current, $I_F$ | 100mA |
| Pulse Forward Current, $I_{FP}$[1] | 1.0A |
| Reverse Voltage, $V_R$ | 5.0V |
| Junction Temperature, $T_J$ | +80°C |
| Storage Temperature, $T_{STG}$ | −30°C to +80°C |

## Electro-Optical Characteristics

$T_A = +25°C$

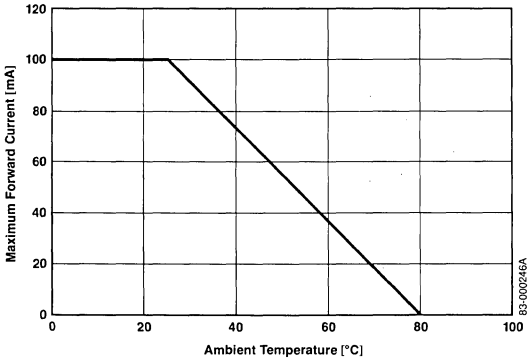
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 1.25 | 1.45 | V | $I_F$ = 50mA |
| Pulse Forward Voltage | $V_{FP}$[1] | | 2.5 | 3.0 | V | $I_{FP}$ = 1.0A |
| Capacitance | $C_T$ | | 40 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 940 | | nm | $I_F$ = 50mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 60 | | nm | $I_F$ = 50mA |
| Output Power | $P_O$ | 3.0 | 6.5 | | mW | $I_F$ = 50mA |
| Peak Output Power | $P_{FP}$[1] | 15 | | | mW | $I_{FP}$ = 1.0A |
| Light Turn-On and Turn-Off | $t_{ON}$, $t_{OFF}$ | | 1 | | μs | |

**Note:** 1. f = 1.0kHz, duty cycle 1%.

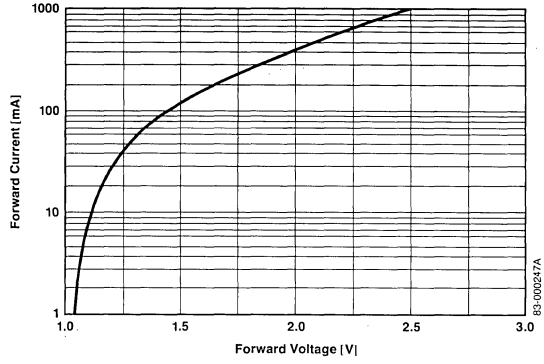
3

## Typical Characteristics
$T_A$ = +25°C

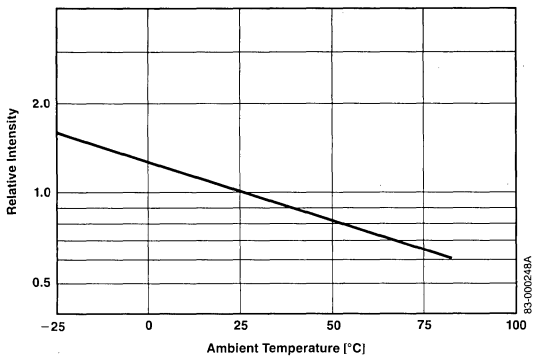
Maximum Forward Current vs Ambient Temperature



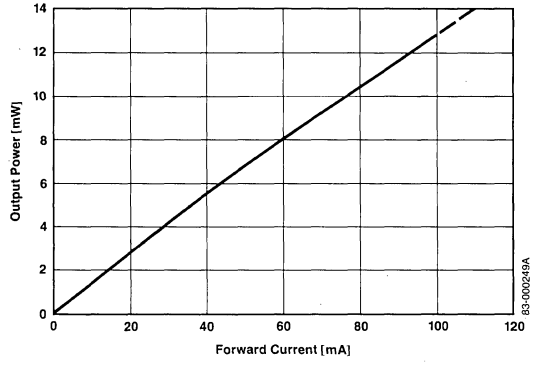

Forward Current vs Forward Voltage



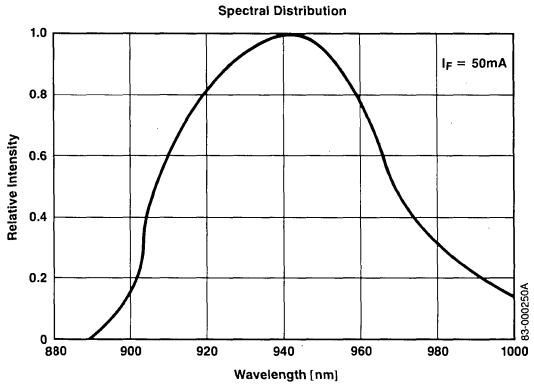

Relative Intensity vs Ambient Temperature



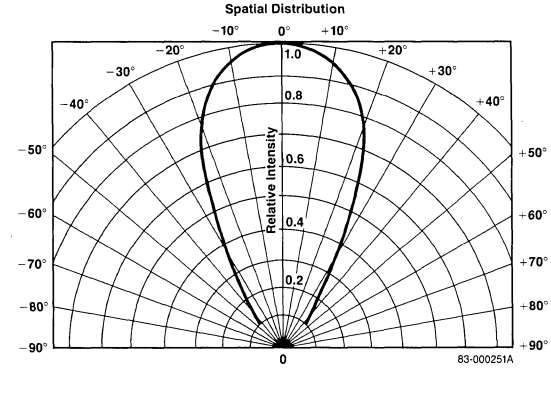

Output Power vs Forward Current




Spectral Distribution




Spatial Distribution



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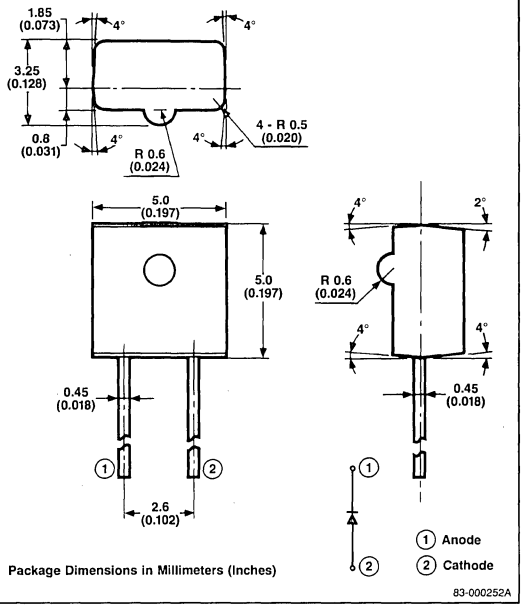
# SE306
# GaAs INFRARED EMITTING DIODE
*NEPOC SERIES*

## Description

The SE306 is a GaAs (Gallium Arsenide) infrared LED in a plastic molded package, and is very suitable for a detector of a photo interrupter. On forward bias, it emits a spectrally narrow band of radiation peaking at 940nm.

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000252A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 50mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electrical Characteristics

$T_A$ = +25°C

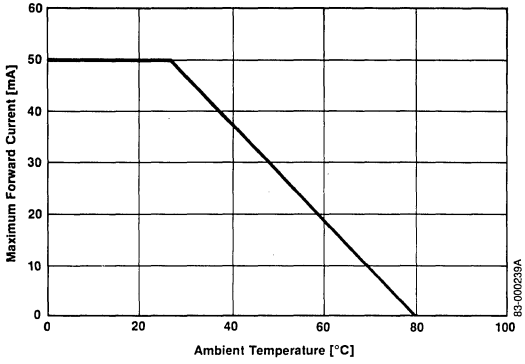
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | | 1.4 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | | 10 | μA | $V_R$ = 5V |
| Capacitance | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 940 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 60 | | nm | $I_F$ = 10mA |
| Output Power | $P_O$ | 0.2 | | | mW/sr | $I_F$ = 10mA |

3

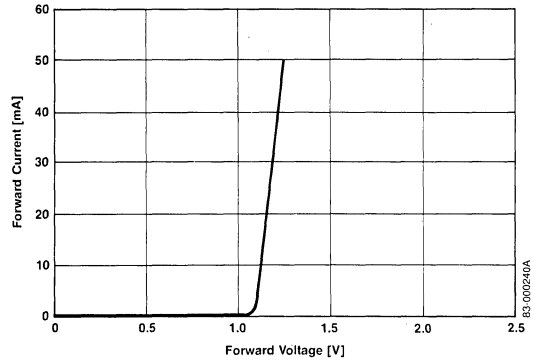
## Typical Characteristics

$T_A$ = +25°C

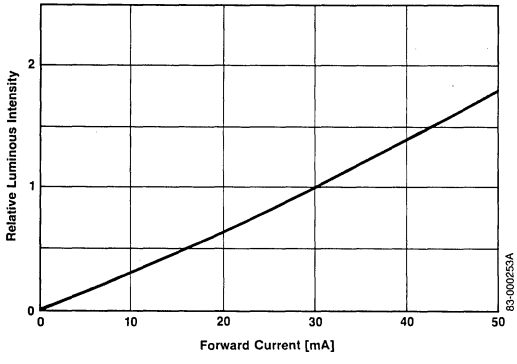
Maximum Forward Current vs Ambient Temperature



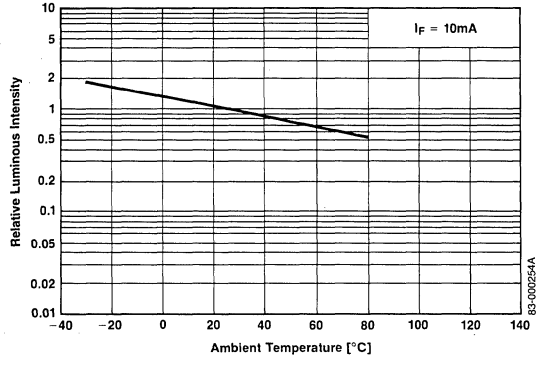

Forward Current vs Forward Voltage



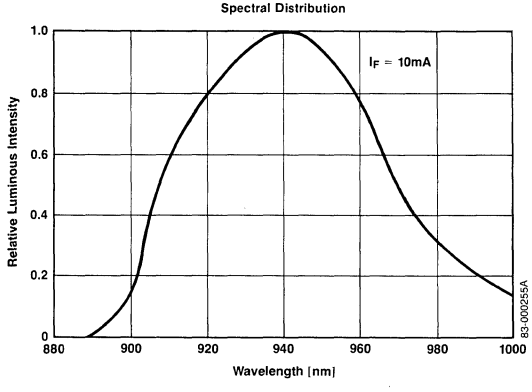

Relative Luminous Intensity vs Forward Current




Relative Luminous Intensity vs Ambient Temperature




Spectral Distribution



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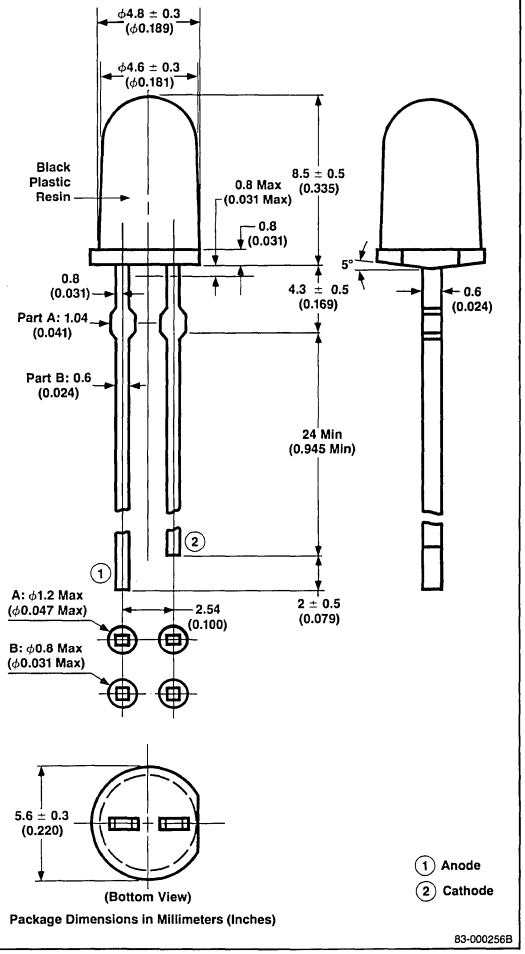
# SE307
# GaAs INFRARED EMITTING DIODE
*NEPOC SERIES*

## Description

The SE307 is a GaAs (Gallium Arsenide) infrared emitting diode which is mounted on the lead frames and molded in plastic. On forward bias, it emits a spectrally narrow band of radiation peaking at 940nm.

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000256B

## Features

- ☐ Economical
- ☐ High radiant intensity
- ☐ Narrow half angle
- ☐ Good linearity
- ☐ Spectrally matched to silicon sensors
- ☐ Long lead

## Applications

- ☐ Light source for TV remote control
- ☐ Light source for smoke detector
- ☐ Optical encoders
- ☐ Photo choppers, isolators

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 150mW |
| Forward Current, $I_F$ | 100mA |
| Pulse Forward Current, $I_{FP}$[1] | 1.5A |
| Reverse Voltage, $V_R$ | 5.0V |
| Junction Temperature, $T_J$ | +80°C |
| Storage Temperature, $T_{STG}$ | −30°C to +80°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 1.25 | 1.45 | V | $I_F$ = 50mA |
| Pulse Forward Voltage | $V_{FP}$[1] | | 2.5 | 3.0 | V | $I_{FP}$ = 1.0A |
| Capacitance | $C_T$ | | 40 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 940 | | nm | $I_F$ = 50mA |
| Spectral Line Half Width | $\Delta_\lambda$ | | 60 | | nm | $I_F$ = 50mA |
| Radiant Intensity | $I_E$ | 10 | 30 | | mW/sr | $I_F$ = 50mA |
| Peak Output Power | $P_{FP}$[1] | 15 | | | mW | $I_{FP}$ =1.0A |
| Light Turn-On and Turn-Off | $t_{ON}$,$t_{OFF}$ | | 1 | | μs | |

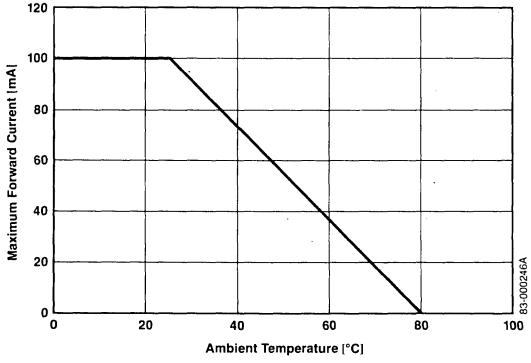
**Note:** 1. f = 1.0kHz, duty cycle 1%.

3

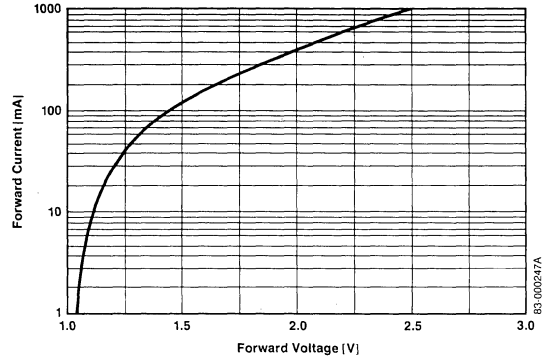
## Typical Characteristics

$T_A$ = +25°C

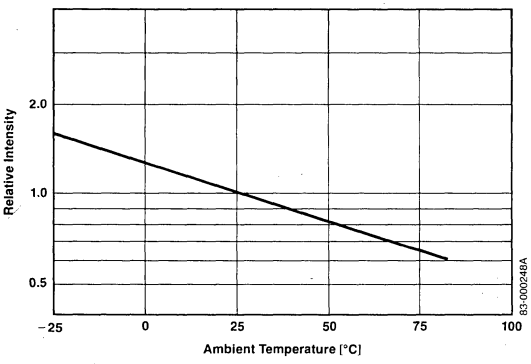
Maximum Forward Current vs Ambient Temperature



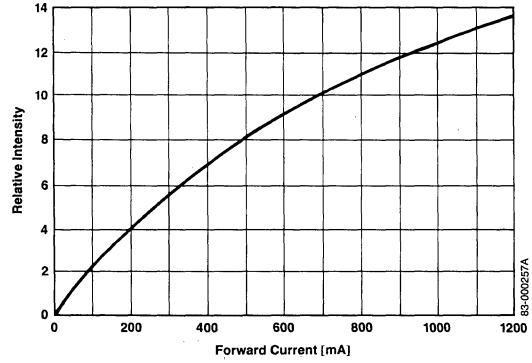

Forward Current vs Forward Voltage



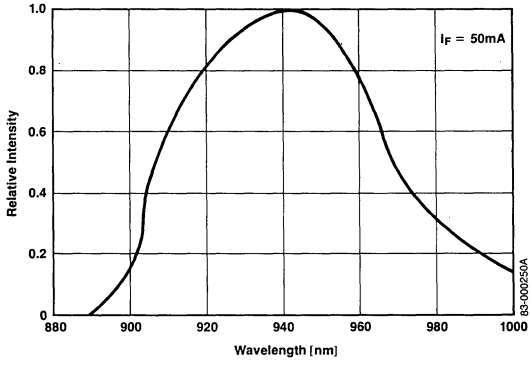

Relative Intensity vs Ambient Temperature



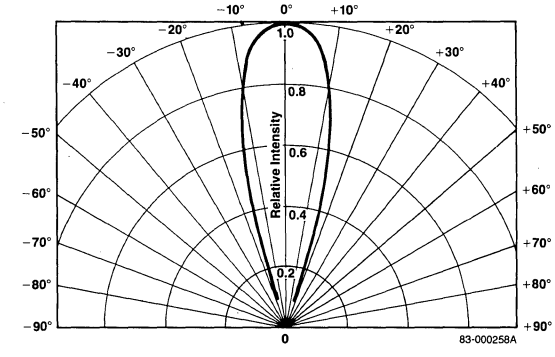

Relative Intensity vs Forward Current




Spectral Distribution




Spatial Distribution



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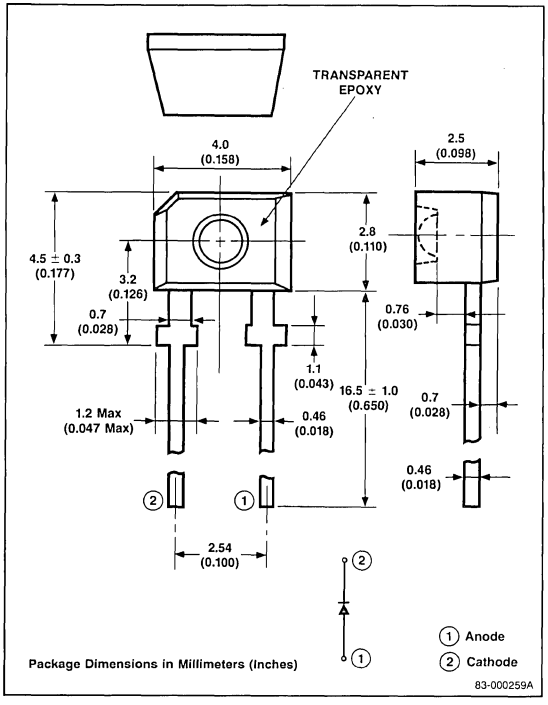
# SE308
# GaAs INFRARED EMITTING DIODE
*NEPOC SERIES*

## Description

The SE308 is a GaAs (Gallium Arsenide) infrared LED in a plastic molded package, and is very suitable as a detector of a photo interrupter. On forward bias, it emits a spectrally narrow band of radiation peaking at 940nm.

## Package Dimensions




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

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 50mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Operating Temperature, $T_{OPT}$ | −20°C ~ +80°C |
| Storage Temperature, $T_{STG}$ | −40°C ~ +100°C |

## Electrical Characteristics
$T_A$ = +25°C

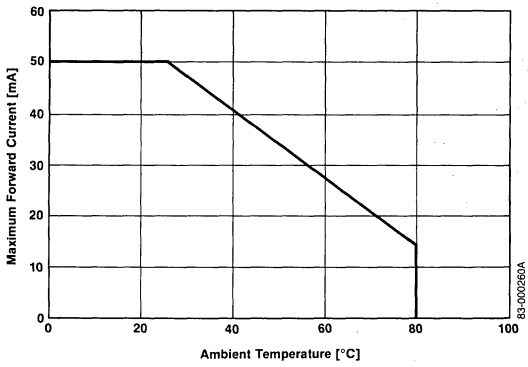
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 1.1 | 1.4 | V | $I_F$ = 20mA |
| Reverse Current | $I_R$ | | | 5 | μA | $V_R$ = 5V |
| Capacitance | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 940 | | nm | $I_F$ = 20mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 60 | | nm | $I_F$ = 20mA |
| Radiant Intensity | $I_E$ | 0.5 | 0.85 | | mW/sr | $I_F$ = 20mA |
| Response Time | $t_{ON}$, $t_{OFF}$ | | 1 | | μs | $I_F$ = 20mA |

3

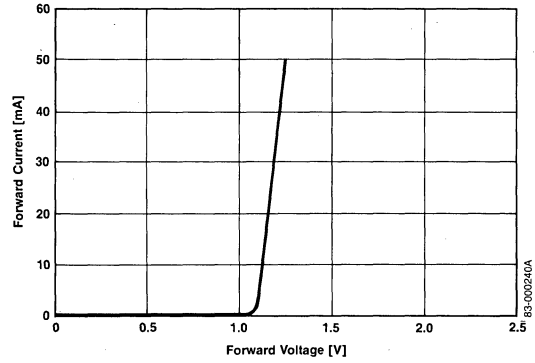
## Typical Characteristics

$T_A$ = +25°C

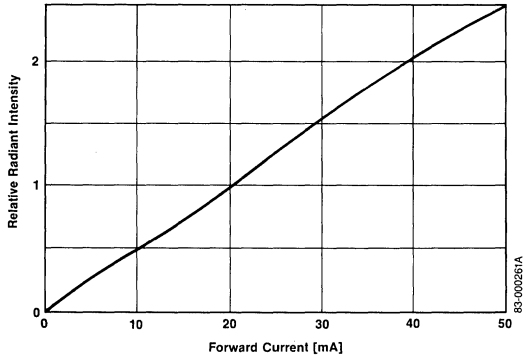
Maximum Forward Current vs Ambient Temperature



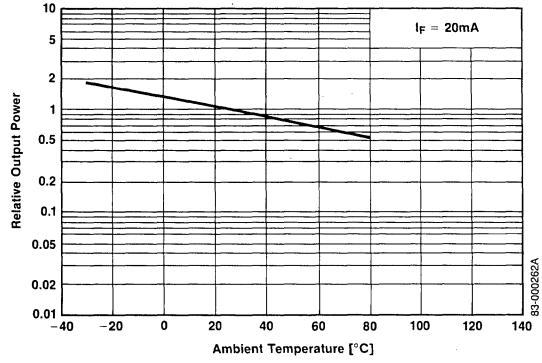

Forward Current vs Forward Voltage



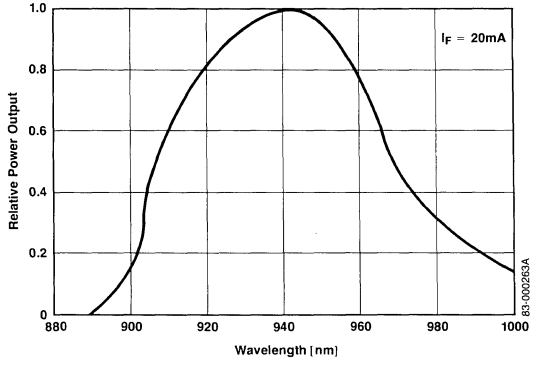

Relative Luminous Intensity vs Forward Current




Relative Output Power vs Ambient Temperature




Spectral Distribution



NEC Electronics Inc.

# SE1003
# GaAlAs on GaAs INFRARED EMITTING DIODE

*NEPOC SERIES*

## Description

The SE1003 is a GaAlAs on GaAs Infrared Emitting Diode which is mounted on a lead frame and molded in plastic. On forward bias, it emits a spectrally narrow band of radiation peaking at 950nm.

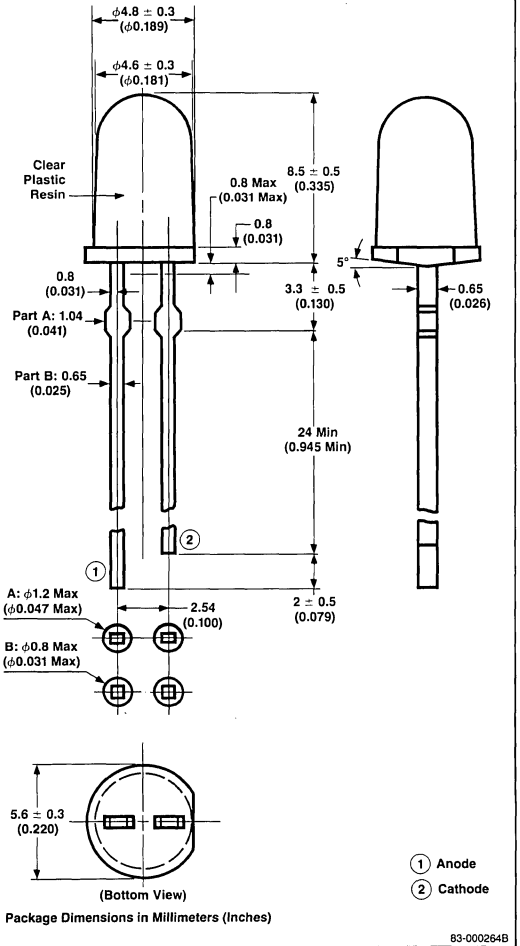
## Features

- ☐ Economical
- ☐ High output power
- ☐ Wide half angle
- ☐ Good linearity
- ☐ Spectrally matched to silicon sensors
- ☐ Long lead

## Applications

- ☐ Light source for TV remote control
- ☐ Light source for smoke detector
- ☐ Optical encoders
- ☐ Photo choppers, isolators

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000264B

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 150mW |
| Forward Current, $I_F$ | 100mA |
| Pulse Forward Current, $I_{FP1}$ | 1.0A |
| Reverse Voltage, $V_R$ | 5.0V |
| Junction Temperature, $T_J$ | +80°C |
| Storage Temperature, $T_{STG}$ | −30°C to +80°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 1.27 | 1.45 | V | $I_F$ = 50mA |
| Pulse Forward Voltage | $V_{FP1}$ | | 2.9 | 3.4 | V | $I_{FP}$ = 1.0A |
| Capacitance | $C_T$ | | 40 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 950 | | nm | $I_F$ = 50mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 50 | | nm | $I_F$ = 50mA |
| Output Power | $I_E$ | 12 | 20 | | mW/sr | $I_F$ = 50mA |
| Light Turn-On and Turn-Off | $t_{ON}$, $t_{OFF}$ | | 1 | | μs | |

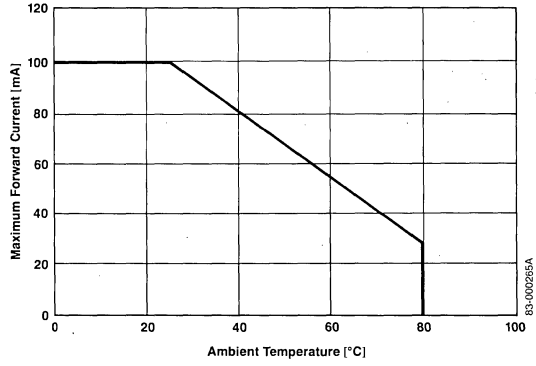
**Note:** 1. f = 1.0kHz, duty cycle 1%.

3

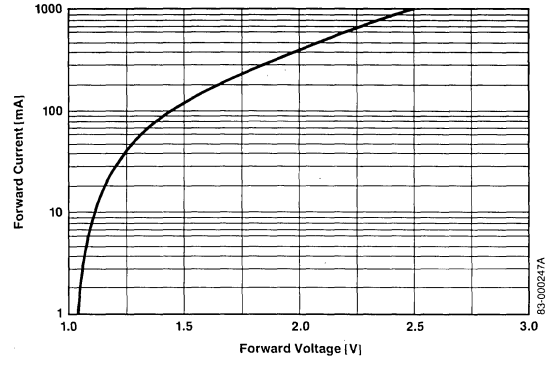
## Typical Characteristics

$T_A$ = +25°C

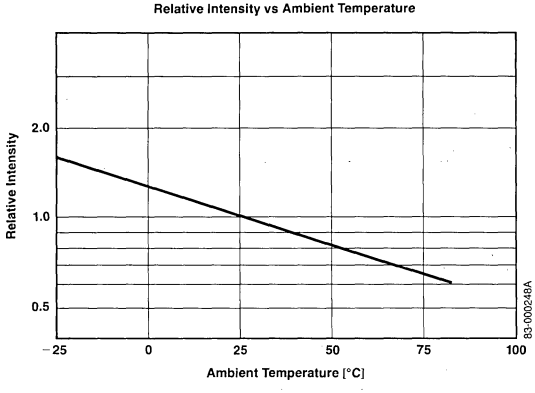
Maximum Forward Current vs Ambient Temperature



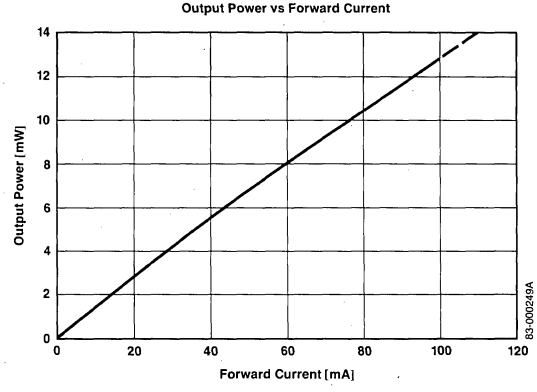

Forward Current vs Forward Voltage



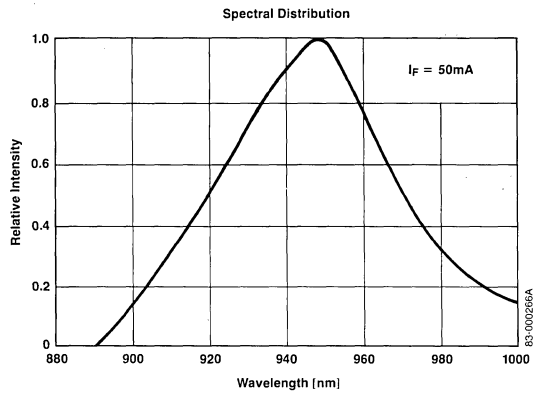

Relative Intensity vs Ambient Temperature



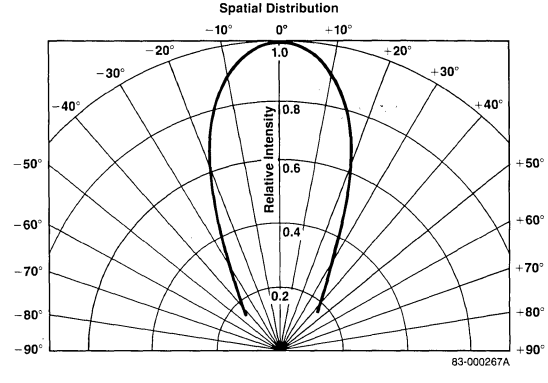

Output Power vs Forward Current




Spectral Distribution




Spatial Distribution



NEC

NEC Electronics Inc.

# SG203DA/TA GREEN GaP HIGH INTENSITY LEDs

*NEPOC SERIES*

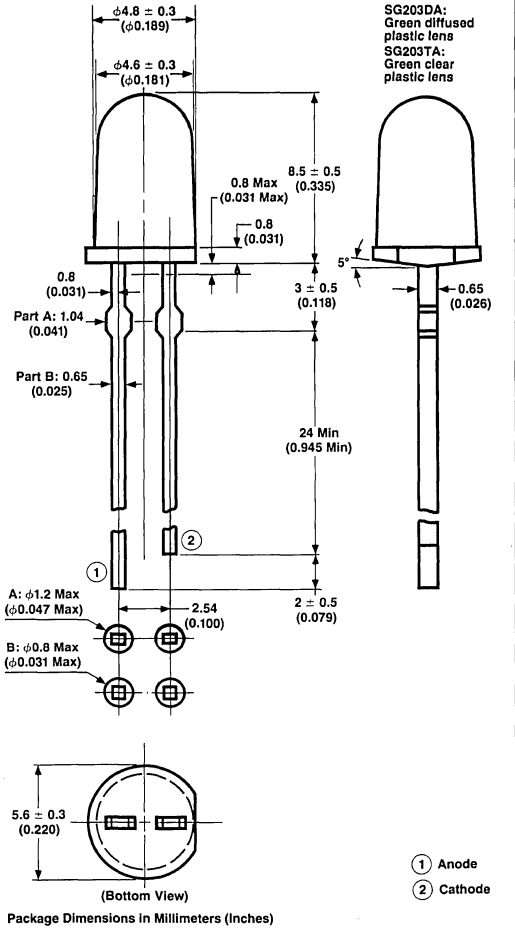
## Description

The SG203DA and SG203TA are full resin-molded LED lamps and emit bright and vivid green light. They are especially suitable for electronic equipment in audio applications which require high-brightness displays.

## Features

- ☐ High intensity
- ☐ Wide angle
- ☐ Long lead
- ☐ Low cost
- ☐ Compatible with integrated circuits

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000268B

## Applications

- ☐ Visual displays
- ☐ Guard systems
- ☐ Mobile equipment indicators
- ☐ Stereo equipment indicators
- ☐ Transceiver indicators

## Absolute Maximum Ratings

$T_A = +25°C$

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A = +25°C$

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.2 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5 |
| Capacitance | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 565 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity (SG203DA) | $I_V$ | 2 | 8 | | mcd | $I_F$ = 10mA |
| Luminous Intensity (SG203TA) | $I_V$ | 5 | 13 | | mcd | $I_F$ = 10mA |

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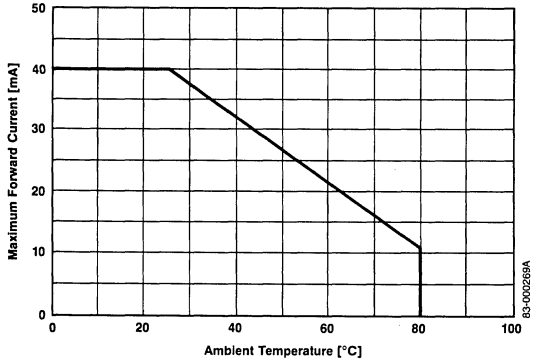
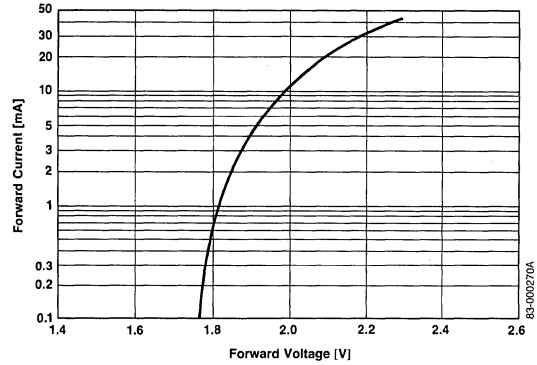
## Typical Characteristics

$T_A$ = +25°C

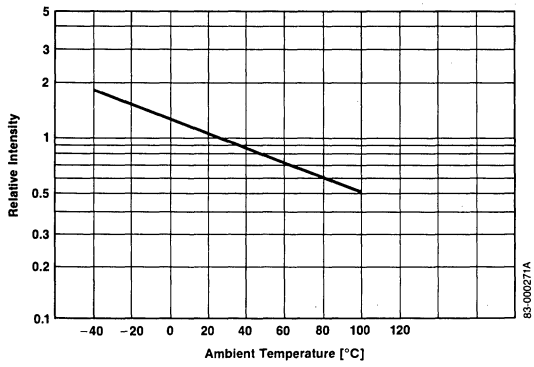
Maximum Forward Current vs Ambient Temperature



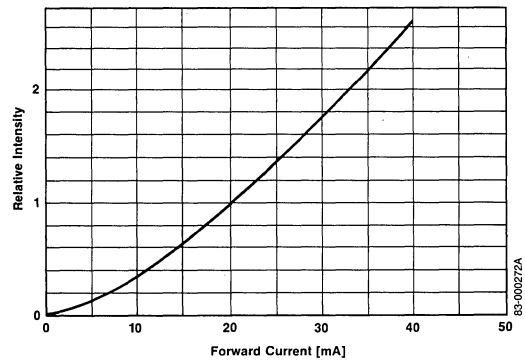

Forward Current vs Forward Voltage



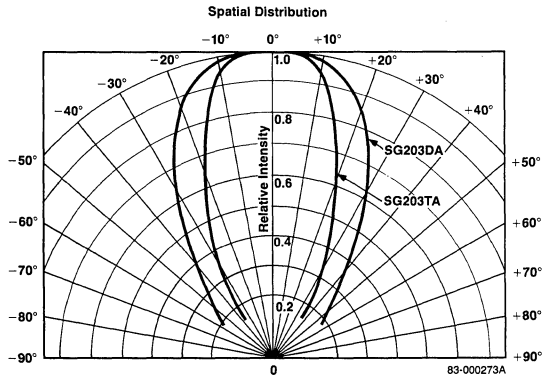

Relative Intensity vs Ambient Temperature



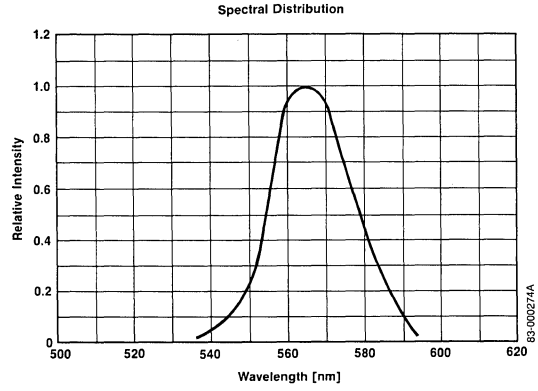

Relative Intensity vs Forward Current




Spatial Distribution




Spectral Distribution



# SG205D/T GREEN GaP LEDs

*NEPOC SERIES*

## Description

The SG205D and SG205T are GaP (Gallium Phosphide) light emitting diodes which are mounted on lead frames and molded in diffused green and clear green plastic, respectively. They are ideally suited for front panel indicator applications.

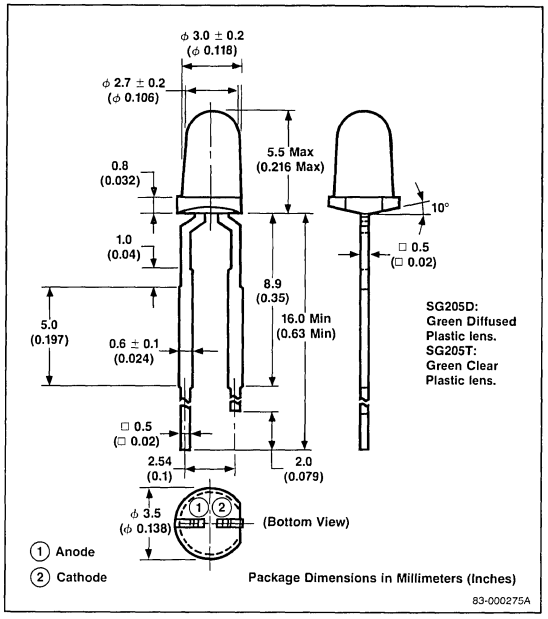
## Features

- ☐ Long life—solid state reliability
- ☐ Low cost
- ☐ High intensity with low current
- ☐ Versatile mounting on PC board or panel
- ☐ Compatible with integrated circuits
- ☐ Fast switching time

## Applications

- ☐ Visual displays
- ☐ Guard systems
- ☐ Radio or stereo equipment indicators
- ☐ Measuring instruments, terminals

## Package Dimensions




## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | +80°C |
| Storage Temperature, $T_{STG}$ | −30°C to +80°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 50 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 565 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 30 | | nm | $I_F$ = 10mA |
| Luminous Intensity | $I_{V1}/I_{V2}$[1] | 1/2 | 3/5 | | mcd | $I_F$ = 10mA |

**Notes:** 1. $I_{V1}/I_{V2}$: Luminous intensity of SG205D/luminous intensity of SG205T.

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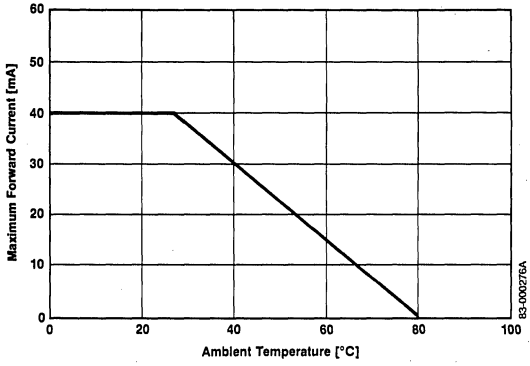
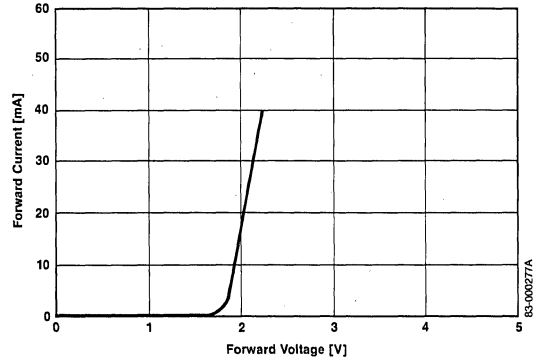
## Typical Characteristics
$T_A$ = +25°C

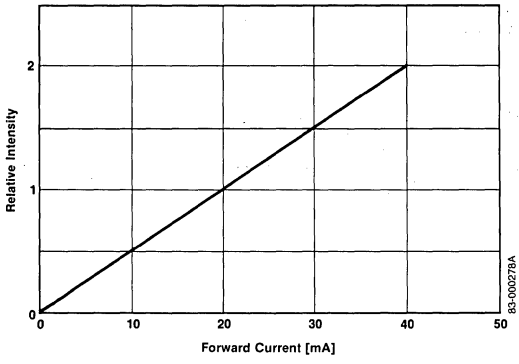
Maximum Forward Current vs Ambient Temperature



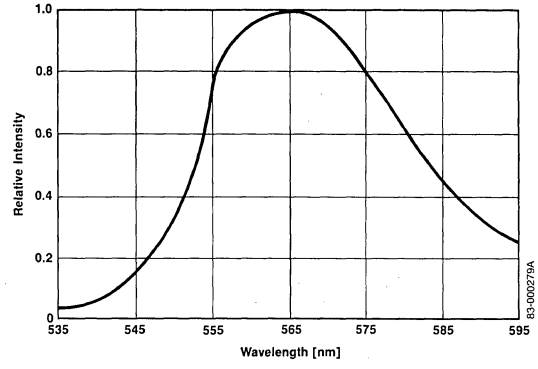

Forward Current vs Forward Voltage



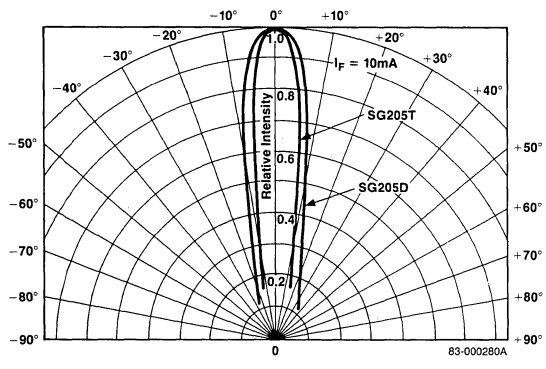

Relative Intensity vs Forward Current




Spectral Distribution




Spatial Distribution



NEC Electronics Inc.

# SG206D/T, SY406D/T, SR506C/D
# GREEN, AMBER, RED
# GaP LEDs
*NEPOC SERIES*

## Description

These six LEDs are full resin-molded LED lamps which uniformly emit brilliant red, green and amber light. They are especially suitable for electronic equipment in audio applications which require fancy displays.

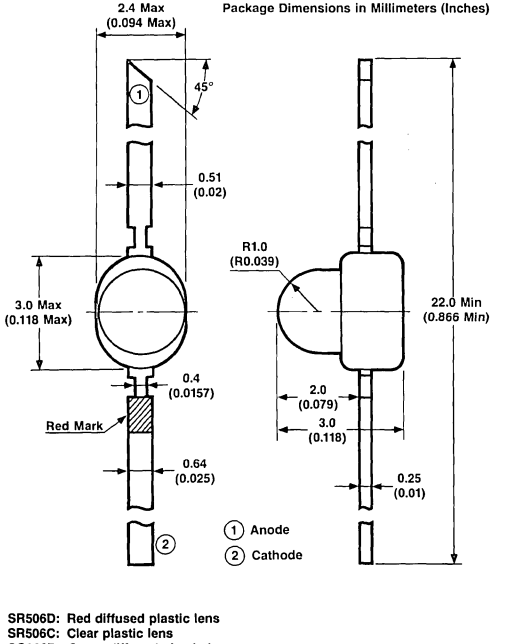
## Features

- ☐ Small size
- ☐ Low cost
- ☐ Easily assembled in arrays
- ☐ Bright red, green or amber
- ☐ Compatible with integrated circuits

## Applications

- ☐ Visual displays
- ☐ Radio and stereo equipment indicators
- ☐ Portable equipment indicators
- ☐ Camera indicators

## Package Dimensions




SR506D: Red diffused plastic lens
SR506C: Clear plastic lens
SG206D: Green diffused plastic lens
SG206T: Green transparent plastic lens
SY406D: Amber diffused plastic lens
SY406T: Amber transparent plastic lens

83-000306A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$1 | 60/100mW |
| Forward Current, $I_F$1 | 30/40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

**Note:** 1. SR506D, SR506C/SG206D, SG206T, SY406D, SY406T.

## Electro-Optical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Forward Voltage** | | | | | | |
| SR506D/SR506C | $V_F$ | | 2.0 | 2.6 | V | $I_F$ = 10mA |
| SG206D/SG206T | $V_F$ | | 2.0 | 2.6 | V | $I_F$ = 10mA |
| SY406D/SY406T | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| **Reverse Current** | | | | | | |
| SR506D/SR506C | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SG206D/SG206T | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SY406D/SY406T | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| **Capacitance** | | | | | | |
| SR506D/SR506C | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SG206D/SG206T | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SY406D/SY406T | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| **Peak Emission Wavelength** | | | | | | |
| SR506D/SR506C | $\lambda_{PEAK}$ | | 695 | | nm | $I_F$ = 10mA |
| SG206D/SG206T | $\lambda_{PEAK}$ | | 565 | | nm | $I_F$ = 10mA |
| SY406D/SY406T | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| **Spectral Line Half Width** | | | | | | |
| SR506D/SR506C | $\Delta\lambda$ | | 100 | | nm | $I_F$ = 10mA |
| SY206D/SY206T | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| SG406D/SG406T | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| **Luminous Intensity** | | | | | | |
| SR506D/SR506C | $I_V$ | 0.5/1 | 1/2 | | mcd | $I_F$ = 10mA |
| SG206D/SG206T | $I_V$ | 0.5/1 | 1.5/3 | | mcd | $I_F$ = 10mA |
| SY406D/SY406T | $I_V$ | 0.5/1 | 1.5/3 | | mcd | $I_F$ = 10mA |

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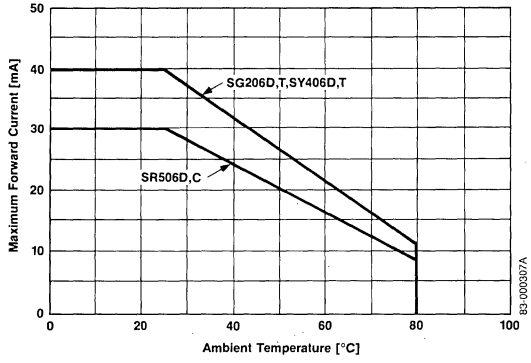
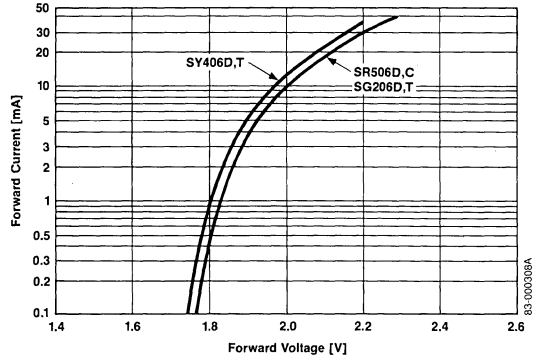
## Typical Characteristics

$T_A$ = +25°C

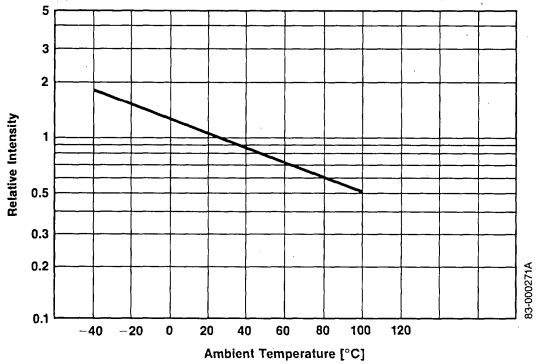
Maximum Forward Current vs Ambient Temperature



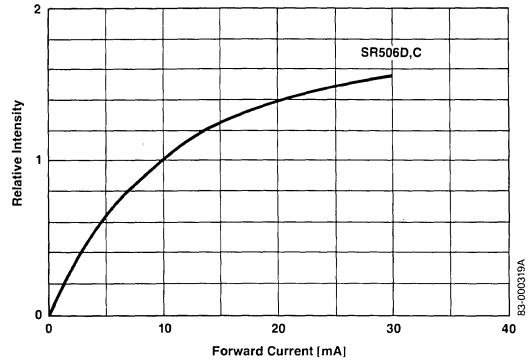

Forward Current vs Forward Voltage



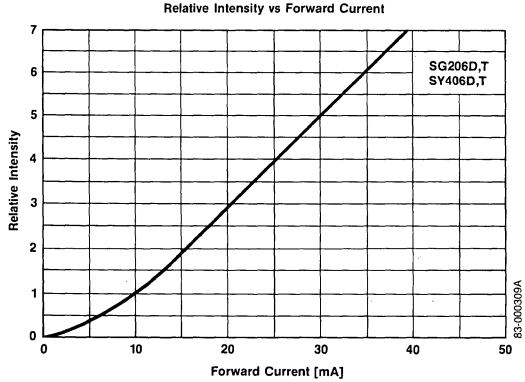

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Relative Intensity vs Forward Current



# SG213D/T GREEN GaP HIGH INTENSITY LEDs

*NEPOC SERIES*

## Description

The SG213D and SG213T are full resin-molded LED lamps which emit bright, brilliant, uniform green light proportional to the forward current ($I_F$). They are especially suitable for electronic equipment in audio applications which require bright, vivid displays. The SG213T is especially suitable as a backlighting source.

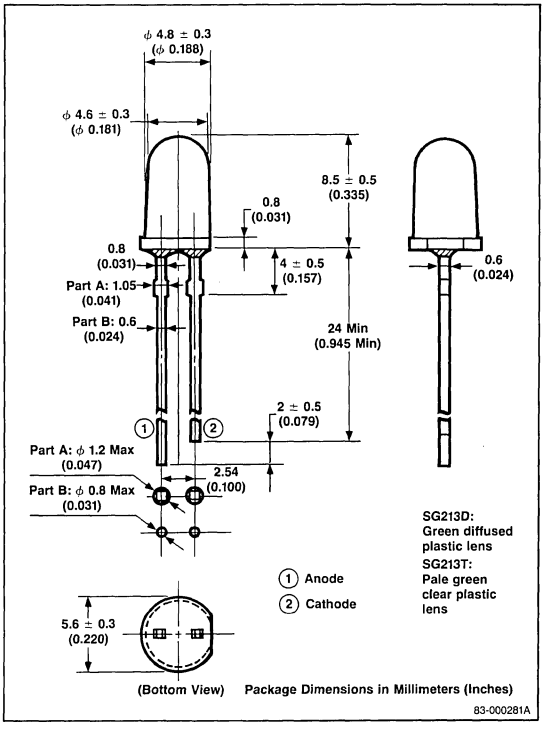
## Features

- ☐ High intensity
- ☐ Bright green
- ☐ Long lead
- ☐ Low cost
- ☐ Compatible with integrated circuits

## Applications

- ☐ Visual displays
- ☐ Guard systems
- ☐ Mobile equipment indicators
- ☐ Stereo equipment indicators
- ☐ Transceiver indicators

## Package Dimensions




## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5 |
| Capacitance | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 565 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity (SG213D) | $I_V$ | 3 | 15 | | mcd | $I_F$ = 10mA |
| Luminous Intensity (SG213T) | $I_V$ | 12 | 45 | | mcd | $I_F$ = 10mA |

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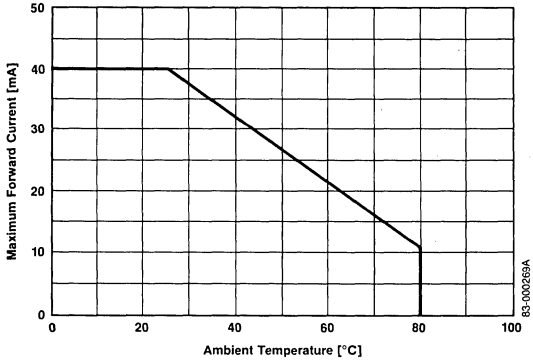
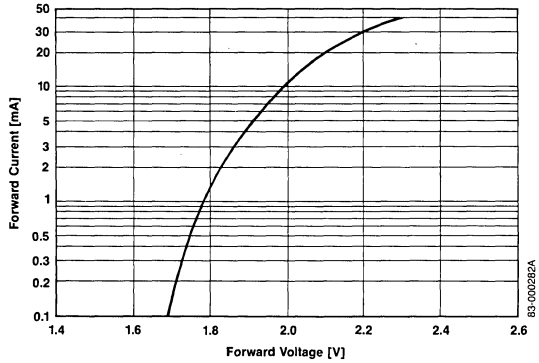
## Typical Characteristics

$T_A$ = +25°C

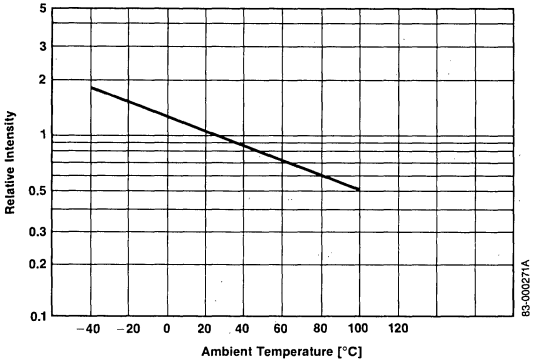
Maximum Forward Current vs Ambient Temperature



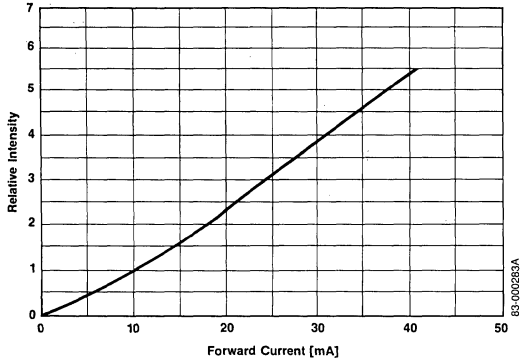

Forward Current vs Forward Voltage



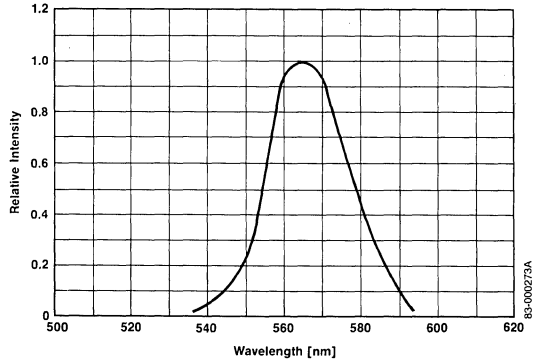

Relative Intensity vs Ambient Temperature



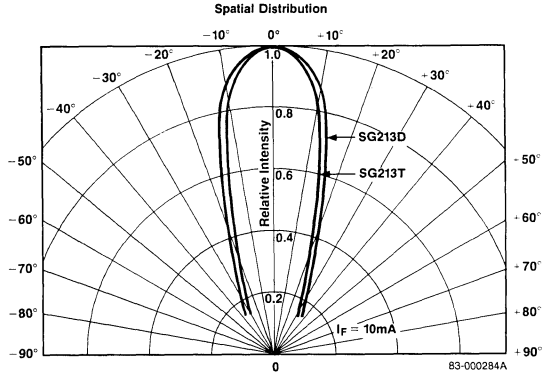

Relative Intensity vs Forward Current




Spectral Distribution




Spatial Distribution



NEC

NEC Electronics Inc.

# SG215D/T GREEN GaP HIGH INTENSITY LEDs

*NEPOC SERIES*

## Description

The SG215D and SG215T are medium-size plastic resin-encapsulated LED lamps from which brilliant green light is emitted uniformly and intensely in proportion to the forward current ($I_F$). They are suitable for use as bright and distinguishable illuminators or indicators on the panels of audio/video equipment and elsewhere.

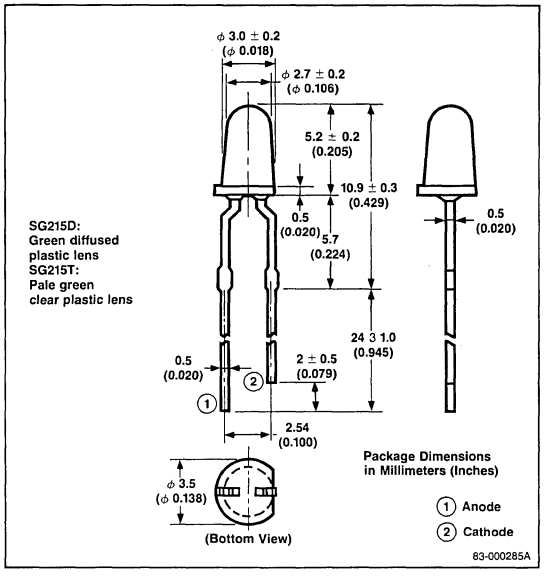
## Features

- ☐ High intensity
- ☐ Bright red
- ☐ Long lead
- ☐ Low cost
- ☐ Compatible with integrated circuits

## Applications

- ☐ Visual displays
- ☐ Guard systems
- ☐ Mobile equipment indicators
- ☐ Stereo equipment indicators
- ☐ Transceiver indicators

## Package Dimensions




## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

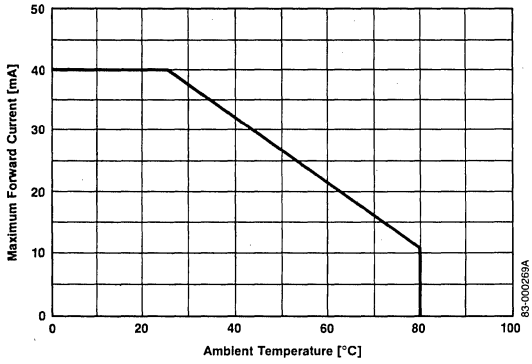
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5 |
| Capacitance | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 565 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity (SG215D) | $I_V$ | 3 | 10 | | mcd | $I_F$ = 10mA |
| Luminous Intensity (SG215T) | $I_V$ | 6 | 20 | | mcd | $I_F$ = 10mA |

3

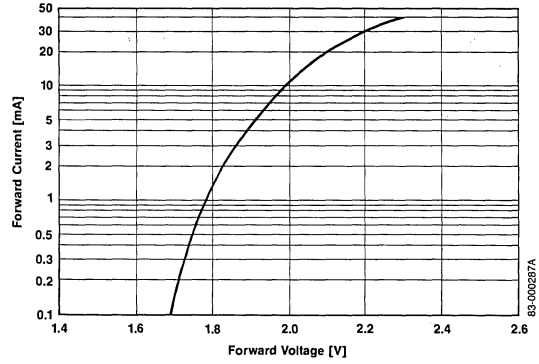
## Typical Characteristics

$T_A$ = +25°C

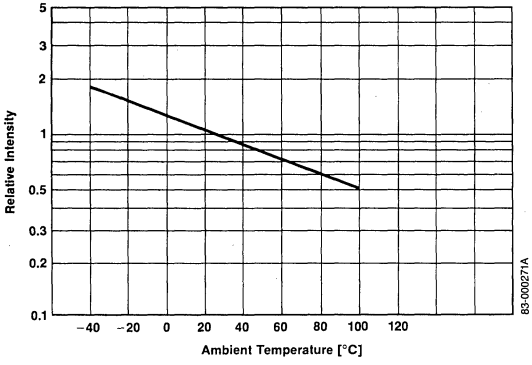
Maximum Forward Current vs Ambient Temperature



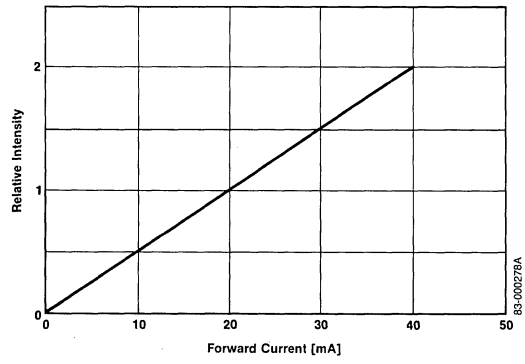

Forward Current vs Forward Voltage



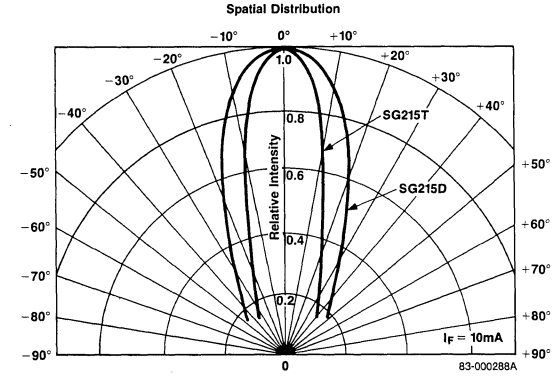

Relative Intensity vs Ambient Temperature



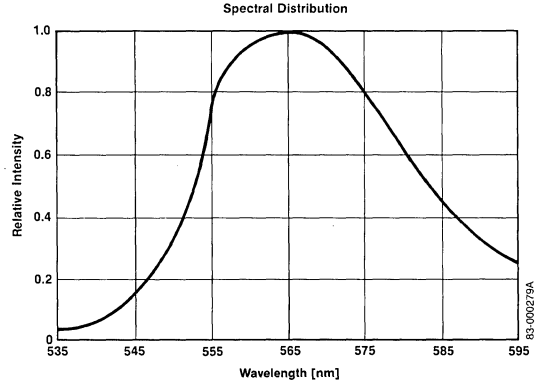

Relative Intensity vs Forward Current




Spatial Distribution




Spectral Distribution

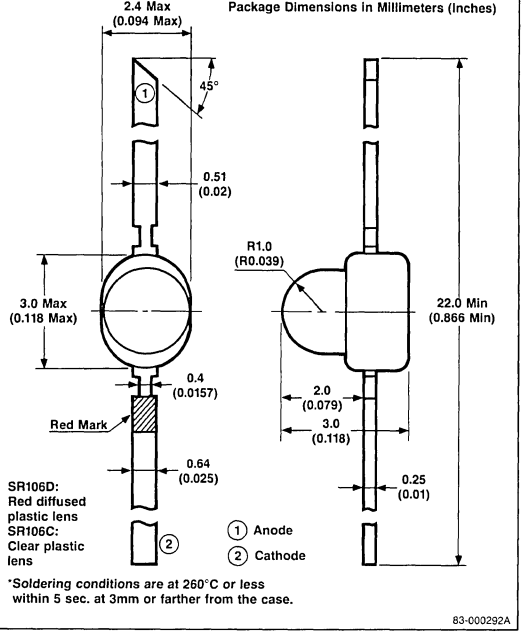


# SR106C/D
# RED
# GaAsP LEDs
*NEPOC SERIES*

## Description

The SR106D and SR106C are GaAsP (Gallium Arsenide Phosphide) light emitting diodes which are mounted on lead frames and molded in diffused red and clear plastic, respectively. They are ideally suited for front panel indicator applications

## Package Dimensions




## Features

- ☐ Small size
- ☐ Low cost
- ☐ Bright
- ☐ Easily assembled in arrays
- ☐ Compatible with integrated circuits
- ☐ Fast switching time

## Applications

- ☐ Visual displays
- ☐ Dial indicators
- ☐ Portable equipment indicators
- ☐ Camera indicators
- ☐ Desk-top calculator indicators

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

| | |
|---|---|
| Power Dissipation, $P_D$ | 80mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 3.0V |
| Junction Temperature, $T_J$ | 80°C |
| Storage Temperature, $T_{STG}$ | −30°C to +80°C |

## Electro-Optical Characteristics
$T_A = +25°C$

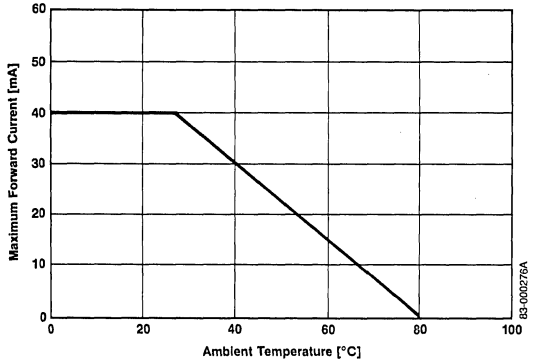
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 1.6 | 2.0 | V | $I_F$ = 20mA |
| Reverse Current | $I_R$ | | 0.01 | 50 | μA | $V_R$ = 3.0V |
| Capacitance | $C_T$ | | 50 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 660 | | nm | $I_F$ = 20mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 35 | | nm | $I_F$ = 20mA |
| Luminous Intensity | $I_V$ | | 1.5 | | mcd | $I_F$ = 20mA |

3

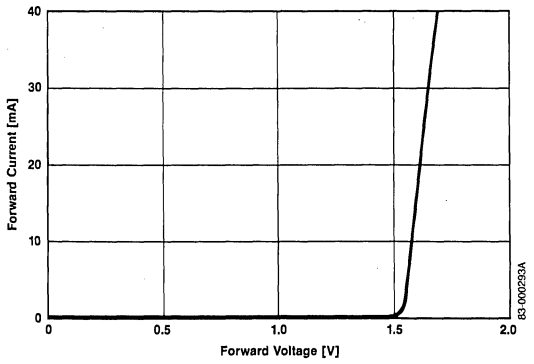
## Typical Characteristics

$T_A$ = +25°C

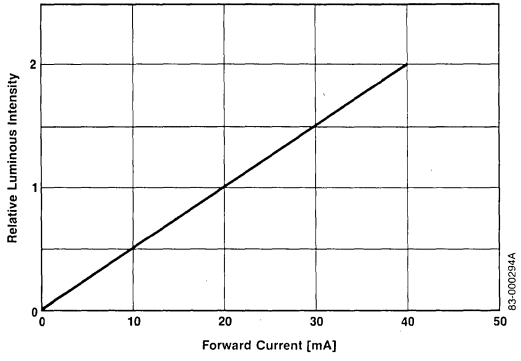
Maximum Forward Current vs Ambient Temperature



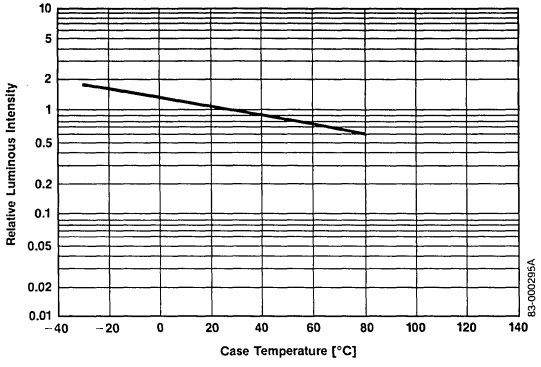

Forward Current vs Forward Voltage



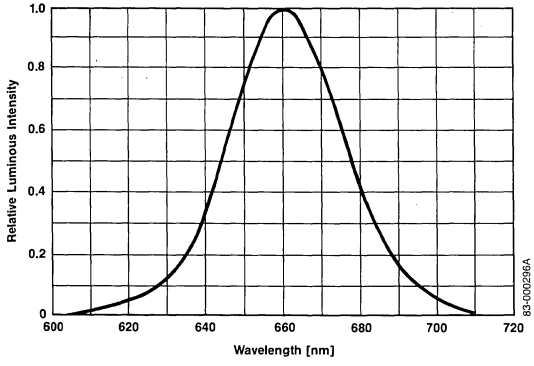

Relative Luminous Intensity vs Forward Current



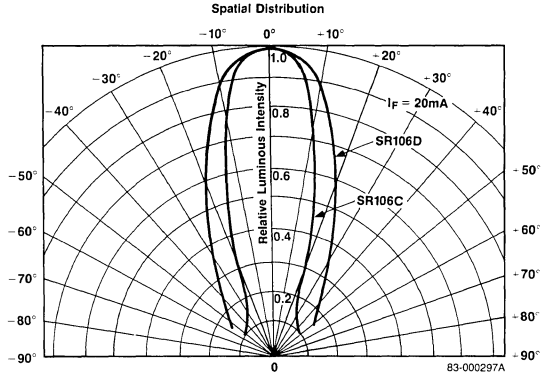

Relative Luminous Intensity vs Case Temperature




Spectral Distribution




Spatial Distribution



NEC
NEC Electronics Inc.

# SR503C/D/W RED GaP HIGH INTENSITY LEDs

*NEPOC SERIES*

## Description

The SR503D, SR503C and SR503W are full resin-molded LED lamps which emit brilliant red light at comparatively low current. They are especially suitable for electronic devices such as battery-driven equipment and audio equipment requiring low-power displays.

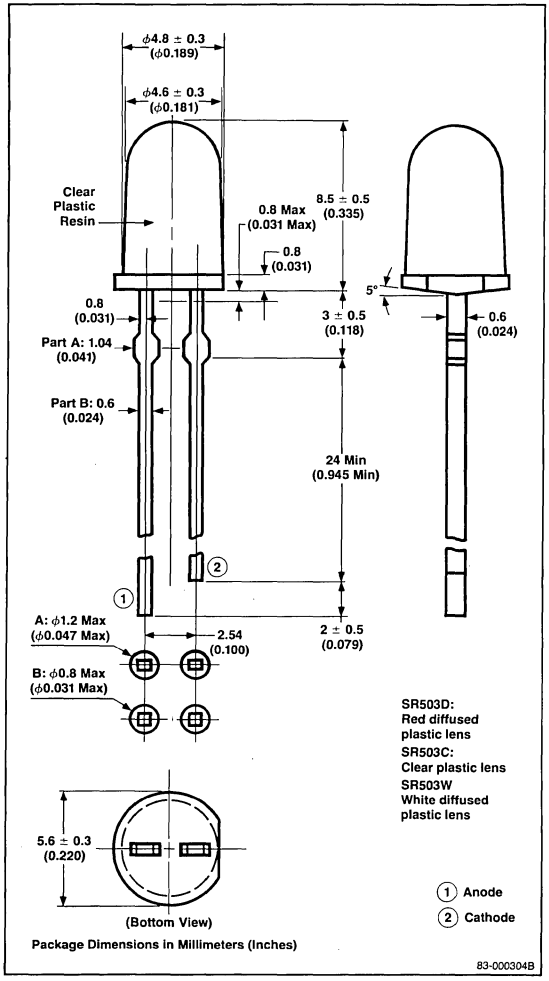
## Features

- ☐ Low cost
- ☐ High intensity with low current
- ☐ Compatible with integrated circuits
- ☐ Long lead
- ☐ Wide view angle
- ☐ Bright red

## Applications

- ☐ Visual displays
- ☐ Guard systems
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instruments, terminals
- ☐ Optical switching light sources

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000304B

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 60mW |
| Forward Current, $I_F$ | 30mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

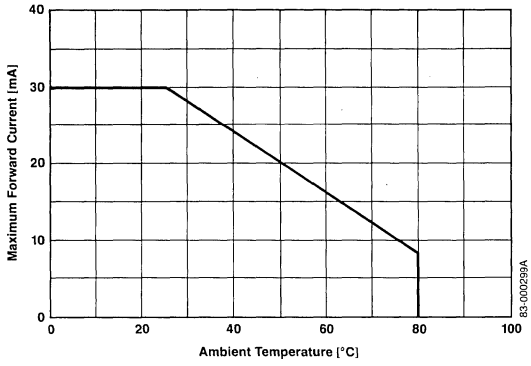
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5 |
| Capacitance | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 695 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 100 | | nm | $I_F$ = 10mA |
| Luminous Intensity (SR503D, SR503W) | $I_V$ | 1.5 | 5 | | mcd | $I_F$ = 10mA |
| Luminous Intensity (SR503C) | $I_V$ | 4 | 10 | | mcd | $I_F$ = 10mA |

3

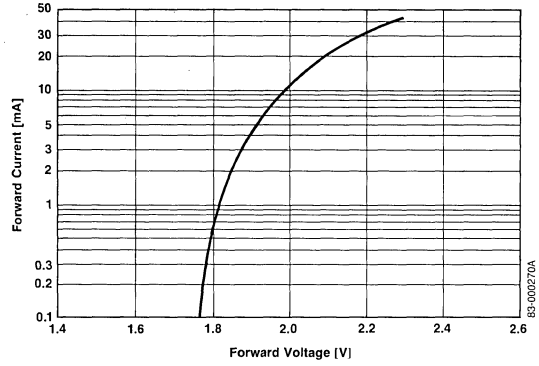
## Typical Characteristics

$T_A$ = +25°C

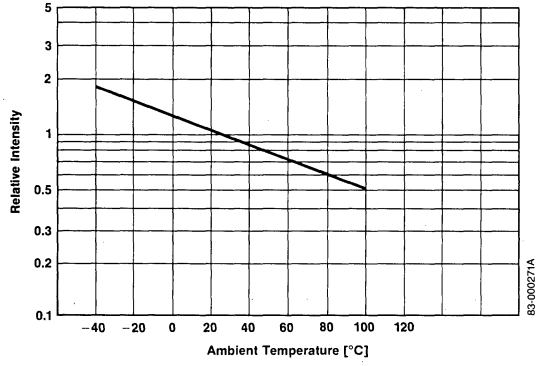
Maximum Forward Current vs Ambient Temperature



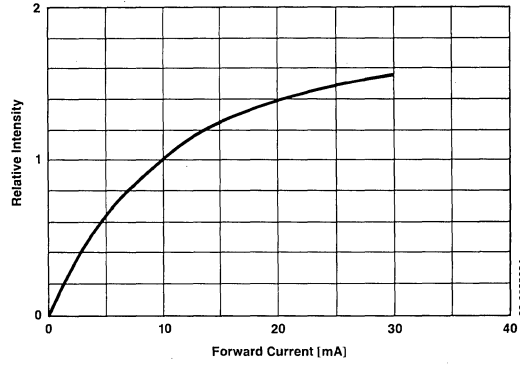

Forward Current vs Forward Voltage



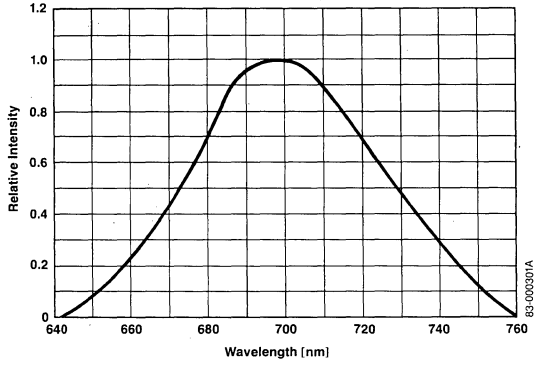

Relative Intensity vs Ambient Temperature



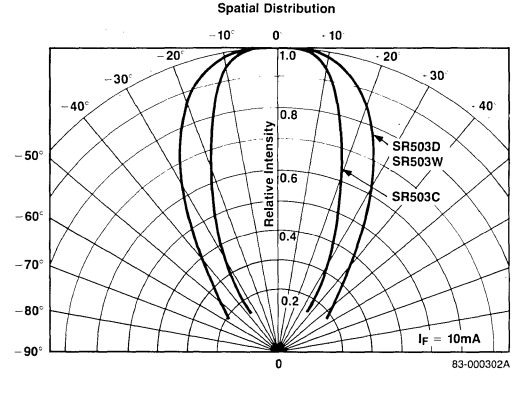

Relative Intensity vs Forward Current




Spectral Distribution




Spatial Distribution



NEC

NEC Electronics Inc.

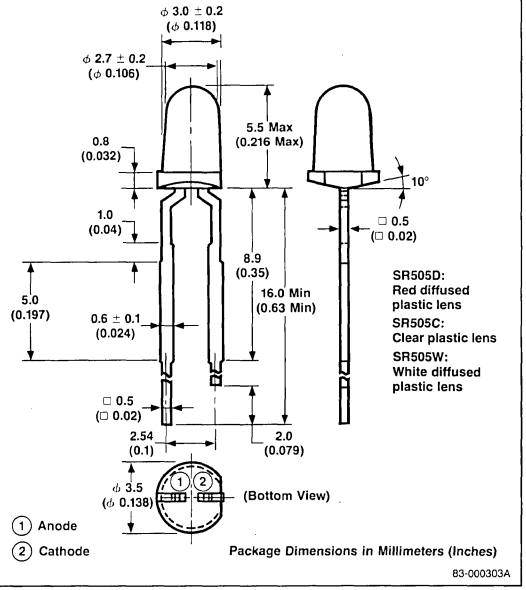
# SR505C/D/W RED GaP HIGH INTENSITY LEDs

*NEPOC SERIES*

## Description

The SR505D, SR505C and SR505W are medium-size, full resin-molded LED lamps which emit brilliant red light at comparatively low current. They are especially suitable for electronic devices such as battery-driven equipment and audio equipment requiring low-power displays.

## Package Dimensions




## Features

- ☐ Low cost
- ☐ High intensity at low current
- ☐ Compatible with integrated circuits
- ☐ Bright red

## Applications

- ☐ Radio and stereo equipment indicators
- ☐ Visual displays
- ☐ Guard systems
- ☐ Measuring instruments, terminals
- ☐ Optical switching light sources

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 60mW |
| Forward Current, $I_F$ | 30mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

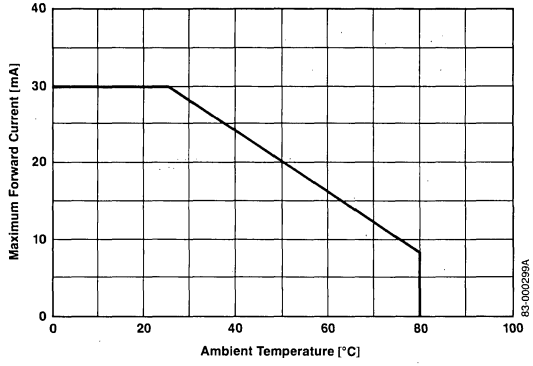
$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5 |
| Capacitance | $C_T$ | | 50 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 695 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 100 | | nm | $I_F$ = 10mA |
| Luminous Intensity (SR505D, SR505W) | $I_V$ | 1 | 3.5 | | mcd | $I_F$ = 10mA |
| Luminous Intensity (SR505C) | $I_V$ | 2 | 6 | | mcd | $I_F$ = 10mA |

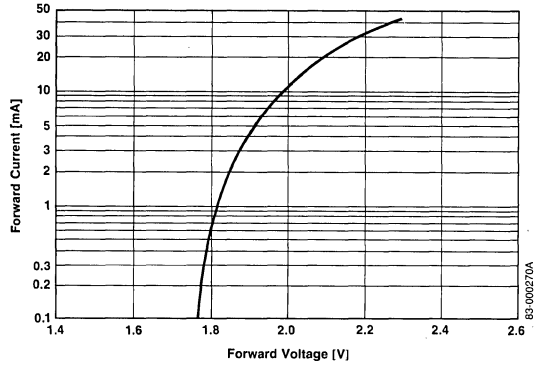
3

## Typical Characteristics
$T_A$ = +25°C

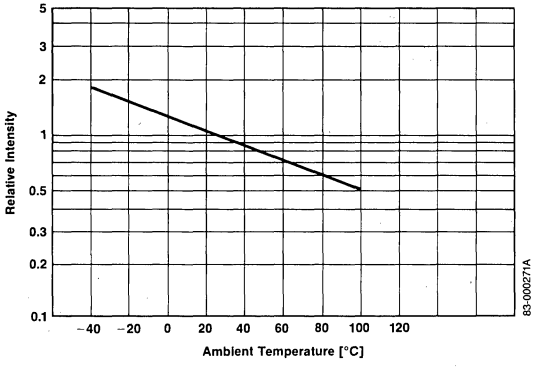
Maximum Forward Current vs Ambient Temperature



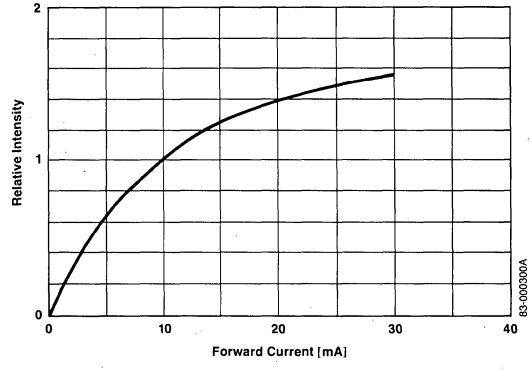

Forward Current vs Forward Voltage



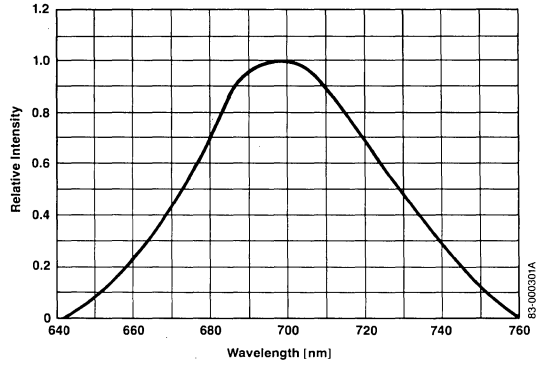

Relative Intensity vs Ambient Temperature



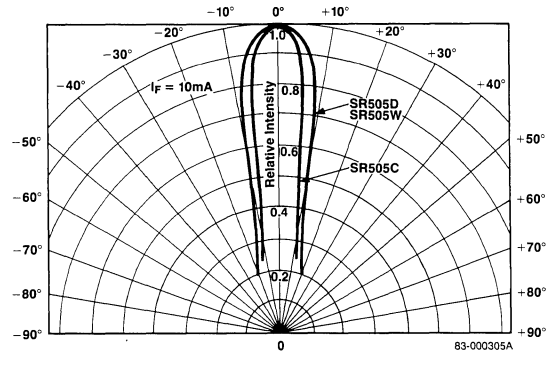

Relative Intensity vs Forward Current




Spectral Distribution




Spatial Distribution



NEC Electronics Inc.

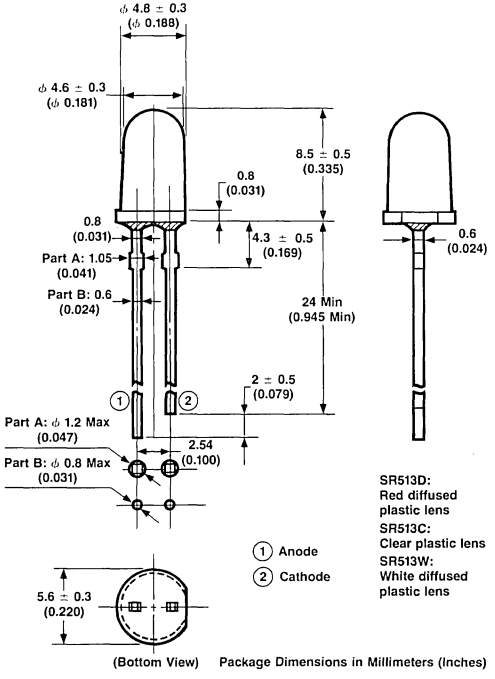
# SR513C/D/W RED GaP HIGH INTENSITY LEDs

*NEPOC SERIES*

## Description

The SR513D, SR513C and SR513W are full resin-molded LED lamps which emit brilliant, uniform red light at comparatively low current. They are especially suitable for electronic devices such as battery-driven and audio equipment requiring low-power displays.

## Package Dimensions




## Features

- ☐ High intensity
- ☐ Bright red
- ☐ Long lead
- ☐ Low cost
- ☐ Compatible with integrated circuits

## Applications

- ☐ Visual displays
- ☐ Guard systems
- ☐ Mobile equipment indicators
- ☐ Stereo equipment indicators
- ☐ Transceiver indicators

## Absolute Maximum Ratings

$T_A = +25°C$

| | |
|---|---|
| Power Dissipation, $P_D$ | 60mW |
| Forward Current, $I_F$ | 30mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A = +25°C$

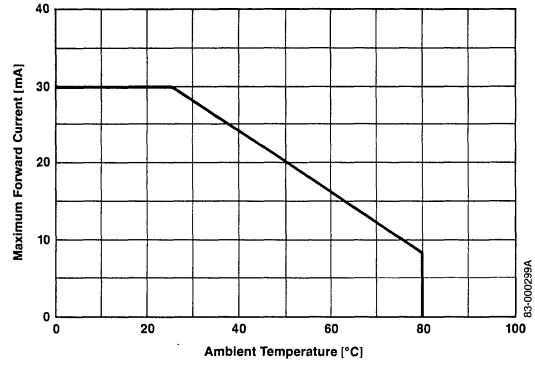
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 50 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 695 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 100 | | nm | $I_F$ = 10mA |
| Luminous Intensity (SR513D, SR513W) | $I_V$ | 1.5 | 5 | | mcd | $I_F$ = 10mA |
| Luminous Intensity (SR513C) | $I_V$ | 4 | 10 | | mcd | $I_F$ = 10mA |

3

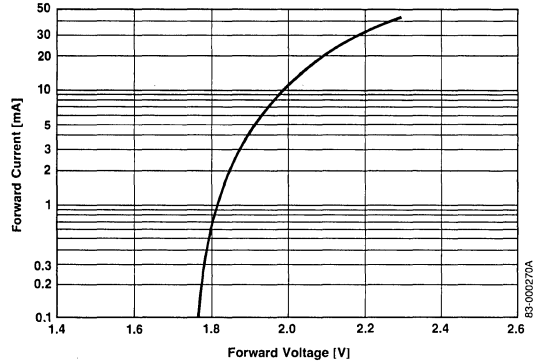
## Typical Characteristics

$T_A$ = +25°C

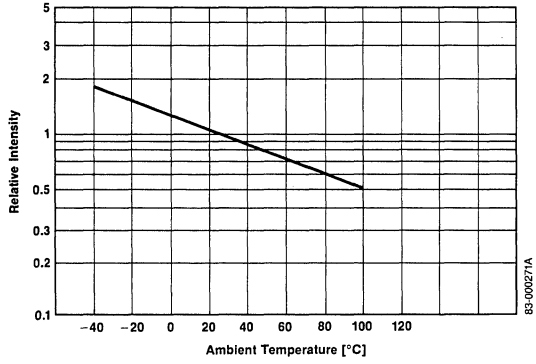
Maximum Forward Current vs Ambient Temperature



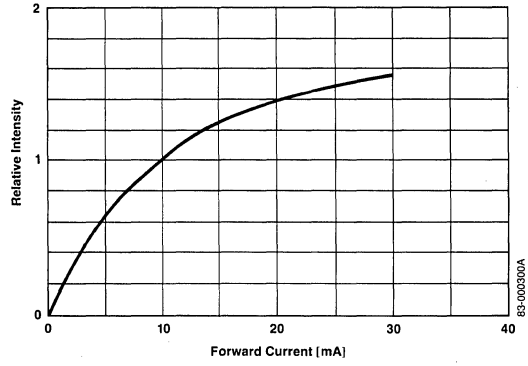

Forward Current vs Forward Voltage



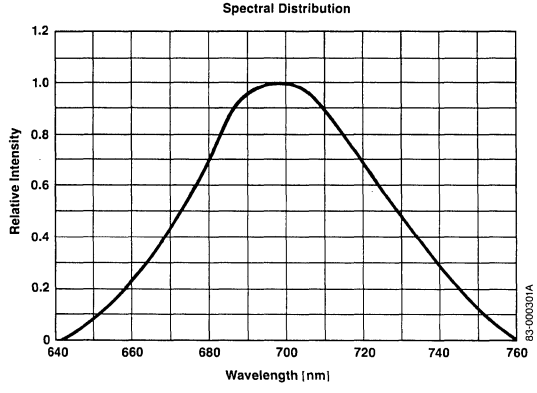

Relative Intensity vs Ambient Temperature



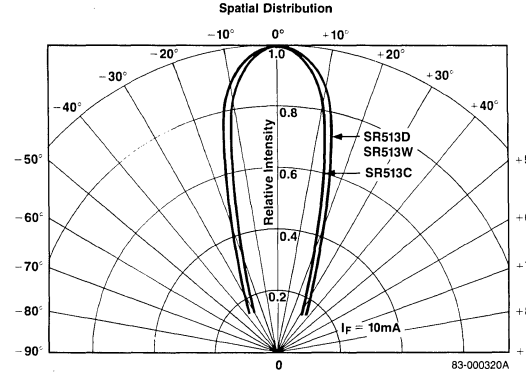

Relative Intensity vs Forward Current




Spectral Distribution




Spatial Distribution



NEC Electronics Inc.

# SR603C/D/W RED GaAsP(N) HIGH INTENSITY LEDs

*NEPOC SERIES*

## Description

The SR603D, SR603C and SR603W are full resin-molded LED lamps which emit brilliant, uniform red light proportional to the forward current ($I_F$). They are especially suitable for electronic equipment in audio applications which require bright, vivid displays.

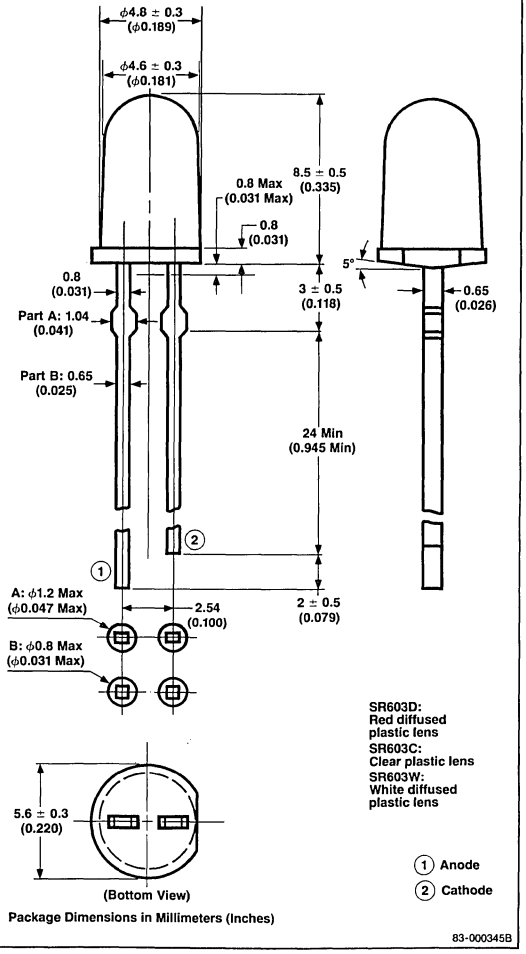
## Features

- ☐ Low cost
- ☐ High intensity
- ☐ Compatible with integrated circuits
- ☐ Long lead
- ☐ Wide view angle
- ☐ Bright red

## Applications

- ☐ Visual displays
- ☐ Guard systems
- ☐ Radio, stereo equipment indicators
- ☐ Measuring instrument terminals
- ☐ Optical switching light sources

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000345B

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P^D$ | 100mW |
| Forward Current, $I_F$ | 50mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

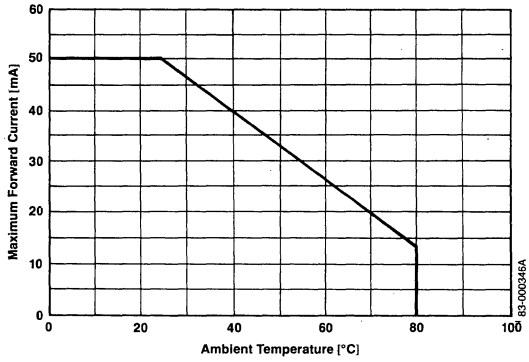
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.4 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 630 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity (SR603D, SR603W) | $I_V$ | 1.5 | 3 | | mcd | $I_F$ = 10mA |
| Luminous Intensity (SR603C) | $I_V$ | 4 | 6 | | mcd | $I_F$ = 10mA |

3

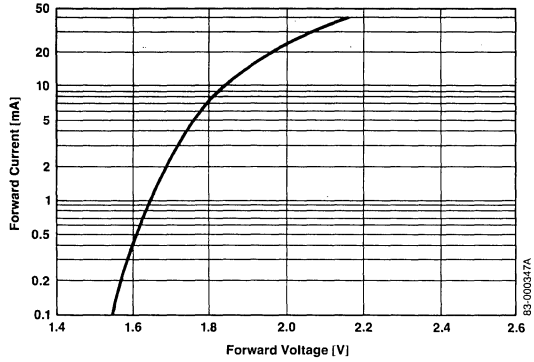
## Typical Characteristics

$T_A$ = +25°C

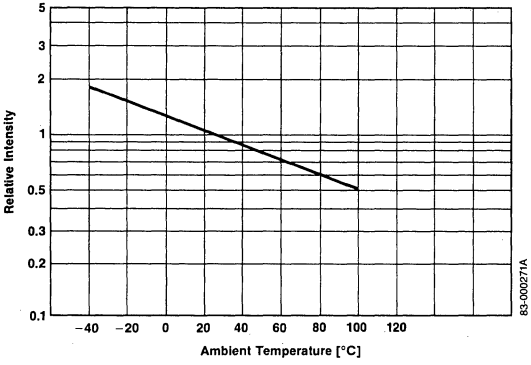
Maximum Forward Current vs Ambient Temperature



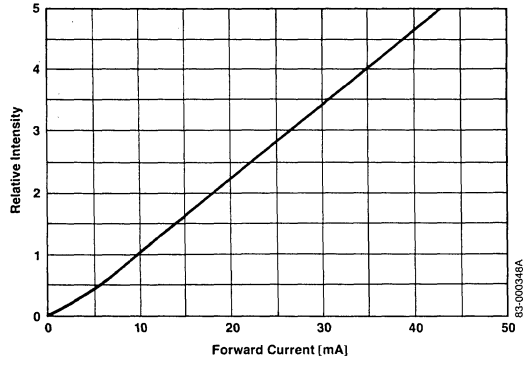

Forward Current vs Forward Voltage



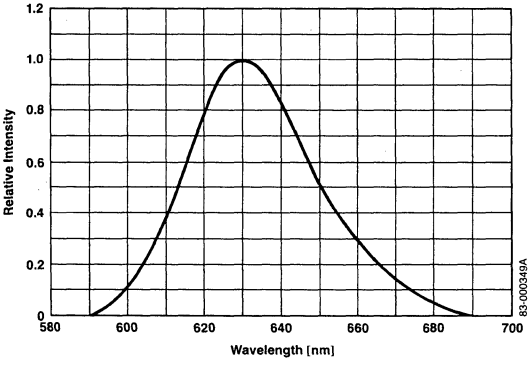

Relative Intensity vs Ambient Temperature



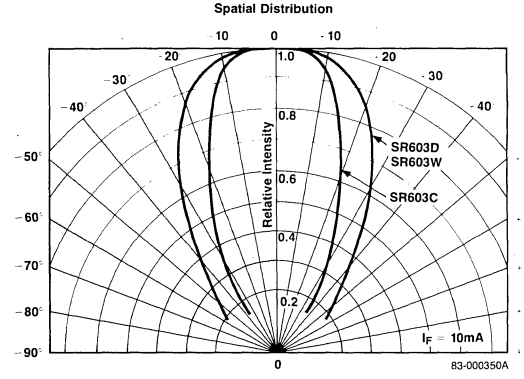

Relative Intensity vs Forward Current




Spectral Distribution




Spatial Distribution



NEC Electronics Inc.

# SR605C/D/W RED GaAsP(N) HIGH INTENSITY LEDs

*NEPOC SERIES*

## Description

The SR605D, SR605C and SR605W are full resin-molded medium-size LED lamps which emit brilliant, uniform red light proportional to the forward current ($I_F$). They are especially suitable for electronic equipment in audio applications which require bright, vivid displays.

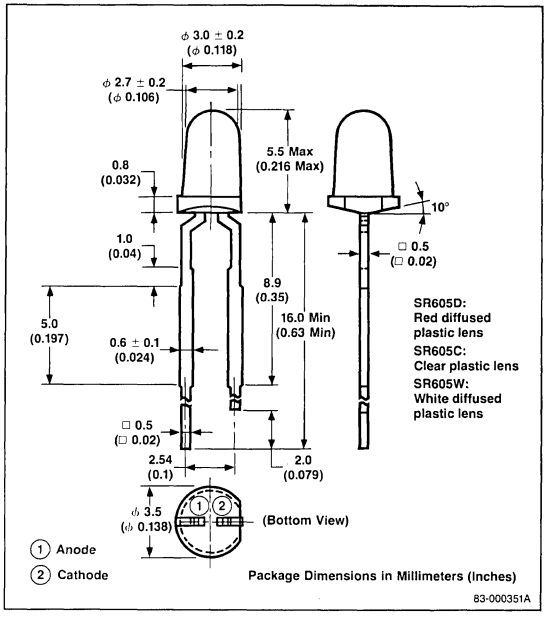
## Features

- ☐ Low cost
- ☐ High intensity
- ☐ Compatible with integrated circuits
- ☐ Bright red

## Applications

- ☐ Visual displays
- ☐ Guard systems
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instrument terminals
- ☐ Optical switching light sources

## Package Dimensions




## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 80mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

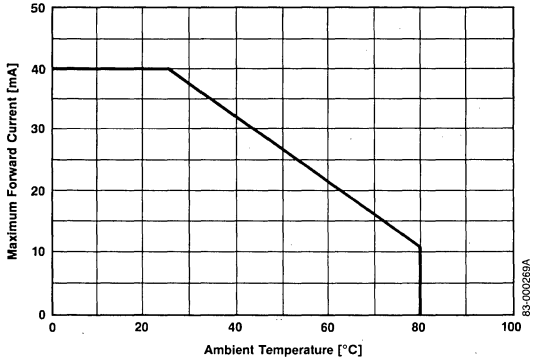
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.4 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 630 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | Δλ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity (SR605D, SR605W) | $I_V$ | 1.5 | 5 | | mcd | $I_F$ = 10mA |
| Luminous Intensity (SR605C) | $I_V$ | 3 | 10 | | mcd | $I_F$ = 10mA |

3

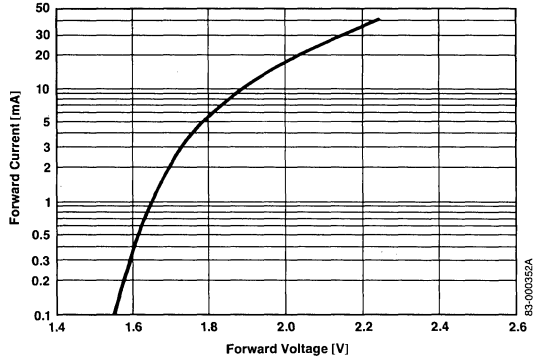
## Typical Characteristics

$T_A$ = +25°C

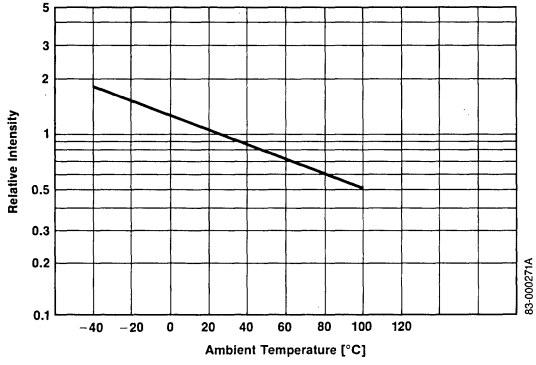
Maximum Forward Current vs Ambient Temperature



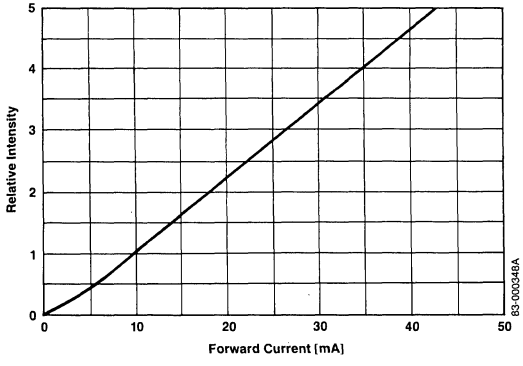

Forward Current vs Forward Voltage



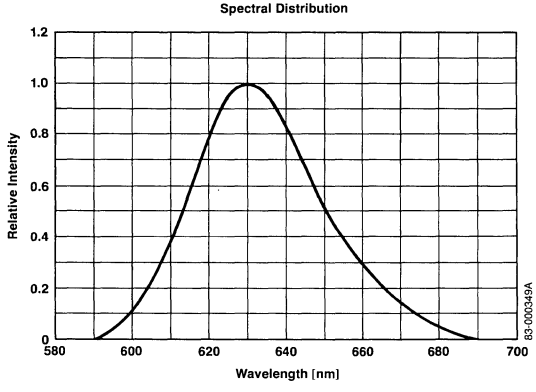

Relative Intensity vs Ambient Temperature



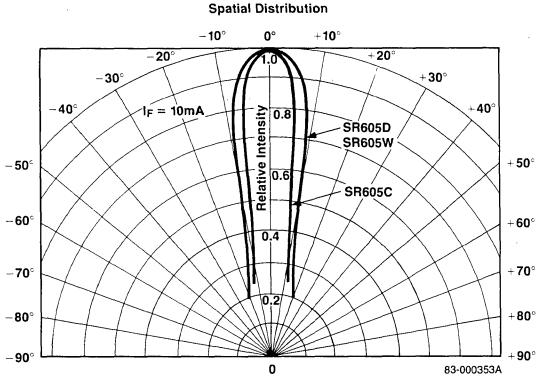

Relative Intensity vs Forward Current




Spectral Distribution




Spatial Distribution



NEC Electronics Inc.

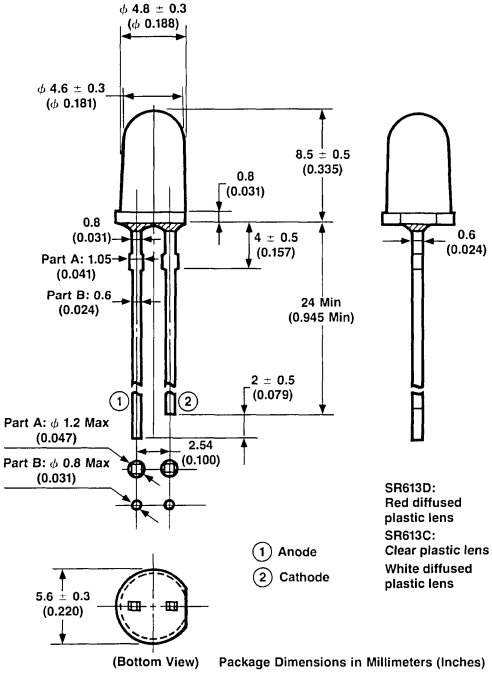
# SR613C/D/W RED GaAsP(N) HIGH INTENSITY LEDs

*NEPOC SERIES*

## Description

The SR613D, SR613C and SR613W are full resin-molded LED lamps which emit brilliant, uniform red light proportional to the forward current ($I_F$). They are especially suitable for electronic equipment in audio applications which require bright, vivid displays. The SR613C is especially suitable as a backlighting source.

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000354A

## Features

- ☐ High intensity
- ☐ Bright red
- ☐ Long lead
- ☐ Low cost
- ☐ Compatible with intgrated circuits

## Applications

- ☐ Visual displays
- ☐ Guard systems
- ☐ Mobile equipment indicators
- ☐ Stereo equipment indicators
- ☐ Transceiver indicators

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 50mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

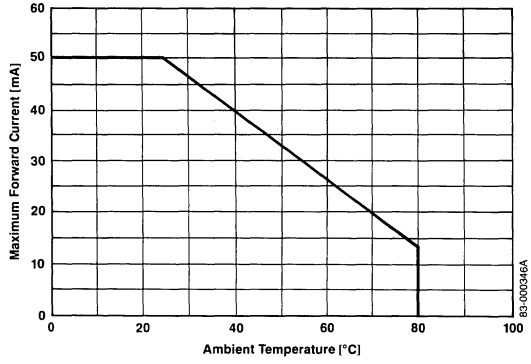
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.4 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 630 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity (SR613D, SR613W) | $I_V$ | 3 | 7 | | mcd | $I_F$ = 10mA |
| Luminous Intensity (SR613C) | $I_V$ | 10 | 20 | | mcd | $I_F$ = 10mA |

3

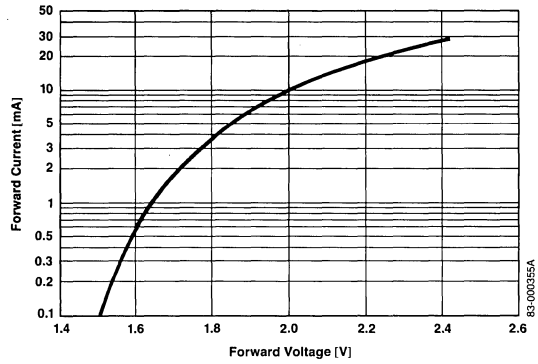
## Typical Characteristics

$T_A$ = +25°C

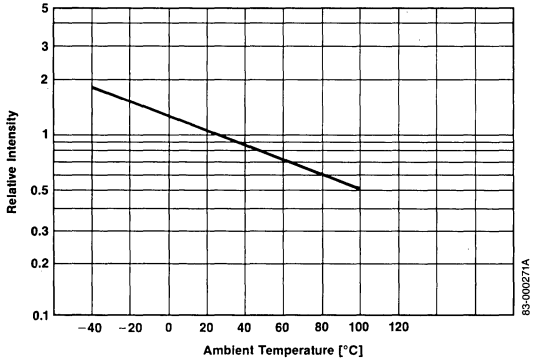
Maximum Forward Current vs Ambient Temperature



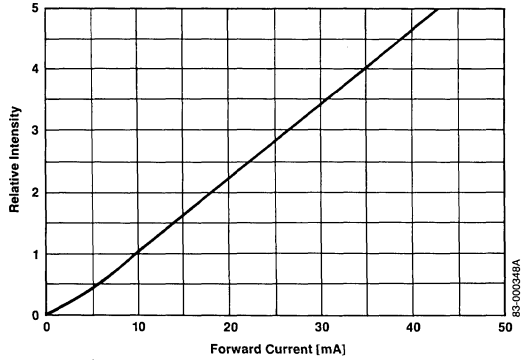

Forward Current vs Forward Voltage



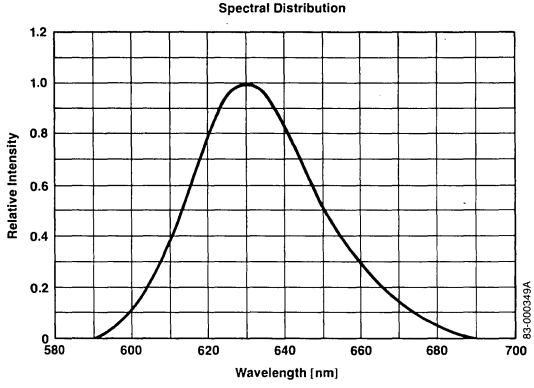

Relative Intensity vs Ambient Temperature



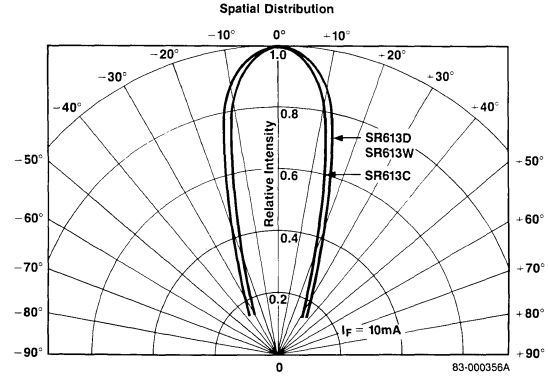

Relative Intensity vs Forward Current




Spectral Distribution




Spatial Distribution



NEC
NEC Electronics Inc.

# SR615C/D/W
# RED
# GaAsP(N) HIGH INTENSITY LEDs

*NEPOC SERIES*

## Description

The SR615D, SR615C and SR615W are medium-size plastic-resin-encapsulated LED lamps from which brilliant red light is emitted uniformly and intensely in proportion to the forward current ($I_F$). They are suitable for use as bright, distinguishable illuminators or indicators on the panels of audio-video equipment and elsewhere.

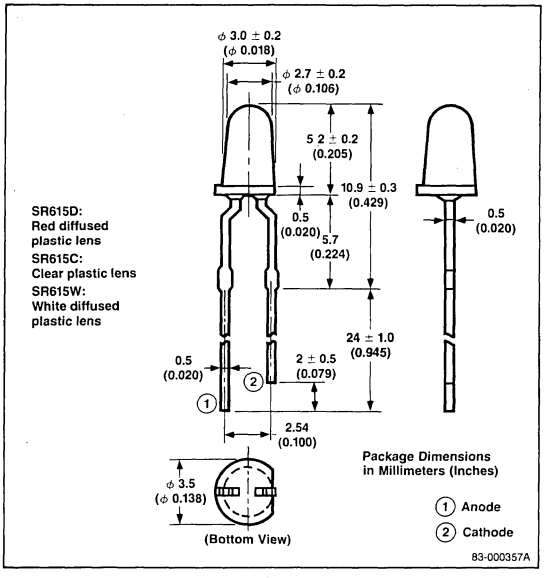
## Features

- ☐ High intensity
- ☐ Bright red
- ☐ Long lead
- ☐ Low cost
- ☐ Compatible with integrated circuits

## Applications

- ☐ Visual displays
- ☐ Guard systems
- ☐ Mobile equipment indicators
- ☐ Stereo equipment indicators
- ☐ Transceiver indicators

## Package Dimensions




## Absolute Maximum Ratings

$T_A = +25°C$

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A = +25°C$

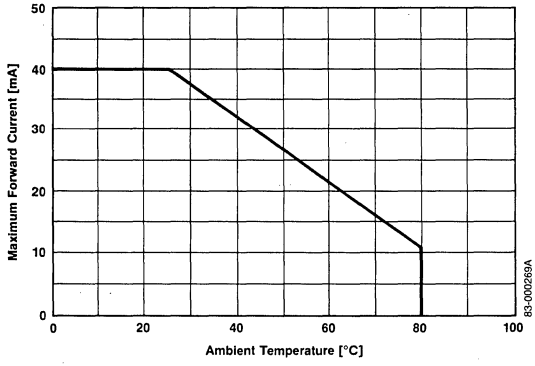
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 630 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity (SR615D, SR615W) | $I_V$ | 3 | 8 | | mcd | $I_F$ = 10mA |
| Luminous Intensity (SR615C) | $I_V$ | 6 | 16 | | mcd | $I_F$ = 10mA |

3

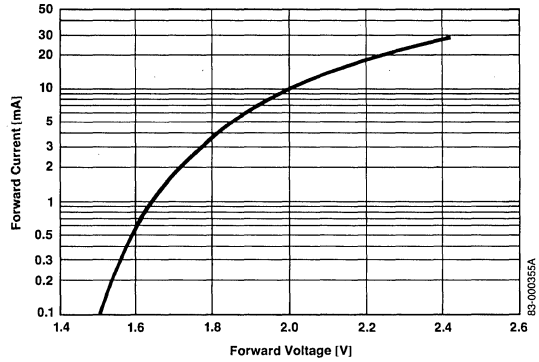
## Typical Characteristics

$T_A$ = +25°C

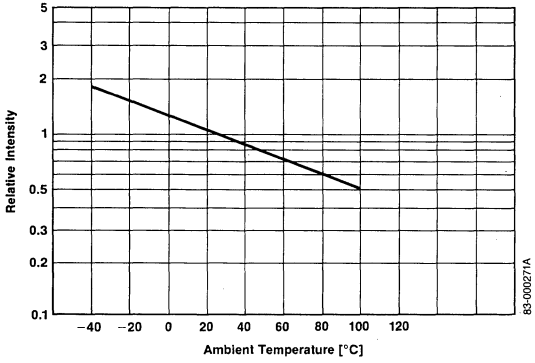
Maximum Forward Current vs Ambient Temperature



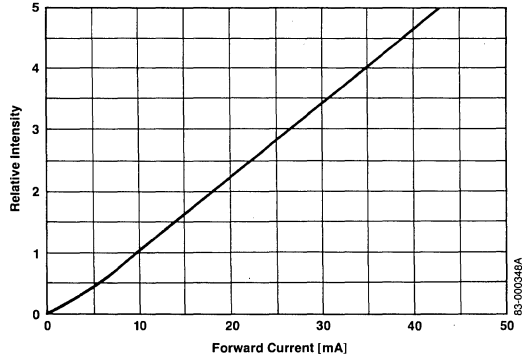

Forward Current vs Forward Voltage



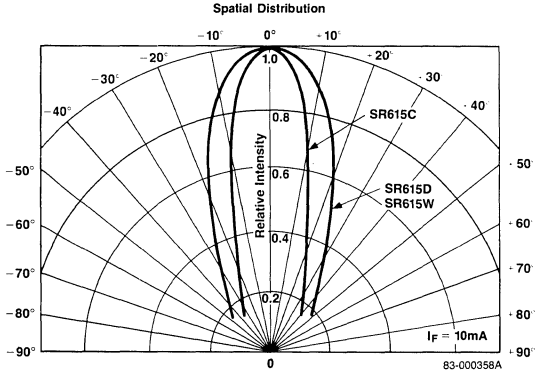

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Spatial Distribution



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NEC Electronics Inc.

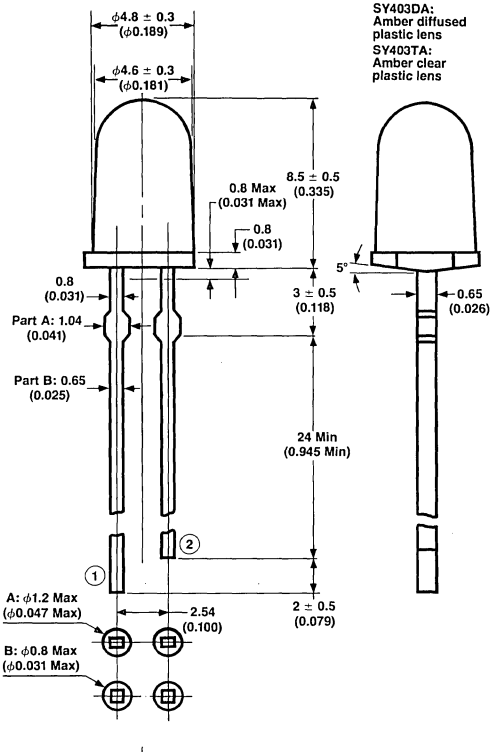
# SY403DA/TA AMBER GaAsP(N) HIGH INTENSITY LEDs

*NEPOC SERIES*

## Description

The SY403DA and SY403TA are full resin-molded lamps which emit bright, vivid amber light. They are especially suitable for electronic equipment in audio applications which require high-brightness displays.

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000362B

## Features

- ☐ High intensity
- ☐ Wide angle
- ☐ Long lead
- ☐ Good sensitivity—590nm
- ☐ Low cost
- ☐ Compatible and intgrated circuits

## Applications

- ☐ Visual displays
- ☐ Guard systems
- ☐ Mobile equipment indicators
- ☐ Stereo equipment indicators
- ☐ Transceiver indicators

3

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

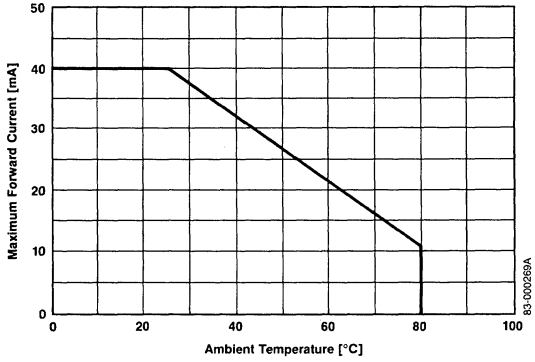
$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.1 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity SR403DA) | $I_V$ | 2 | 5 | | mcd | $I_F$ = 10mA |
| Luminous Intensity (SR403TA) | $I_V$ | 5 | 10 | | mcd | $I_F$ = 10mA |

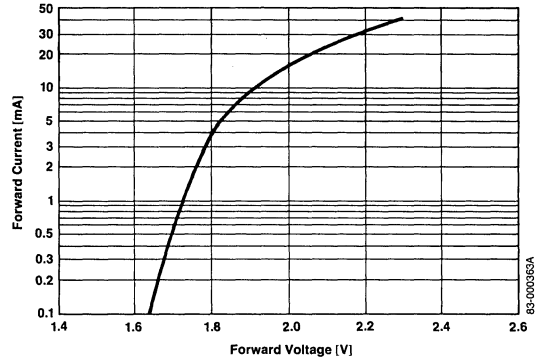
## Typical Characteristics

$T_A$ = +25°C

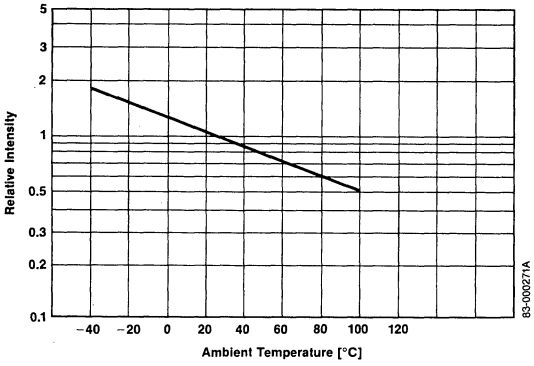
Maximum Forward Current vs Ambient Temperature



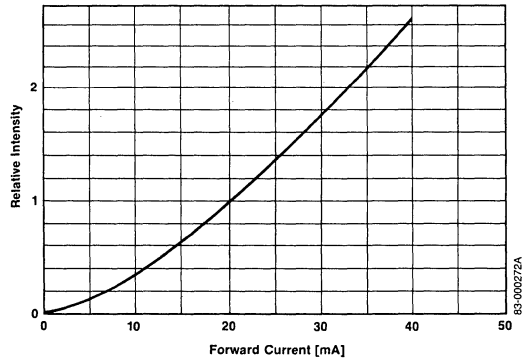

Forward Current vs Forward Voltage



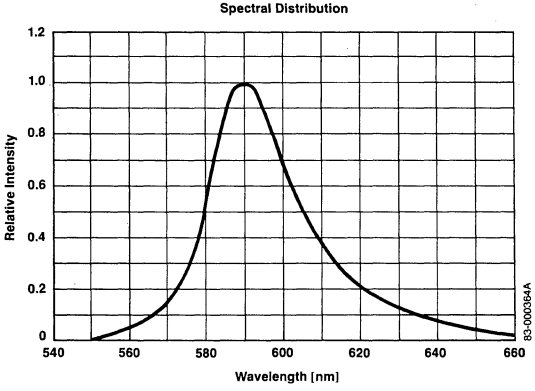

Relative Intensity vs Ambient Temperature



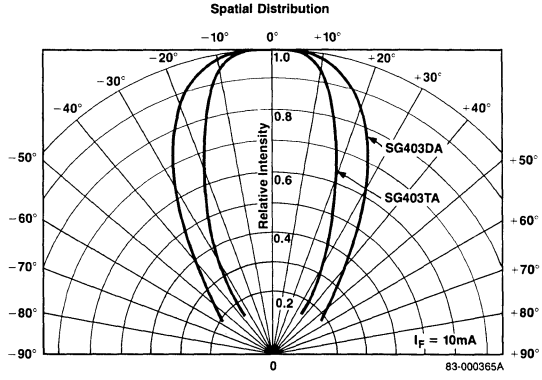

Relative Intensity vs Forward Current




Spectral Distribution




Spatial Distribution



NEC Electronics Inc.

# SY405D/T AMBER GaAsP(N) HIGH INTENSITY LEDs

*NEPOC SERIES*

## Description

The SY405D and SY405T are GaAsP & Gallium Arsenide Phosphide) light emitting diodes which are mounted on lead frames and molded in diffused amber and clear amber plastic, respectively. They are ideally suited for front panel indicator applications.

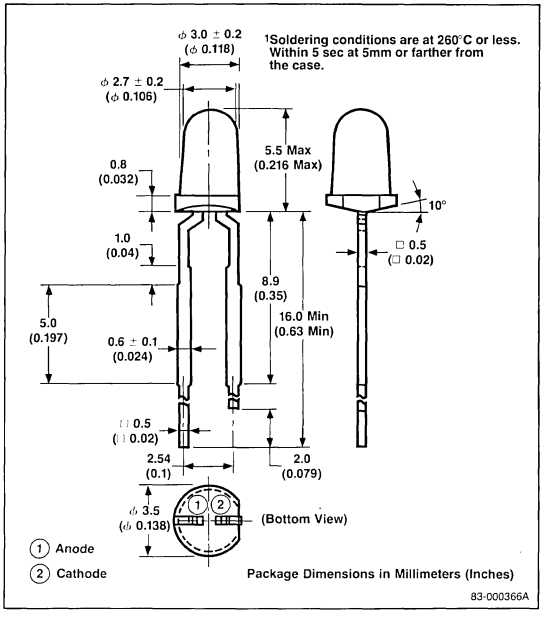
## Features

- ☐ Good sensitivity—590nm
- ☐ Long life—solid state reliability
- ☐ Low cost
- ☐ High intensity with low current
- ☐ Versatile mounting on PC board or panel
- ☐ Compatible with integrated circuits
- ☐ Fast switching time

## Applications

- ☐ Visual displays
- ☐ Guard systems
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instruments, terminals

## Package Dimensions




## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 80°C |
| Storage Temperature, $T_{STG}$ | −30°C to +80°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.2 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 50 | μA | $V_R$ = 4.5 |
| Capacitance | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | Δλ | | 35 | | nm | $I_F$ = 10mA |
| Luminous Intensity | $I_{V1}/I_{V2}$1 | 1/3 | 3/5 | | mcd | $I_F$ = 10mA |

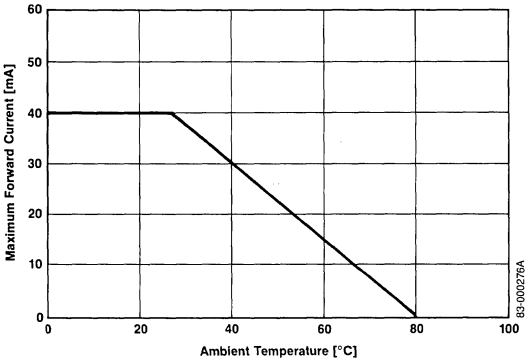
**Note:** 1. $I_{V1}/I_{V2}$: Luminous intensity of SY 405D/luminous intensity of SY405T.

3

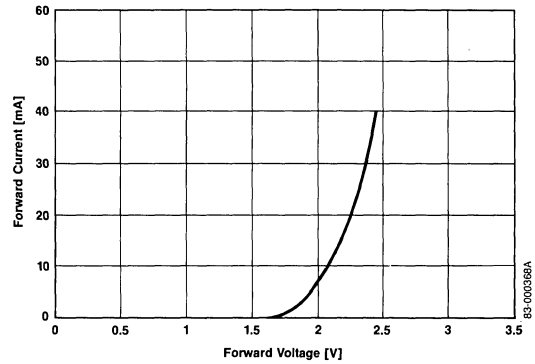
## Typical Characteristics

$T_A$ = +25°C

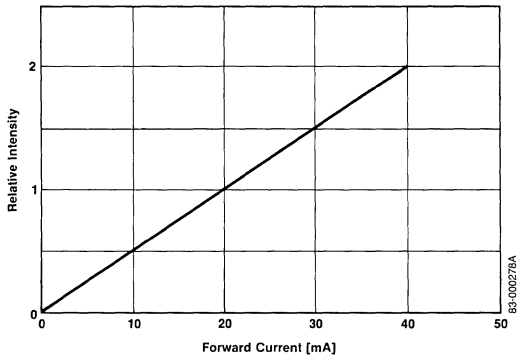
Maximum Forward Current vs Ambient Temperature



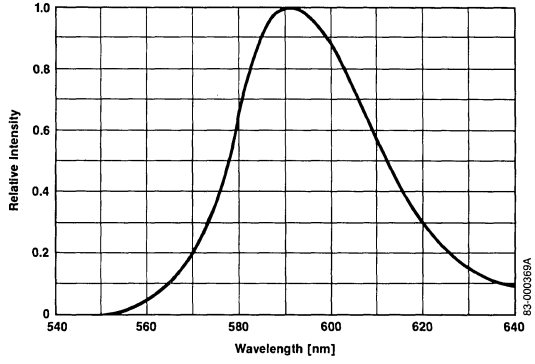

Forward Current vs Forward Voltage



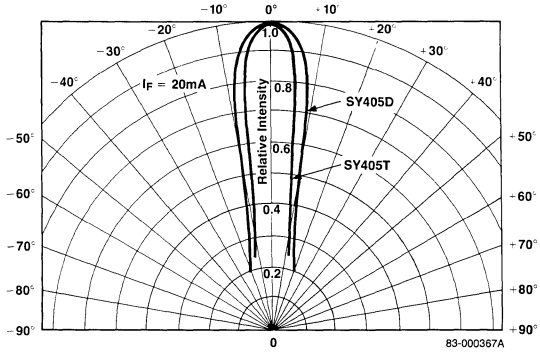

Relative Intensity vs Forward Current




Spectral Distribution




Spatial Distribution



# SY406D/T
# AMBER
# GaAs LEDs
*NEPOC SERIES*

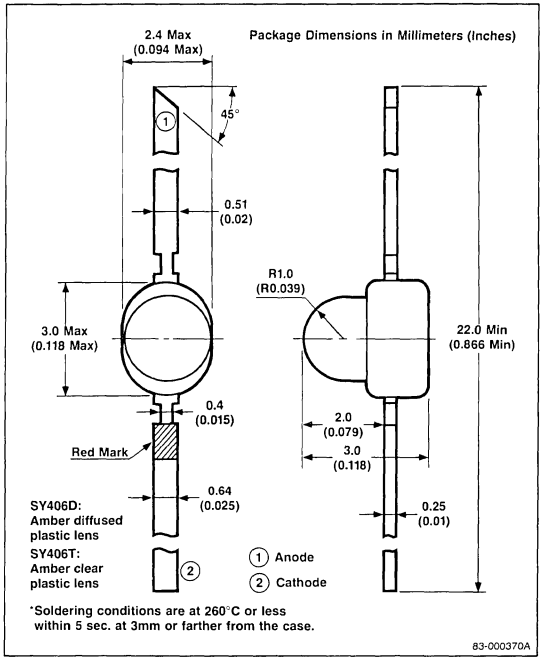
## Description

The SY406D and SY406T are GaAsP (Gallium Arsenide Phosphide) light emitting diodes which are mounted on lead frames and molded in diffused amber and clear amber plastic, respectively. They are ideally suited for front panel indicator applications.

## Features

- ☐ Good sensitivity — 590nm
- ☐ Small size
- ☐ Bright
- ☐ Easily assembled in arrays
- ☐ Compatible with integrated circuits
- ☐ Fast switching time

## Package Dimensions




## Applications

- ☐ Visual displays
- ☐ Panel indicators
- ☐ Desk top calculator indicators
- ☐ Portable equipment indicators
- ☐ Camera indicators

3

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

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 80°C |
| Storage Temperature, $T_{STG}$ | −30°C to +80°C |

## Electro-Optical Characteristics
$T_A$ = +25°C

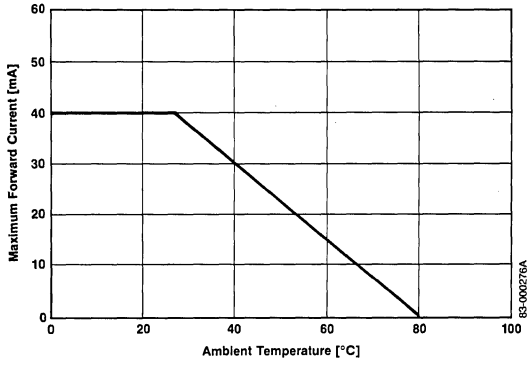
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.2 | 2.5 | V | $I_F$ = 20mA |
| Reverse Current | $I_R$ | | 0.01 | 50 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 35 | | nm | $I_F$ = 10mA |
| Luminous Intensity | $I_{V1}/I_{V2}$ | 1/2 | 2/4 | | mcd | $I_F$ = 10mA |

*$I_{V1}/I_{V2}$: Luminous Intensity of SY406D/Luminous Intensity of SY406T.

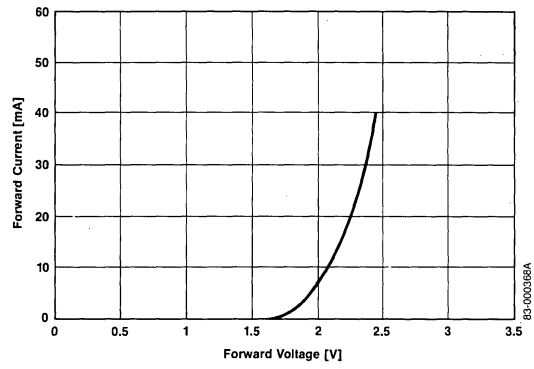
## Typical Characteristics

$T_A$ = +25°C

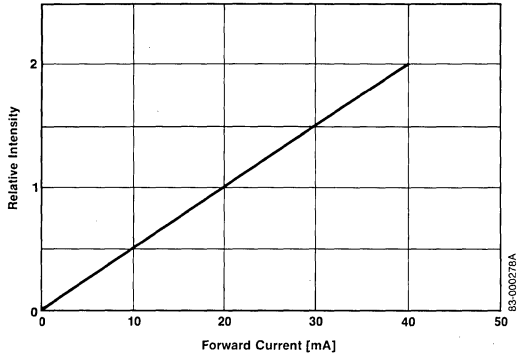
Maximum Forward Current vs Ambient Temperature



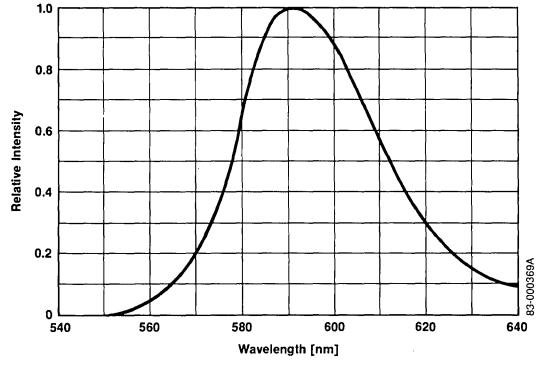

Forward Current vs Forward Voltage



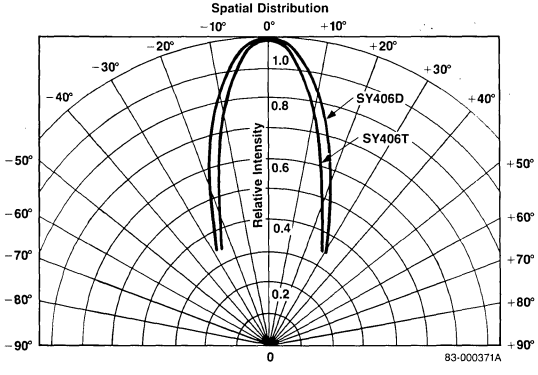

Relative Intensity vs Forward Current




Spectral Distribution




Spatial Distribution



NEC

NEC Electronics Inc.

# SY413D/T AMBER GaAsP HIGH INTENSITY LEDs

*NEPOC SERIES*

## Description

The SY413D and SY413T are full resin-molded LED lamps which emit bright, brilliant, uniform amber light proportional to the forward current ($I_F$). They are especially suitable for electronic equipment which require bright, vivid displays. The SY413T is especially suitable as a backlighting source.

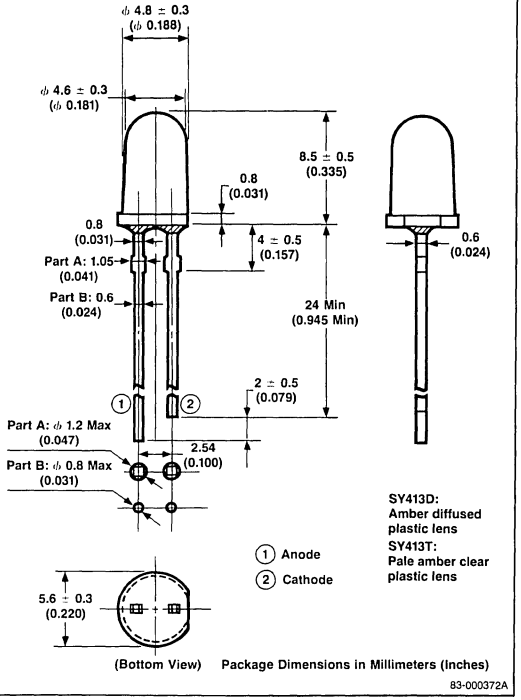
## Features

- ☐ High intensity
- ☐ Bright amber
- ☐ Long lead
- ☐ Low cost
- ☐ Compatible with integrated circuits

## Applications

- ☐ Visual displays
- ☐ Guard systems
- ☐ Mobile equipment indicators
- ☐ Stereo equipment indicators
- ☐ Transceiver indicators

## Package Dimensions




## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

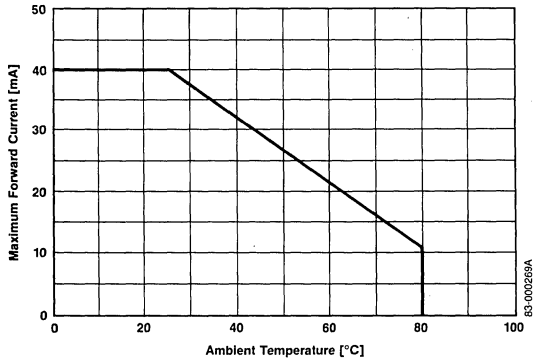
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity (SY413D) | $I_V$ | 4 | 10 | | mcd | $I_F$ = 10mA |
| Luminous Intensity (SY413T) | $I_V$ | 12 | 30 | | mcd | $I_F$ = 10mA |

3

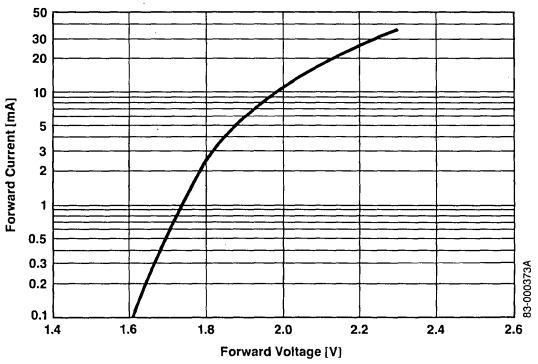
## Typical Characteristics

$T_A$ = +25°C

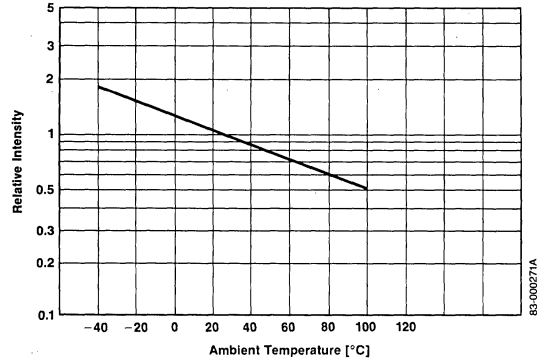
Maximum Forward Current vs Ambient Temperature



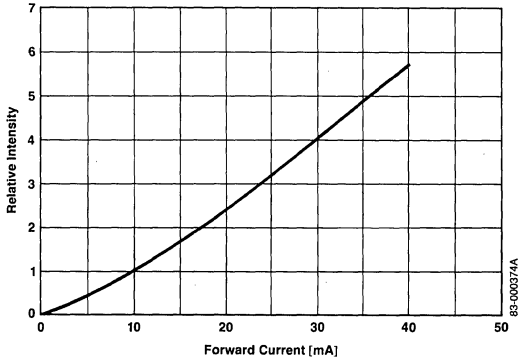

Forward Current vs Forward Voltage



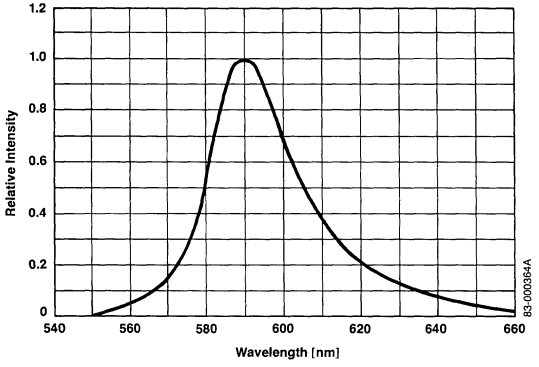

Relative Intensity vs Ambient Temperature



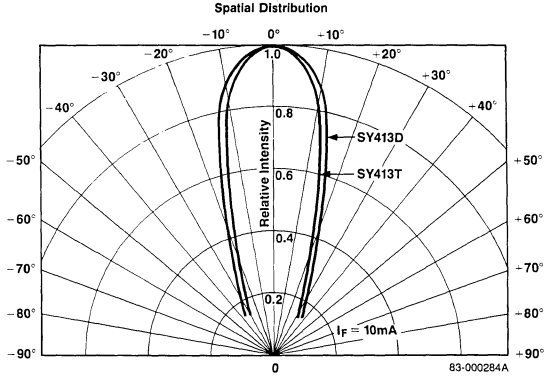

Relative Intensity vs Forward Current




Spectral Distribution




Spatial Distribution



NEC

NEC Electronics Inc.

# SY415D/T AMBER GaAsP HIGH INTENSITY LEDs

*NEPOC SERIES*

## Description

The SY415D and SY415T are medium-size plastic resin-encapsulated LED lamps which emit brilliant amber light uniformly and intensely in proportion to the forward current ($I_F$). They are suitable as bright, distinguishable illuminators or indicators on the panels of audio/video equipment and elsewhere.

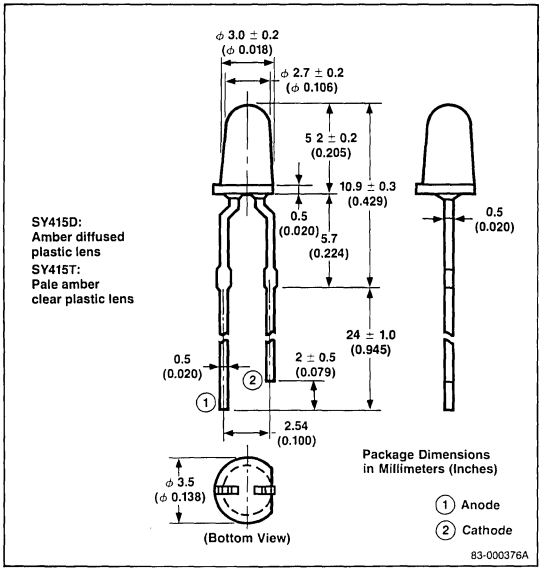
## Features

- ☐ High intensity
- ☐ Bright amber
- ☐ Long lead
- ☐ Low cost
- ☐ Compatible with integrated circuits

## Applications

- ☐ Visual displays
- ☐ Guard systems
- ☐ Mobile equipment indicators
- ☐ Stereo equipment indicators
- ☐ Transceiver indicators

## Package Dimensions




## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

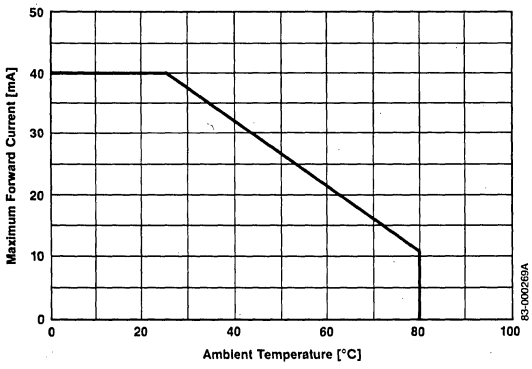
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity (SY415D) | $I_V$ | 4 | 10 | | mcd | $I_F$ = 10mA |
| Luminous Intensity (SY415T) | $I_V$ | 7 | 20 | | mcd | $I_F$ = 10mA |

3

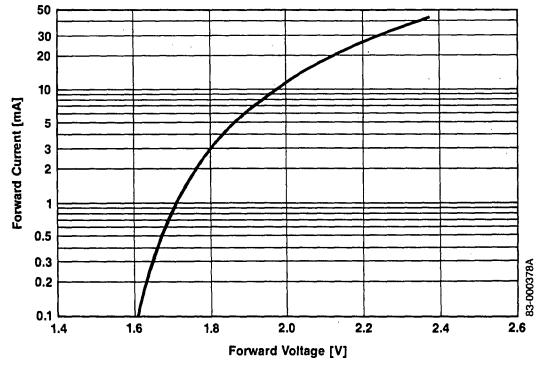
## Typical Characteristics

$T_A$ = +25°C

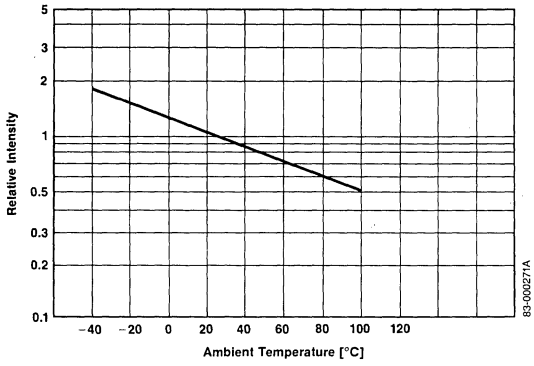
Maximum Forward Current vs Ambient Temperature



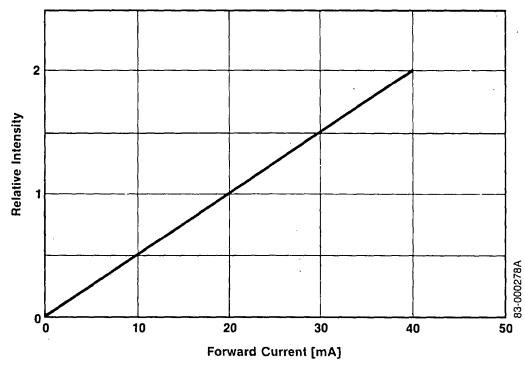

Forward Current vs Forward Voltage



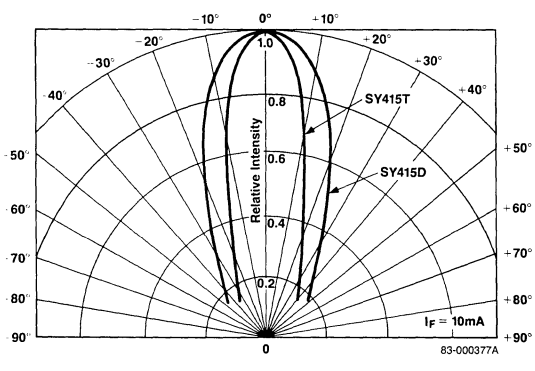

Relative Intensity vs Ambient Temperature



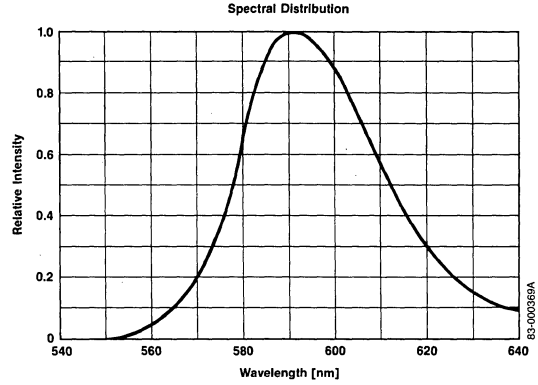

Relative Intensity vs Forward Current




Spatial Distribution




Spectral Distribution



# FASHION LEDs 4

**Section 4 — Fashion LEDs**

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# SG231D
# GREEN
# GaP FASHION LED
*NEPOC SERIES*

## Description

The SG231D is a full resin-molded LED lamp with a flat rectangular face which uniformly emits brilliant green light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

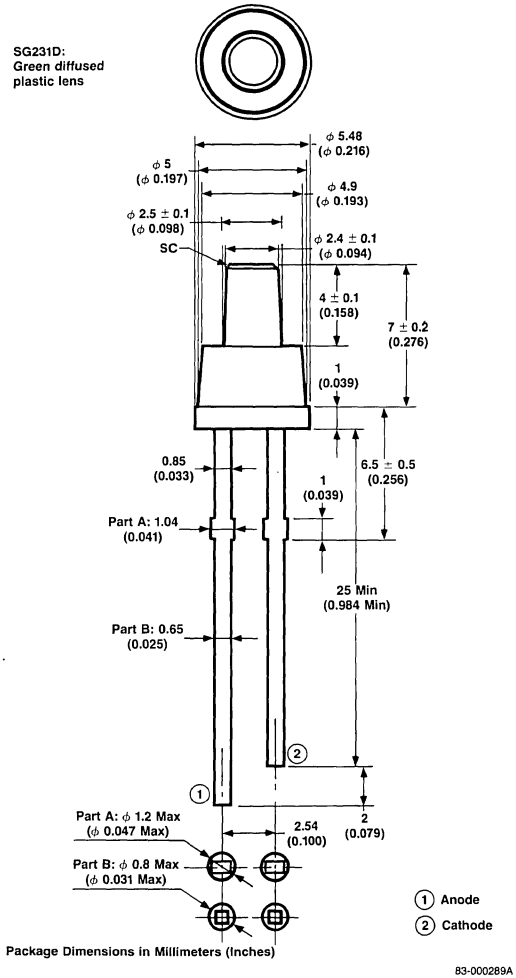
## Features

- ☐ Flat circular face
- ☐ Low cost
- ☐ Long lead
- ☐ Bright green
- ☐ Compatible with integrated circuits
- ☐ Red (SR531D) and amber (SY431D) LEDs are available in the same package

## Applications

- ☐ Visual displays
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instruments, terminals

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000289A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 565 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 35 | | nm | $I_F$ = 10mA |
| Luminous Intensity | $I_V$ | 0.1 | 0.3 | | mcd | $I_F$ = 10mA |

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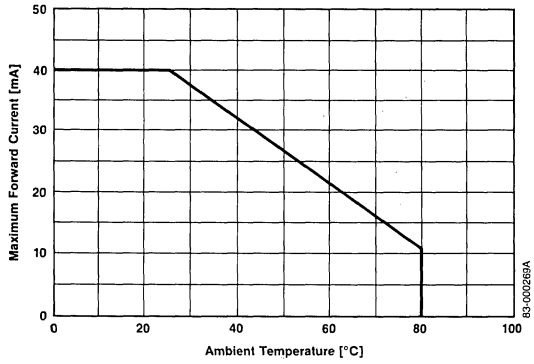
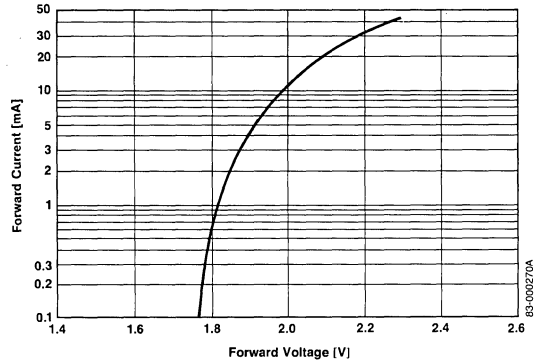
## Typical Characteristics

$T_A$ = +25°C

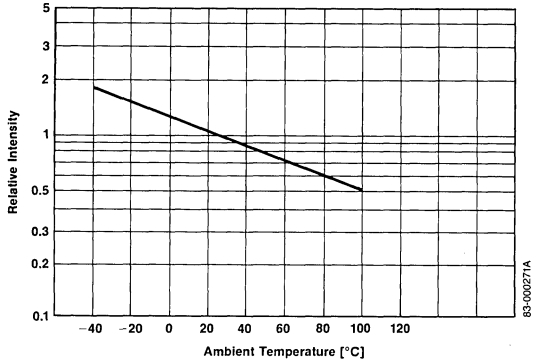
Maximum Forward Current vs Ambient Temperature



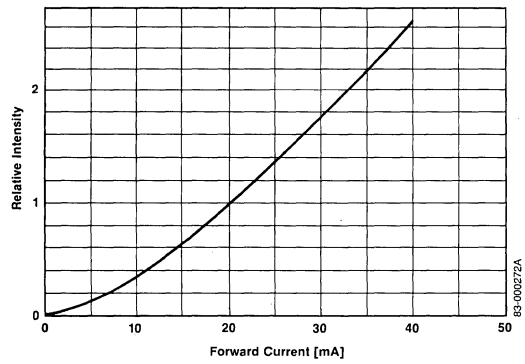

Forward Current vs Forward Voltage



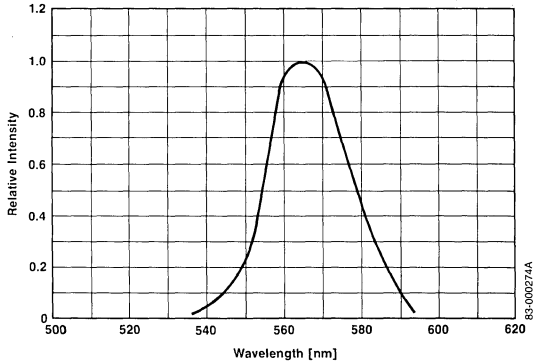

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Spectral Distribution



NEC Electronics Inc.

# SG232D
# GREEN
# GaP FASHION LED

*NEPOC SERIES*

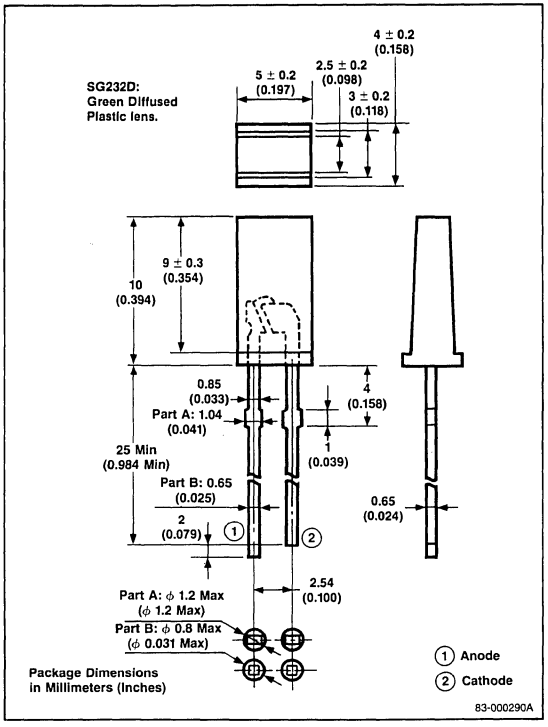
## Description

The SG232D is a full resin-molded LED lamp with a flat rectangular face which uniformly emits brilliant green light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

## Features

- ☐ Flat rectangular face
- ☐ Low cost
- ☐ Long lead
- ☐ Bright green
- ☐ Compatible with integrated circuits
- ☐ Red (SR632D) and amber (SY432D) LEDs are available in the same package style

## Package Dimensions




## Applications

- ☐ Visual displays
- ☐ Peak level indicators
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instruments, terminals

## Absolute Maximum Ratings

$T_A = +25°C$

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40 to +100°C |

## Electro-Optical Characteristics

$T_A = +25°C$

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 565 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity | $I_V$ | 0.2 | 0.5 | | mcd | $I_F$ = 10mA |

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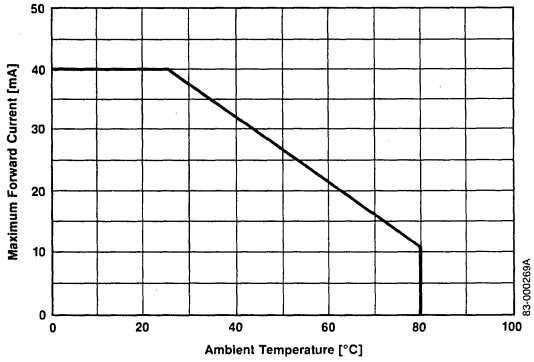
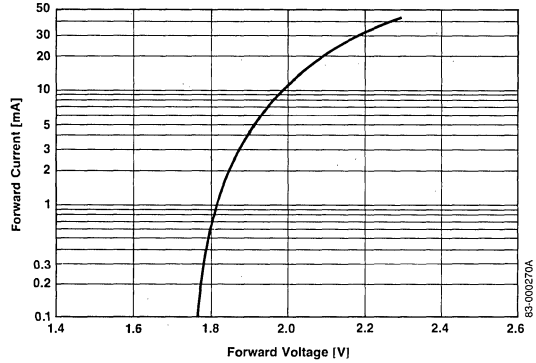
## Typical Characteristics

$T_A$ = +25°C

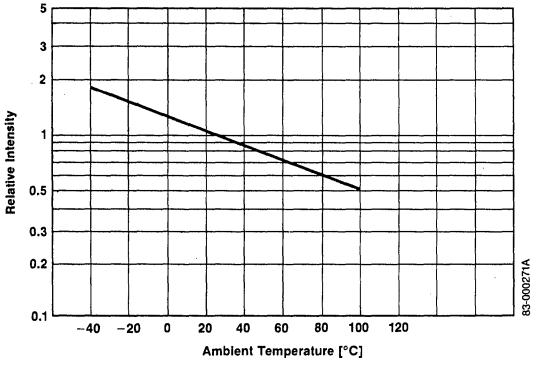
Maximum Forward Current vs Ambient Temperature



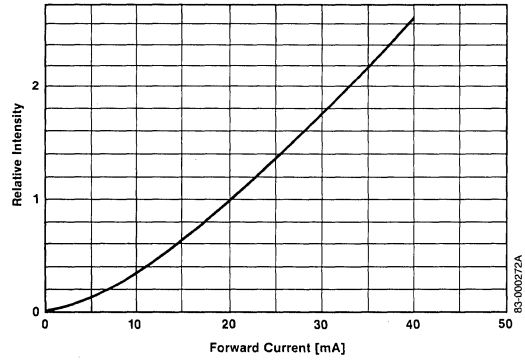

Forward Current vs Forward Voltage



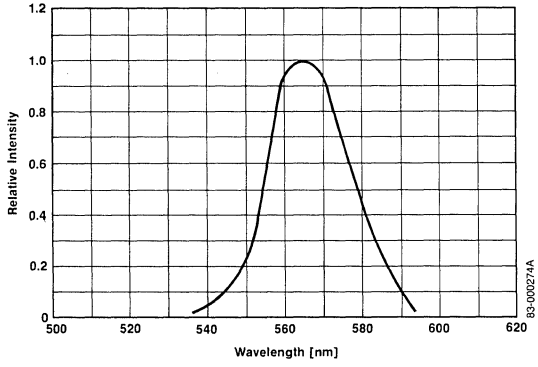

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Spectral Distribution



NEC Electronics Inc.

# SG233D, SY433D, SR533D
# GREEN, AMBER, RED
# FASHION LEDs

*NEPOC SERIES*

## Description

These three LEDs are full resin-molded LED lamps and have flat triangular faces which uniformly emit brilliant red, green and amber light. They are especially suitable for electronic equipment in audio applications which require fancy displays.

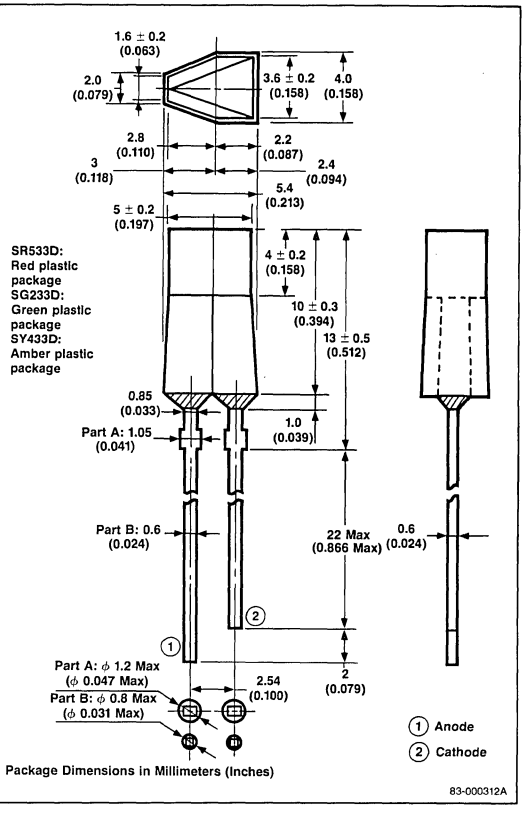
## Features

- ☐ Flat triangular face
- ☐ Low cost
- ☐ Long lead
- ☐ Bright red, green or amber
- ☐ Compatible with integrated circuits

## Applications

- ☐ Visual displays
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instrument terminals
- ☐ Direction indicators

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000312A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$1 | 60/100mW |
| Forward Current, $I_F$1 | 30/40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

**Note:** 1. SR533D/SG233D, SY433D.

## Electro-Optical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Forward Voltage** | | | | | | |
| SR533D | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| SG233D | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| SY433D | $V_F$ | | 2.0 | 2.4 | V | $I_F$ = 10mA |
| **Reverse Current** | | | | | | |
| SR533D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SG233D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SY433D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| **Capacitance** | | | | | | |
| SR533D | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SG233D | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SY433D | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| **Peak Emission Wavelength** | | | | | | |
| SR533D | $\lambda_{PEAK}$ | | 695 | | nm | $I_F$ = 10mA |
| SG233D | $\lambda_{PEAK}$ | | 565 | | nm | $I_F$ = 10mA |
| SY433D | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| **Spectral Line Half Width** | | | | | | |
| SR533D | $\Delta\lambda$ | | 100 | | nm | $I_F$ = 10mA |
| SY233D | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| SR433D | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| **Luminous Intensity** | | | | | | |
| SR533D | $I_V$ | 0.2 | 0.5 | | mcd | $I_F$ = 10mA |
| SG233D | $I_V$ | 0.2 | 0.7 | | mcd | $I_F$ = 10mA |
| SY433D | $I_V$ | 0.2 | 0.7 | | mcd | $I_F$ = 10mA |

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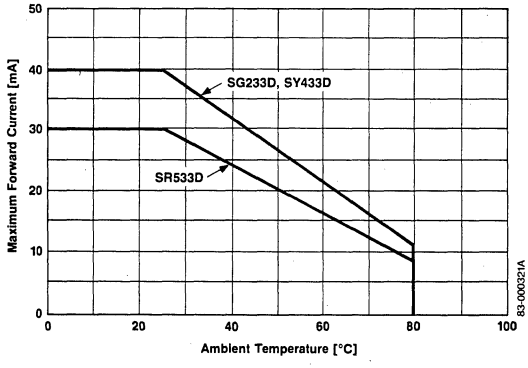
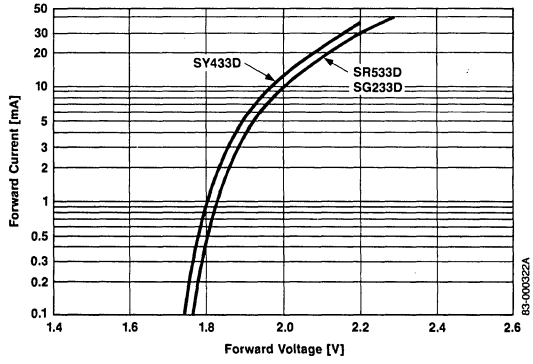
## Typical Characteristics

$T_A$ = +25°C

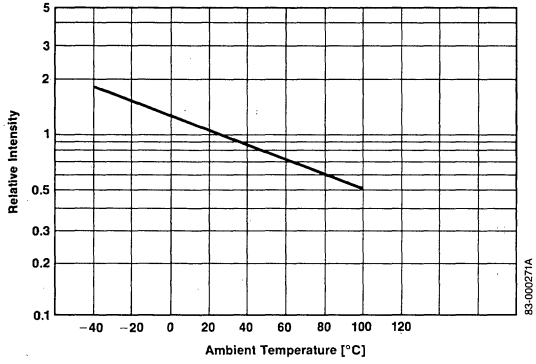
Maximum Forward Current vs Ambient Temperature



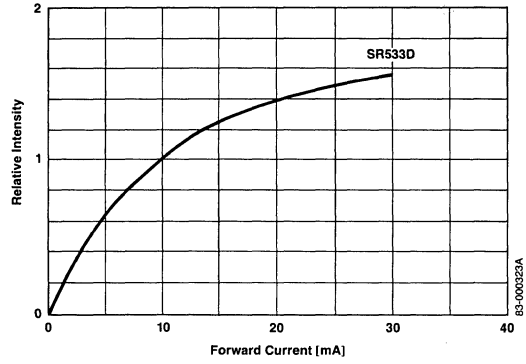

Forward Current vs Forward Voltage



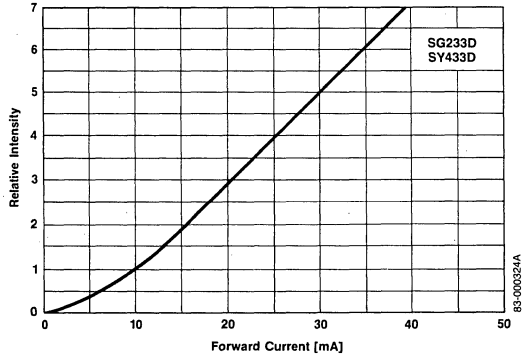

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Relative Intensity vs Forward Current



NEC Electronics Inc.

# SG235D, SY435D, SR535D
# GREEN, AMBER, RED
# FASHION LEDs

*NEPCO SERIES*

## Description

These three LEDs are full resin-molded LED lamps with flat rectangular faces which uniformly emit brilliant red, green and amber light. They are especially suitable for electronic equipment in audio applications which require fancy displays.

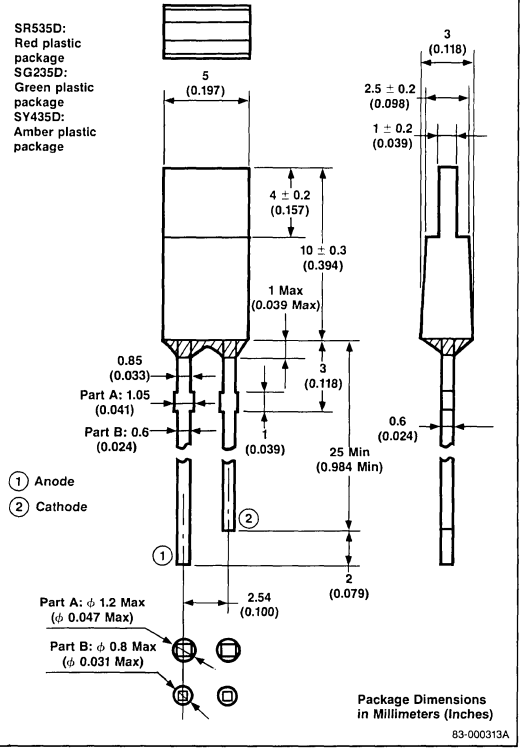
## Features

- ☐ Flat rectangular face
- ☐ Low cost
- ☐ Long lead
- ☐ Bright red, green or amber
- ☐ Compatible with integrated circuits

## Applications

- ☐ Visual displays
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instrument terminals

## Package Dimensions




## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$1 | 60/100mW |
| Forward Current, $I_F$1 | 30/40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

**Note:** 1. SR535D/SG235D, SY435D

## Electro-Optical Characteristics

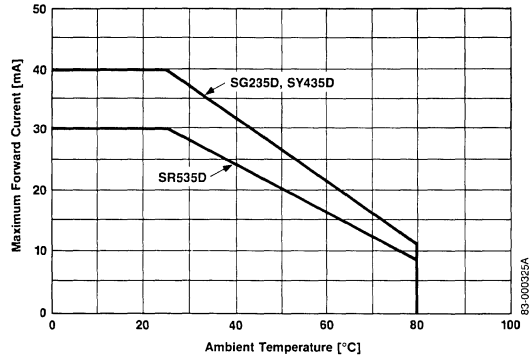
$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Forward Voltage** | | | | | | |
| SR535D | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| SG235D | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| SY435D | $V_F$ | | 2.0 | 2.4 | V | $I_F$ = 10mA |
| **Reverse Current** | | | | | | |
| SR535D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SG235D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SY435D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| **Capacitance** | | | | | | |
| SR535D | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SG235D | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SY435D | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| **Peak Emission Wavelength** | | | | | | |
| SR535D | $\lambda_{PEAK}$ | | 695 | | nm | $I_F$ = 10mA |
| SG235D | $\lambda_{PEAK}$ | | 565 | | nm | $I_F$ = 10mA |
| SY435D | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| **Spectral Line Half Width** | | | | | | |
| SR535D | $\Delta\lambda$ | | 100 | | nm | $I_F$ = 10mA |
| SY235D | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| SR435D | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| **Luminous Intensity** | | | | | | |
| SR535D | $I_V$ | 0.2 | 0.5 | | mcd | $I_F$ = 10mA |
| SG235D | $I_V$ | 0.2 | 0.7 | | mcd | $I_F$ = 10mA |
| SY435D | $I_V$ | 0.2 | 0.7 | | mcd | $I_F$ = 10mA |

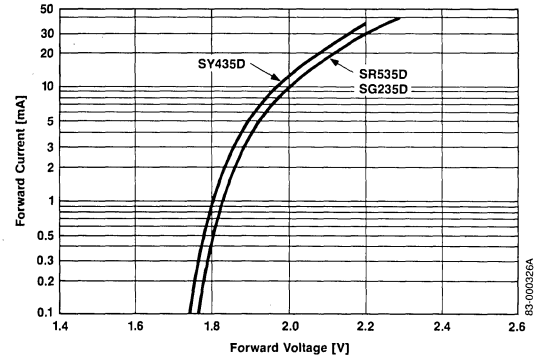
4

## Typical Characteristics
$T_A$ = +25°C

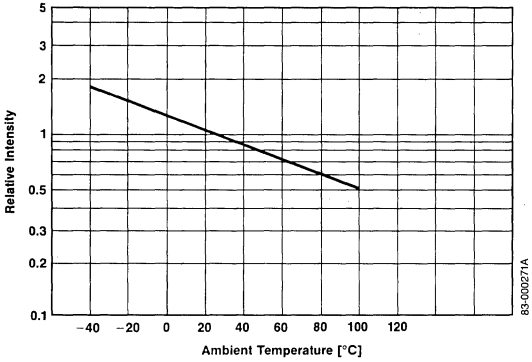
Maximum Forward Current vs Ambient Temperature



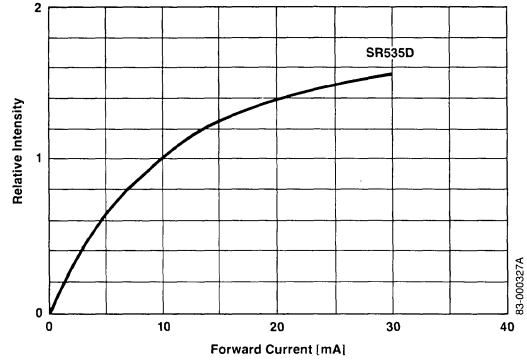

Forward Current vs Forward Voltage



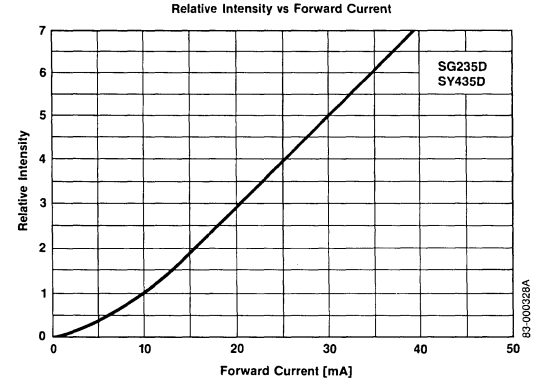

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Relative Intensity vs Forward Current



NEC
NEC Electronics Inc.

# SG236D, SY436D, SR536D
# GREEN, AMBER, RED
# FASHION LEDs

*NEPCO SERIES*

## Description

These three LEDs are full resin-molded LED lamps with flat hexagonal faces which uniformly emit brilliant red, green and amber light. They are especially suitable for electronic equipment in audio applications which require fancy displays.

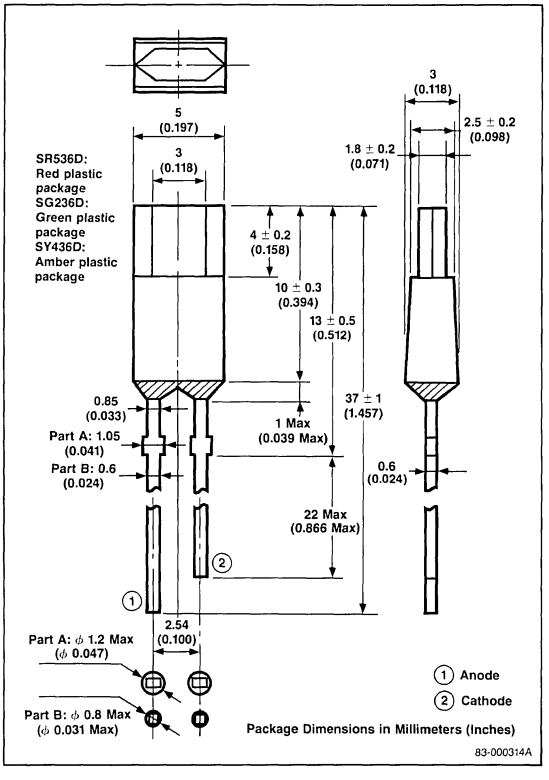
## Features

- ☐ Flat hexagonal face
- ☐ Low cost
- ☐ Long lead
- ☐ Bright red, green or amber
- ☐ Compatible with integrated circuits

## Applications

- ☐ Visual displays
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instrument terminals

## Package Dimensions




## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$1 | 60/100mW |
| Forward Current, $I_F$1 | 30/40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

**Note:** 1. SR536D/SG236D, SY436D

## Electro-Optical Characteristics

$T_A$ = +25°C

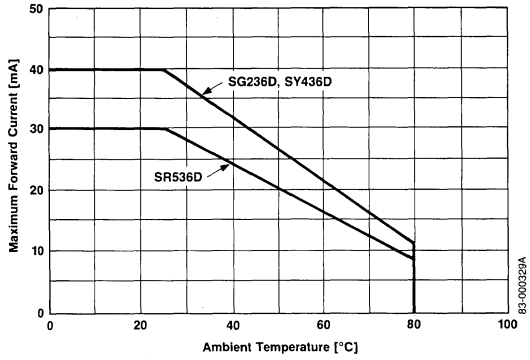
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Forward Voltage** | | | | | | |
| SR536D | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| SG236D | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| SY436D | $V_F$ | | 2.0 | 2.4 | V | $I_F$ = 10mA |
| **Reverse Current** | | | | | | |
| SR536D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SG236D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SY436D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| **Capacitance** | | | | | | |
| SR536D | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SG236D | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SY436D | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| **Peak Emission Wavelength** | | | | | | |
| SR536D | $\lambda_{PEAK}$ | | 695 | | nm | $I_F$ = 10mA |
| SG236D | $\lambda_{PEAK}$ | | 565 | | nm | $I_F$ = 10mA |
| SY436D | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| **Spectral Line Half Width** | | | | | | |
| SR536D | $\Delta\lambda$ | | 100 | | nm | $I_F$ = 10mA |
| SY236D | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| SR436D | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| **Luminous Intensity** | | | | | | |
| SR536D | $I_V$ | 0.2 | 0.5 | | mcd | $I_F$ = 10mA |
| SG236D | $I_V$ | 0.2 | 0.7 | | mcd | $I_F$ = 10mA |
| SY436D | $I_V$ | 0.2 | 0.7 | | mcd | $I_F$ = 10mA |

4

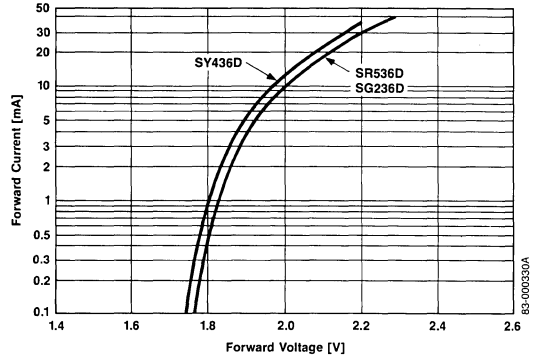
## Typical Characteristics

$T_A$ = +25°C

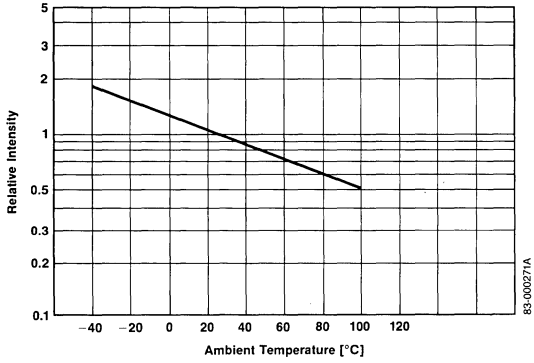
Maximum Forward Current vs Ambient Temperature



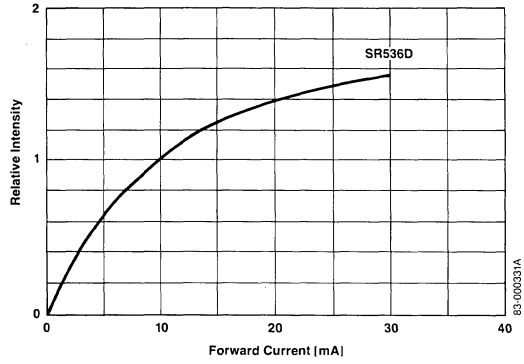

Forward Current vs Forward Voltage



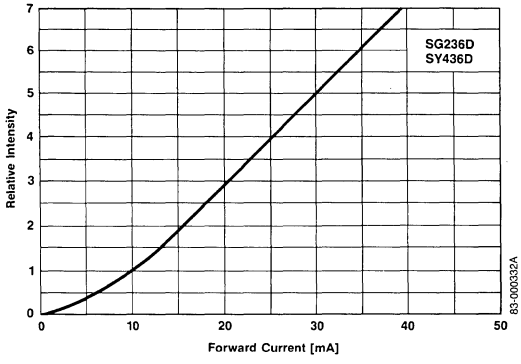

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Relative Intensity vs Forward Current



NEC Electronics Inc.

# SG237D, SY437D, SR537D
# GREEN, AMBER, RED
# FASHION LEDs

*NEPOC SERIES*

## Description

These three LEDs are full resin-molded LED lamps with flat elliptical faces which uniformly emit brilliant red, green and amber light. They are especially suitable for electronic equipment in audio applications which require fancy displays.

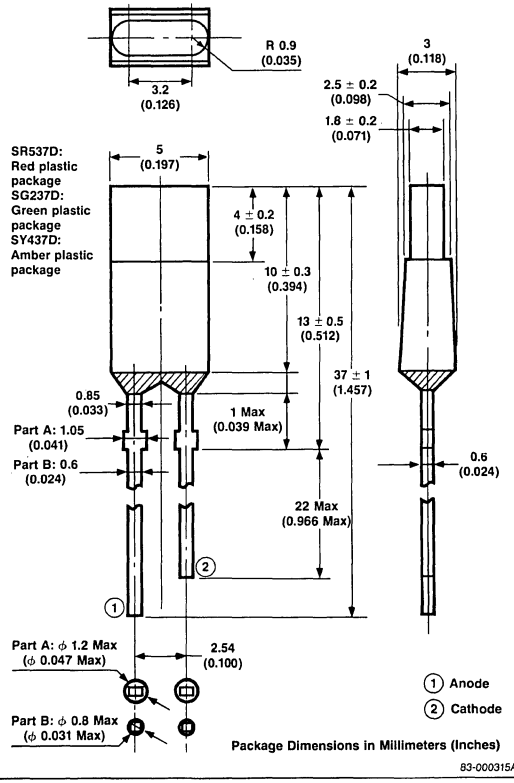
## Features

- ☐ Flat elliptical face
- ☐ Low cost
- ☐ Long lead
- ☐ Bright red, green or amber
- ☐ Compatible with integrated circuits

## Applications

- ☐ Visual displays
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instrument terminals

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000315A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_{D1}$ | 60/100mW |
| Forward Current, $I_{F1}$ | 30/40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

**Note:** 1. SR537D/SG237D, SY437D

## Electro-Optical Characteristics

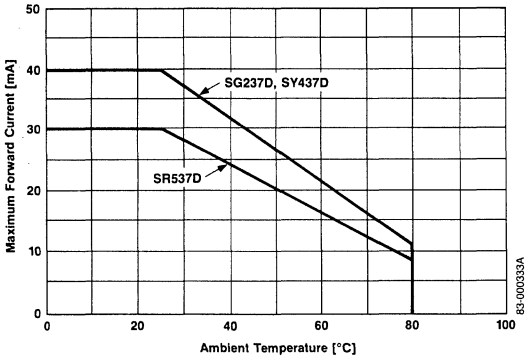
$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Forward Voltage** | | | | | | |
| SR537D | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| SG237D | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| SY437D | $V_F$ | | 2.0 | 2.4 | V | $I_F$ = 10mA |
| **Reverse Current** | | | | | | |
| SR537D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SG237D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SY437D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| **Capacitance** | | | | | | |
| SR537D | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SG237D | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SY437D | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| **Peak Emission Wavelength** | | | | | | |
| SR537D | $\lambda_{PEAK}$ | | 695 | | nm | $I_F$ = 10mA |
| SG237D | $\lambda_{PEAK}$ | | 565 | | nm | $I_F$ = 10mA |
| SY437D | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| **Spectral Line Half Width** | | | | | | |
| SR537D | $\Delta\lambda$ | | 100 | | nm | $I_F$ = 10mA |
| SY237D | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| SR437D | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| **Luminous Intensity** | | | | | | |
| SR537D | $I_V$ | 0.2 | 0.5 | | mcd | $I_F$ = 10mA |
| SG237D | $I_V$ | 0.2 | 0.7 | | mcd | $I_F$ = 10mA |
| SY437D | $I_V$ | 0.2 | 0.7 | | mcd | $I_F$ = 10mA |

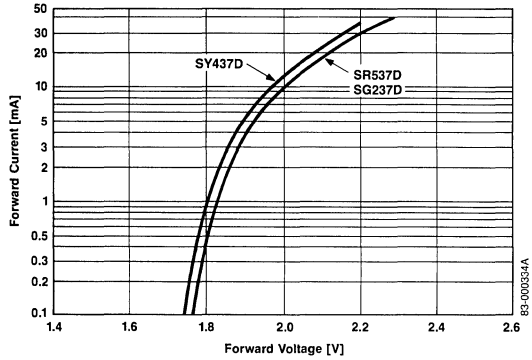
4

## Typical Characteristics
$T_A$ = +25°C

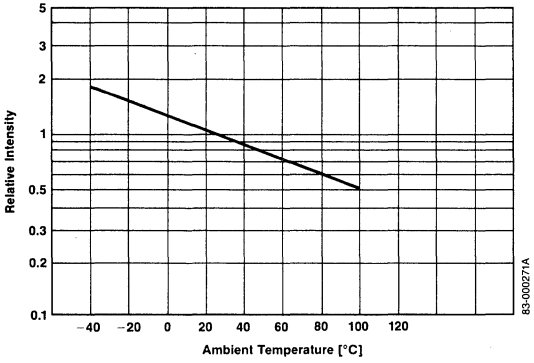
Maximum Forward Current vs Ambient Temperature



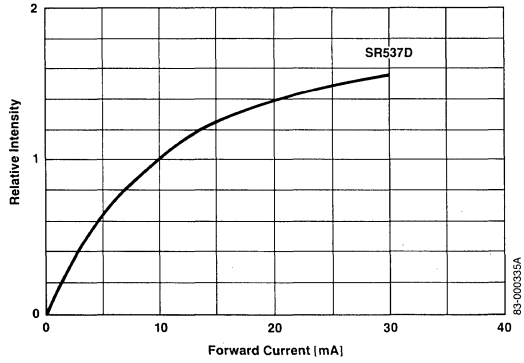

Forward Current vs Forward Voltage



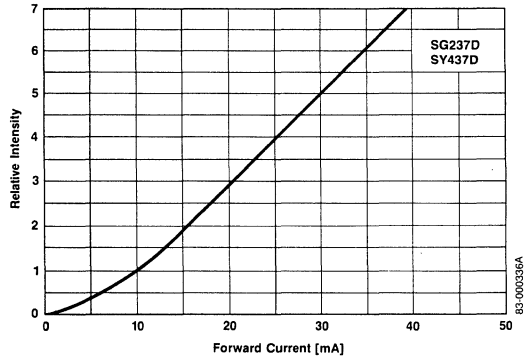

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Relative Intensity vs Forward Current



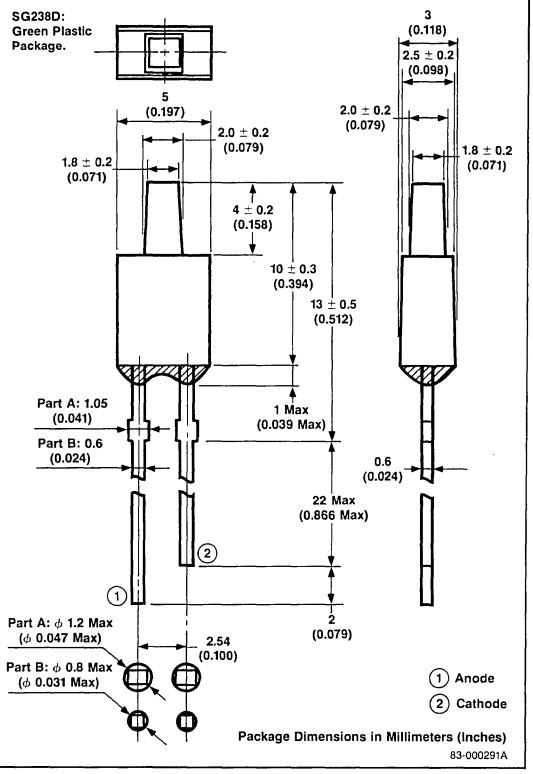
NEC
NEC Electronics Inc.

# SG238D
# GREEN
# FASHION LED
*NEPOC SERIES*

## Description

The SG238D is a full resin-molded LED lamp with a flat rectangular face which uniformly emits brilliant green light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

## Package Dimensions




## Features

- ☐ Flat rectangular face
- ☐ Low cost
- ☐ Long lead
- ☐ Bright green
- ☐ Compatible with integrated circuits
- ☐ Red (SR538D) and amber (SY438D) LEDs are available in the same package style

## Applications

- ☐ Visual displays
- ☐ Peak level indicators
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instruments, terminals

## Absolute Maximum Ratings

$T_A = +25°C$

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40 to +100°C |

## Electro-Optical Characteristics

$T_A = +25°C$

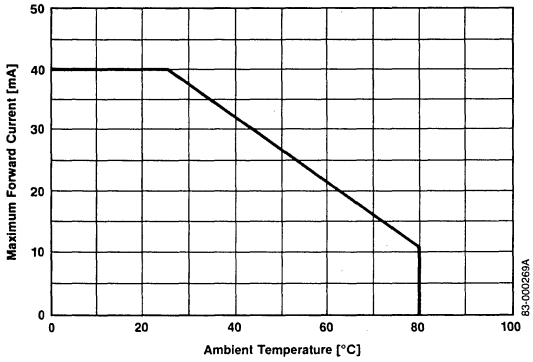
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 565 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity | $I_V$ | 0.2 | 0.5 | | mcd | $I_F$ = 10mA |

4

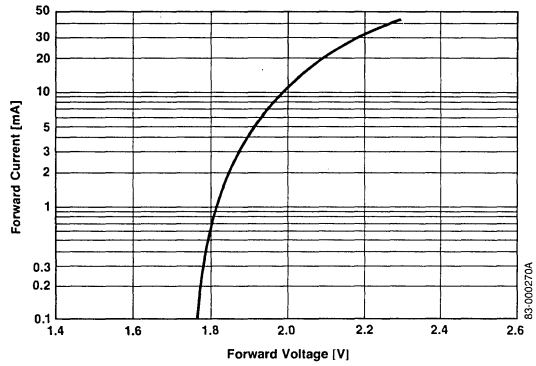
## Typical Characteristics

$T_A$ = +25°C

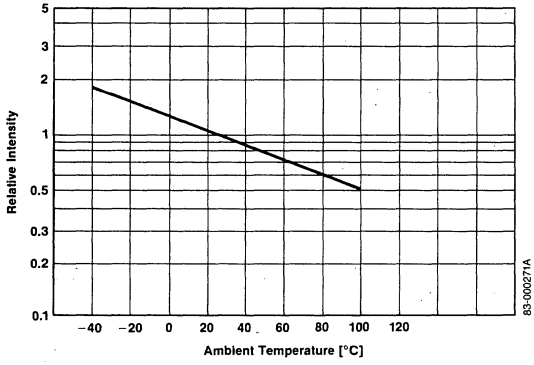
Maximum Forward Current vs Ambient Temperature



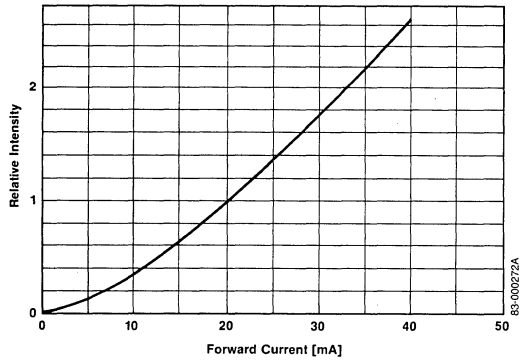

Forward Current vs Forward Voltage



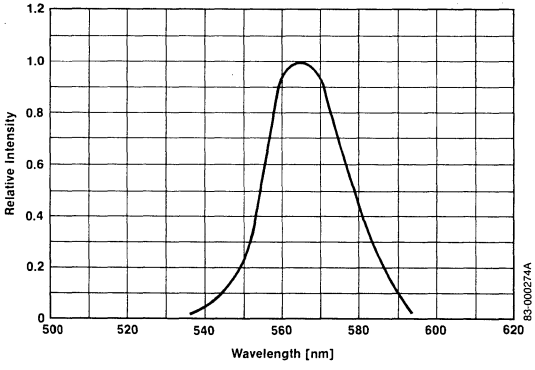

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Spectral Distribution



NEC Electronics Inc.

# SG239D, SY439D, SR539D
# GREEN, AMBER, RED
# FASHION LEDs

*NEPOC SERIES*

## Description

These three LEDs are full resin-molded LED lamps with flat circular faces which uniformly emit brilliant red, green and amber light. They are especially suitable for electronic equipment in audio applications which require fancy displays.

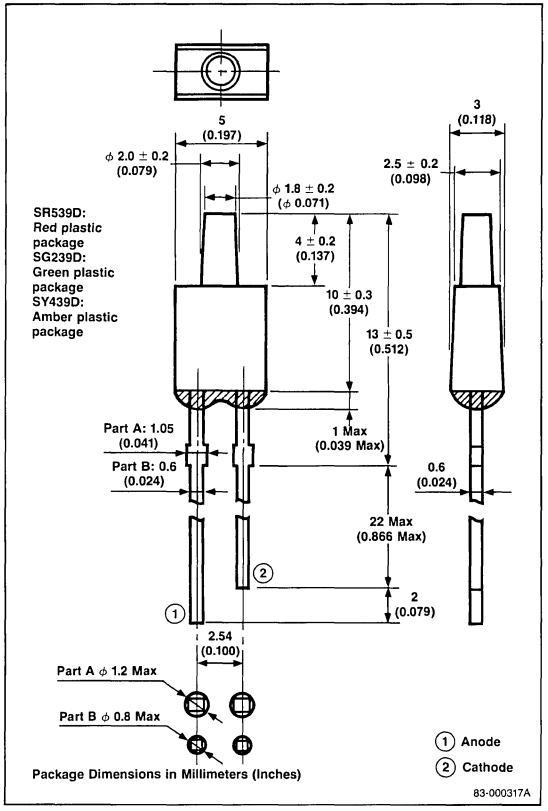
## Features

- ☐ Flat circular face
- ☐ Low cost
- ☐ Long lead
- ☐ Bright red, green or amber
- ☐ Compatible with integrated circuits

## Applications

- ☐ Visual displays
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instrument terminals

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000317A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$1 | 60/100mW |
| Forward Current, $I_F$1 | 30/40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

**Note:** 1. SR539D/SG239D, SY439D

## Electro-Optical Characteristics

$T_A$ = +25°C

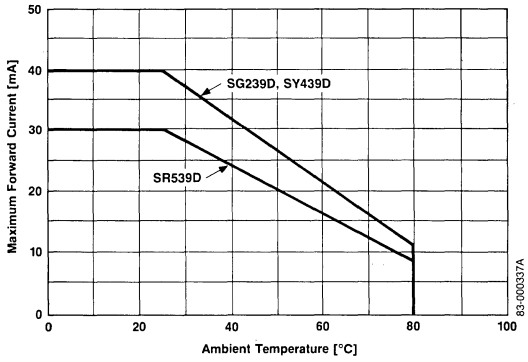
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Forward Voltage** | | | | | | |
| SR539D | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| SG239D | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| SY439D | $V_F$ | | 2.0 | 2.4 | V | $I_F$ = 10mA |
| **Reverse Current** | | | | | | |
| SR539D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SG239D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SY439D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| **Capacitance** | | | | | | |
| SR539D | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SG239D | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SY439D | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| **Peak Emission Wavelength** | | | | | | |
| SR539D | $\lambda_{PEAK}$ | | 695 | | nm | $I_F$ = 10mA |
| SG239D | $\lambda_{PEAK}$ | | 565 | | nm | $I_F$ = 10mA |
| SY439D | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| **Spectral Line Half Width** | | | | | | |
| SR539D | $\Delta\lambda$ | | 100 | | nm | $I_F$ = 10mA |
| SY239D | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| SR439D | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| **Luminous Intensity** | | | | | | |
| SR539D | $I_V$ | 0.2 | 0.5 | | mcd | $I_F$ = 10mA |
| SG239D | $I_V$ | 0.2 | 0.7 | | mcd | $I_F$ = 10mA |
| SY439D | $I_V$ | 0.2 | 0.7 | | mcd | $I_F$ = 10mA |

4

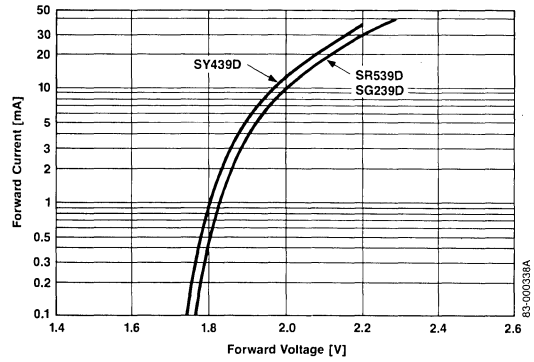
## Typical Characteristics

$T_A$ = +25°C

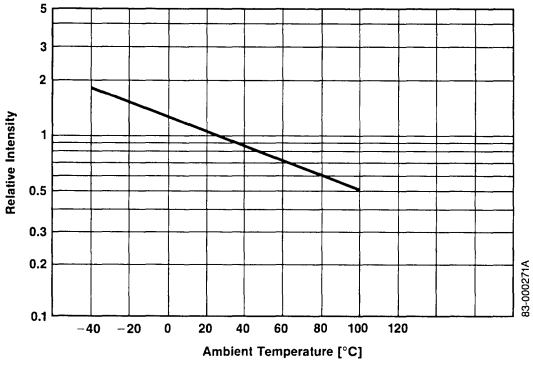
Maximum Forward Current vs Ambient Temperature



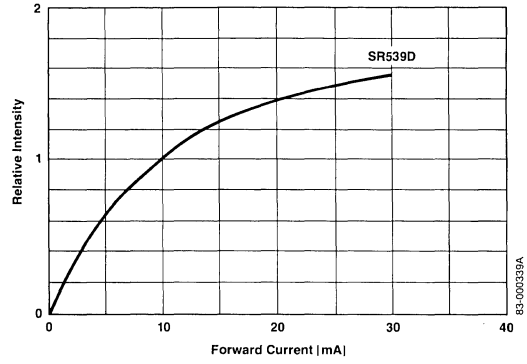

Forward Current vs Forward Voltage



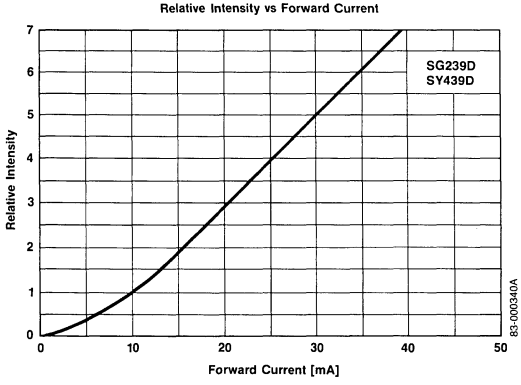

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Relative Intensity vs Forward Current



NEC Electronics Inc.

# SG240D, SY440D, SR540D
# GREEN, AMBER, RED
# FASHION LEDs

*NEPOC SERIES*

## Description

These three LEDs are full resin-molded LED lamps with flat rectangular faces which uniformly emit brilliant red, green and amber light. They are especially suitable for electronic equipment in audio applications which require fancy displays.

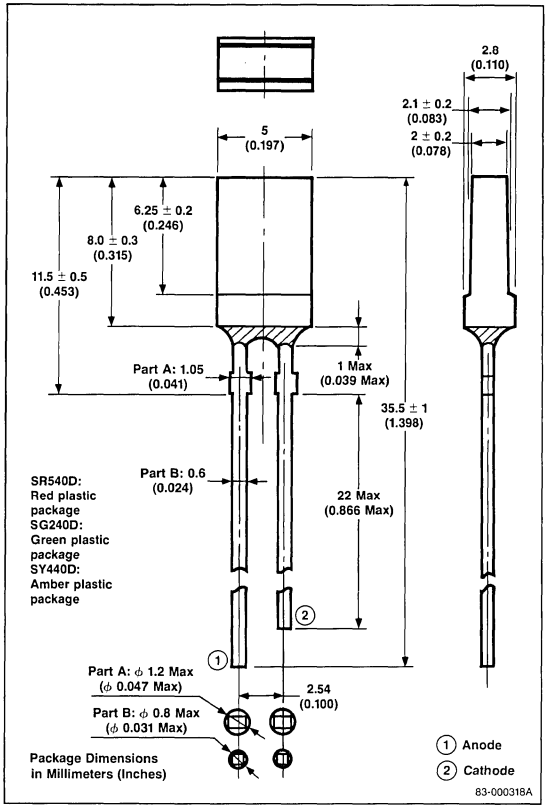
## Features

- ☐ Flat rectangular face
- ☐ Low cost
- ☐ Long lead
- ☐ Bright red, green or amber
- ☐ Compatible with integrated circuits

## Applications

- ☐ Visual displays
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instrument terminals

## Package Dimensions




## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$1 | 60/100mW |
| Forward Current, $I_F$1 | 30/40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

**Note:** 1. SR540D/SG240D, SY440D

## Electro-Optical Characteristics

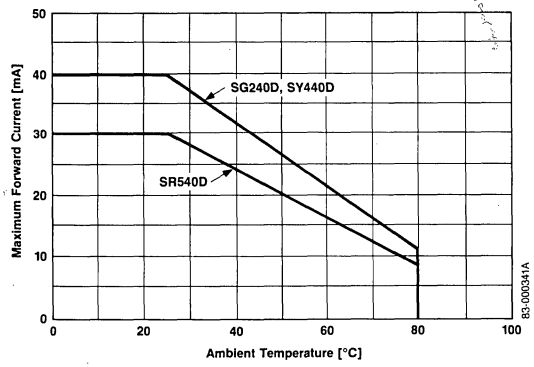
$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Forward Voltage** | | | | | | |
| SR540D | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| SG240D | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| SY440D | $V_F$ | | 2.0 | 2.4 | V | $I_F$ = 10mA |
| **Reverse Current** | | | | | | |
| SR540D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SG240D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SY440D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| **Capacitance** | | | | | | |
| SR540D | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SG240D | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SY440D | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| **Peak Emission Wavelength** | | | | | | |
| SR540D | $\lambda_{PEAK}$ | | 695 | | nm | $I_F$ = 10mA |
| SG240D | $\lambda_{PEAK}$ | | 565 | | nm | $I_F$ = 10mA |
| SY440D | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| **Spectral Line Half Width** | | | | | | |
| SR540D | $\Delta\lambda$ | | 100 | | nm | $I_F$ = 10mA |
| SY240D | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| SR440D | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| **Luminous Intensity** | | | | | | |
| SR540D | $I_V$ | 0.3 | 0.8 | | mcd | $I_F$ = 10mA |
| SG240D | $I_V$ | 0.7 | 1.5 | | mcd | $I_F$ = 10mA |
| SY440D | $I_V$ | 0.7 | 1.5 | | mcd | $I_F$ = 10mA |

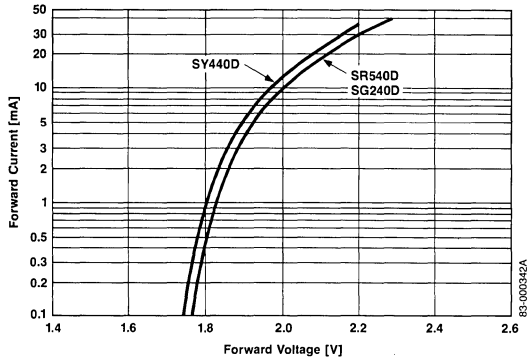
4

## Typical Characteristics
$T_A$ = +25°C

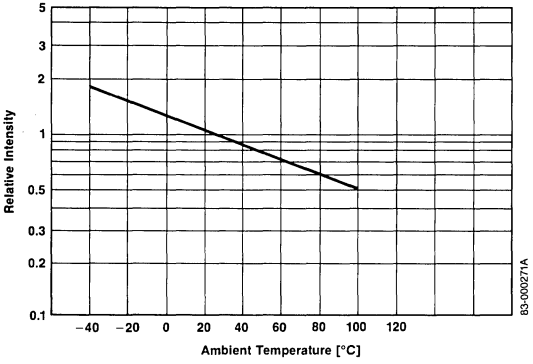
Maximum Forward Current vs Ambient Temperature



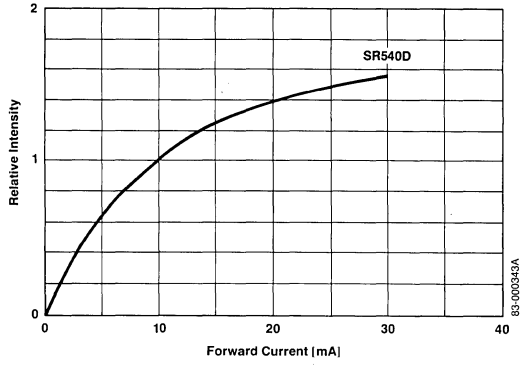

Forward Current vs Forward Voltage



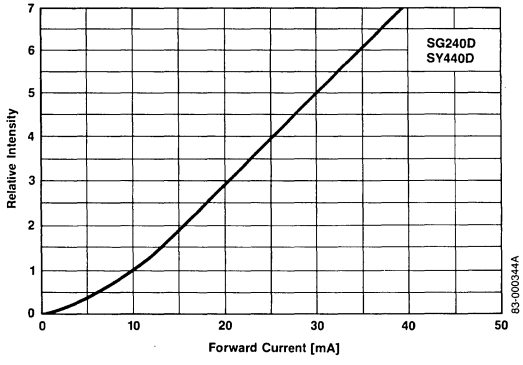

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Relative Intensity vs Forward Current



NEC Electronics Inc.

# SG261D, SY461D, SR661D
# GREEN, AMBER, RED
# FASHION LEDs

*NEPOC SERIES*

## Description

The SR661D, SG261D and SY461D are rectangular (2mm × 3mm) plastic-resin-encapsulated LED lamps which uniformly emit brilliant red, green and amber light. They are suitable for use as fashionable indicators on the panels of audio/video equipment and elsewhere.

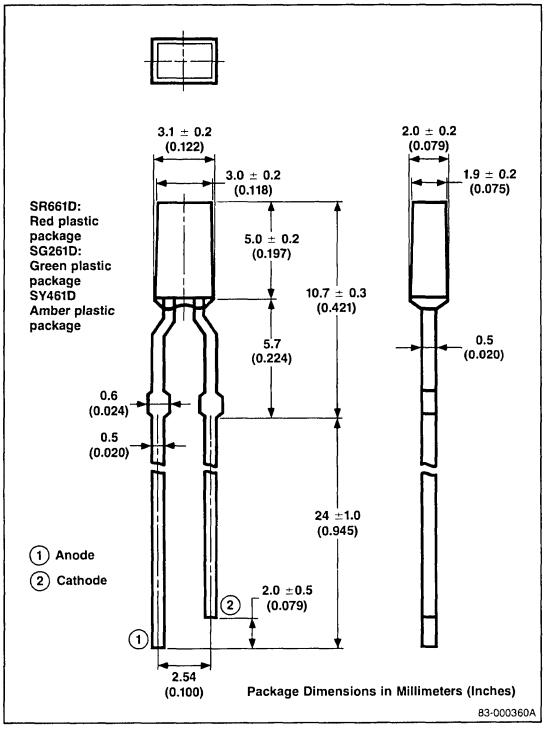
## Features

- ☐ Flat rectangular face
- ☐ Low cost
- ☐ Long lead
- ☐ Bright red, green or amber
- ☐ Compatible with integrated circuits

## Applications

- ☐ Visual displays
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instrument terminals

## Package Dimensions




## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

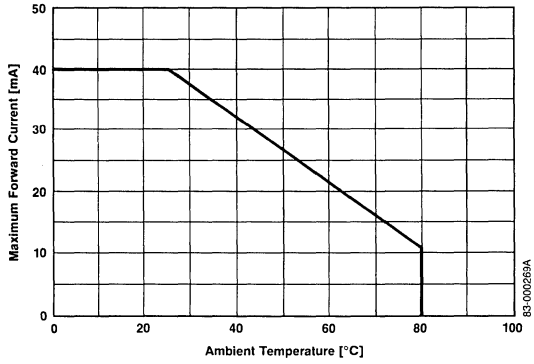
$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Forward Voltage** | | | | | | |
| SR661D | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| SG261D | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| SY461D | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| **Reverse Current** | | | | | | |
| SR661D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SG261D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| SY461D | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| **Capacitance** | | | | | | |
| SR661D | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SG261D | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| SY461D | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| **Peak Emission Wavelength** | | | | | | |
| SR661D | $\lambda_{PEAK}$ | | 630 | | nm | $I_F$ = 10mA |
| SG261D | $\lambda_{PEAK}$ | | 565 | | nm | $I_F$ = 10mA |
| SY461D | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| **Spectral Line Half Width** | | | | | | |
| SR661D | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| SG261D | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| SY461D | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| **Luminous Intensity** | | | | | | |
| SR661D | $I_V$ | 0.4 | 1.0 | | mcd | $I_F$ = 10mA |
| SG261D | $I_V$ | 0.4 | 1.5 | | mcd | $I_F$ = 10mA |
| SY461D | $I_V$ | 0.4 | 1.5 | | mcd | $I_F$ = 10mA |

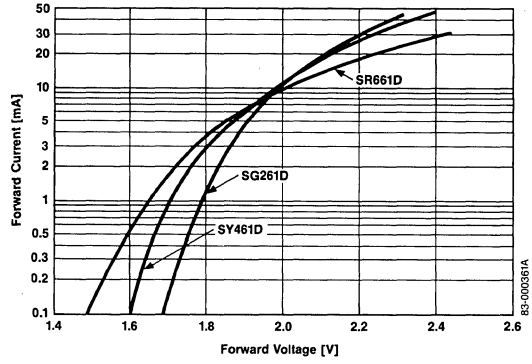
4

## Typical Characteristics
$T_A$ = +25°C

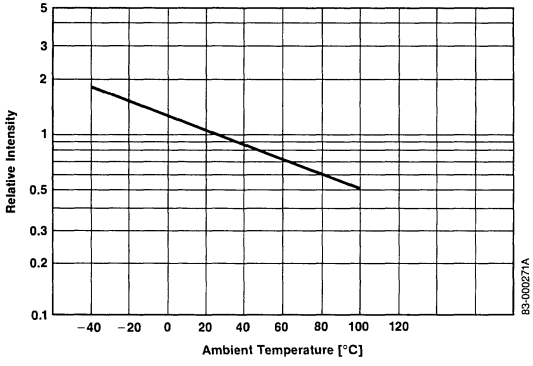
Maximum Forward Current vs Ambient Temperature



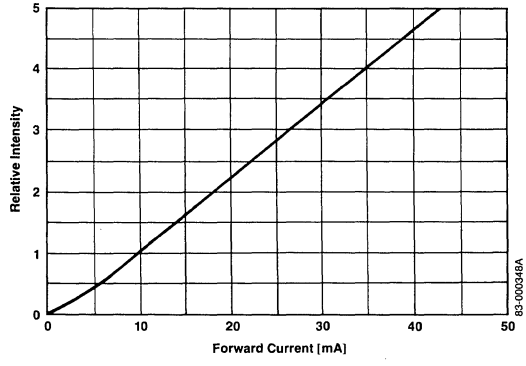

Forward Current vs Forward Voltage




Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current



NEC Electronics Inc.

# SR531D
# RED
# FASHION LED
*NEPOC SERIES*

## Description

The SR531D is a full resin-molded LED lamp with a flat circular face which uniformly emits brilliant red light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

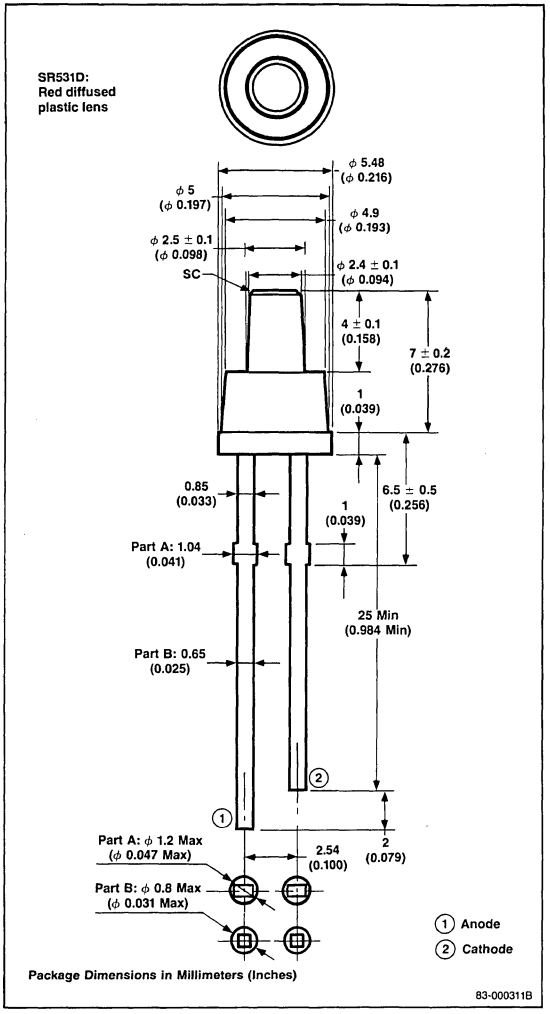
## Features

- ☐ Flat circular face
- ☐ Low cost
- ☐ Long lead
- ☐ Bright red
- ☐ Compatible with integrated circuits
- ☐ Green (SG231D) and amber (SY431D) LEDs are available in the same package style

## Applications

- ☐ Visual displays
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instruments, terminals

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000311B

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

| | |
|---|---|
| Power Dissipation, $P_D$ | 60mW |
| Forward Current, $I_F$ | 30mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics
$T_A = +25°C$

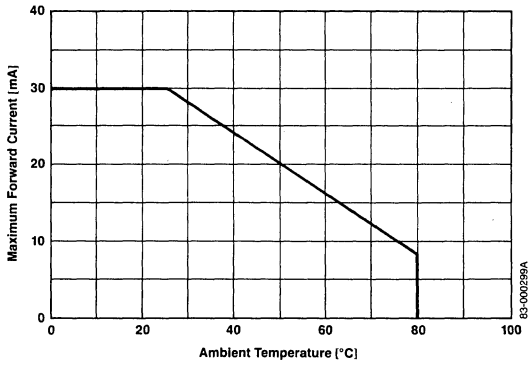
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5 |
| Capacitance | $C_T$ | | 100 | | pF | V = 0<br>F = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 695 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 100 | | nm | $I_F$ = 10mA |
| Luminous Intensity | $I_V$ | 0.2 | 0.5 | | mcd | $I_F$ = 10mA |

4

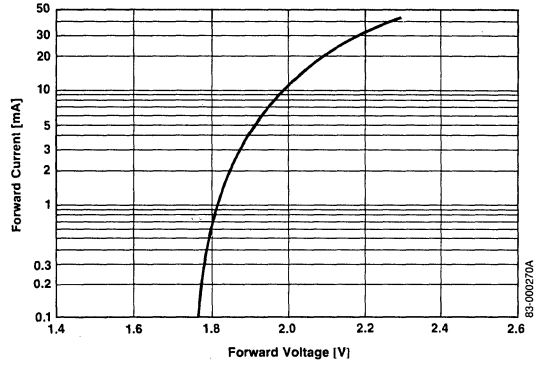
## Typical Characteristics

$T_A$ = +25°C

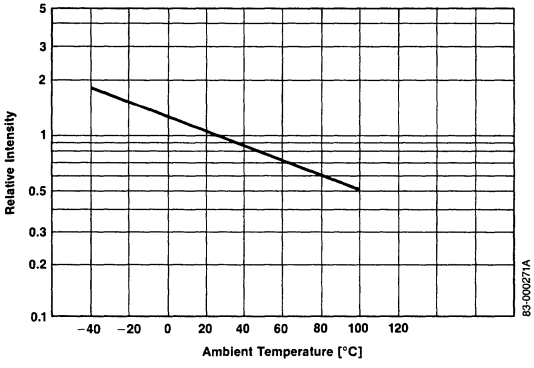
Maximum Forward Current vs Ambient Temperature



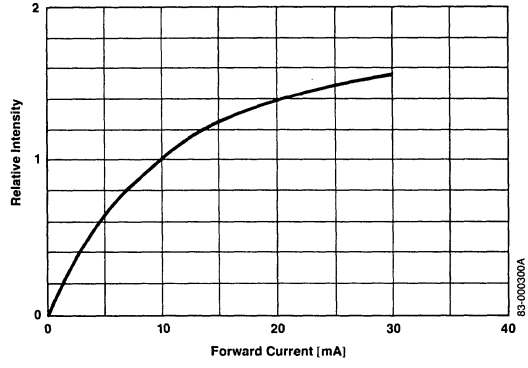

Forward Current vs Forward Voltage



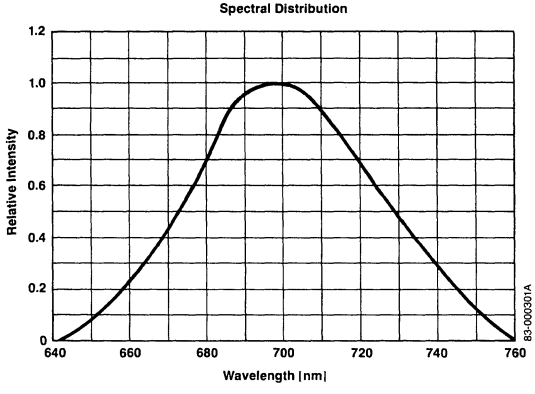

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Spectral Distribution

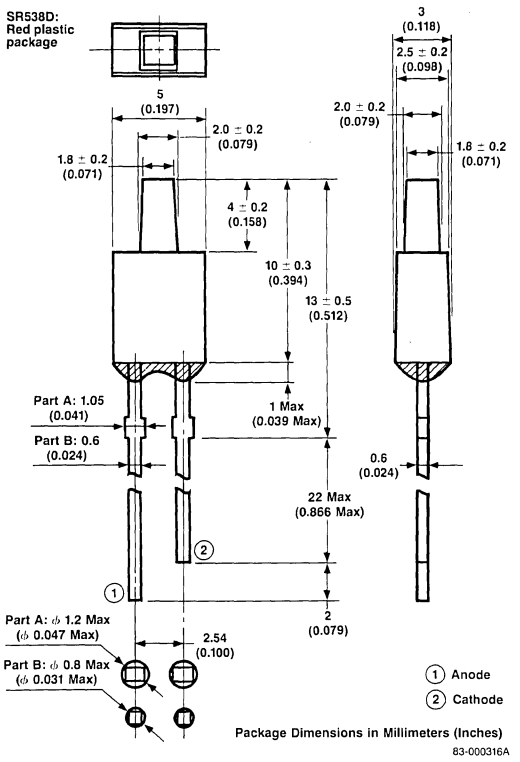


# SR538D
# RED
# FASHION LED
*NEPOC SERIES*

## Description

The SR538D is a full resin-molded LED lamp with a flat rectangular face which uniformly emits brilliant red light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

## Package Dimensions




## Features

- ☐ Flat rectangular face
- ☐ Low cost
- ☐ Long lead
- ☐ Bright red
- ☐ Compatible with integrated circuits
- ☐ Green (SG238D) and amber (SY438D) LEDs are available in the same package style

## Applications

- ☐ Visual displays
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instruments, terminals

## Absolute Maximum Ratings

$T_A = +25°C$

| | |
|---|---|
| Power Dissipation, $P_D$ | 60mW |
| Forward Current, $I_F$ | 30mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A = +25°C$

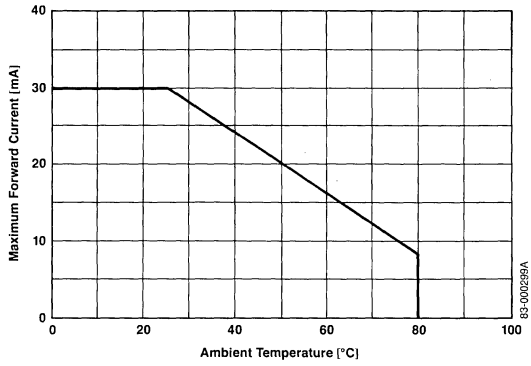
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.5 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 695 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 100 | | nm | $I_F$ = 10mA |
| Luminous Intensity | $I_V$ | 0.2 | 0.5 | | mcd | $I_F$ = 10mA |

4

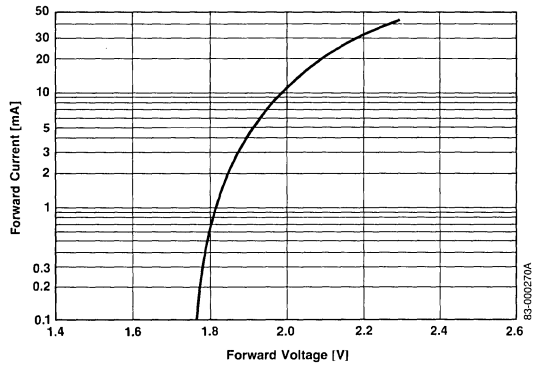
## Typical Characteristics

$T_A$ = +25°C

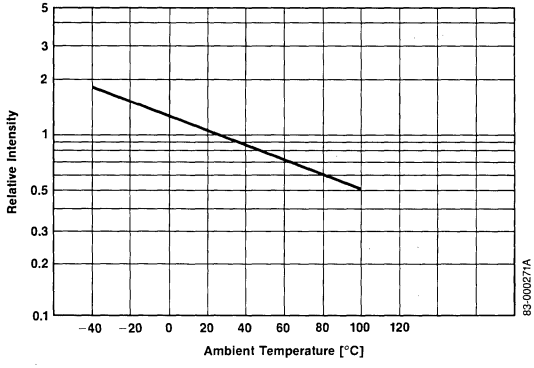
Maximum Forward Current vs Ambient Temperature



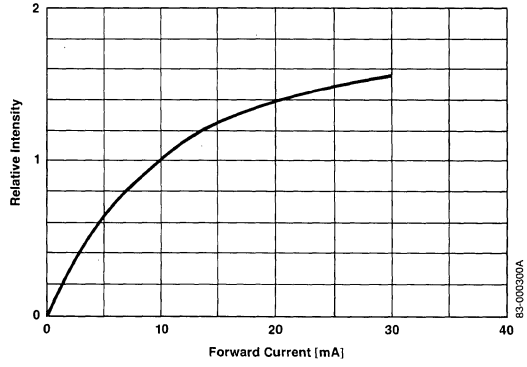

Forward Current vs Forward Voltage



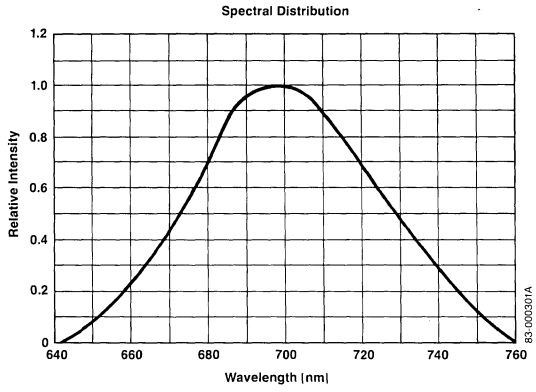

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Spectral Distribution



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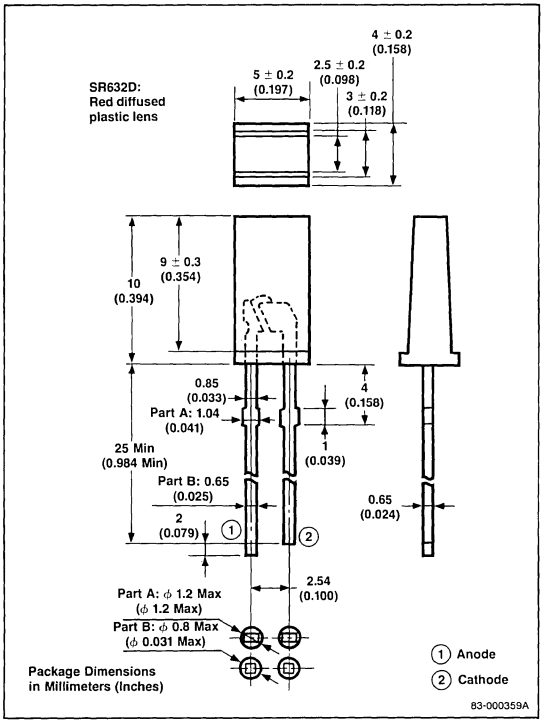
# SR632D
# RED
# GaAsP(N)
# FASHION LED

*NEPOC SERIES*

## Description

The SR632D is a full resin-molded LED lamp with a flat rectangular face which uniformly emits brilliant red light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

## Package Dimensions




## Features

- ☐ Flat rectangular face
- ☐ Low cost
- ☐ Long lead
- ☐ Bright red
- ☐ Compatible with integrated circuits
- ☐ Green (SG232D) and amber (SY432D) LEDs are available in the same package style

## Applications

- ☐ Visual displays
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instruments, terminals

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

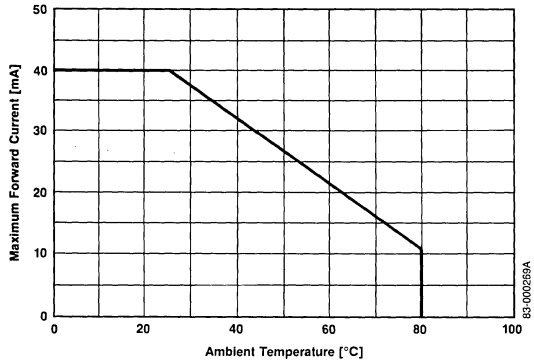
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.4 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 5V |
| Capacitance | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 630 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity | $I_V$ | 0.5 | 1.2 | | mcd | $I_F$ = 10mA |

4

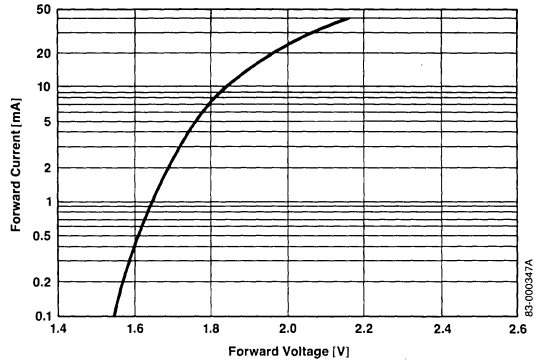
## Typical Characteristics

$T_A$ = +25°C

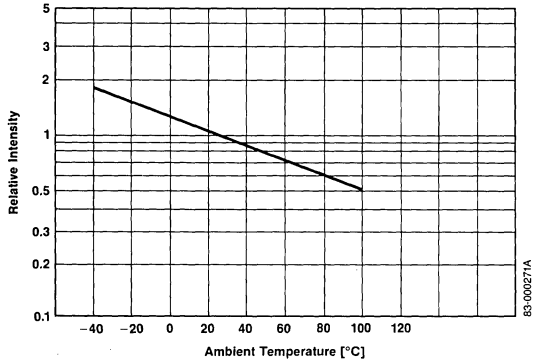
Maximum Forward Current vs Ambient Temperature



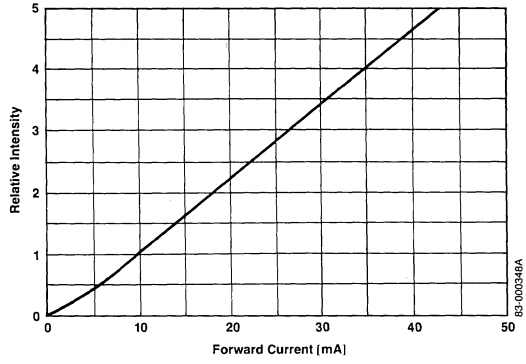

Forward Current vs Forward Voltage



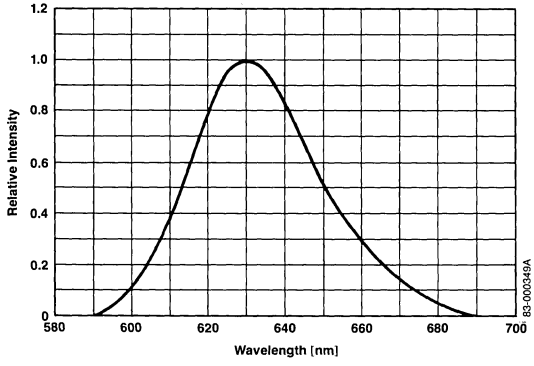

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Spectral Distribution



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# SY431D
# AMBER
# GaAsP
# FASHION LED

*NEPOC SERIES*

## Description

The SY431D is a full resin-molded LED lamp and has a circular flat face which emits brilliant amber light uniformly. It is especially suitable for electronic equipment as for audio uses which require some fancy looking displays.

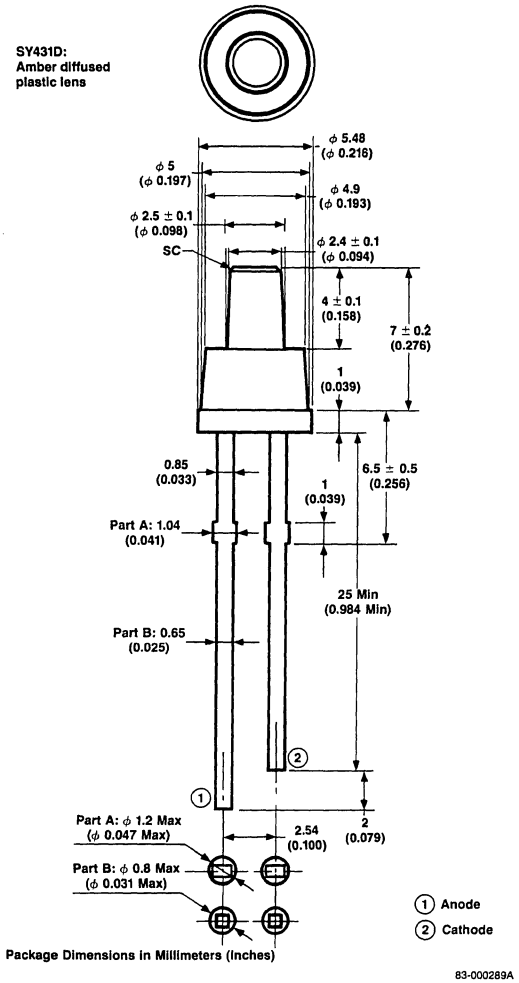
## Features

- ☐ Circular flat face type
- ☐ Low cost
- ☐ Long lead
- ☐ Bright amber
- ☐ Compatible with integrated circuits
- ☐ Red (SR531D) and green (SG231D) LEDs are available in the same package

## Applications

- ☐ Visual displays
- ☐ Radioand stereo equipment indicators
- ☐ Measuring instrument, terminal

## Package Dimensions




## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5A |
| Junction Temperatures, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

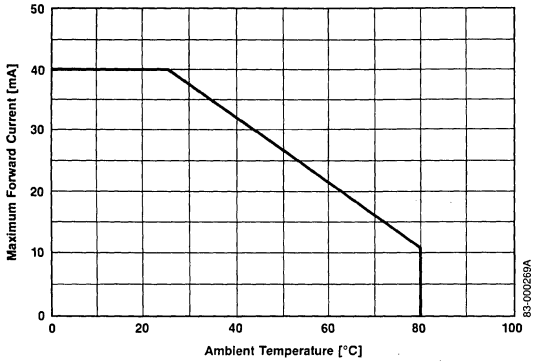
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.4 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity | $I_V$ | 0.1 | 30 | | mcd | $I_F$ = 10mA |

4

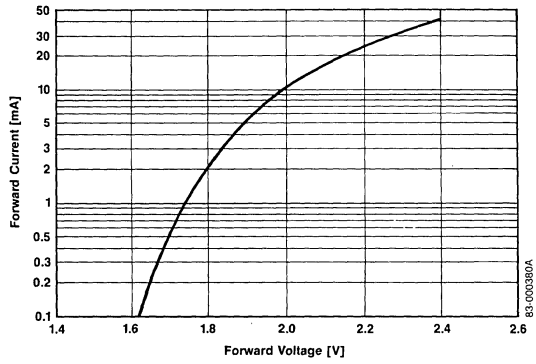
## Typical Characteristics

$T_A$ = +25°C

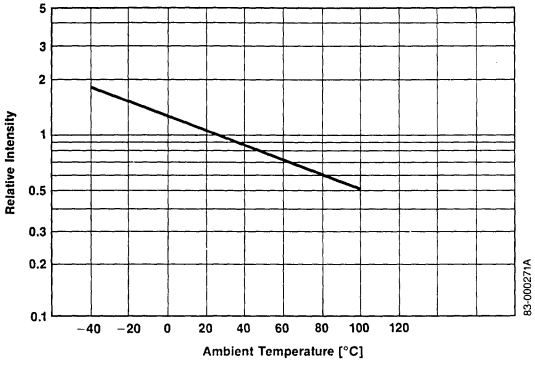
Maximum Forward Current vs Ambient Temperature



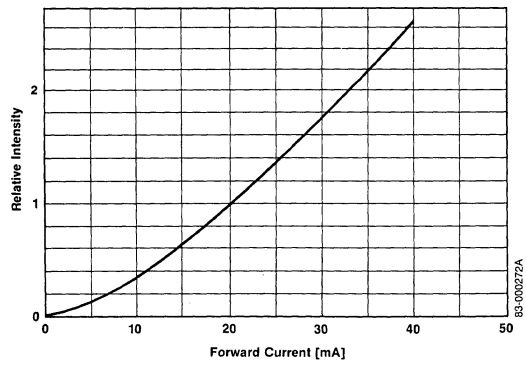

Forward Current vs Forward Voltage



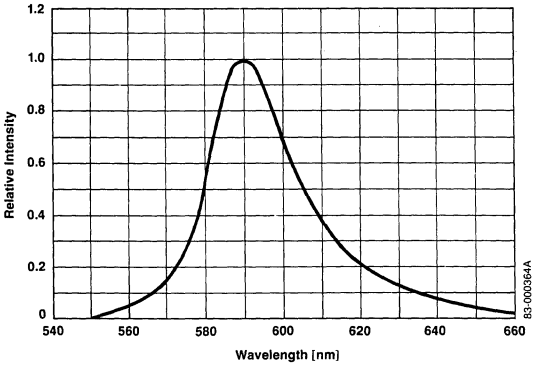

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Spectral Distribution



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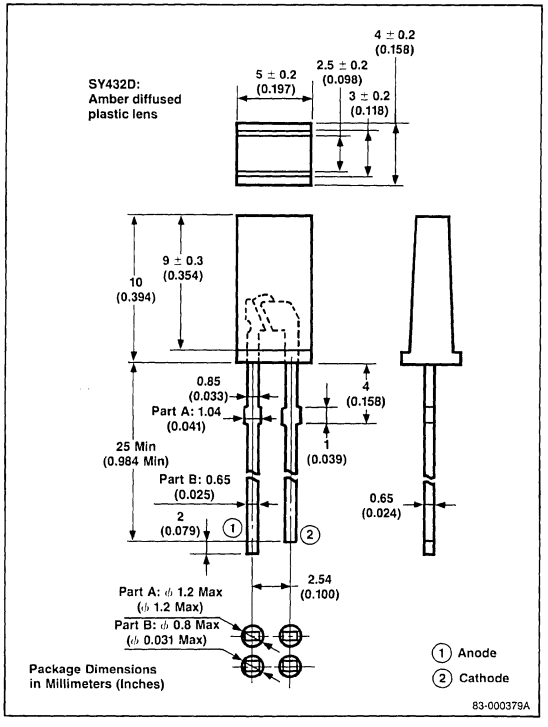
# SY432D
# AMBER
# FASHION LED

*NEPOC SERIES*

## Description

The SY432D is a full resin-molded LED lamp with a flat rectangular face which uniformly emits brilliant amber light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

## Package Dimensions




## Features

- ☐ Flat rectangular face
- ☐ Low cost
- ☐ Long lead
- ☐ Bright amber
- ☐ Compatible with integrated circuits
- ☐ Red (SR632D) and green (SG232D) LEDs are available in the same package style

## Applications

- ☐ Visual displays
- ☐ Peak level indicators
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instruments, terminals

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

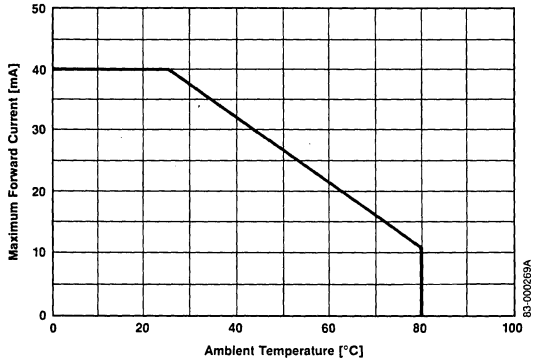
| | | Limits | | | | |
|---|---|---|---|---|---|---|
| Parameters | Symbol | Min | Typ | Max | Unit | Test Conditions |
| Forward Voltage | $V_F$ | | 2.0 | 2.4 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity | $I_V$ | 0.2 | 0.5 | | mcd | $I_F$ = 10mA |

4

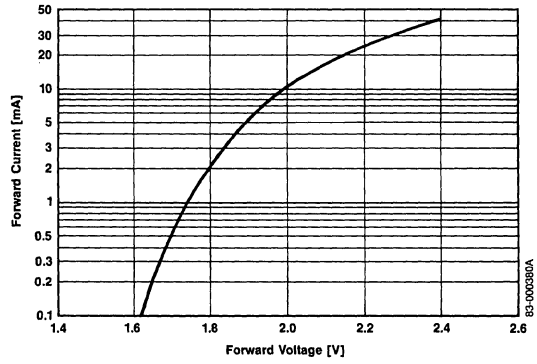
## Typical Characteristics

$T_A$ = +25°C

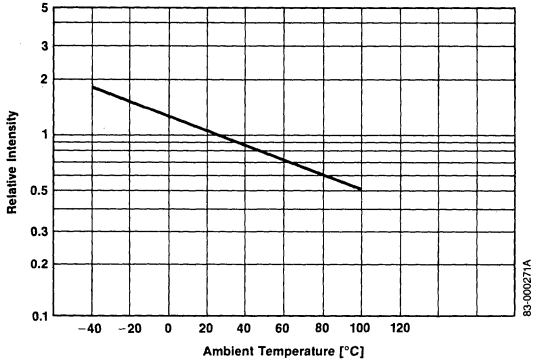
Maximum Forward Current vs Ambient Temperature



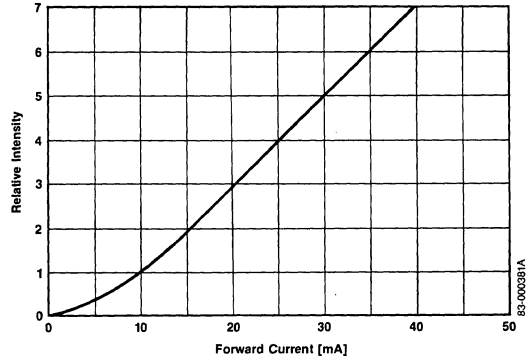

Forward Current vs Forward Voltage



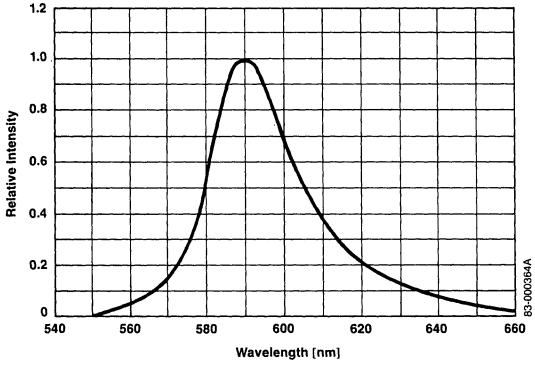

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Spectral Distribution



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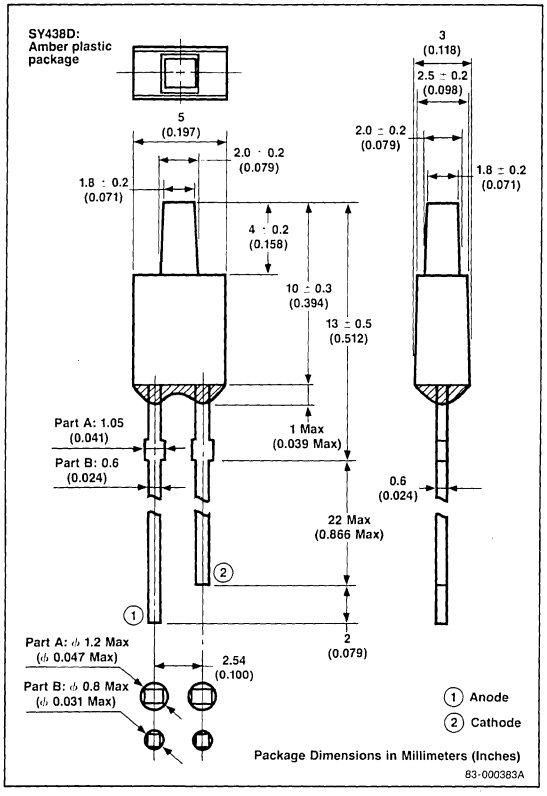
# SY438D
# AMBER
# FASHION LED
*NEPOC SERIES*

## Description

The SY438D is a full resin-molded LED lamp with a flat rectangular face which uniformly emits brilliant amber light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

## Package Dimensions




## Features

- ☐ Flat rectangular face
- ☐ Low cost
- ☐ Long lead
- ☐ Bright amber
- ☐ Compatible with integrated circuits
- ☐ Red (SR538D) and green (SG238D) LEDs are available in the same package style

## Applications

- ☐ Visual displays
- ☐ Peak level indicators
- ☐ Radio and stereo equipment indicators
- ☐ Measuring instruments, terminals

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 100mW |
| Forward Current, $I_F$ | 40mA |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electro-Optical Characteristics

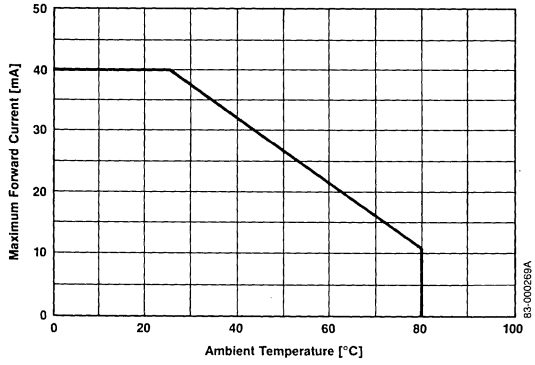
$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 2.0 | 2.4 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 4.5V |
| Capacitance | $C_T$ | | 100 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 590 | | nm | $I_F$ = 10mA |
| Spectral Line Half Width | $\Delta\lambda$ | | 40 | | nm | $I_F$ = 10mA |
| Luminous Intensity | $I_V$ | 0.2 | 0.5 | | mcd | $I_F$ = 10mA |

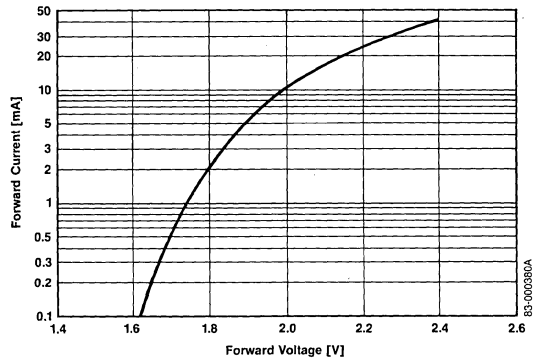
4

## Typical Characteristics
$T_A$ = +25°C

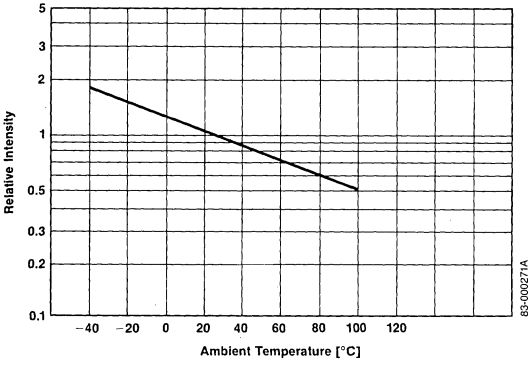
Maximum Forward Current vs Ambient Temperature



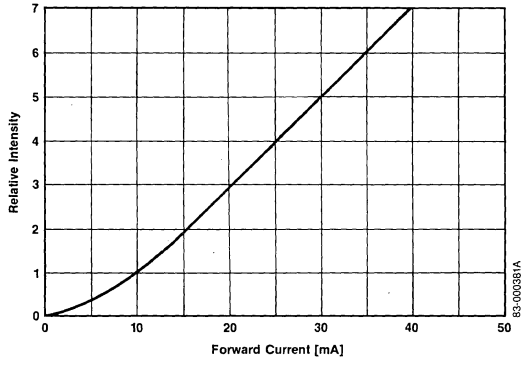

Forward Current vs Forward Voltage



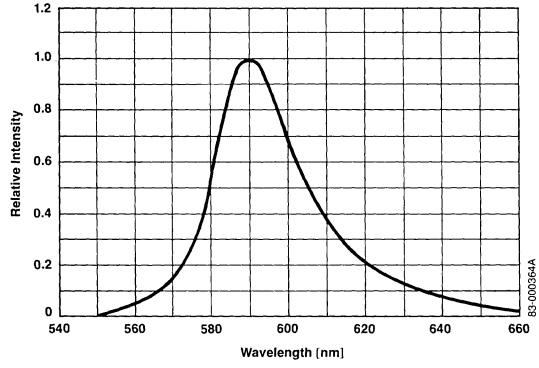

Relative Intensity vs Ambient Temperature




Relative Intensity vs Forward Current




Spectral Distribution



NEC

# PHOTO COUPLERS 5

**Section 5 — Photo Couplers**



**Note: All Photo Couplers are UL approved. UL file #E72422.**

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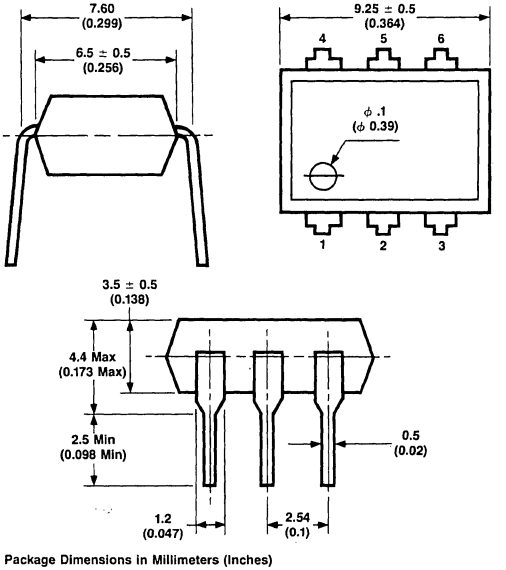
# 4N25
# PHOTO COUPLER
# SINGLE TRANSISTOR

*NEPOC SERIES*

## Description

The 4N25 is an optically coupled isolator containing a GaAs light emitting diode and an NPN silicon photo transistor.

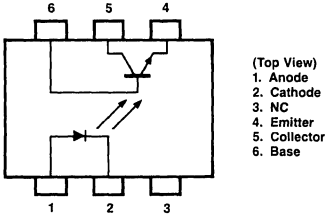
## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000421A

## Pin Connection




(Top View)
1. Anode
2. Cathode
3. NC
4. Emitter
5. Collector
6. Base

83-000385A

## Features

- ☐ High isolation voltage: $2500V_{DC}$
- ☐ High transfer ratio: 20% min
- ☐ High speed switching: $t_r$, $t_f$ = 4$\mu$s typ
- ☐ Economical, compact, dual in-line plastic package

## Applications

- ☐ Interface circuit for various instruments and control equipment
- ☐ Chopper circuits
- ☐ Computer and peripheral manufacture
- ☐ Pulse transformers
- ☐ Data communication equipment

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 5.0V |
| Forward Current (DC), $I_F$ | 80mA |
| Power Dissipation, $P_D$ | 150mW |
| Peak Forward Current (300$\mu$s, 2% duty cycle), $I_{F(peak)}$ | 3A |
| **Transistor** | |
| Collector to Emitter Voltage, $V_{CEO}$ | 30V |
| Collector to Base Voltage, $V_{CBO}$ | 70V |
| Emitter to Collector Voltage, $V_{ECO}$ | 7V |
| Collector Current, $I_C$ | 100mA |
| Power Dissipation, $P_D$ | 150mW |
| Isolation Voltage[1], BV | $2500V_{DC}$ |
| Isolation Voltage[1], BV | $2000V_{AC}$ |
| Storage Temperature, $T_{STG}$ | −55°C to +150°C |
| Operating Temperature, $T_{OPT}$ | −55°C to +100°C |
| Lead Temperature (Soldering 10s) | 260°C |
| Total Power Dissipation, $P_T$ | 250mW |

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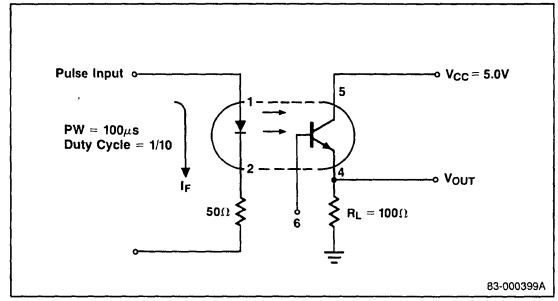
## Electrical Characteristics
$T_A$ = +25°C

| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | 1.1 | 1.4 | V | $I_F$ = 10mA |
| Forward Voltage | $V_F$ | | 1.2 | 1.5 | V | $I_F$ = 50mA |
| Reverse Current | $I_R$ | | | 10 | μA | $V_R$ = 5V |
| Junction Capacitance | C | | 50 | | pF | V = 0, f = 1.0MHz |
| **Transistor** | | | | | | |
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 50 | nA | $V_{CE}$ = 10V, $I_F$ = 0 |
| DC Current Gain | $h_{FE}$ | | 500 | | | $I_C$ = 2mA, $V_{CE}$ = 5.0V |
| Collector to Emitter Breakdown Voltage | $BV_{CEO}$ | 30 | 60 | | V | $I_C$ = 1mA, $I_B$ = 0 |
| Collector to Base Breakdown Voltage | $BV_{CBO}$ | 70 | 120 | | V | $I_C$ = 100μA, $I_E$ = 0 |
| Emitter to Collector Breakdown Voltage | $BV_{ECO}$ | 7 | 9 | | V | $I_E$ = 100μA, $I_B$ = 0 |
| **Coupled** | | | | | | |
| Current Transfer Ratio | CTR ($I_C/I_F$) | 20 | | | % | $I_F$ = 10mA, $V_{CE}$ = 5.0V |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | | 0.3 | V | $I_F$ = 10mA, $I_C$ =2.0mA |
| Isolation Resistance | $R_{1-2}$ | $10^{11}$ | | | Ω | $V_{IN-OUT}$ = 1.0kV |
| Isolation Capacitance | $C_{1-2}$ | | 0.8 | | pF | V = 0, f = 1.0MHz |
| Rise Time | $t_r$ | | 4 | | μs | $V_{CC}$ = 5.0V, $I_C$ = 2mA, $R_L$ = 100Ω[2] |
| Fall Time | $t_f$ | | 4 | | μs | $V_{CC}$ = 5.0V, $I_C$ = 2mA, $R_L$ = 100Ω[2] |

**Notes:** 1. Measuring Conditions: DC or AC voltage for 1 min at $T_A$ = +25°C, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).

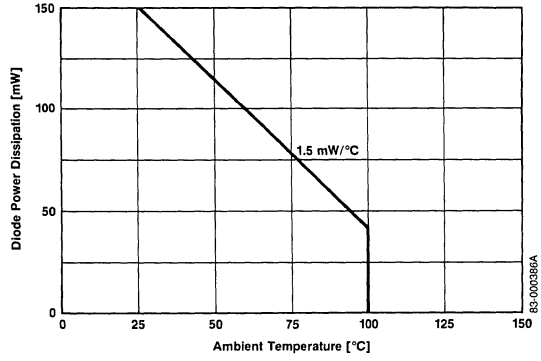
2. Test circuit for switching time.

*Test circuit for switching time*

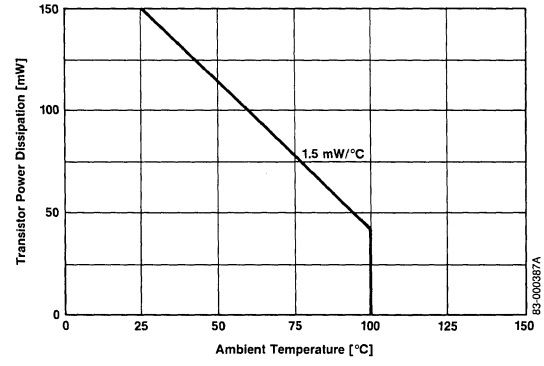



## Typical Characteristics
$T_A$ = +25°C

Diode Power Dissipation vs Ambient Temperature



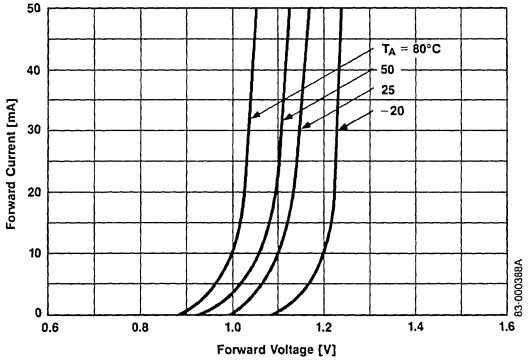

Transistor Power Dissipation vs Ambient Temperature



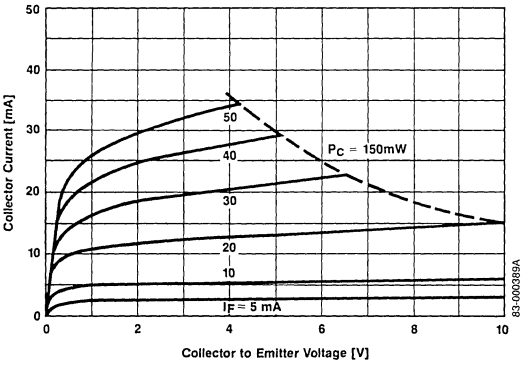
## Typical Characteristics (cont)

$T_A$ = +25°C

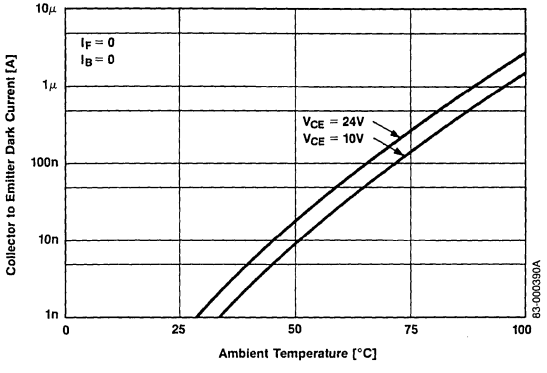
Forward Current vs Forward Voltage



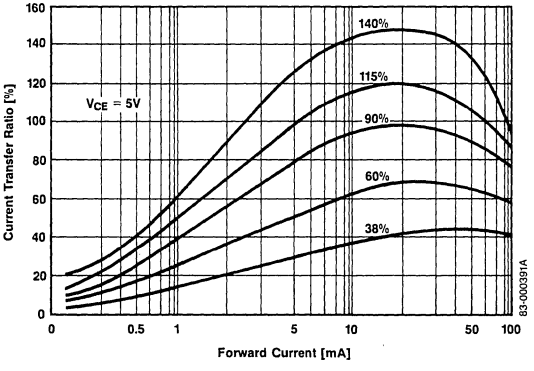

Collector Current vs Collector to Emitter Voltage



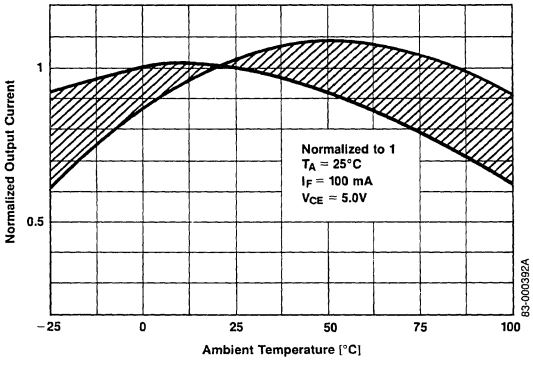

Collector to Emitter Dark Current vs Ambient Temperature



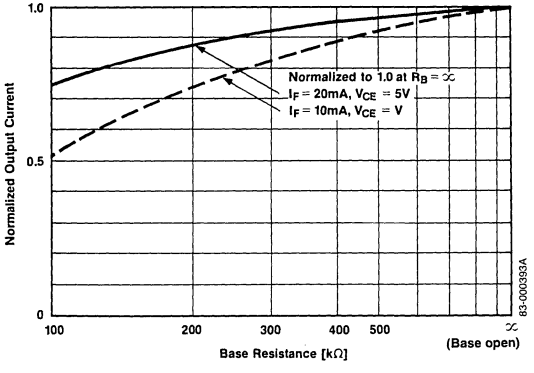

Current Transfer Ratio vs Forward Current




Normalized Output Current vs Ambient Temperature




Normalized Output Current vs Base Resistance

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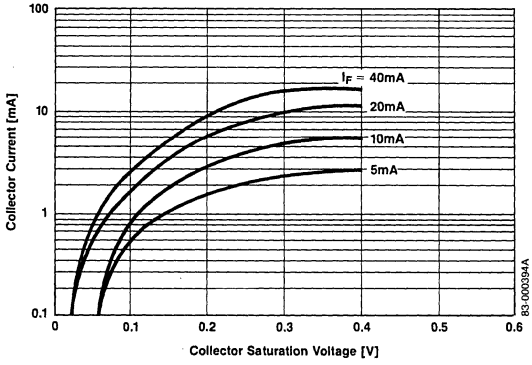
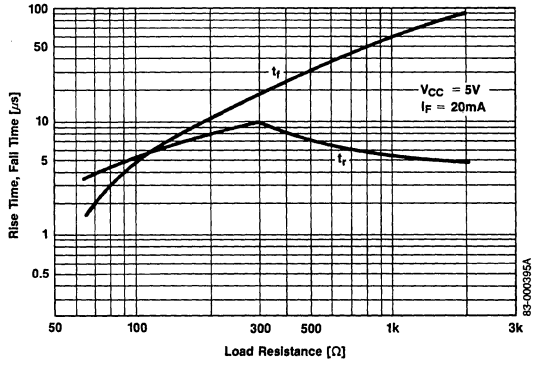
## Typical Characteristics (cont)

$T_A = +25°C$

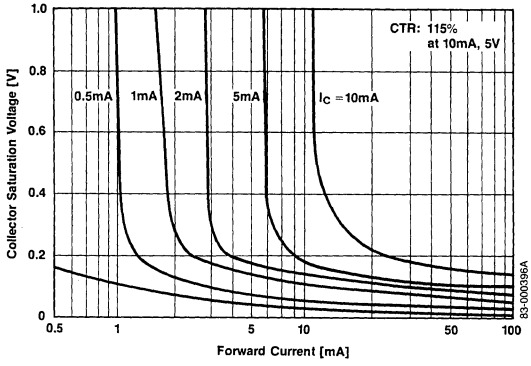
Collector Current vs Collector Saturation Voltage



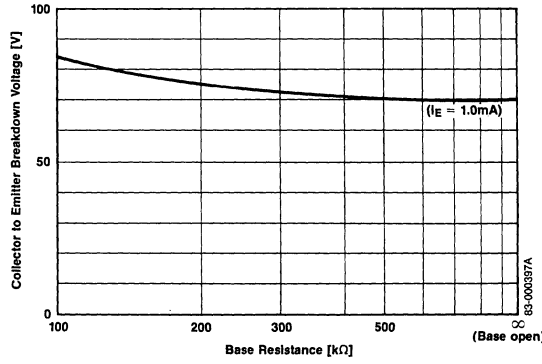

Switching Time vs Load Resistance



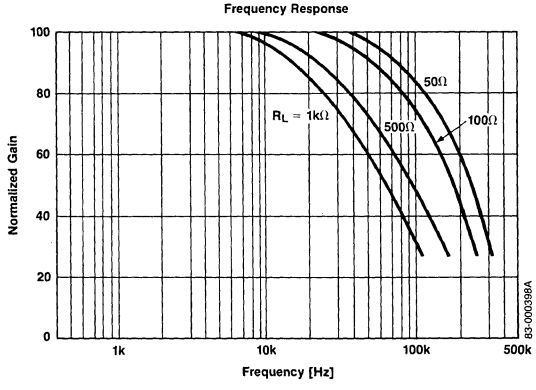

Saturation Voltage vs Forward Current




Collector to Emitter Breakdown Voltage vs Base Resistance




Frequency Response



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# 6N136
# HIGH SPEED PHOTO COUPLER
*NEPOC SERIES*

## Description

The 6N136 is a high speed photo coupler containing GaAsP light emitting diode and a PN photo diode connected to a high speed transistor. The CTR is 15% min.

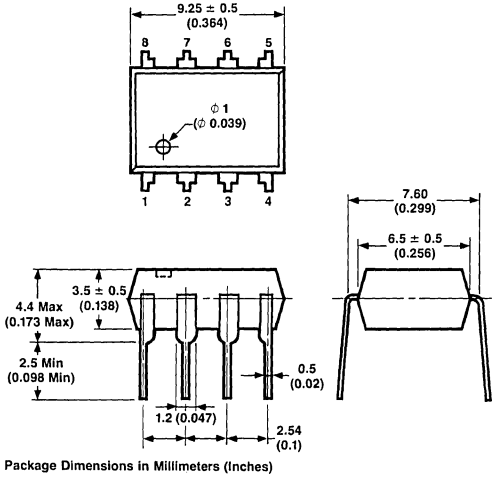
## Features

- ☐ High isolation voltage: 3000$V_{DC}$ min
- ☐ High speed response: $t_{PHL}$, $t_{PLH}$ = 300ns typ
- ☐ Compact, dual in-line plastic package

## Applications

- ☐ Interface circuit for various instruments and control equipment
- ☐ Floating power supply feedback networks
- ☐ Computer and peripheral manufacture
- ☐ Pulse transformers
- ☐ High speed digital and analog line receivers

## Package Dimensions




Package Dimensions in Millimeters (Inches)

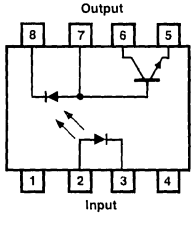
83-000420A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 5V |
| Forward Current, $I_F$ | 25mA |
| Power Dissipation, $P_D$ | 45mW |
| **Detector** | |
| Supply Voltage, $V_{CC}$ | −0.5V to +15V |
| Output Voltage, $V_O$ | −0.5V to +15V |
| Output Current, $I_O$ | 8mA |
| Emitter to Base Voltage, $V_{EBO}$ | 5V |
| Power Dissipation, $P_D$ | 100mW |
| Isolation Voltage[1], BV | 3000$V_{DC}$ |
| Storage Temperature, $T_{STG}$ | −55°C to +125°C |
| Operating Temperature, $T_{OPT}$ | −55°C to +100°C |

## Pin Connection




| PIN | | Function |
|---|---|---|
| Input | 1. | NC |
| | 2. | Anode |
| | 3. | Cathode |
| | 4. | NC |
| Output | 5. | Emitter |
| | 6. | $V_O$ |
| | 7. | Base |
| | 8. | $V_{CC}$ |

83-000410A

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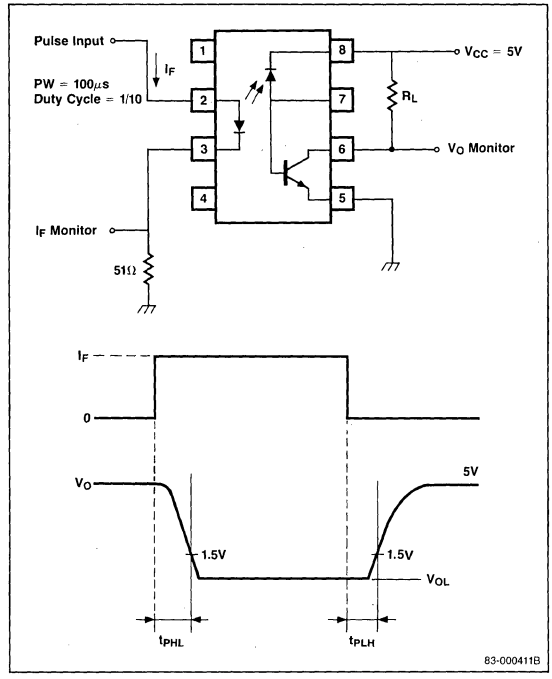
## Electrical Characteristics
$T_A$ = +25°C

| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | 1.43 | 1.7 | V | $I_F$ = 16mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 5V |
| Forward Voltage Temperature Coefficient | $\Delta V_F/\Delta T$ | | −1.51 | | mV/°C | $I_F$ = 16mA |
| Capacitance | $C_T$ | | 60 | | pF | V = 0, f = 1MHz |
| **Detector** | | | | | | |
| High Level Output Current | $I_{OH}$1 | | 3 | 500 | nA | $I_F$ = 0mA, $V_{CC}$ = 5.5V $V_O$ = 5.5V |
| High Level Output Current | $I_{OH}$2 | | | 100 | μA | $I_F$ = 0ma, $V_{CC}$ = 15V $V_O$ = 15V |
| DC Current Gain | $h_{FE}$ | | 120 | | | $V_O$ = 5V, $I_O$ = 3mA |
| **Coupled** | | | | | | |
| Current Transfer Ratio | CTR | 15 | 22 | | % | $I_F$ = 16mA, $V_{CC}$ = 4.5V $V_O$ = 0.4V |
| Low Level Output Voltage | $V_{OL}$ | | 0.1 | 0.4 | V | $I_F$ = 16mA, $V_{CC}$ = 4.5V $I_O$ = 2.4mA |
| Low Level Supply Current | $I_{CCL}$ | | 50 | | μA | $I_F$ = 16mA, $V_O$ = Open, $V_{CC}$ = 15V |
| High Level Supply Current | $I_{CCH}$ | | 0.01 | 1 | μA | $I_F$ = 0mA, $V_O$ = Open, $V_{CC}$ = 15V |
| Isolation Resistance | $R_{1-2}$ | | $10^{12}$ | | Ω | $V_{IN-OUT}$ = 1kV |
| Isolation Capacitance | $C_{1-2}$ | | 0.7 | | pF | V = 0, f = 1MHz |
| Propagation Delay Time to Low Output Level | $t_{PHL}$2 | | 0.3/ .05 | 0.8/ 1.5 | μs | $I_F$ = 16mA, $V_{CC}$ = 5V $R_L$ = 1.9kΩ/ 4.1kΩ |
| Propagation Delay Time to High Output Level | $t_{PLH}$2 | | 0.3/ .05 | 0.8/ 1.5 | μs | $I_F$ = 16mA, $V_{CC}$ = 5V $R_L$ = 1.9kΩ/ 4.1kΩ |

**Notes:** 1. Measuring Conditions: DC voltage for 1 min at $T_A$ = +25°C, RH = 60% between input (pins 1, 2, 3, and 4 common) and output (pins 5, 6, 7, and 8 common).

2. Measuring circuit.

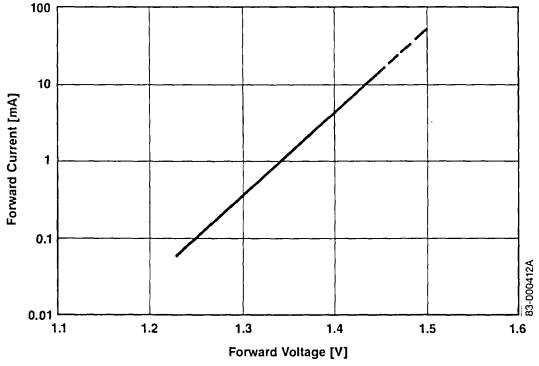
### *Measuring circuit*



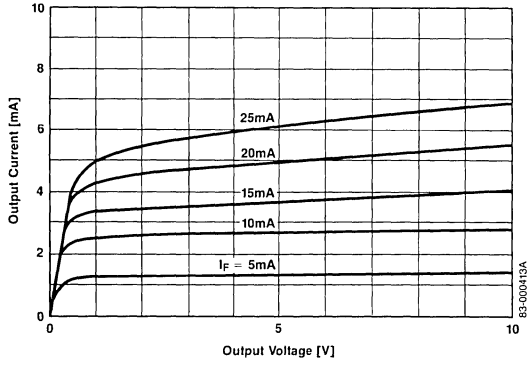
## Typical Characteristics

$T_A$ = +25°C

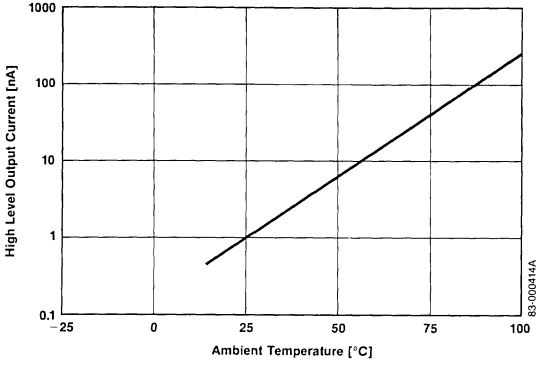
Forward Current vs Forward Voltage



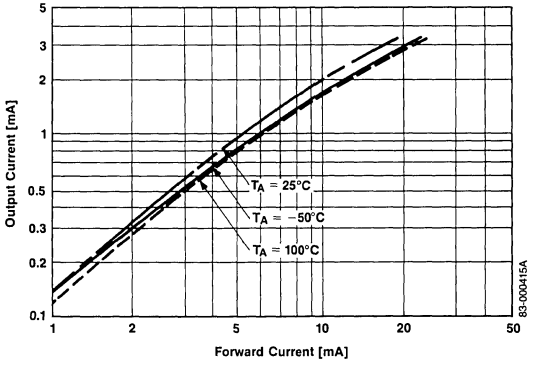

Output Current vs Output Voltage



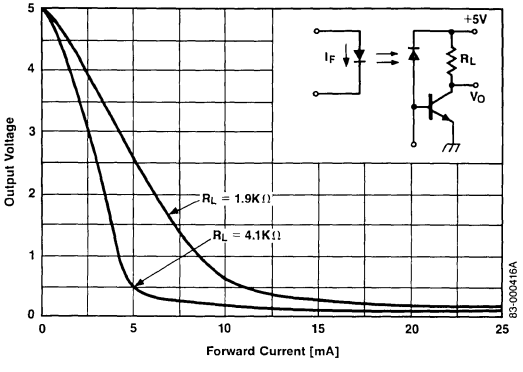

High Level Output Current vs Ambient Temperature



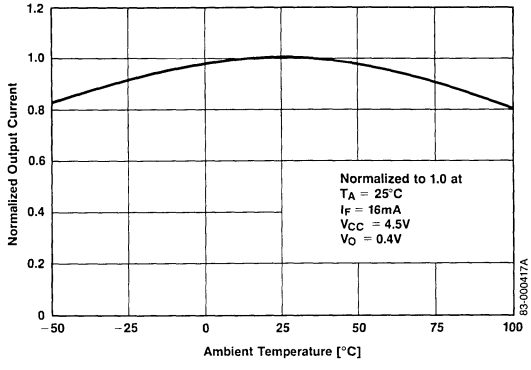

Output Current vs Forward Current




Output Voltage vs Forward Current




Normalized Output Current vs Ambient Temperature

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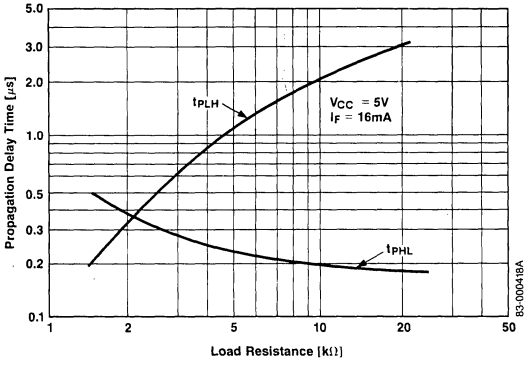
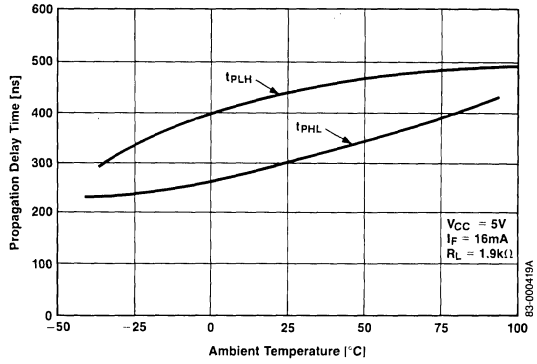
## Typical Characteristics (cont)

$T_A = +25°C$

Propagation Delay Time vs Load Resistance




Propagation Delay Time vs Ambient Temperature



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NEC Electronics Inc.

# 6N137
# HIGH SPEED PHOTO COUPLER
*NEPOC SERIES*

## Description

The 6N137 is a high speed photo coupler containing a GaAsP light emitting diode and an integrated detector consisting of a photo diode and a high gain linear amplifier that drives a Schottky clamped open collector output transistor in a plastic DIP (Dual In-line Package).

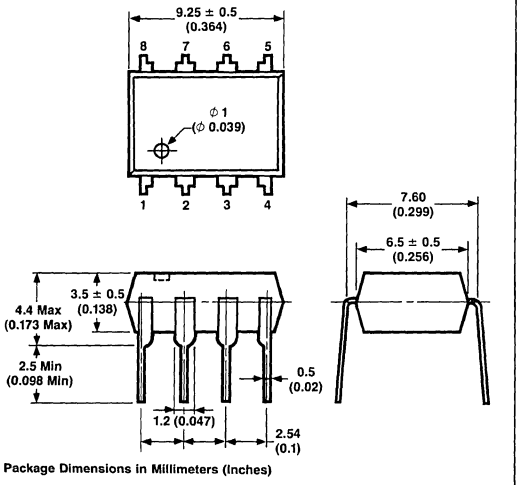
## Features

- ☐ Ultra high speed (50ns typ)
- ☐ High isolation voltage (3000$V_{DC}$ min)
- ☐ Low input current requirement (5mA)
- ☐ Economical, compact, plastic dual in-line package
- ☐ TTL compatible (5V supply)

## Applications

- ☐ Line receiver
- ☐ Floating power supply
- ☐ Computer and peripheral memory
- ☐ Replaceable with mechanical relays and reed relays
- ☐ Replaceable with pulse transformer

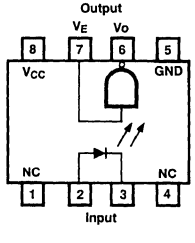
## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000420A

## Pin Connection




| PIN | | Function |
|---|---|---|
| Input | 1. | NC |
| | 2. | Anode |
| | 3. | Cathode |
| | 4. | NC |
| Output | 5. | GND |
| | 6. | $V_O$ |
| | 7. | $V_E$ |
| | 8. | $V_{CC}$ |

83-000422A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 5V |
| Forward Current, $I_F$ | 10mA |
| **Detector** | |
| Supply Voltage, $V_{CC}$ | 7V |
| Output Voltage, $V_O$ | 7V |
| Output Current, $I_O$ | 50mA |
| Enable Voltage, $V_E$ | 5.5V |
| Power Dissipation, $P_D$ | 85mW |
| Isolation Voltage, BV[1] | 3000$V_{DC}$ |
| Storage Temperature, $T_{STG}$ | −55°C to +125°C |
| Operating Temperature, $T_{OPT}$ | 0°C to +70°C |

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## Electrical Characteristics
$T_A$ = 0 to +75°C

| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | 1.42 | 1.7 | V | $I_F$ = 10mA, $T_A$ = 25°C |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 5V, $T_A$ = 25°C |
| Capacitance | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| **Detector** | | | | | | |
| High Level Enable Current | $I_{EH}$ | | −0.8 | | mA | $V_{CC}$ = 5.5V, $V_{EH}$ = 2.0V |
| Low Level Enable Current | $I_{EL}$ | | −1.2 | −2.0 | mA | $V_{CC}$ = 5.5V, $V_{EL}$ = 0.5V |
| **Coupled** | | | | | | |
| High Level Output Current | $I_{OH}$ | | 30 | 250 | μA | $V_{CC}$ = 5.5V $V_O$ = 5.5V, $I_F$ = 250μA, $V_E$ = 2.0V |
| Low Level Output Voltage | $V_{OL}$ | | 0.4 | 0.6 | V | $V_{CC}$ = 5.5V, $V_E$ = 2.0V, $I_F$ = 5mA, $I_O$ = 13mA |
| Low Level Supply Current | $I_{CCL}$ | | 10 | 18 | mA | $V_{CC}$ = 5.5V, $V_E$ = 2V, $I_F$ = 10mA |
| High Level Supply Current | $I_{CCH}$ | | 7 | 15 | mA | $V_{CC}$ = 5.5V, $V_E$ = 0.5V, $I_F$ = 0mA |

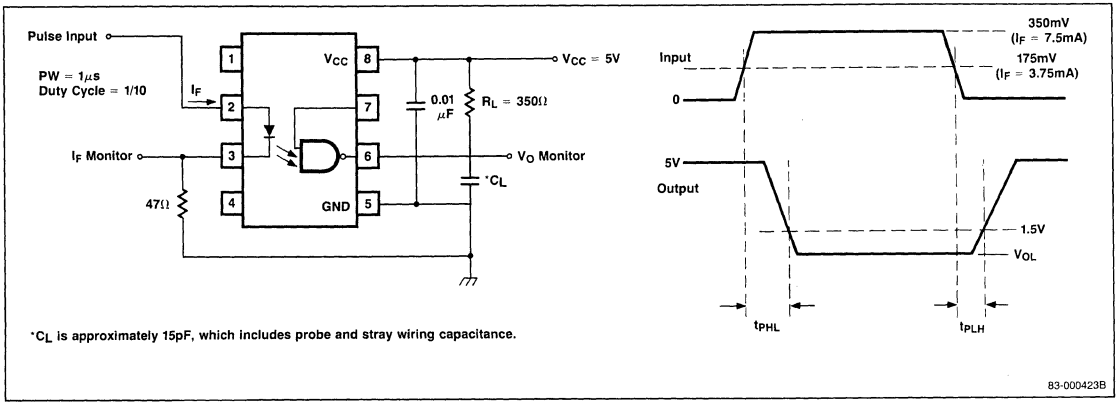
## Electrical Characteristics (cont)
$T_A$ = +25°C

| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Coupled** | | | | | | |
| Current Transfer Ratio | CTR | | 600 | | % | $I_F$ = 5mA, $V_{CC}$ = 5V $R_L$ = 100Ω |
| Isolation Resistance | $R_{I-2}$ | | $10^{12}$ | | Ω | $V_{IN-OUT}$ = 1kV |
| Isolation Capacitance | $C_{I-2}$ | | 0.7 | | pF | V = 0, f = 1MHz |
| Propagation Delay Time to Low Output Level | $t_{PHL}$[2] | | 50 | 75 | ns | $I_F$ = 7.5mA, $V_{CC}$ = 5V $R_L$ = 350Ω, $C_L$ = 15pF |
| Propagation Delay Time to High Output Level | $t_{PLH}$[2] | | 50 | 75 | ns | |
| Propagation Delay Time of Enable to Low Output Level | $t_{EHL}$ | | 15 | | ns | $I_F$ = 7.5mA, $V_{CC}$ = 5V $R_L$ = 350Ω, $V_{EH}$ = 3V $C_L$ = 15pF |
| Propagation Delay Time of Enable to High Output Level | $t_{ELH}$ | | 30 | | ns | |

**Notes:** 1. Measuring conditions: DC voltage for 1 min at $T_A$ = 25°C, RH = 60% between input (pins 1, 2, 3, 4 common) and output (pins 5, 6, 7, 8 common)

2. Measuring circuit

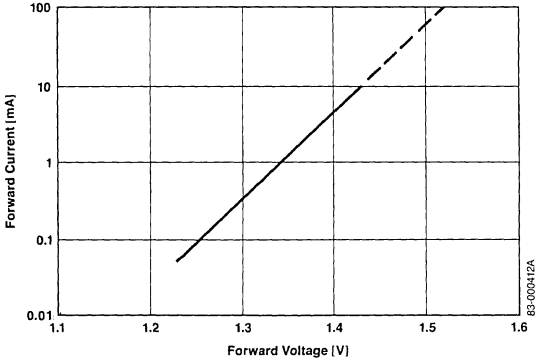
### *Measuring circuit*



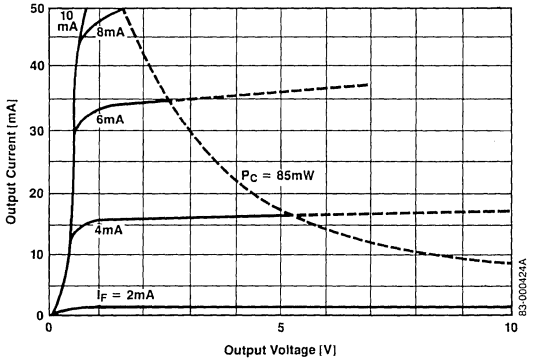
## Typical Characteristics

$T_A$ = +25°C

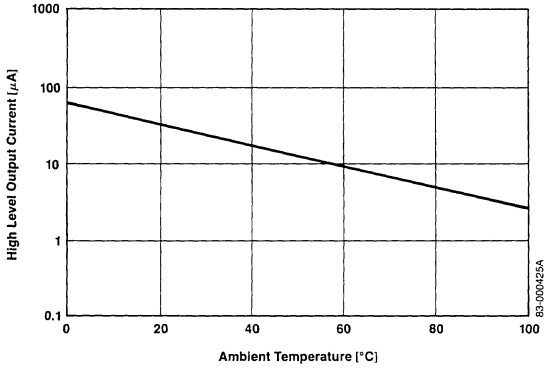
Forward Current vs Forward Voltage



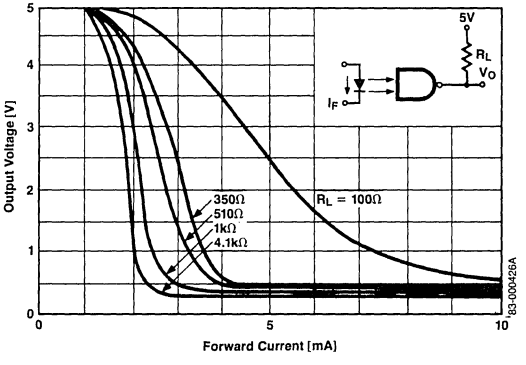

Output Current vs Output Voltage



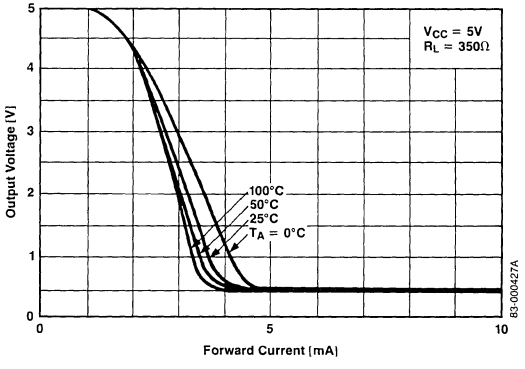

High Level Output Current vs Ambient Temperature



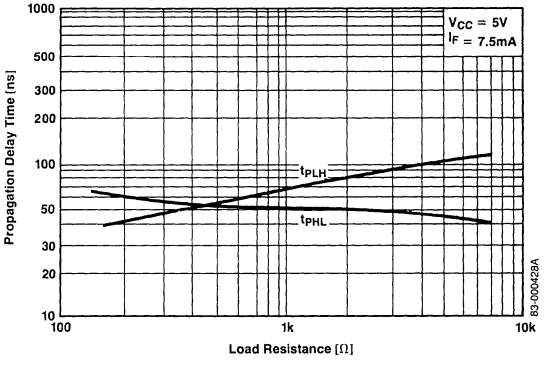

Output Voltage vs Forward Current




Output Voltage vs Forward Current




Propagation Delay Time vs Load Resistance

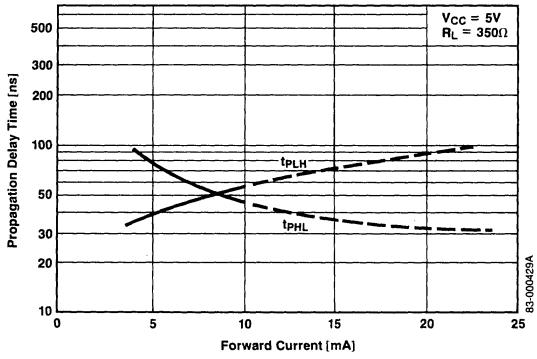



5

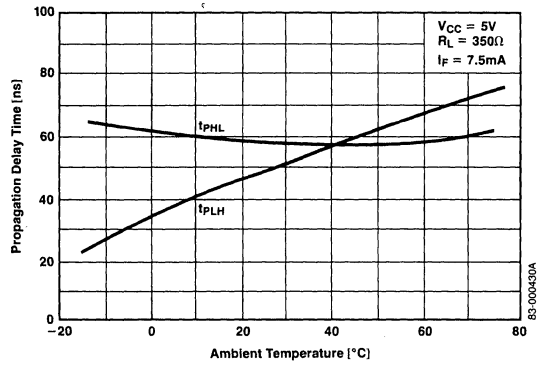
## Typical Characteristics (cont)

$T_A = +25°C$

Propagation Delay Time vs Forward Current




Propagation Delay Time vs Ambient Temperature



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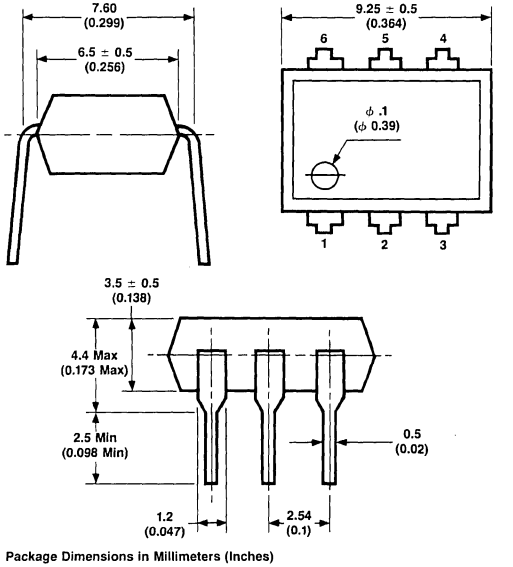
# MCT2
# PHOTO COUPLER
# SINGLE TRANSISTOR
*NEPOC SERIES*

## Description

The MCT2 is an optically coupled isolator containing a GaAs light emitting diode and an NPN silicon photo transistor.

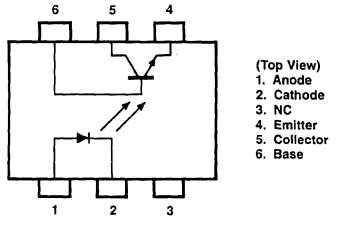
## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000421A

## Pin Connection




(Top View)
1. Anode
2. Cathode
3. NC
4. Emitter
5. Collector
6. Base

83-000385A

## Features

- ☐ High isolation voltage: $2000V_{AC}$, $2500V_{DC}$
- ☐ High transfer ratio: 20% min
- ☐ High speed switching: $t_r$, $t_f$ = 4$\mu$s typ
- ☐ Economical, compact, dual in-line plastic package

## Applications

- ☐ Interface circuit for various instruments and control equipment
- ☐ Chopper circuits
- ☐ Computer and peripheral manufacture
- ☐ Pulse transformers
- ☐ Data communication equipment

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 5.0V |
| Forward Current (DC), $I_F$ | 80mA |
| Power Dissipation, $P_D$ | 150mW |
| Peak Forward Current (300$\mu$s, 2% duty cycle), $I_{F(peak)}$ | 3A |
| **Transistor** | |
| Collector to Emitter Voltage, $V_{CEO}$ | 30V |
| Collector to Base Voltage, $V_{CBO}$ | 70V |
| Emitter to Collector Voltage, $V_{ECO}$ | 7V |
| Collector Current, $I_C$ | 100mA |
| Power Dissipation, $P_D$ | 150mW |
| Isolation Voltage[1], BV | $2500V_{DC}$ |
| Isolation Voltage[1], BV | $2000V_{AC}$ |
| Storage Temperature, $T_{STG}$ | −55°C to +150°C |
| Operating Temperature, $T_{OPT}$ | −55°C to +100°C |
| Lead Temperature (Soldering 10s) | 260°C |
| Total Power Dissipation, $P_T$ | 250mW |

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## Electrical Characteristics
$T_A$ = +25°C

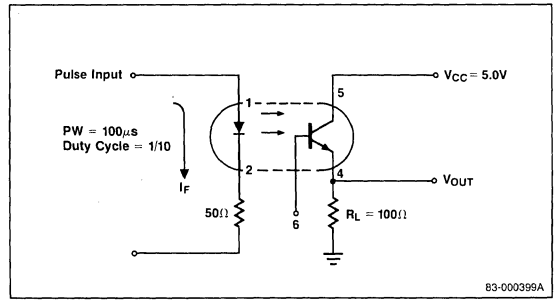
| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | 1.1 | 1.4 | V | $I_F$ = 10mA |
| Forward Voltage | $V_F$ | | 1.2 | 1.5 | V | $I_F$ = 50mA |
| Reverse Current | $I_R$ | | | 10 | μA | $V_R$ = 5V |
| Junction Capacitance | C | | 50 | | pF | V = 0, f = 1.0MHz |
| **Transistor** | | | | | | |
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 50 | nA | $V_{CE}$ = 10V, $I_F$ = 0 |
| DC Current Gain | $h_{FE}$ | | 700 | | | $I_C$ = 2mA, $V_{CE}$ = 5.0V |
| Collector to Emitter Breakdown Voltage | $BV_{CEO}$ | 30 | 60 | | V | $I_C$ = 1mA, $I_B$ = 0 |
| Collector to Base Breakdown Voltage | $BV_{CBO}$ | 70 | 120 | | V | $I_C$ = 100μA, $I_E$ = 0 |
| Emitter to Collector Breakdown Voltage | $BV_{ECO}$ | 7 | 9 | | V | $I_E$ = 100μA, $I_B$ = 0 |
| **Coupled** | | | | | | |
| Current Transfer Ratio[2] | CTR ($I_C/I_F$) | 20 | | | % | $I_F$ = 10mA, $V_{CE}$ = 5.0V |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | | 0.3 | V | $I_F$ = 10mA, $I_C$ = 2.0mA |
| Isolation Resistance | $R_{1-2}$ | $10^{11}$ | | | Ω | $V_{IN-OUT}$ = 1.0kV |
| Isolation Capacitance | $C_{1-2}$ | | 0.8 | | pF | V = 0, f = 1.0MHz |
| Rise Time[3] | $t_r$ | | 4 | | μs | $V_{CC}$ = 5.0V, $I_C$ = 2mA, $R_L$ = 100Ω |
| Fall Time[3] | $t_f$ | | 4 | | μs | $V_{CC}$ = 5.0V, $I_C$ = 2mA, $R_L$ = 100Ω |

**Notes:** 1. Measuring Conditions: DC or AC voltage for 1 min at $T_A$ = +25°C, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).

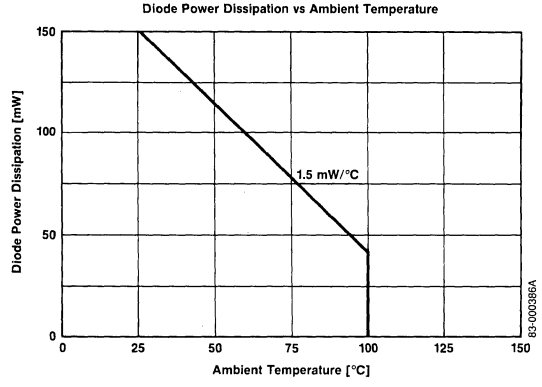
2. CTR rank: K: 80% ~ 210%, L: 50% ~ 110%, M: 20% ~ 70%.

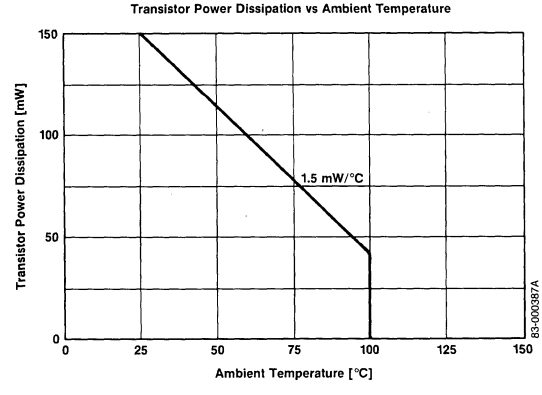
3. Test circuit for switching time.

### *Test circuit for switching time*




## Typical Characteristics
$T_A$ = +25°C

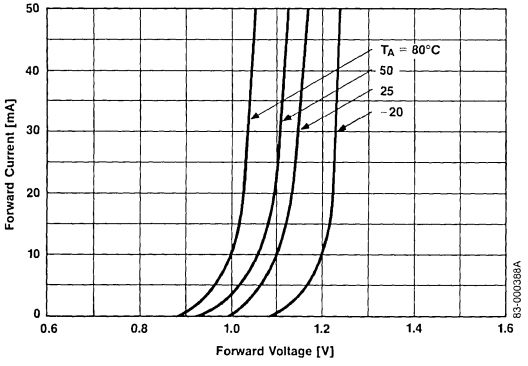


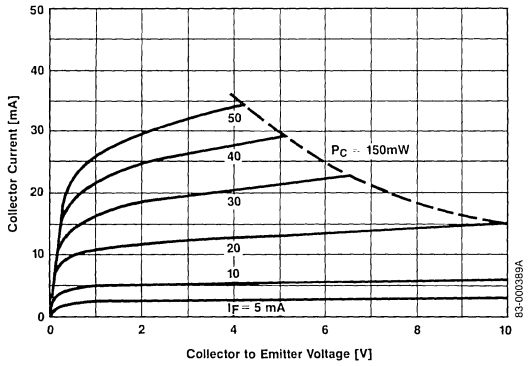
## Typical Characteristics (cont)

$T_A$ = +25°C

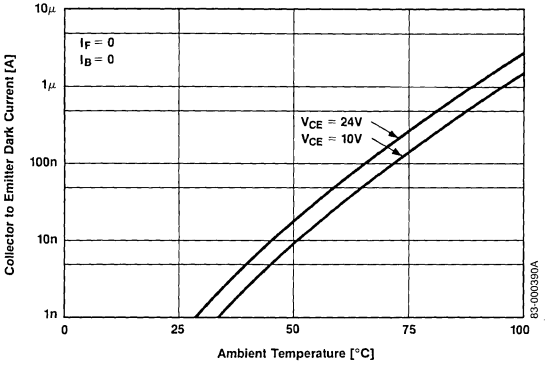
Forward Current vs Forward Voltage



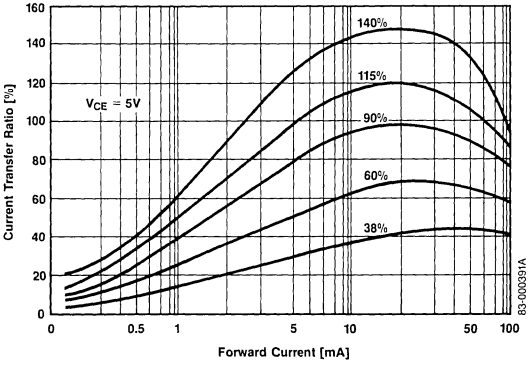

Collector Current vs Collector to Emitter Voltage



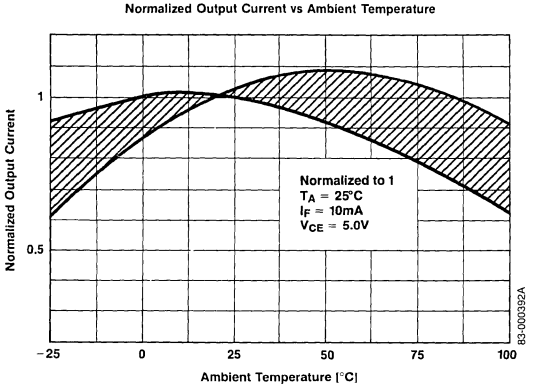

Collector to Emitter Dark Current vs Ambient Temperature



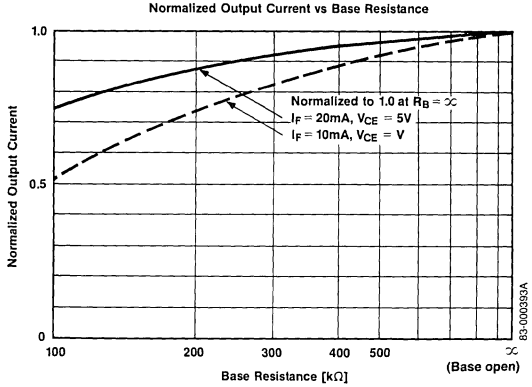

Current Transfer Ratio vs Forward Current




Normalized Output Current vs Ambient Temperature




Normalized Output Current vs Base Resistance

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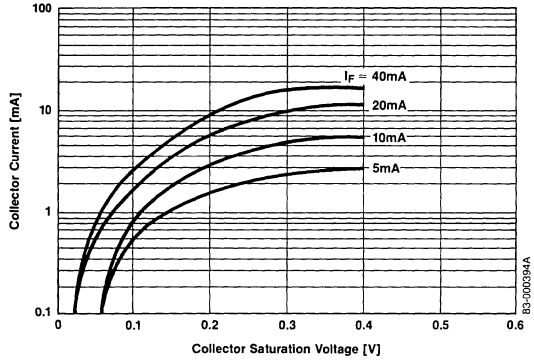
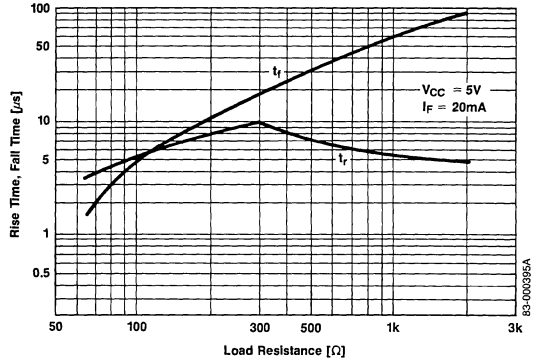
## Typical Characteristics (cont)

$T_A = +25°C$

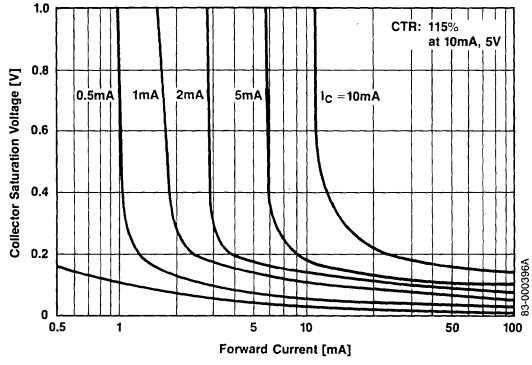
Collector Current vs Collector Saturation Voltage



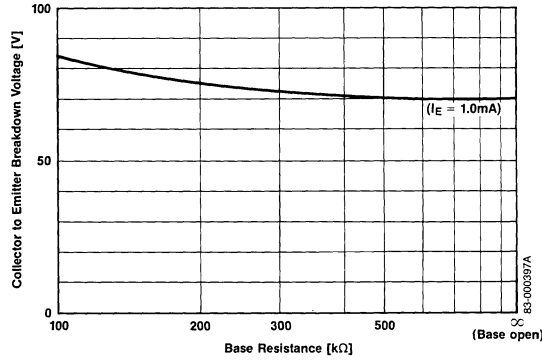

Switching Time vs Load Resistance



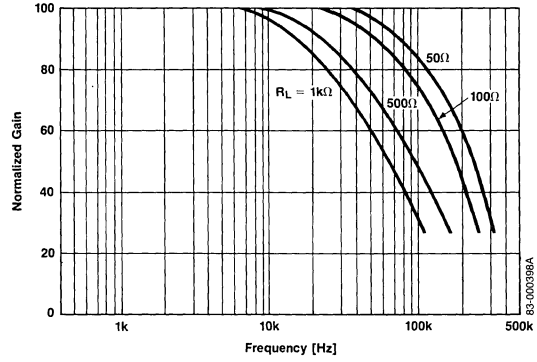

Saturation Voltage vs Forward Current




Collector to Emitter Breakdown Voltage vs Base Resistance




Frequency Response



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# PS2002B
# PHOTO COUPLER
# DARLINGTON TRANSISTOR

*NEPOC SERIES*

## Description

The PS2002B is an optically coupled isolator containing a GaAsP light emitting diode and an NPN silicon Darlington-connected photo transistor.

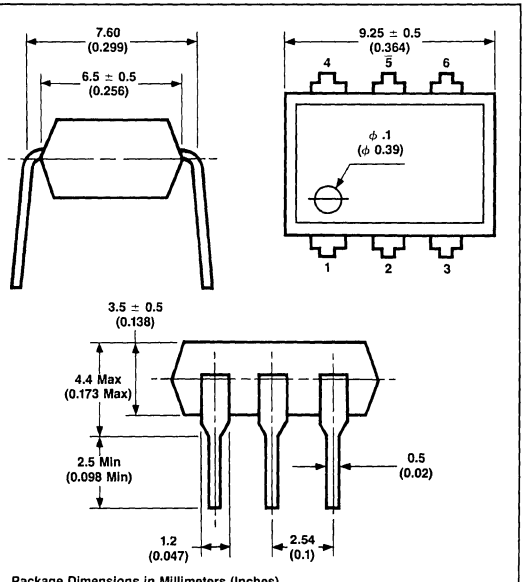
## Features

- ☐ High-voltage isolation: 2500$V_{DC}$ min
- ☐ High transfer ratio: 100% min
- ☐ Economical, compact, plastic dual in-line package

## Applications

- ☐ ECR
- ☐ Automat
- ☐ Replacement of pulse transformers
- ☐ Replacement of mechanical and reed relays

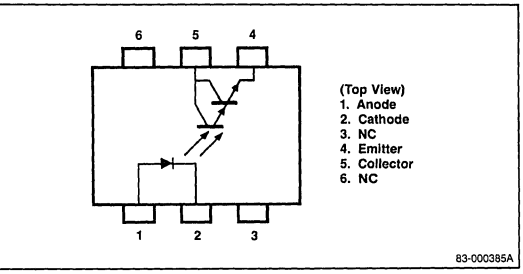
## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000421A

## Pin Connection




83-000385A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 7.0V |
| Forward Current, $I_F$ | 50mA |
| Power Dissipation, $P_D$ | 100mW |
| **Transistor** | |
| Collector to Emitter Voltage, $V_{CEO}$ | 40V |
| Collector Current, $I_C$ | 50mA |
| Power Dissipation, $P_D$ | 100mW |
| Isolation Voltage[1], BV | 2500$V_{DC}$ |
| Storage Temperature, $T_{STG}$ | −55°C to +125°C |
| Operating Temperature, $T_{OPT}$ | −55°C to +100°C |

5

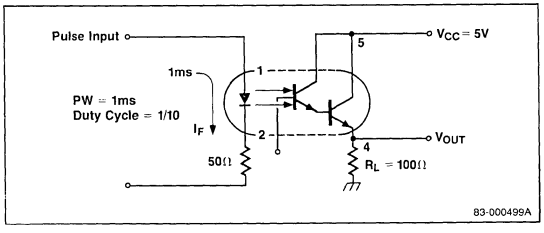
## Electrical Characteristics
$T_A$ = +25°C

| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | | 1.9 | V | $I_F$ = 5.0mA |
| Reverse Current | $I_R$ | | | 2.0 | μA | $V_R$ = 4.0V |
| Junction Capacitance | C | | 100 | | pF | V = 0, f = 1.0MHz |
| **Transistor** | | | | | | |
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 400 | nA | $V_{CE}$ = 10V, $I_F$ = 0 |
| DC Current Gain | $h_{FE}$ | | 5000 | | | $I_C$ = 4.0mA, $V_{CE}$ = 2.0V |
| **Coupled** | | | | | | |
| Current Transfer Ratio | CTR ($I_C/I_F$) | 100 | | | % | $I_F$ = 5.0mA, $V_{CE}$ = 2.0V |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | | 1.2 | V | $I_F$ = 5.0mA, $I_C$ =2.0mA |
| Isolation Resistance | $R_{1-2}$ | $10^{11}$ | | | Ω | $V_{IN-OUT}$ = 1.0kV |
| Isolation Capacitance | $C_{1-2}$ | | 0.8 | | pF | V = 0, f = 1.0MHz |
| Rise Time[2] | $t_r$ | | 100 | | μs | $V_{CC}$ = 5.0V, $I_F$ = 10mA, $R_L$ = 100Ω |
| Fall Time[2] | $t_f$ | | 120 | | μs | $V_{CC}$ = 5.0V, $I_F$ = 10mA, $R_L$ = 100Ω |

**Notes:** 1. Measuring Conditions: DC or AC voltage for 1 min at $T_A$ = +25°C, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).

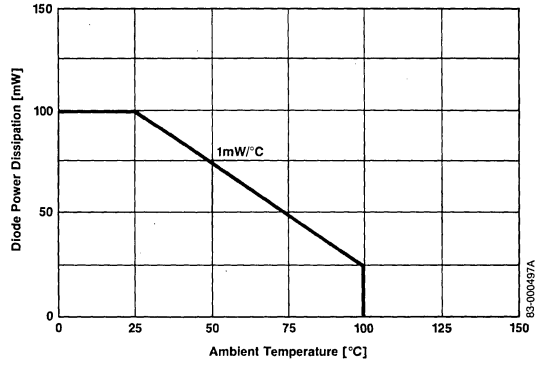
2. Test circuit for switching time.

### *Test circuit for switching time*

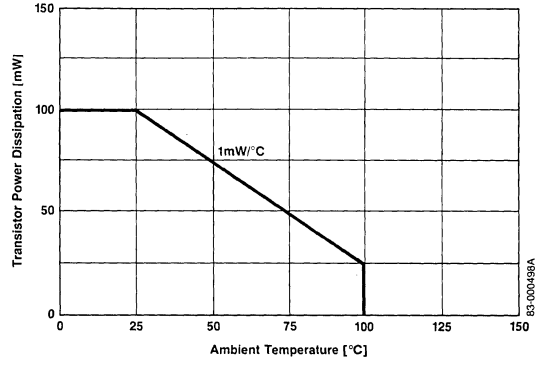



## Typical Characteristics
$T_A$ = +25°C

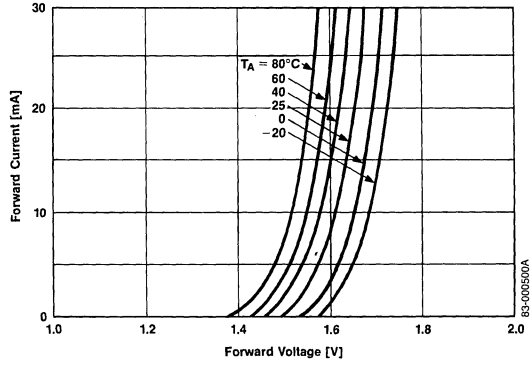
Diode Power Dissipation vs Ambient Temperature




Transistor Power Dissipation vs Ambient Temperature



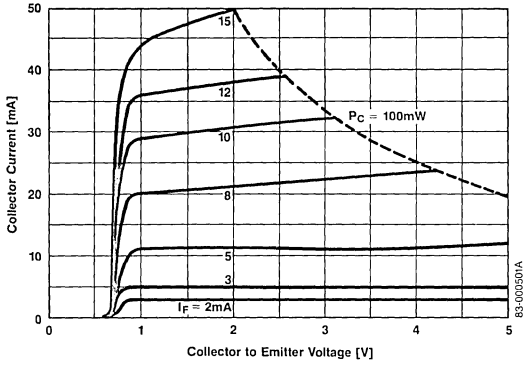

Forward Current vs Forward Voltage



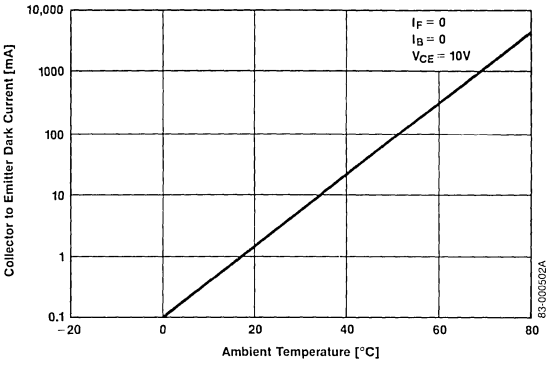
## Typical Characteristics (cont)

$T_A = +25°C$

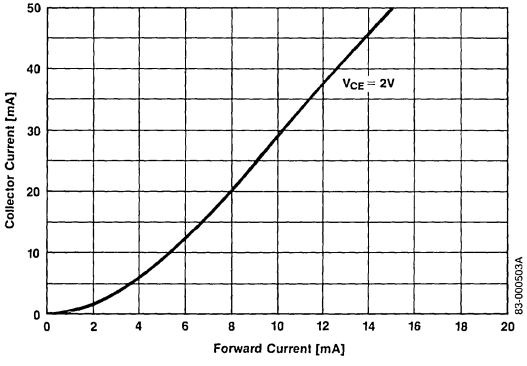
Collector Current vs Collector to Emitter Voltage



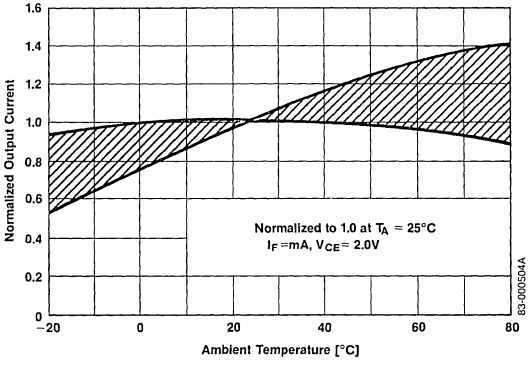

Collector to Emitter Dark Current vs Ambient Temperature



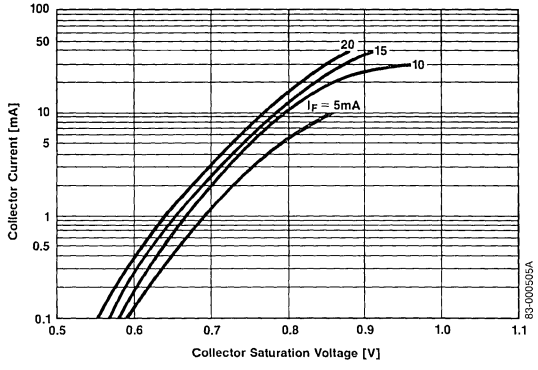

Collector Current vs Forward Current



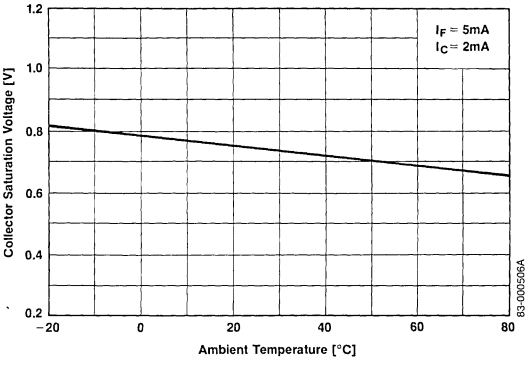

Normalized Output Current vs Ambient Temperature




Collector Current vs Collector Saturation Voltage




Collector Saturation Voltage vs Ambient Temperature



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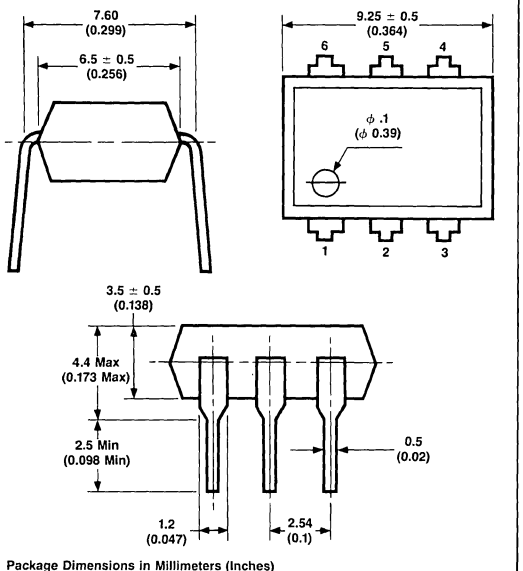
# PS2004B
# PHOTO COUPLER
# DARLINGTON TRANSISTOR

*NEPOC SERIES*

## Description

The PS2004B is an optically coupled isolator containing a GaAs light emitting diode and an NPN silicon Darlington photo transistor in a plastic DIP (Dual In-line Package).

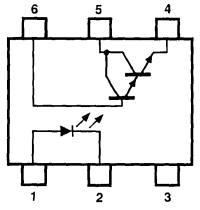
## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000421A

## Pin Connection




1. Anode
2. Cathode
3. NC
4. Emitter
5. Collector
6. Base

83-000400A

## Features

- ☐ High-voltage isolation: 2500V min
- ☐ Ultra high transfer ratio: 1300% min
- ☐ High output current: 200mA max
- ☐ Economical, compact, plastic dual in-line package

## Applications

- ☐ Copy machine
- ☐ Replacement for mechanical and reed relays
- ☐ Replacement of pulse transformers

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 5.0V |
| Forward Current, $I_F$ | 50mA |
| Power Dissipation, $P_D$ | 100mW |
| **Transistor** | |
| Collector to Emitter Voltage, $V_{CEO}$ | 30V |
| Collector Current, $I_C$ | 200mA |
| Power Dissipation, $P_D$ | 200mW |
| Total Power Dissipation, $P_{TOTAL}$ | 250mW |
| Isolation Voltage[1], BV | $2500V_{DC}$ |
| Isolation Voltage[1], BV | $2000V_{AC}$ (rms) |
| Storage Temperature, $T_{STG}$ | −55°C to +125°C |
| Operating Temperature, $T_{OPT}$ | −55°C to +100°C |

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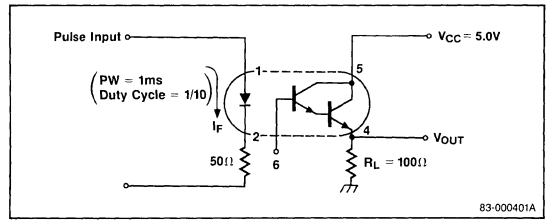
## Electrical Characteristics
$T_A$ = 25°C

| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | | 1.4 | V | $I_F$ = 20mA |
| Reverse Current | $I_R$ | | | 5.0 | μA | $V_R$ = 4.0V |
| Junction Capacitance | C | | 100 | | pF | V = 0, f = 1.0MHz |
| **Transistor** | | | | | | |
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 400 | nA | $V_{CE}$ = 10V, $I_F$ = 0 |
| **Coupled** | | | | | | |
| Current Transfer Ratio | CTR ($I_C/I_F$) | 1300 | | | % | $I_F$ = 5.0mA, $V_{CE}$ = 2.0V |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | | 1.2 | V | $I_F$ = 5.0mA, $I_C$ = 2.0mA |
| Isolation Resistance | $R_{1-2}$ | $10^{11}$ | | | Ω | $V_{IN-OUT}$ = 1.0kV |
| Isolation Capacitance | $C_{1-2}$ | | 0.8 | | pF | V = 0, f = 1.0MHz |
| Rise Time | $t_r$ | | 100 | | μs | $V_{CC}$ = 5.0V, $I_F$ = 5.0mA, $R_L$ = 100Ω[2] |
| Fall Time | $t_f$ | | 250 | | μs | $V_{CC}$ = 5.0V, $I_F$ = 5.0mA, $R_L$ = 100Ω[2] |

**Notes:** 1. Measuring Conditions: DC or AC voltage for 1 min at $T_A$ = +25°C, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).

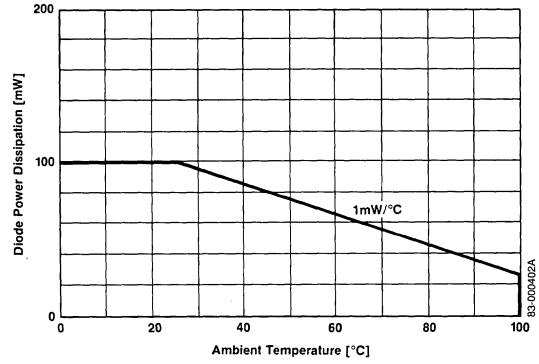
2. Test circuit for switching time.

*Test circuit for switching time*

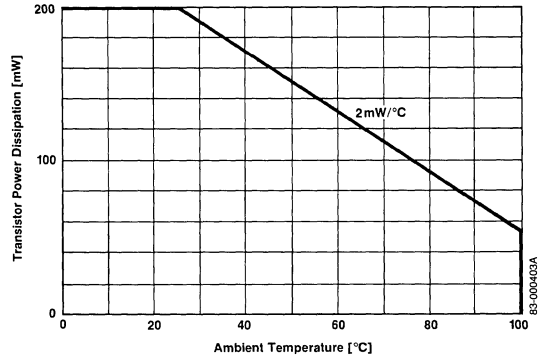



## Typical Characteristics
$T_A$ = +25°C

Diode Power Dissipation vs Ambient Temperature



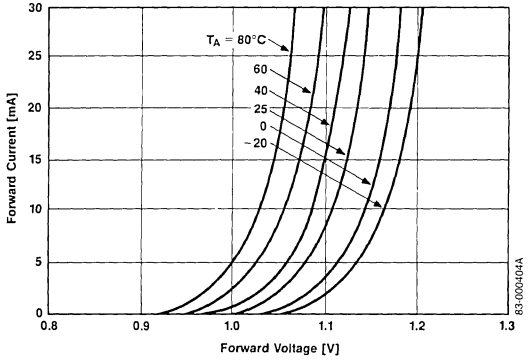

Transistor Power Dissipation vs Ambient Temperature



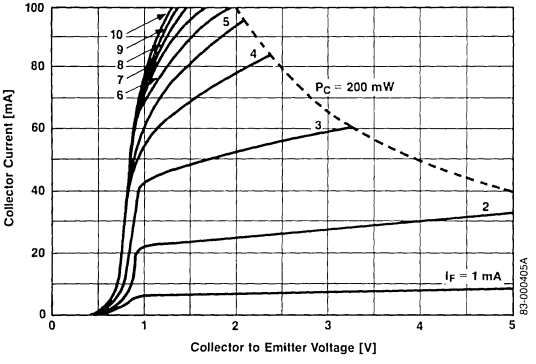
## Typical Characteristics (cont)

$T_A$ = +25°C

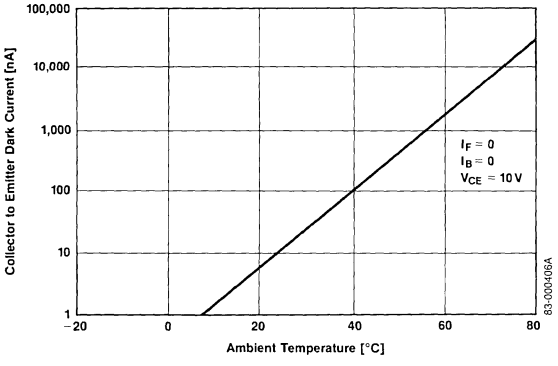
Forward Current vs Forward Voltage



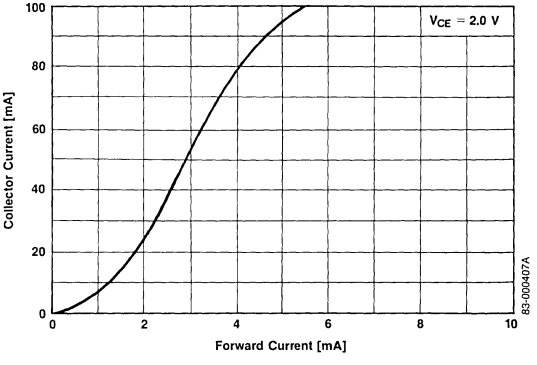

Collector Current vs Collector to Emitter Voltage



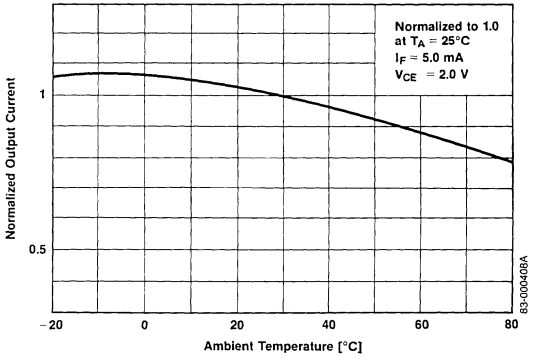

Collector to Emitter Dark Current vs Ambient Temperature



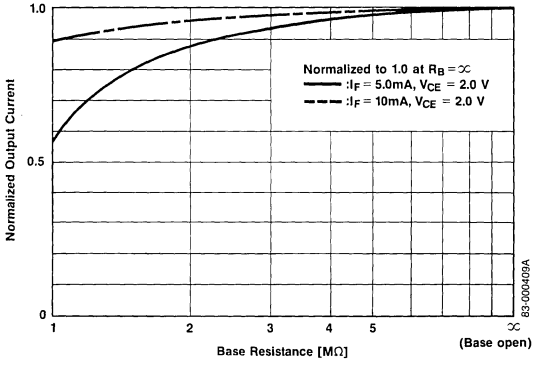

Collector Current vs Forward Current




Normalized Output Current vs Ambient Temperature




Normalized Output Current vs Base Resistance

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# PS2005B
# PHOTO COUPLER
# HIGH IMPACT CURRENT
# SINGLE TRANSISTOR

*NEPOC SERIES*

## Description

The PS2005B is an optically coupled isolator containing a GaAsP light emitting diode and an NPN silicon photo transistor.

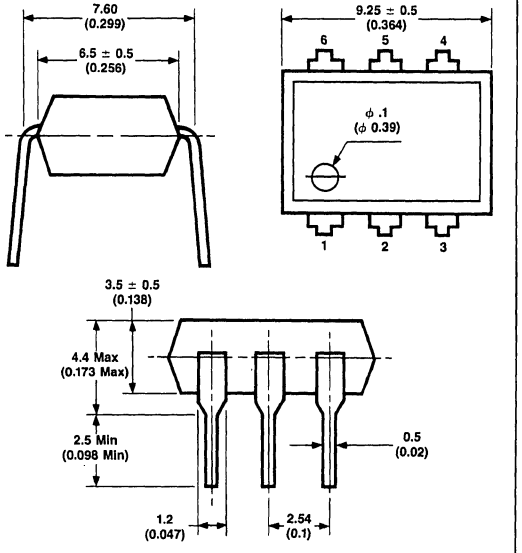
## Features

- ☐ High-voltage isolation: 2500V
- ☐ Large forward input (current): 150mA max
- ☐ High transfer ratio: 10% min
- ☐ High speed switching: $t_r$, $t_f$ = 5$\mu$s typ
- ☐ Economical, compact, dual in-line plastic package

## Applications

- ☐ Telephone/telegraph line receivers
- ☐ Replacement for reed relays

## Package Dimensions




Package Dimensions in Millimeters (Inches)

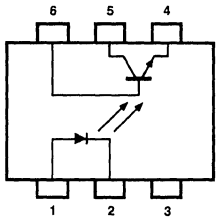
83-000421A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 7.0V |
| Forward Current, $I_F$ | 150mA |
| Power Dissipation, $P_D$ | 200mW |
| **Transistor** | |
| Collector to Emitter Voltage, $V_{CEO}$ | 30V |
| Collector Current, $I_C$ | 50mA |
| Power Dissipation, $P_D$ | 150mW |
| Total Power Dissipation, $P_{TOTAL}$ | 250mW |
| Isolation Voltage[1], BV | 2500$V_{DC}$ |
| Isolation Voltage[1], BV | 2000$V_{AC}$ (rms) |
| Storage Temperature, $T_{STG}$ | −55°C to +125°C |
| Operating Temperature, $T_{OPT}$ | −55°C to +100°C |

## Pin Connection




(Top View)
1. Anode
2. Cathode
3. NC
4. Emitter
5. Collector
6. Base

83-000385A

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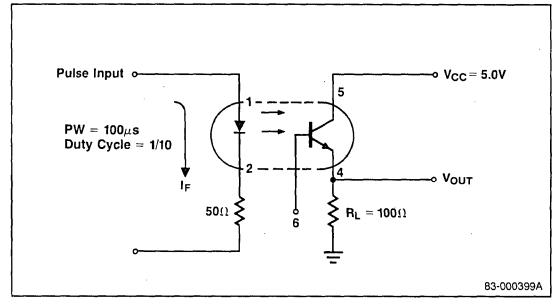
## Electrical Characteristics
$T_A$ = +25°C

| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | | 2.0 | V | $I_F$ = 100mA |
| Reverse Current | $I_R$ | | | 5.0 | μA | $V_R$ = 4.0V |
| Junction Capacitance | C | | 250 | | pF | V = 0, f = 1.0MHz |
| **Transistor** | | | | | | |
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 200 | nA | $V_{CE}$ = 10V, $I_F$ = 0 |
| DC Current Gain | $h_{FE}$ | | 400 | | | $I_C$ = 4.0mA, $V_{CE}$ = 5.0V |
| **Coupled** | | | | | | |
| Current Transfer Ratio | CTR ($I_C/I_F$) | 10 | | | % | $I_F$ = 100mA, $V_{CE}$ = 5.0V |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | | 0.3 | V | $I_F$ = 100mA, $I_C$ =4.0mA |
| Isolation Resistance | $R_{1-2}$ | $10^{11}$ | | | Ω | $V_{IN-OUT}$ = 1.0kV |
| Isolation Capacitance | $C_{1-2}$ | | 0.8 | | pF | V = 0, f = 1.0MHz |
| Rise Time | $t_r$ | | 5.0 | | μs | $V_{CC}$ = 5.0V, $I_F$ = 100mA, $R_L$ = 100Ω[2] |
| Fall Time | $t_f$ | | 5.0 | | μs | $V_{CC}$ = 5.0V, $I_F$ = 100mA, $R_L$ = 100Ω[2] |

**Notes:** 1. Measuring Conditions: DC or AC voltage for 1 min at $T_A$ = +25°C, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).

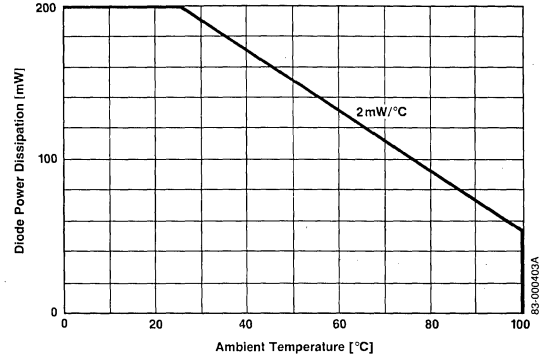
2. Test circuit for switching time.

### *Test circuit for switching time*

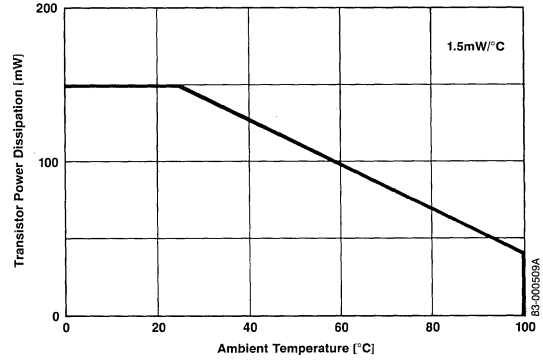



## Typical Characteristics
$T_A$ = +25°C

Diode Power Dissipation vs Ambient Temperature



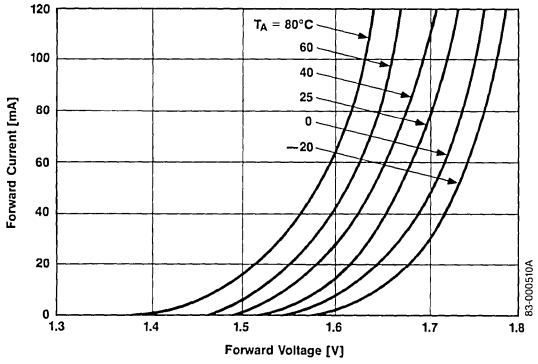

Transistor Power Dissipation vs Ambient Temperature



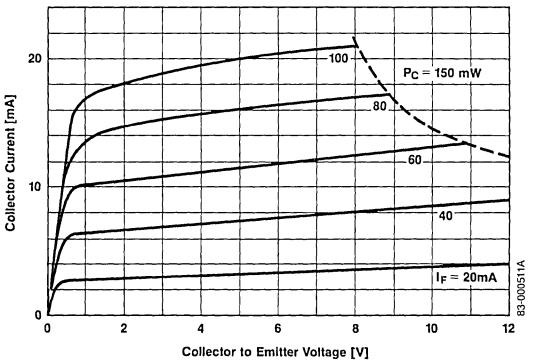
## Typical Characteristics (cont)

$T_A$ = +25°C

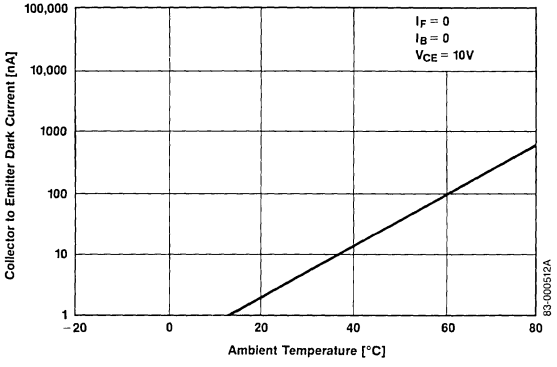
Forward Current vs Forward Voltage



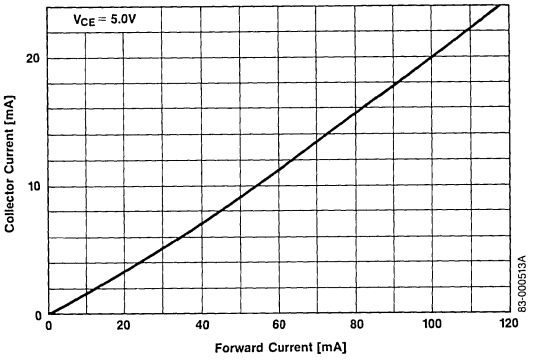

Collector Current vs Collector to Emitter Voltage



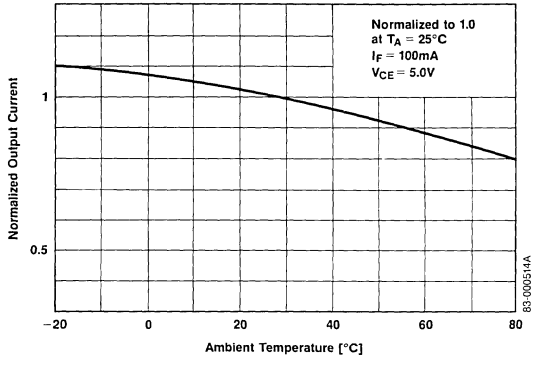

Collector to Emitter Dark Current vs Ambient Temperature



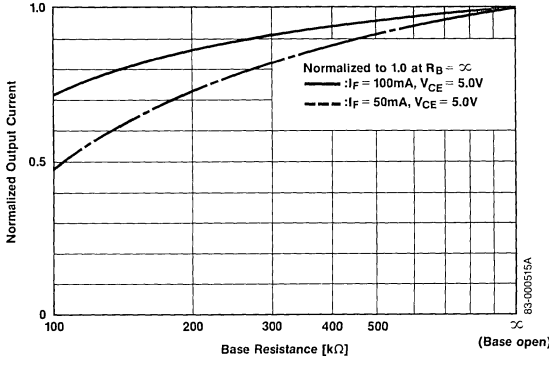

Collector Current vs Forward Current




Normalized Output Current vs Ambient Temperature




Normalized Output Current vs Base Resistance



NEC

NEC Electronics Inc.

# PS2006B/B(1) HIGH SPEED PHOTO COUPLERS

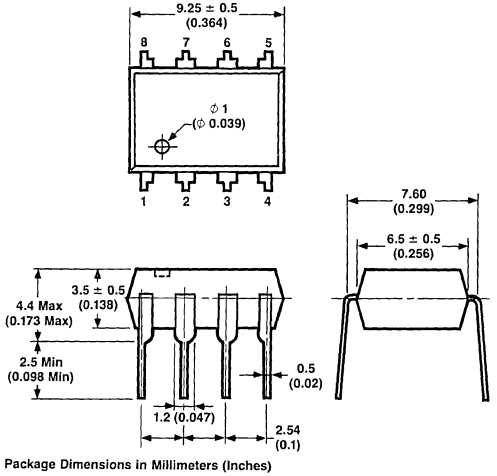
*NEPOC SERIES*

## Description

The PS2006B and PS2006B(1) are high speed photo couplers containing a GaAsP light emitting diode and a p-n photo diode connected to a high speed transistor.

The CTR are 15%min for PS2006B and 7% min for PS2006B(1).

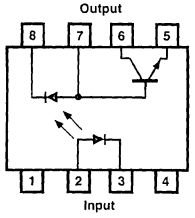
## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000420A

## Pin Connection




| PIN | | Function |
|---|---|---|
| Input | 1. | NC |
| | 2. | Anode |
| | 3. | Cathode |
| | 4. | NC |
| Output | 5. | Emitter |
| | 6. | $V_O$ |
| | 7. | Base |
| | 8. | $V_{CC}$ |

83-000410A

## Features

- ☐ High isolation voltage: $3000V_{DC}$ min
- ☐ High speed response: $t_{PHL}$, $t_{PLH}$ = 300ns typ
- ☐ Compact, dual in-line plastic package
- ☐ Equivalent to 6N135, 6N136

## Applications

- ☐ Interface circuit for various instruments and control equipment
- ☐ Floating power supply feedback networks
- ☐ Computer and peripheral manufacture
- ☐ Pulse transformer
- ☐ High speed digital and analog line receivers

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 5V |
| Forward Current, $I_F$ | 25mA |
| Power Dissipation, $P_D$ | 45mW |
| **Detector** | |
| Supply Voltage, $V_{CC}$ | −0.5V to +15V |
| Output Voltage, $V_O$ | −0.5V to +15V |
| Output Current, $I_O$ | 8mA |
| Emitter to Base Voltage, $V_{EBO}$ | 5V |
| Power Dissipation, $P_D$ | 100mW |
| Isolation Voltage[1], BV | $3000V_{DC}$ |
| Storage Temperature, $T_{STG}$ | −55°C to +125°C |
| Operating Temperature, $T_{OPT}$ | +55°C to +100°C |

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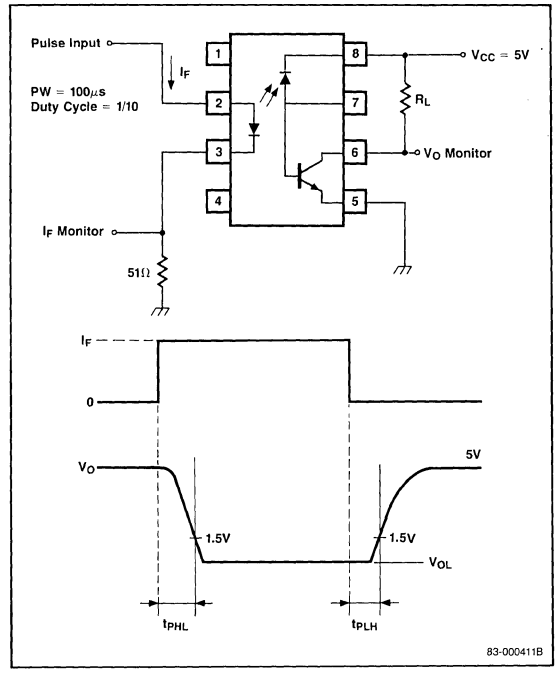
## Electrical Characteristics
$T_A$ = +25°C

| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | 1.43 | 1.7 | V | $I_F$ = 16mA |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 5V |
| Forward Voltage Temperature Coefficient | $\Delta V_F/\Delta T$ | | −1.51 | | mV/°C | $I_F$ = 16mA |
| Capacitance | $C_T$ | | 60 | | pF | V = 0, f = 1MHz |
| **Detector** | | | | | | |
| High Level Output Current | $I_{OH}$[1] | | 3 | 500 | nA | $I_F$ = 0mA, $V_{CC}$ = $V_O$ = 5.5V |
| High Level Output Current | $I_{OH}$[2] | | | 100 | μA | $I_F$ = 00mA, $V_{CC}$ = $V_O$ = 15V |
| DC Current Gain | $h_{FE}$ | | 120 | | | $V_O$ = 5V, $I_O$ = 3mA |
| **Coupled** | | | | | | |
| Current Transfer Ratio | CTR | 15/7 | 22 | | % | $I_F$ = 16mA, $V_{CC}$ = 4.5V $V_O$ = 0.4V |
| Low Level Output Voltage | $V_{OL}$ | | 0.1 | 0.4 | V | $I_F$ = 16mA, $V_{CC}$ = 4.5V $I_O$ = 2.4mA/ 1.1mA |
| Low Level Supply Current | $I_{CCL}$ | | 50 | | μA | $I_F$ = 16mA, $V_O$ = Open, $V_{CC}$ = 15V |
| High Level Supply Current | $I_{CCH}$ | | 0.01 | 1 | μA | $I_F$ = 0mA, $V_O$ = Open, $V_{CC}$ = 15V |
| Isolation Resistance | $R_{I-2}$ | | $10^{12}$ | | Ω | $V_{IN-OUT}$ = 1kV |
| Isolation Capacitance | $C_{I-2}$ | | 0.7 | | pF | V = 0, f = 1MHz |
| Propagation Delay Time to Low Output Level | $t_{PHL}$[2] | | 0.3/ 0.5 | 0.8/ 1.5 | μs | $I_F$ = 16mA, $V_{CC}$ = 5V $R_L$ = 1.9kΩ/ 4.1kΩ |
| Propagation Delay Time to High Output Level | $t_{PLH}$[2] | | 0.3/ 0.8 | 0.8/ 1.5 | μs | $I_F$ = 16mA, $V_{CC}$ = 5V $R_L$ = 1.9kΩ/ 4.1kΩ |

**Notes:** In the "Min", "Typ" and "Max" columns, figures to the left and right of the slash represent values for the PS2006B and PS2006B(1), respectively.

1. Measuring Conditions: DC voltage for 1 min at $T_A$ = +25°C, RH = 60% between input (pins 1, 2, 3, and 4 common) and output (pins 5, 6, 7, and 8 common).
2. Measuring Circuit.

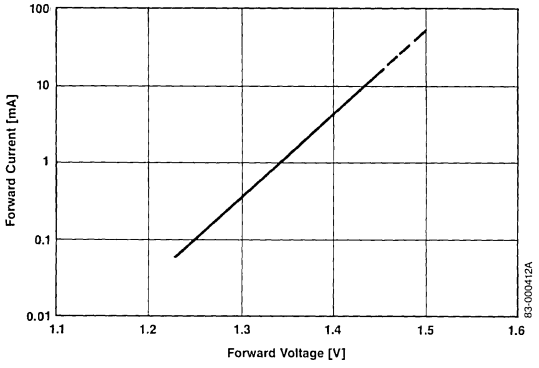
### *Measuring circuit*



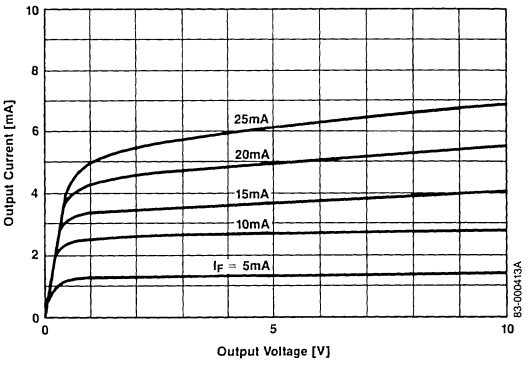
## Typical Characteristics

$T_A$ = +25°C

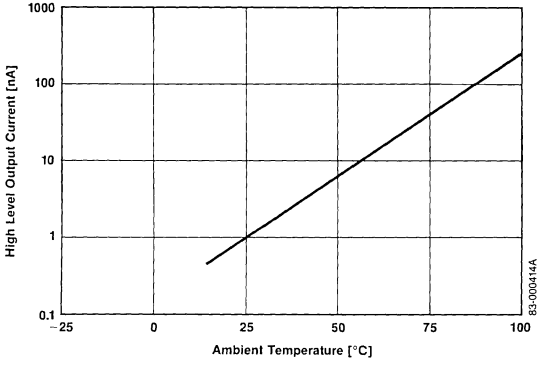
Forward Current vs Forward Voltage



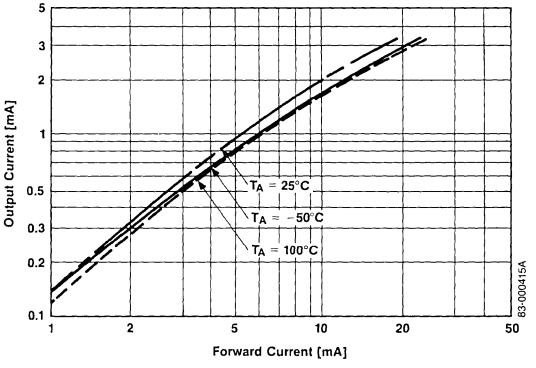

Output Current vs Output Voltage



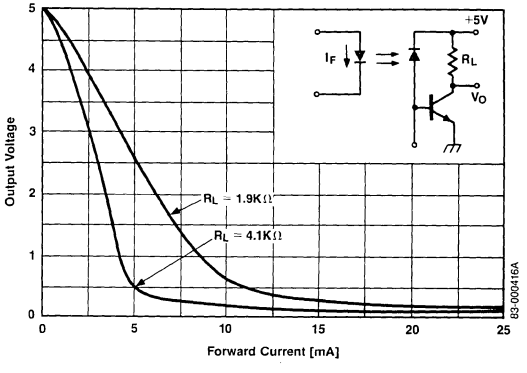

High Level Output Current vs Ambient Temperature



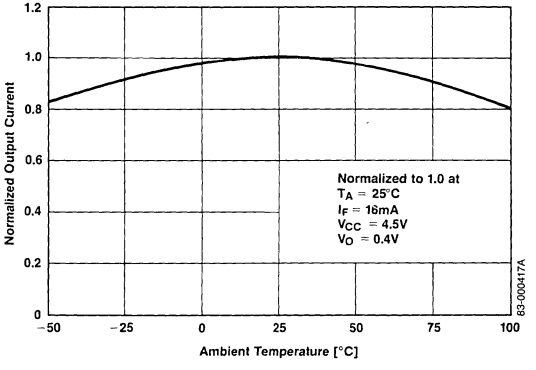

Output Current vs Forward Current




Output Voltage vs Forward Current




Normalized Output Current vs Ambient Temperature

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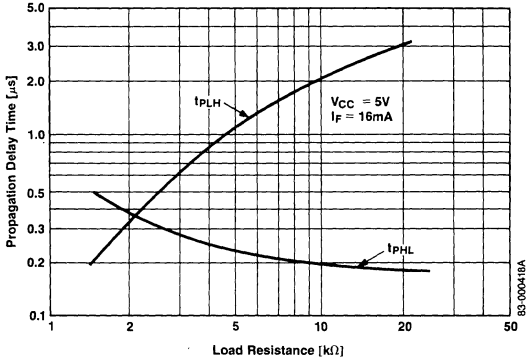
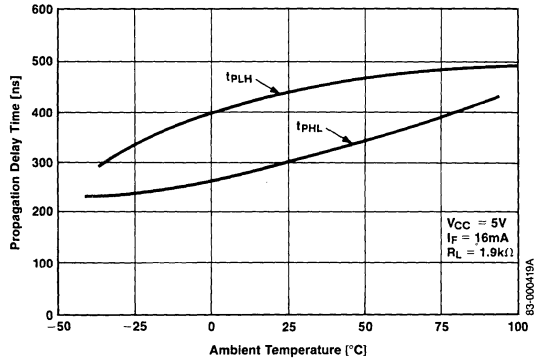
## Typical Characteristics (cont)

$T_A$ = +25°C

Propagation Delay Time vs Load Resistance




Propagation Delay Time vs Ambient Temperature



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# PS2007B
# HIGH SPEED
# PHOTO COUPLER
*NEPOC SERIES*

## Description

The PS2007B is a high speed photo coupler containing a GaAsP light emitting diode and an integrated detector consisting of a photo diode and a high gain linear amplifier that drives a Schottky clamped open collector output transistor in a plastic DIP (Dual In-line Package).

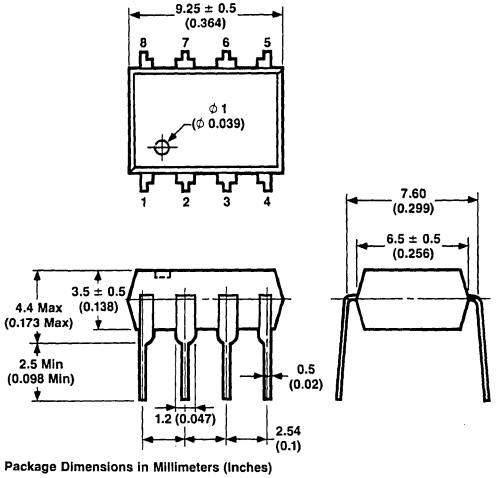
## Features

- ☐ Ultra high speed: 50ns typ
- ☐ High isolation voltage: 3000$V_{DC}$ min
- ☐ Low input current requirement: 5mA
- ☐ Economical, compact, plastic dual in-line package
- ☐ TTL compatible: 5V supply
- ☐ Equivalent to 6N137

## Applications

- ☐ Line receivers
- ☐ Floating power supplies
- ☐ Computer and peripheral memory
- ☐ Replacement for mechanical and reed relays
- ☐ Replacement for pulse transformers

## Package Dimensions




Package Dimensions in Millimeters (Inches)

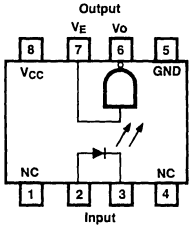
83-000420A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 5V |
| Forward Current, $I_F$ | 10mA |
| **Detector** | |
| Supply Voltage, $V_{CC}$ | 7V |
| Output Voltage, $V_O$ | 7V |
| Output Current, $I_O$ | 50mA |
| Enable Voltage, $V_E$ | 5.5V |
| Power Dissipation, $P_D$ | 85mW |
| Isolation Voltage, BV[1] | 3000$V_{DC}$ |
| Storage Temperature, $T_{STG}$ | −55°C to +125°C |
| Operating Temperature, $T_{OPT}$ | 0°C to +70°C |

## Pin Connection




| PIN | | Function |
|---|---|---|
| Input | 1. | NC |
| | 2. | Anode |
| | 3. | Cathode |
| | 4. | NC |
| Output | 5. | GND |
| | 6. | $V_O$ |
| | 7. | $V_E$ |
| | 8. | $V_{CC}$ |

83-000422A

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## Electrical Characteristics
$T_A$ = 0 to +70°C

| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | 1.42 | 1.7 | V | $I_F$ = 10mA, $T_A$ = +25°C |
| Reverse Current | $I_R$ | | 0.01 | 10 | μA | $V_R$ = 5V, $T_A$ = +25°C |
| Capacitance | $C_T$ | | 60 | | pF | V = 0, f = 1.0MHz |
| **Detector** | | | | | | |
| High Level Enable Current | $I_{EH}$ | | −0.8 | | mA | $V_{CC}$ = 5.5V, $V_{EH}$ = 2.0V |
| Low Level Enable Current | $I_{EL}$ | | −1.2 | −2.0 | mA | $V_{CC}$ = 5.5V, $V_{EL}$ = 0.5V |
| **Coupled** | | | | | | |
| High Level Output Current | $I_{OH}$ | | 30 | 250 | μA | $V_{CC}$ = 5.5V $V_O$ = 5.5V, $I_F$ = 250μA $V_E$ = 2.0V |
| Low Level Output Voltage | $V_{OL}$ | | 0.4 | 0.6 | V | $V_{CC}$ = 5.5V, $V_E$ = 2.0V $I_F$ = 5mA, $I_O$ = 13mA |
| Low Level Supply Current | $I_{CCL}$ | | 10 | 18 | mA | $V_{CC}$ = 5.5V, $V_E$ = 2V $I_F$ = 10mA |
| High Level Supply Current | $I_{CCH}$ | | 7 | 15 | mA | $V_{CC}$ = 5.5V, $V_E$ = 0.5V $I_F$ = 0mA |

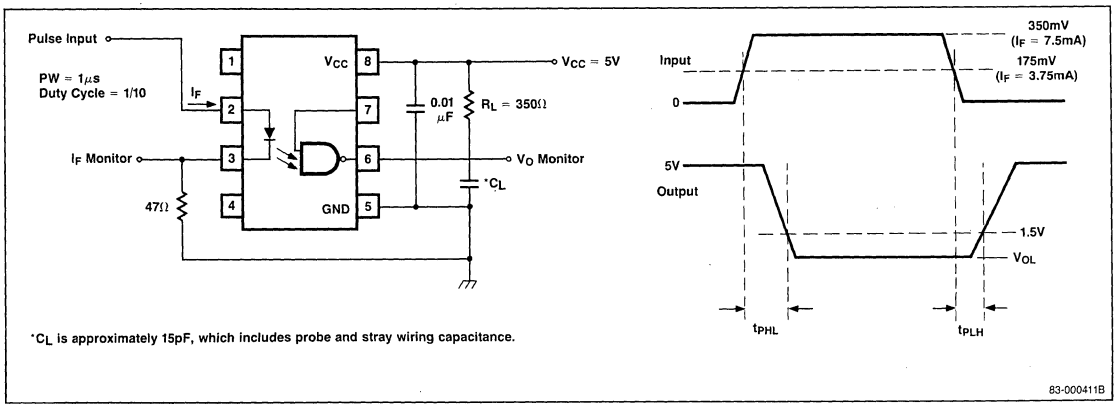
## Electrical Characteristics (cont)
$T_A$ = +25°C

| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Coupled** | | | | | | |
| Current Transfer Ratio | CTR | | 600 | | % | $I_F$ = 5mA, $V_{CC}$ = 5V, $R_L$ = 100Ω |
| Isolation Resistance | $R_{I-2}$ | | $10^{12}$ | | Ω | $V_{IN-OUT}$ = 1kV |
| Isolation Capacitance | $C_{I-2}$ | | 0.7 | | pF | V = 0, f = 1MHz |
| Propagation Delay Time to Low Output Level | $t_{PHL}$[2] | | 50 | 75 | ns | $I_F$ = 7.5mA, $V_{CC}$ = 5V $R_L$ = 350Ω, $C_L$ = 15pF |
| Progation Delay Time to High Output Level | $t_{PLH}$[2] | | 50 | 75 | ns | |
| Propagation Delay Time of Enable to Low Output Level | $t_{EHL}$ | | 15 | | ns | $I_F$ = 7.5mA, $V_{CC}$ = 5V $R_L$ = 350Ω, $V_{EH}$ = 3V $C_L$ = 15pF |
| Propagation Delay Time of Enable to High Output Level | $t_{ELH}$ | | 30 | | ns | |

**Notes:** 1. Test Conditions: DC voltage for 1 min at $T_A$ = +25°C, RH = 60% between input (pins 1, 2, 3, and 4 common) and output (Pins 5, 6, 7, and 8 common).

2. Measuring Circuit.

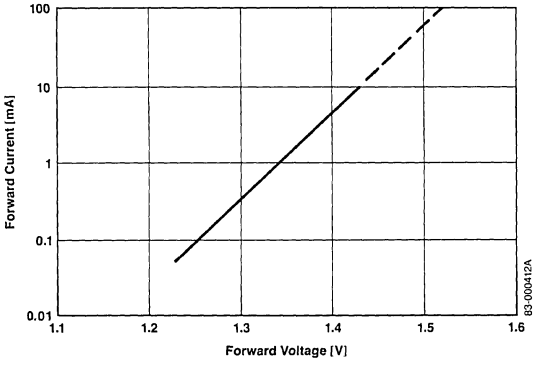
### *Measuring circuit*



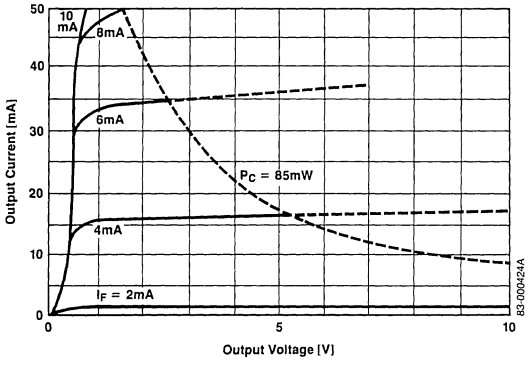
## Typical Characteristics

$T_A$ = +25°C

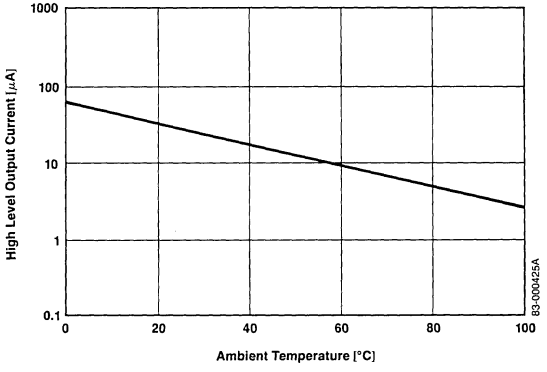
Forward Current vs Forward Voltage



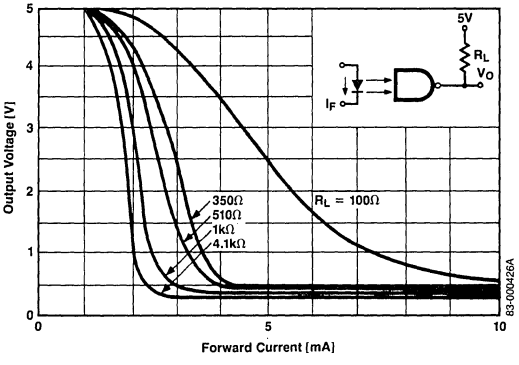

Output Current vs Output Voltage



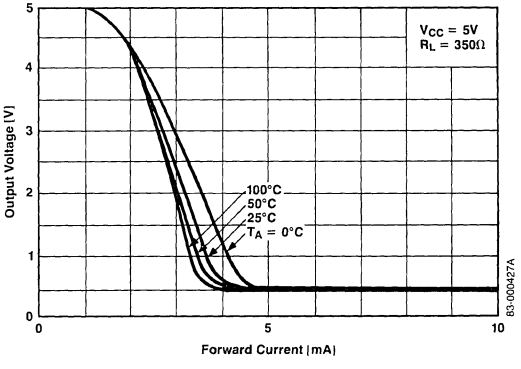

High Level Output Current vs Ambient Temperature



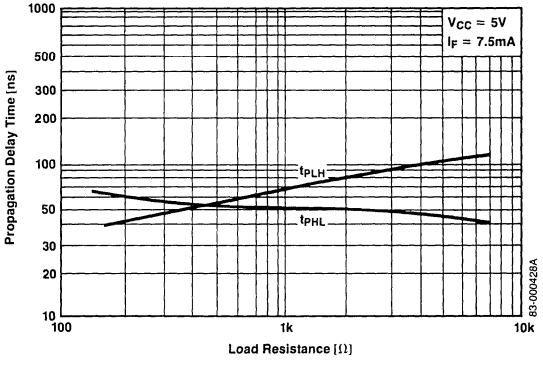

Output Voltage vs Forward Current




Output Voltage vs Forward Current




Propagation Delay Time vs Load Resistance

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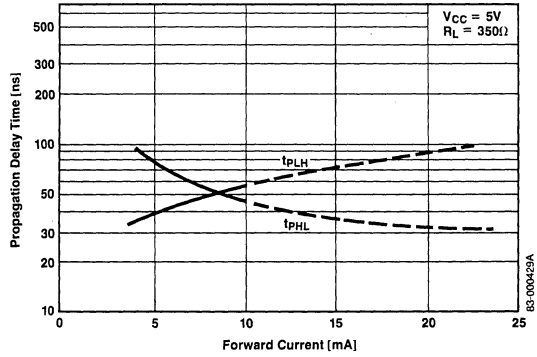
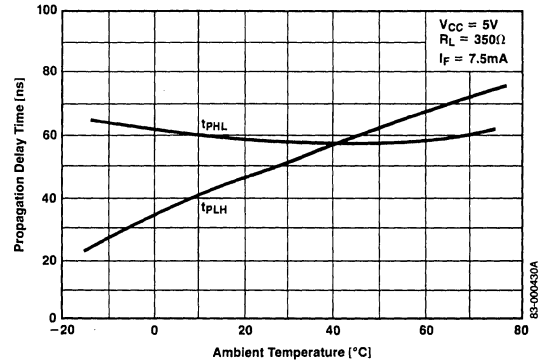
## Typical Characteristics (cont)

$T_A = +25°C$

Propagation Delay Time vs Forward Current




Propagation Delay Time vs Ambient Temperature



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# PS2010
# PHOTO COUPLER
# SINGLE TRANSISTOR

*NEPOC SERIES*

## Description

The PS2010 is an optically coupled isolator containing a GaAs light emitting diode and an NPN silicon photo transistor. Compatible with MCT2, H11A1-H11A5 and 4N25-4N28.

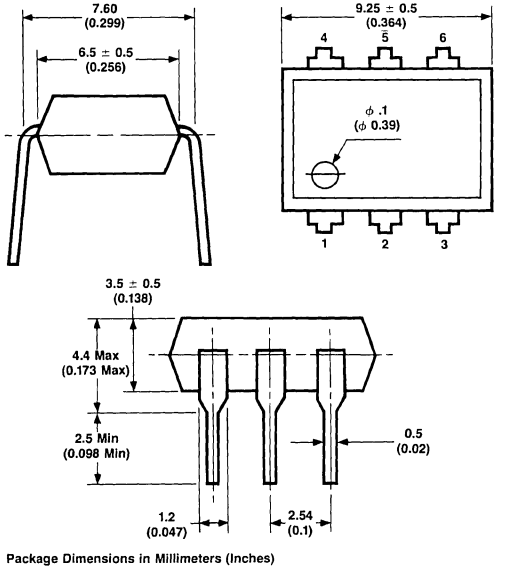
## Features

- ☐ High isolation voltage: $2000V_{AC}$
- ☐ High transfer ratio: 20% min
- ☐ High speed switching: $t_r$, $t_f$ = 4$\mu$s typ
- ☐ Economical, compact, dual in-line plastic package

## Applications

- ☐ Interface circuit for various instruments and control equipment
- ☐ Chopper circuits
- ☐ Computer and peripheral manufacture
- ☐ Pulse transformers
- ☐ Data communication equipment

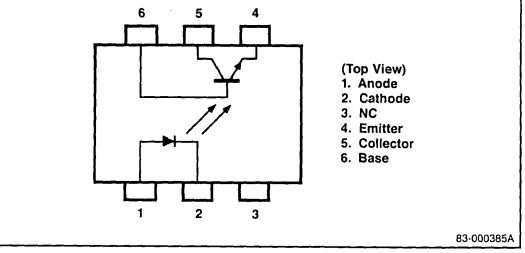
## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000421A

## Pin Connection




83-000385A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 5.0V |
| Forward Current (DC), $I_F$ | 80mA |
| Power Dissipation, $P_D$ | 150mW |
| Peak Forward Current (300$\mu$s, 2% duty cycle), $I_{F\ (peak)}$ | 3A |
| **Transistor** | |
| Collector to Emitter Voltage, $V_{CEO}$ | 30V |
| Collector to Base Voltage, $V_{CBO}$ | 70V |
| Emitter to Collector Voltage, $V_{ECO}$ | 7V |
| Collector Current, $I_C$ | 100mA |
| Power Dissipation, $P_D$ | 150mW |
| Isolation Voltage[1], BV | $2500V_{DC}$ |
| Isolation Voltage[1], BV | $2000V_{AC}$ |
| Storage Temperature, $T_{STG}$ | −55°C to +150°C |
| Operating Temperature, $T_{OPT}$ | −55°C to +100°C |
| Lead Temperature (Soldering 10s) | 260°C |
| Total Power Dissipation, $P_T$ | 250mW |

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## Electrical Characteristics
$T_A$ = +25°C

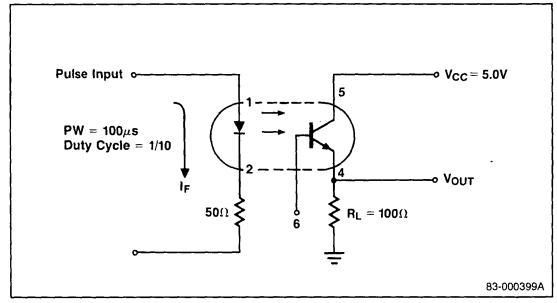
| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | 1.1 | 1.4 | V | $I_F$ = 10mA |
| Forward Voltage | $V_F$ | | 1.2 | 1.5 | V | $I_F$ = 50mA |
| Reverse Current | $I_R$ | | | 10 | μA | $V_R$ = 5V |
| Junction Capacitance | C | | 50 | | pF | V = 0, f = 1.0MHz |
| **Transistor** | | | | | | |
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 50 | nA | $V_{CE}$ = 10V, $I_F$ = 0 |
| DC Current Gain | $h_{FE}$ | | 700 | | | $I_C$ = 2mA, $V_{CE}$ = 5.0V |
| Collector to Emitter Breakdown Voltage | $BV_{CEO}$ | 30 | 60 | | V | $I_C$ = 1mA, $I_B$ = 0 |
| Collector to Base Breakdown Voltage | $BV_{CBO}$ | 70 | 120 | | V | $I_C$ = 100μA, $I_E$ = 0 |
| Emitter to Collector Breakdown Voltage | $BV_{ECO}$ | 7 | 9 | | V | $I_E$ = 100μA, $I_B$ = 0 |
| **Coupled** | | | | | | |
| Current Transfer Ratio[2] | CTR ($I_C/I_F$) | 20 | | | % | $I_F$ = 10mA, $V_{CE}$ = 5.0V |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | | 0.3 | V | $I_F$ = 10mA, $I_C$ = 2.0mA |
| Isolation Resistance | $R_{1-2}$ | $10^{11}$ | | | Ω | $V_{IN-OUT}$ = 1.0kV |
| Isolation Capacitance | $C_{1-2}$ | | 0.8 | | pF | V = 0, f = 1.0MHz |
| Rise Time[3] | $t_R$ | | 4 | | μs | $V_{CC}$ = 5.0V, $I_C$ = 2mA, $R_L$ = 100Ω |
| Fall Time[3] | $t_F$ | | 4 | | μs | $V_{CC}$ = 5.0V, $I_C$ = 2mA, $R_L$ = 100Ω |

**Notes:** 1. Measuring Conditions: DC or AC voltage for 1 min at $T_A$ = +25°C, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).

2. CTR rank: K: 80%~210%, L: 50%~110%, M: 20%~70%.

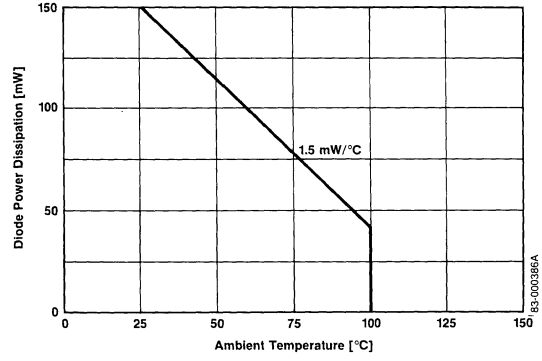
3. Test circuit for switching time.

*Test circuit for switching time*

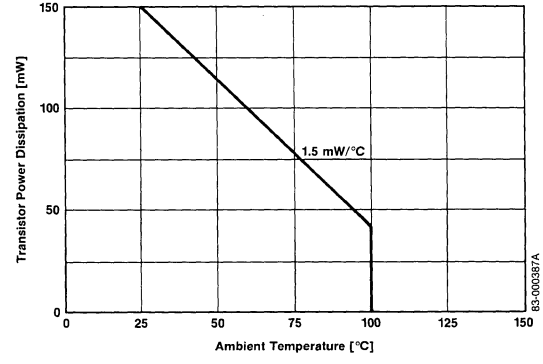



## Typical Characteristics
$T_A$ = +25°C

Diode Power Dissipation vs Ambient Temperature



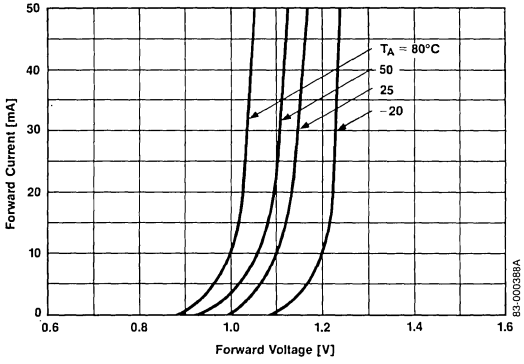

Transistor Power Dissipation vs Ambient Temperature



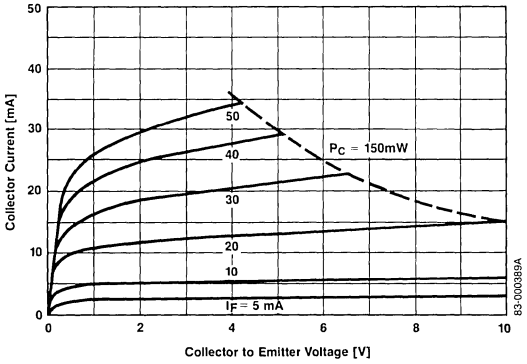
## Typical Characteristics (cont)

$T_A$ = +25°C

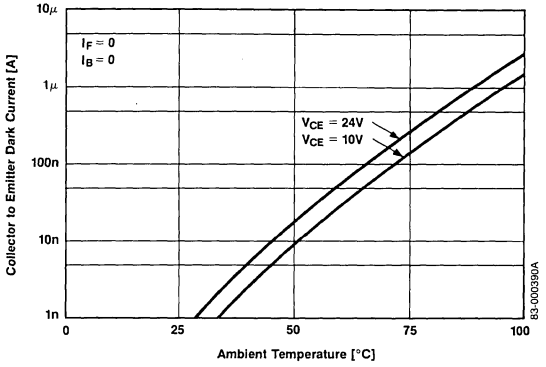
Forward Current vs Forward Voltage



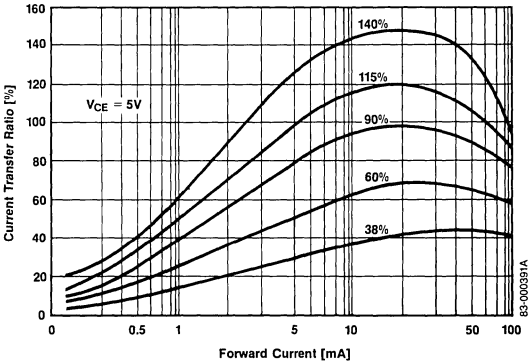

Collector Current vs Collector to Emitter Voltage



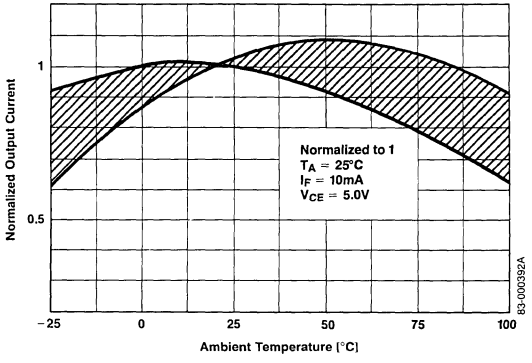

Collector to Emitter Dark Current vs Ambient Temperature



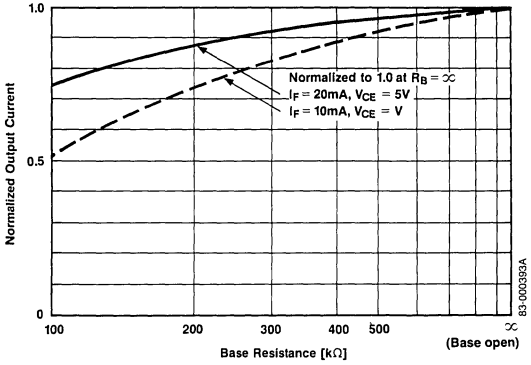

Current Transfer Ratio vs Forward Current




Normalized Output Current vs Ambient Temperature




Normalized Output Current vs Base Resistance

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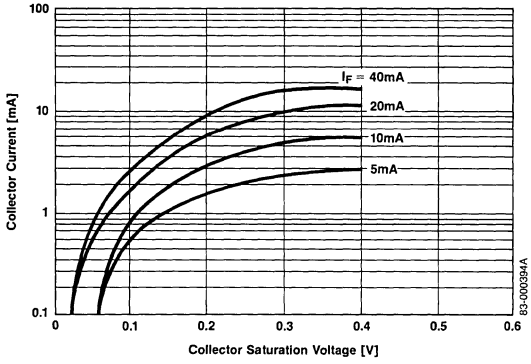
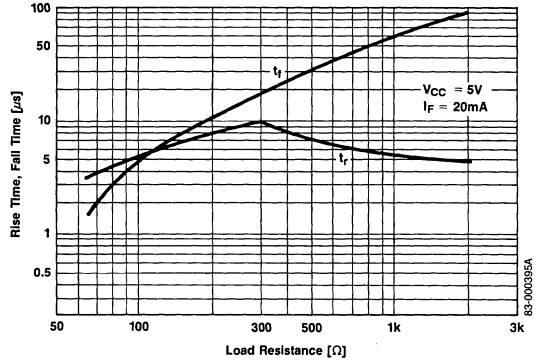
## Typical Characteristics (cont)

$T_A$ = +25°C

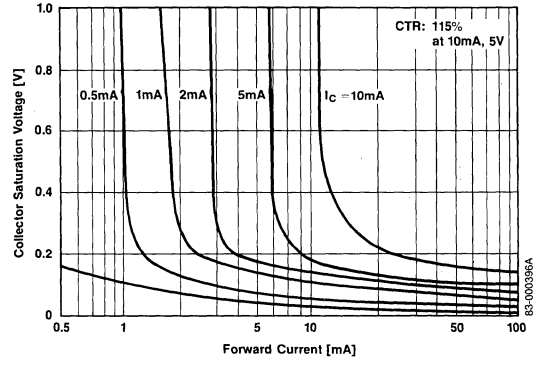
Collector Current vs Collector Saturation Voltage



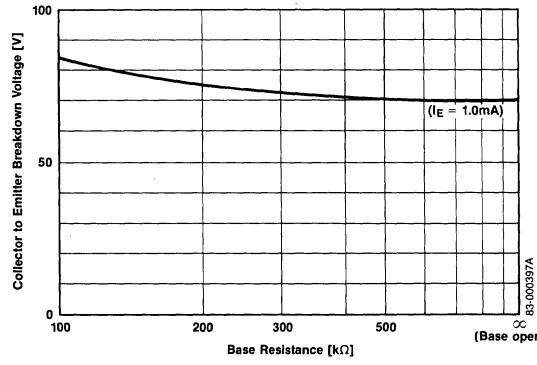

Switching Time vs Load Resistance



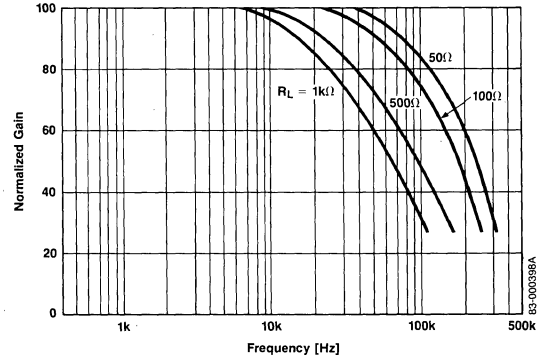

Saturation Voltage vs Forward Current




Collector to Emitter Breakdown Voltage vs Base Resistance




Frequency Response



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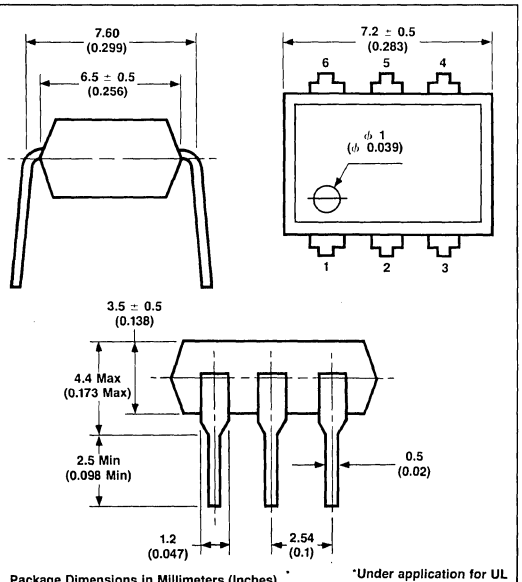
# PS2021
# PHOTO COUPLER
# HIGH ISOLATION VOLTAGE
# SINGLE TRANSISTOR

*NEPOC SERIES*

## Description

The PS2021 is an optically coupled isolator containing a GaAs light emitting diode and an NPN silicon photo transistor.

## Package Dimensions

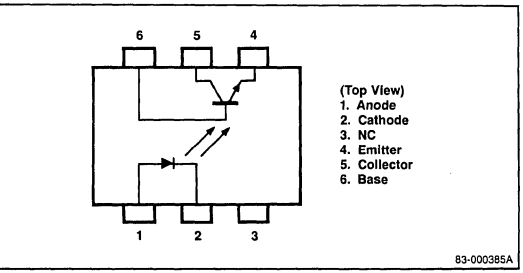



Package Dimensions in Millimeters (Inches)

*Under application for UL

83-000557A

## Pin Connection




83-000385A

## Features

- ☐ Small package: 7.2 × 6.5 × 3.5mm
- ☐ High isolation voltage: 4000$V_{AC}$ rating
- ☐ High transfer ratio: 50% min
- ☐ High speed switching: $t_r$, $t_f$ = 3$\mu$s typ
- ☐ Economical, compact, dual in-line plastic package

## Applications

- ☐ Interface circuit for various instruments and control equipment
- ☐ Chopper circuits
- ☐ Computer and peripheral manufacture
- ☐ Pulse transformers
- ☐ Data communication equipment

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 5.0V |
| Forward Current (DC), $I_F$ | 80mA |
| Power Dissipation, $P_D$ | 150mW |
| Peak Forward Current(300$\mu$s, 2% duty cycle), $I_{F\ (peak)}$ | 3A |
| **Transistor** | |
| Collector to Emitter Voltage, $V_{CEO}$ | 40V |
| Collector to Base Voltage, $V_{CBO}$ | 70V |
| Emitter to Collector Voltage, $V_{ECO}$ | 7V |
| Collector Current, $I_C$ | 100mA |
| Power Dissipation, $P_D$ | 150mW |
| Isolation Voltage[1], BV | 4000$V_{AC}$ |
| Storage Temperature, $T_{STG}$ | −55°C to +150°C |
| Operating Temperature, $T_{OPT}$ | −55°C to +100°C |
| Lead Temperature (Soldering 10s) | 260°C |
| Total Power Dissipation, $P_T$ | 250mW |

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## Electrical Characteristics
$T_A$ = +25°C

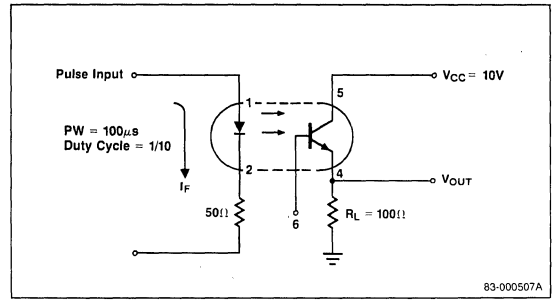
| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | 1.1 | 1.4 | V | $I_F$ = 10mA |
| Forward Voltage | $V_F$ | | 1.2 | 1.5 | V | $I_F$ = 50mA |
| Reverse Current | $I_R$ | | | 10 | μA | $V_R$ = 5V |
| Junction Capacitance | C | | 50 | | pF | V = 0, f = 1.0MHz |
| **Transistor** | | | | | | |
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 50 | nA | $V_{CE}$ = 10V, $I_F$ = 0 |
| DC Current Gain | $h_{FE}$ | | 700 | | | $I_C$ = 2mA, $V_{CE}$ = 5.0V |
| Collector to Emitter Breakdown Voltage | $BV_{CEO}$ | 40 | 60 | | V | $I_C$ = 1mA, $I_B$ = 0 |
| Collector to Base Breakdown Voltage | $BV_{CBO}$ | 70 | 120 | | V | $I_C$ = 100μA, $I_E$ = 0 |
| Emitter to Collector Breakdown Voltage | $BV_{ECO}$ | 7 | 9 | | V | $I_E$ = 100μA, $I_B$ = 0 |
| **Coupled** | | | | | | |
| Current Transfer Ratio[2] | CTR ($I_C/I_F$) | 50 | | | % | $I_F$ = 10mA, $V_{CE}$ = 5.0V |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | | 0.3 | V | $I_F$ = 10mA, $I_C$ = 2.0mA |
| Isolation Resistance | $R_{1-2}$ | $10^{11}$ | | | Ω | $V_{IN-OUT}$ = 1.0kV |
| Isolation Capacitance | $C_{1-2}$ | | 0.5 | | pF | V = 0, f = 1.0MHz |
| Rise Time[3] | $t_r$ | | 3 | | μs | $V_{CC}$ = 10V, $I_C$ = 2mA, $R_L$ = 100Ω |
| Fall Time[3] | $t_f$ | | 3 | | μs | $V_{CC}$ = 10V, $I_C$ = 2mA, $R_L$ = 100Ω |

**Notes:** 1. Measuring Conditions: DC or AC voltage for 1 min at $T_A$ = +25°C, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).

2. CTR rank: K: 150%~300%, L: 90%~180%, M: 50%~110%.

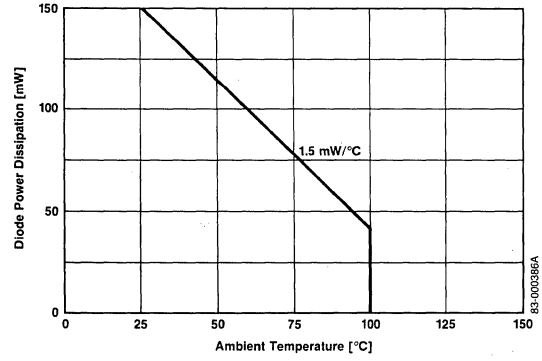
3. Test circuit for switching time.

### *Test circuit for switching time*

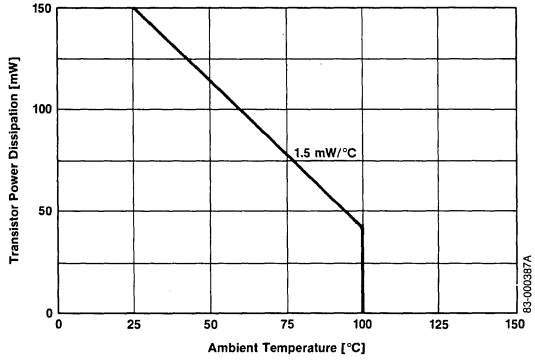



## Typical Characteristics
$T_A$ = +25°C

Diode Power Dissipation vs Ambient Temperature



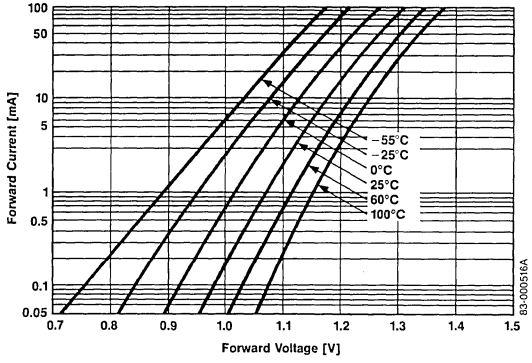

Transistor Power Dissipation vs Ambient Temperature



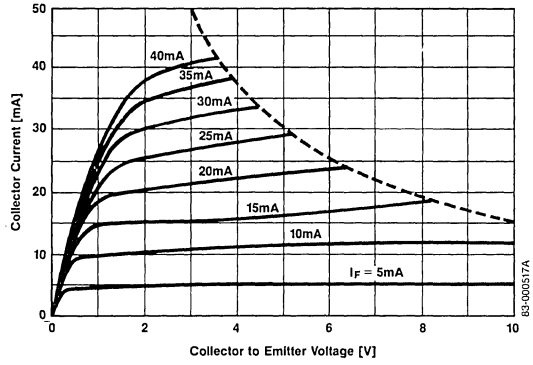
## Typical Characteristics (cont)

$T_A = +25°C$

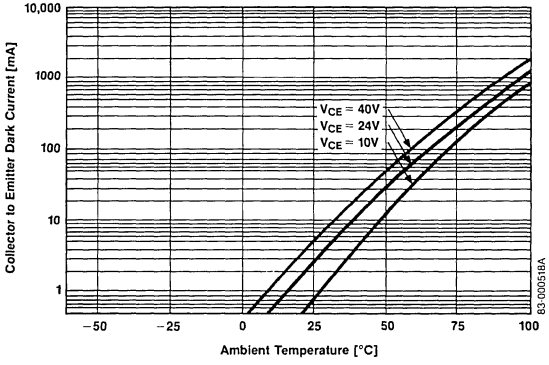
Forward Current vs Forward Voltage



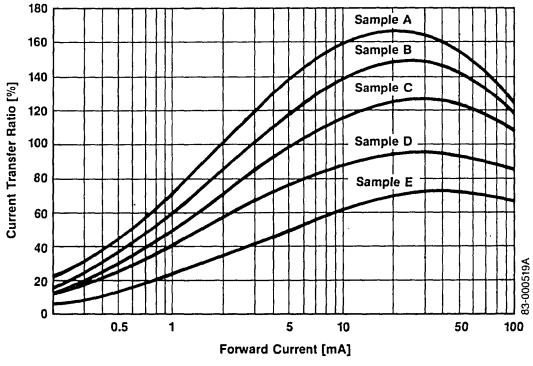

Collector Current vs Collector to Emitter Voltage



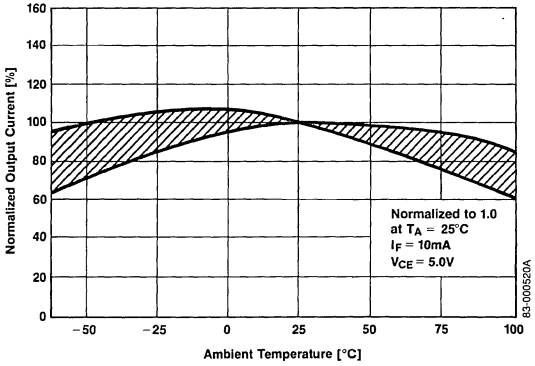

Collector to Emitter Dark Current vs Ambient Temperature



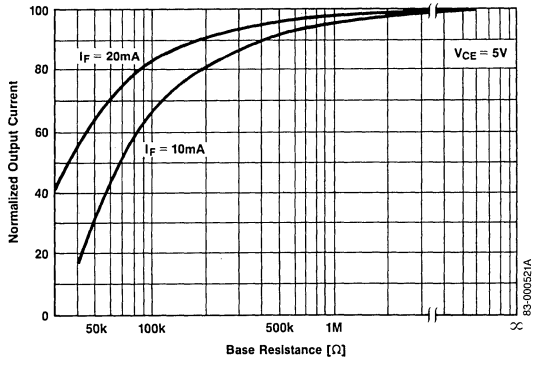

Current Transfer Ratio vs Forward Current




Normalized Output Current vs Ambient Temperature




Normalized Output Current vs Base Resistance (Typical)

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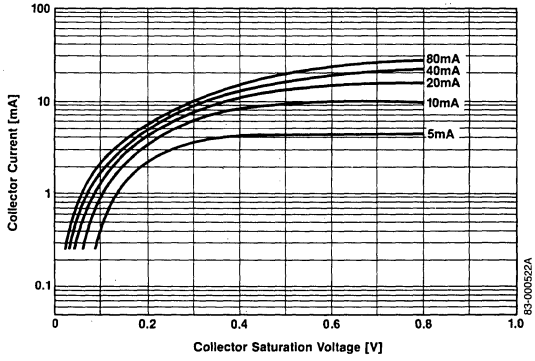
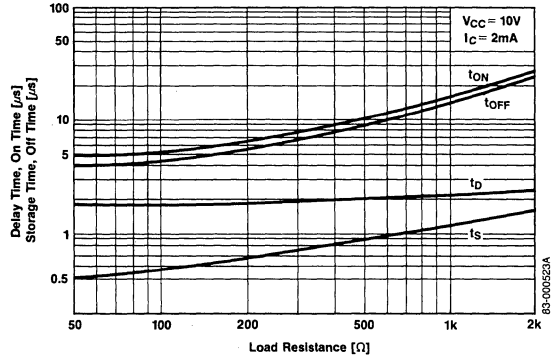
## Typical Characteristics (cont)

$T_A = +25°C$

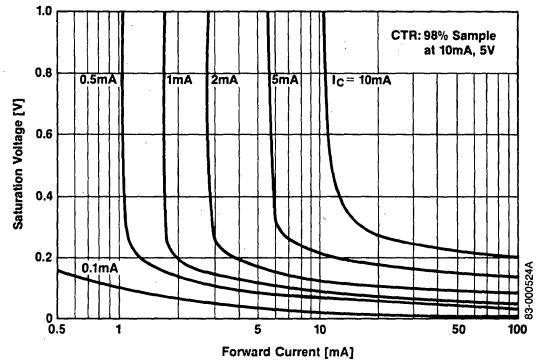
Collector Current vs Collector Saturation Voltage



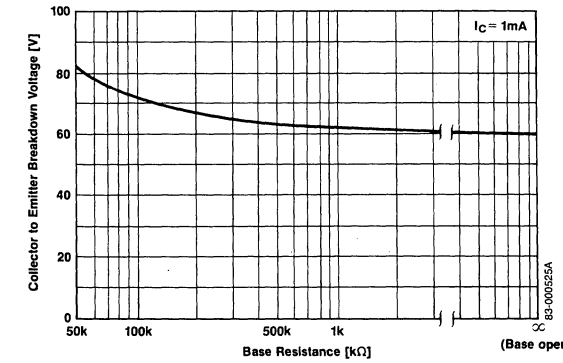

Switching Time vs Load Resistance



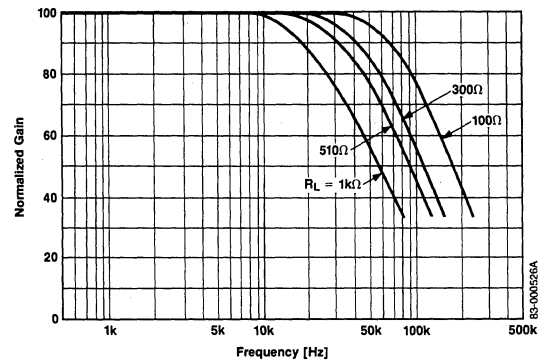

Saturation Voltage vs Forward Current




Collector to Emitter Breakdown Voltage vs Base Resistance




Frequency Response



NEC Electronics Inc.

# PS2022
# PHOTO COUPLER
# HIGH ISOLATION VOLTAGE
# DARLINGTON TRANSISTOR

*NEPOC SERIES*

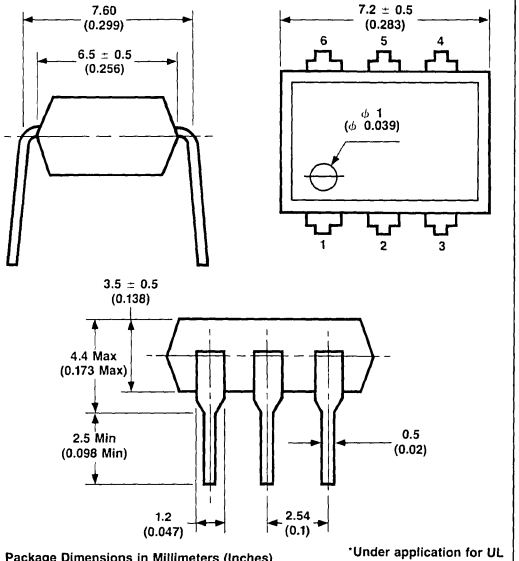
## Description

The PS2022 is an optically coupled isolator containing a GaAs light emitting diode and an NPN silicon Darlington-connected photo transistor.

## Features

- ☐ Small package: 7.2 × 6.5 × 3.5mm
- ☐ High isolation voltage: 4000$V_{AC}$ rating
- ☐ High transfer ratio: 200% min
- ☐ High speed switching: $t_r$, $t_f$ = 80$\mu$s typ
- ☐ Economical, compact, dual in-line plastic package

## Package Dimensions

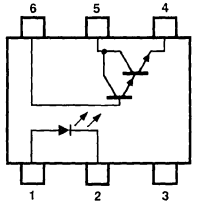



Package Dimensions in Millimeters (Inches)

*Under application for UL

83-000557A

## Pin Connection




1. Anode
2. Cathode
3. NC
4. Emitter
5. Collector
6. Base

83-000400A

## Applications

- ☐ Interface circuit for various instruments and control equipment
- ☐ Chopper circuits
- ☐ Computer and peripheral manufacture
- ☐ Pulse transformers
- ☐ Data communication equipment

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 5.0V |
| Forward Current (DC), $I_F$ | 80mA |
| Power Dissipation, $P_D$ | 150mW |
| Peak Forward Current (300$\mu$s, 2% duty cycle), $I_{F\ (peak)}$ | 3A |
| **Transistor** | |
| Collector to Emitter Voltage, $V_{CEO}$ | 40V |
| Collector to Base Voltage, $V_{CBO}$ | 40V |
| Emitter to Collector Voltage, $V_{ECO}$ | 7V |
| Collector Current, $I_C$ | 100mA |
| Power Dissipation, $P_D$ | 150mW |
| Isolation Voltage[1], BV | 4000$V_{AC}$ |
| Storage Temperature, $T_{STG}$ | −55°C to +150°C |
| Operating Temperature, $T_{OPT}$ | −55°C to +100°C |
| Lead Temperature (Soldering 10s) | 260°C |
| Total Power Dissipation, $P_T$ | 250mW |

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## Electrical Characteristics
$T_A$ = +25°C

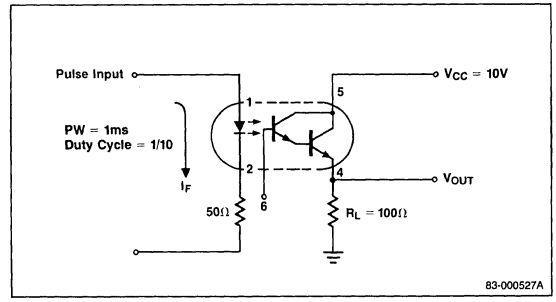
| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | 1.1 | 1.4 | V | $I_F$ = 10mA |
| Forward Voltage | $V_F$ | | 1.2 | 1.5 | V | $I_F$ = 50mA |
| Reverse Current | $I_R$ | | | 10 | μA | $V_R$ = 5V |
| Junction Capacitance | C | | 50 | | pF | V = 0, f = 1.0MHz |
| **Transistor** | | | | | | |
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 100 | nA | $V_{CE}$ = 10V, $I_F$ = 0 |
| DC Current Gain | $h_{FE}$ | | | | | $I_C$ = 0.5mA, $V_{CE}$ = 5.0V |
| Collector to Emitter Breakdown Voltage | $BV_{CEO}$ | 40 | 60 | | V | $I_C$ = 1mA, $I_B$ = 0 |
| Collector to Base Breakdown Voltage | $BV_{CBO}$ | 40 | 90 | | V | $I_C$ = 100μA, $I_E$ = 0 |
| Emitter to Collector Breakdown Voltage | $BV_{ECO}$ | 7 | 9 | | V | $I_E$ = 100μA, $I_B$ = 0 |
| **Coupled** | | | | | | |
| Current Transfer Ratio[2] | CTR ($I_C/I_F$) | 200 | | | % | $I_F$ = 10mA, $V_{CE}$ = 5.0V |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | | 1.0 | V | $I_F$ = 5mA, $I_C$ = 2.0mA |
| Isolation Resistance | $R_{1-2}$ | $10^{11}$ | | | Ω | $V_{IN-OUT}$ = 1.0kV |
| Isolation Capacitance | $C_{1-2}$ | | 0.5 | | pF | V = 0, f = 1.0MHz |
| Rise Time[3] | $t_R$ | | 80 | | μs | $V_{CC}$ = 10V, $I_C$ = 50mA, $R_L$ = 100Ω |
| Fall Time[3] | $t_F$ | | 80 | | μs | $V_{CC}$ = 10V, $I_C$ = 50mA, $R_L$ = 100Ω |

**Notes:** 1. Measuring Conditions: DC or AC voltage for 1 min at $T_A$ = +25°C, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).

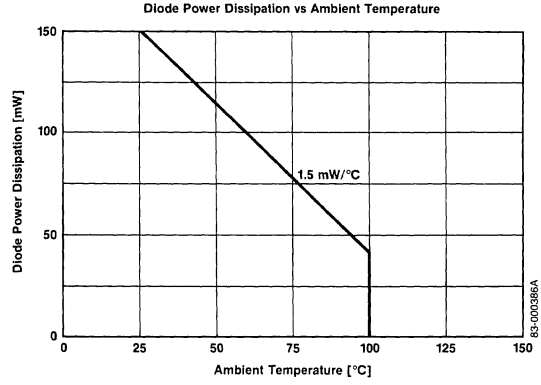
2. CTR rank: K: ~ 900%, L: ~ 500%, M: ~ 200%.

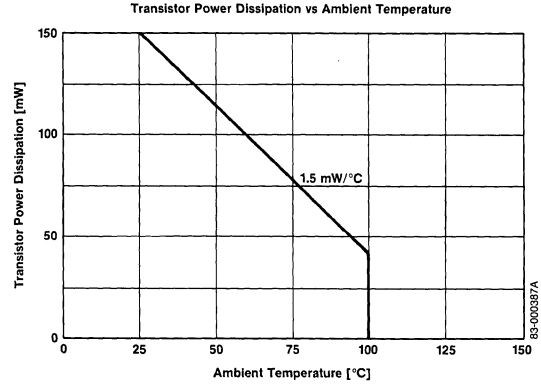
3. Test circuit for switching time.

*Test circuit for switching time*




## Typical Characteristics
$T_A$ = +25°C

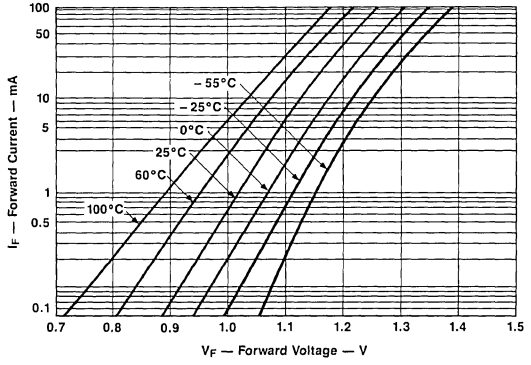


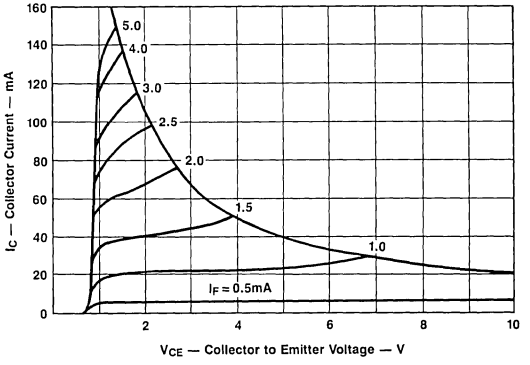
## Typical Characteristics (cont)

$T_A$ = +25°C

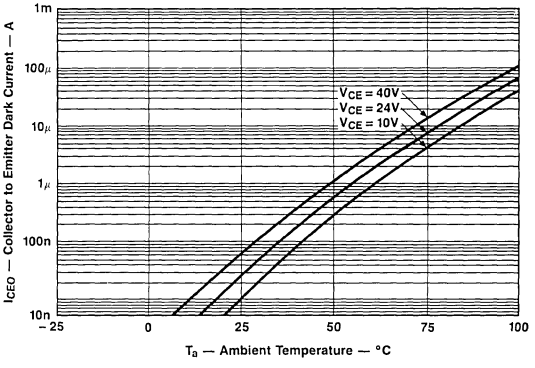
Forward Current vs Forward Voltage



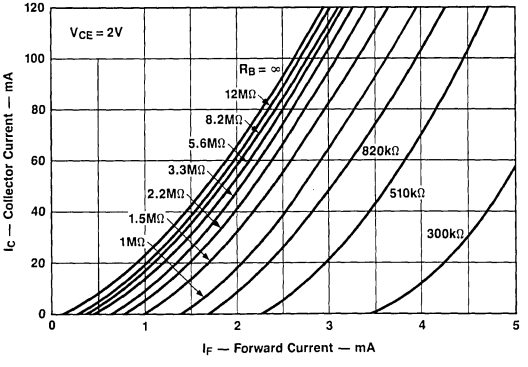

Collector Current vs Collector to Emitter Voltage



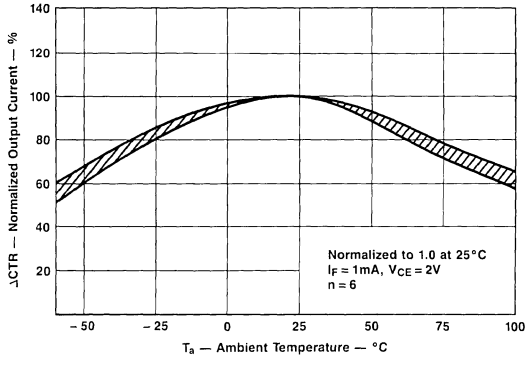

Collector to Emitter Dark Current vs Ambient Temperature



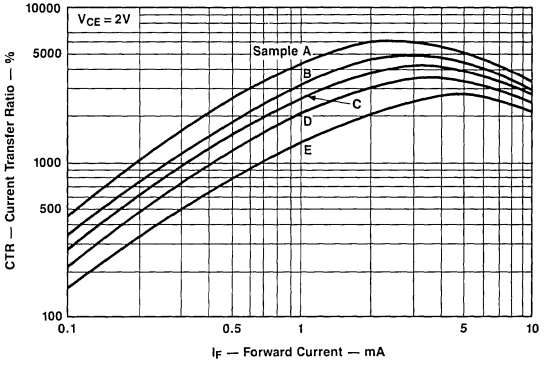

Collector Current vs Forward Current




Normalized Output Current vs Ambient Temperature




Current Transfer Ratio vs Forward Current

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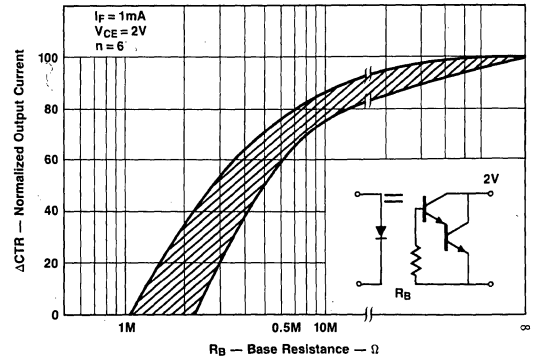
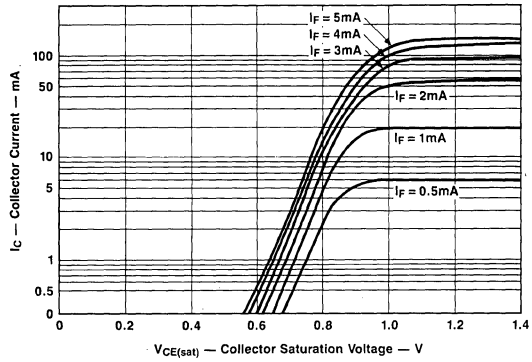
## Typical Characteristics (cont)

$T_A$ = +25°C

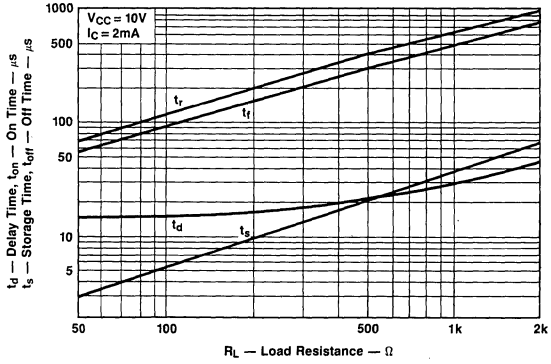
Normalized Output Current vs Base Resistance (Typical)




Collector Current vs Collector Saturation Voltage




Switching Time vs Load Resistance



NEC Electronics Inc.

# PS2401A-1/-2/-3/-4
# MULTICHANNEL PHOTO COUPLER
# HIGH ISOLATION VOLTAGE
# SINGLE TRANSISTORS

*NEPOC SERIES*

## Description

The PS2401A-1, -2, -3, and -4 series are optically coupled isolators containing a GaAs light emitting diode and an NPN silicon photo transistor. Each is mounted in a dual in-line package.

## Features

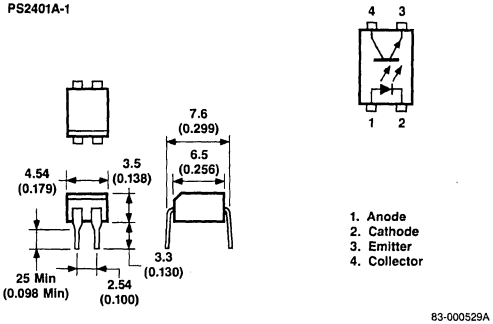
- ☐ Small package size
- ☐ Isolated channels
- ☐ High isolation voltage: 5000$V_{AC}$ rating
- ☐ High transfer ratio: 300 % typ
- ☐ High speed switching: $t_r$, $t_f$ = 3$\mu$s typ
- ☐ Low cost

## Applications

- ☐ Interface circuit for various instrumentations, control equipment
- ☐ AC line digital logic: isolate high voltage transients
- ☐ Digital logic: eliminate spurious ground loops
- ☐ Twisted pair line receiver: eliminate ground loop pick-up
- ☐ Telephone/telegraph line receiver: isolate high voltage transients
- ☐ High frequency power supply: feedback control, maintain floating ground
- ☐ Relay contact monitor: isolate floating grounds and transients
- ☐ Power supply monitor: isolate transients and ground systems

## Package Dimensions

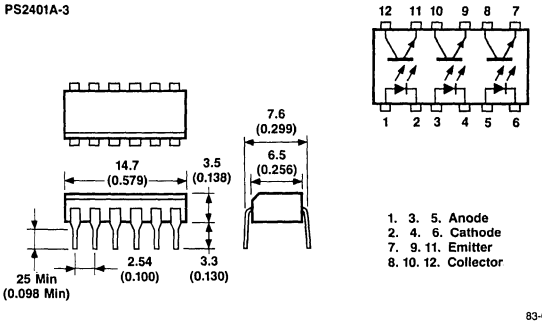
PS2401A-1




1. Anode
2. Cathode
3. Emitter
4. Collector

83-000529A

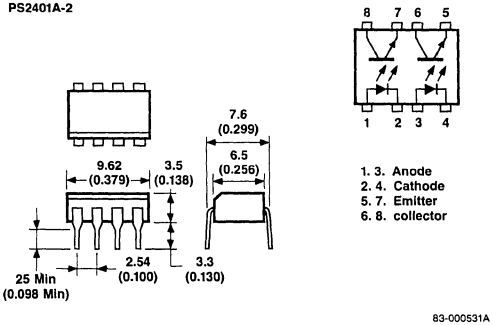
PS2401A-3




1. 3. 5. Anode
2. 4. 6. Cathode
7. 9. 11. Emitter
8. 10. 12. Collector

83-000530A

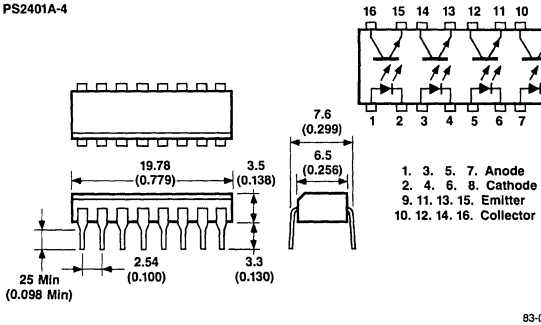
PS2401A-2




1. 3. Anode
2. 4. Cathode
5. 7. Emitter
6. 8. collector

83-000531A

PS2401A-4




1. 3. 5. 7. Anode
2. 4. 6. 8. Cathode
9. 11. 13. 15. Emitter
10. 12. 14. 16. Collector

83-000532A

5

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

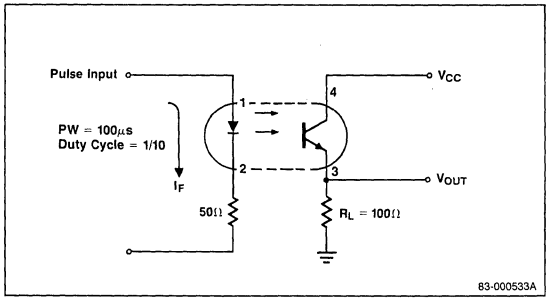
| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 6.0V |
| Forward Current (DC), $I_F$ | 80mA |
| Power Dissipation, $P_D$ | 150mW |
| Peak Forward Current (300μs, 2% duty cycle), $I_{F\ (peak)}$ | 3A |
| **Transistor** | |
| Collector to Emitter Voltage, $V_{CEO}$ | 40V |
| Emitter to Collector Voltage, $V_{ECO}$ | 7V |
| Collector Current, $I_C$ | 100mA |
| Power Dissipation, $P_D$ | 150mW |
| Isolation Voltage[1], BV | 5000$V_{AC}$ |
| Storage Temperature, $T_{STG}$ | −55°C to +150°C |
| Operating Temperature, $T_{OPT}$ | −55°C to +100°C |
| Lead Temperature (Soldering 10s), $T_{SOL}$ | 260°C |
| Total Power Dissipation, $P_T$ | 250mW |

**Notes:** 1. Measuring Conditions: AC voltage for 1 min at $T_A$ = +25°C, RH = 60%.

2. CTR rank: (PS2401A-1 only) K: 300% to 600%, L: 200% to 400%, M: 80% to 240%.

3. Test circuit for switching time.

### *Test circuit for switching time*



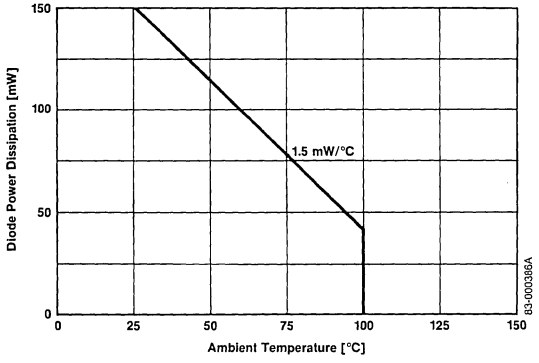

## Electrical Characteristics
$T_A$ = +25°C

| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | 1.1 | 1.4 | V | $I_F$ = 10mA |
| Reverse Current | $I_R$ | | | 5 | μA | $V_R$ = 5V |
| Junction Capacitance | C | | 50 | | pF | V = 0, f = 1.0MHz |
| **Transistor** | | | | | | |
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 50 | nA | $V_{CE}$ = 10V, $I_F$ = 0 |
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 100 | nA | $V_{CE}$ = 40V, $I_F$ = 0 |
| Collector to Emitter Breakdown Voltage | $BV_{CEO}$ | 40 | 60 | | V | $I_C$ = 1mA, $I_B$ = 0 |
| Emitter to Collector Breakdown Voltage | $BV_{ECO}$ | 7 | 9 | | V | $I_E$ = 100μA, $I_B$ = 0 |
| **Coupled** | | | | | | |
| Current Transfer Ratio[2] | CTR ($I_C/I_F$) | 80 | | 600 | % | $I_F$ = 10mA, $V_{CE}$ = 5.0V |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | | 0.3 | V | $I_F$ = 10mA, $I_C$ = 2.0mA |
| Isolation Resistance | $R_{1-2}$ | $10^{11}$ | | | Ω | $V_{IN-OUT}$ = 1.0kV |
| Isolation Capacitance | $C_{1-2}$ | | 0.5 | | pF | V = 0, f = 1.0MHz |
| Rise Time[3] | $t_r$ | | 3 | | μs | $V_{CC}$ = 10V, $I_C$ = 2mA, $R_L$ = 100Ω |
| Fall Time[3] | $t_f$ | | 3 | | μs | $V_{CC}$ = 10V, $I_C$ = 2mA, $R_L$ = 100Ω |

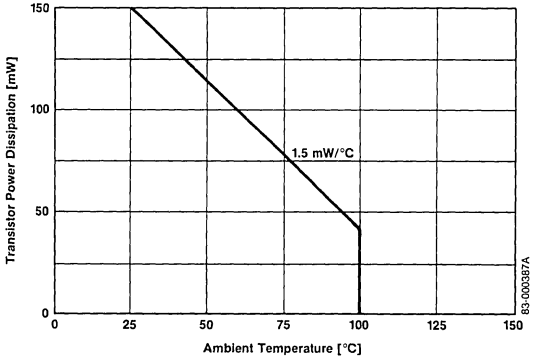
## Typical Characteristics

$T_A$ = +25°C

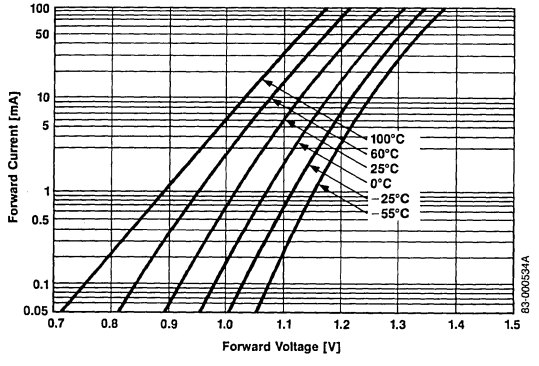
Diode Power Dissipation vs Ambient Temperature



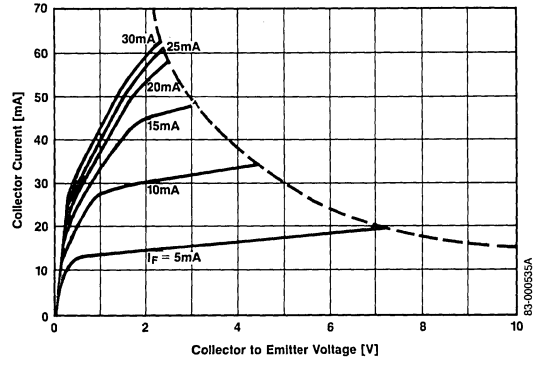

Transistor Power Dissipation vs Ambient Temperature



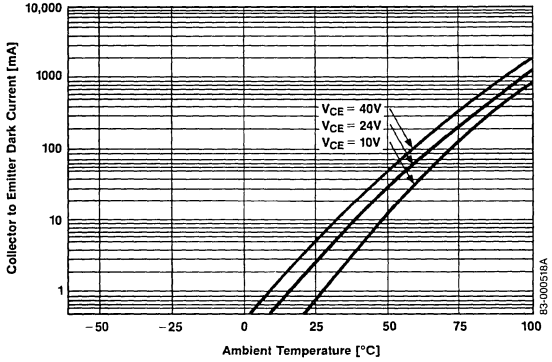

Forward Current vs Forward Voltage



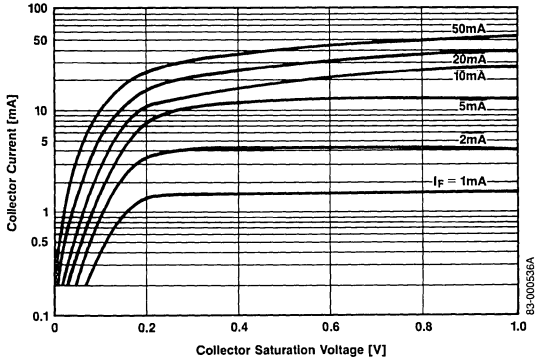

Collector Current vs Collector to Emitter Voltage




Collector to Emitter Dark Current vs Ambient Temperature




Collector Current vs Collector Saturation Voltage

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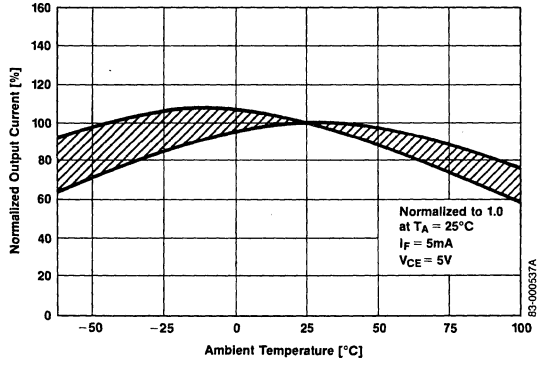
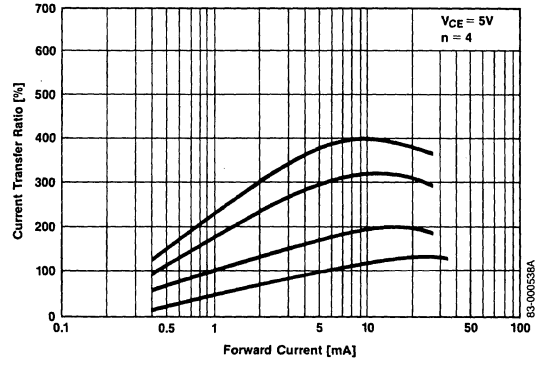
## Typical Characteristics (cont)

$T_A$ = +25°C

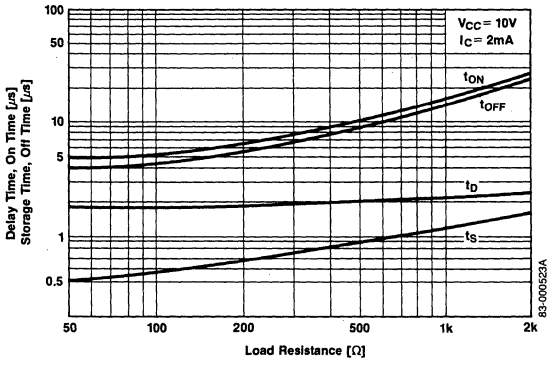
Normalized Output Current vs Ambient Temperature



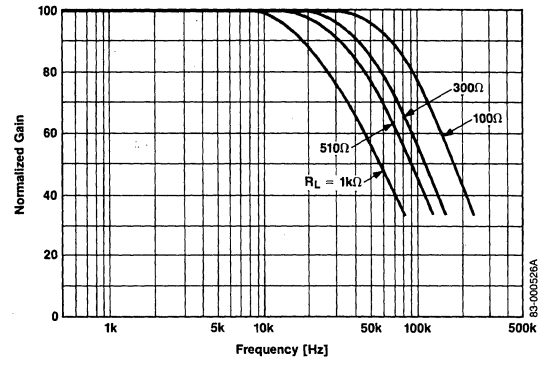

Current Transfer Ratio (CTR) vs Forward Current




Switching Time vs Load Resistance




Frequency Response

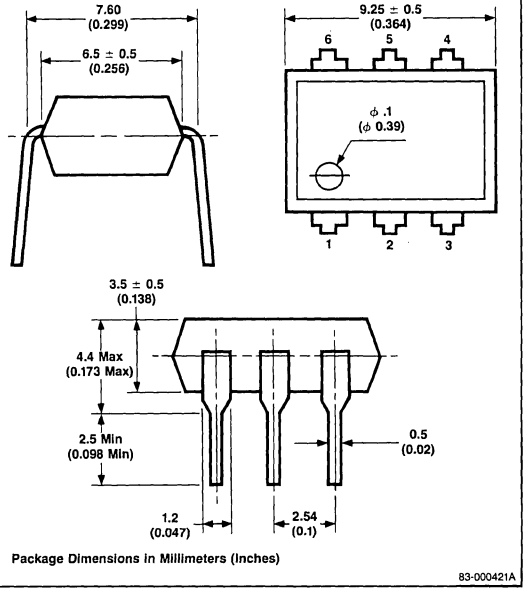


# PS3001/2
# SCR PHOTO COUPLERS
*NEPOC SERIES*

## Description

The PS3001 and PS3002 are optically coupled isolators containing a GaAs infrared emitting diode and a PNPN silicon photo SCR.

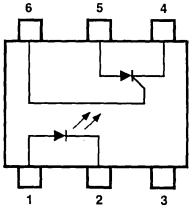
## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000421A

## Pin Connection




(Top View)

1. Anode
2. Cathode
3. NC
4. Cathode
5. Anode
6. Gate

83-000556A

## Features

- ☐ High voltage isolation: 2000$V_{AC}$ min
- ☐ Low turn-on current: 12mA max
- ☐ Plastic dual-in-line package
- ☐ High-speed switching
- ☐ Economical, compact

## Applications

- ☐ Interface circuit for various instruments and control equipment
- ☐ Replacement for reed relays

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 6V |
| Forward Current (DC), $I_F$ | 80mA |
| Peak Forward Current, $I_{FP}$ | 3A |
| Power Dissipation, $P_D$ | 100mW |
| **SCR** | |
| Peak Off and Reverse Voltage, $V_{DRM}$, $V_{RRM}$ | PS3001 200V |
| Peak Off and Reverse Voltage, $V_{DRM}$, $V_{RRM}$ | PS3002 400V |
| Direct On-Site Current, $I_T$ | 300mA |
| Peak Pulse Current[1], $I_{TP}$ | 3A |
| Peak Surge on Current, $I_{TSM}$ | 3A |
| Power Dissipation, $P_D$ | 350mW |
| Isolation Voltage[2], BV | 2500$V_{DC}$ |
| Storage Temperature, $T_{STG}$ | −55°C to +125°C |
| Operating Temperature, $T_{OPT}$ | −55°C to +100°C |
| Lead Soldering Time (at 260°C) | 10s |

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## Electrical Characteristics
$T_A$ = +25°C

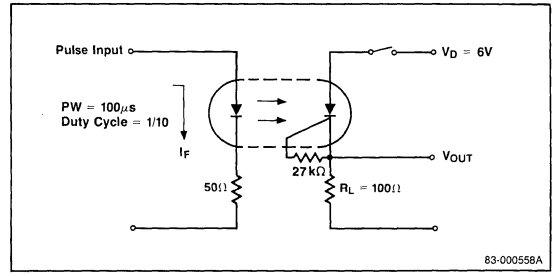
| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | 1.1 | 1.4 | V | $I_F$ = 20mA |
| Reverse Current | $I_R$ | | | 10 | μA | $V_R$ = 6V |
| Junction Capacitance | $C_T$ | | 50 | | pf | V = 0, f = 1.0MHz |
| **Photo SCR** | | | | | | |
| Peak Off-State Current | $I_{DRM}$ | | | 10 | μA | $V_{DRM}$ = Rated, $R_{GK}$ = 27KΩ, $T_A$ = +100°C |
| Reverse Current | $I_{RRM}$ | | | 10 | μA | |
| On State Voltage | $V_{TM}$ | | | 1.3 | V | $I_T$ = 300mA |
| Holding Current | $I_H$ | | 0.2 | 1 | mA | $R_{GK}$ = 27kΩ, $V_D$ = 24V |
| Rate of Rise of Forward Blocking Voltage | dV/dt | 0.5 | 1.0 | | V/μs | $V_{DRM}$ = Rated, $R_{GK}$ = 27kΩ, $T_A$ = +100°C |
| **Coupled** | | | | | | |
| Turn on Current | $I_{FT}$ | | 5 | 12 | mA | $V_D$ = 6V, $R_{GK}$ = 27kΩ |
| Isolation Breakdown Voltage | $V_{1-2}$ | 2500 | | | $V_{DC}$ | DC/1 min |
| Isolation Resistance | $R_{1-2}$ | $10^{11}$ | | | Ω | $V_{IN-OUT}$ = 1.0kV |
| Isolation Capacitance | $C_{1-2}$ | | 0.8 | | pF | V = 0, f = 1.0MHz |
| Turn-on Time[3] | $t_{ON}$ | | 10 | | μs | $I_{FT}$ = 50mA, $V_D$ = 6V, $R_{GK}$ = 27kΩ, $R_L$ = 100Ω |

**Notes:** 1. Pulse width = 100μs, repetition frequency = 100Hz.

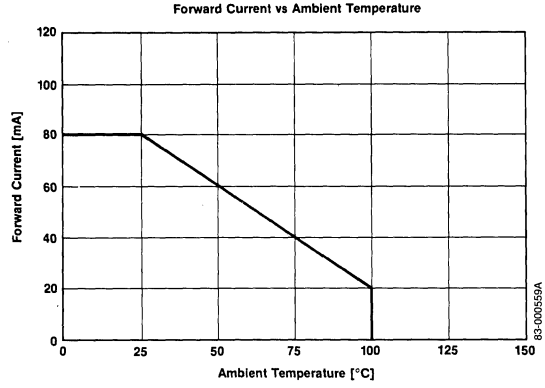
2. Measuring Conditions: DC voltage for 1 minute at $T_A$ = +25°C; RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).

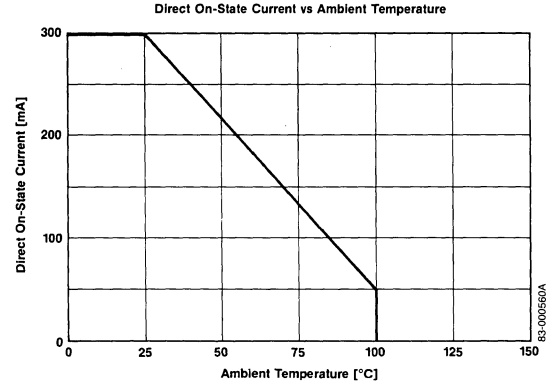
3. Turn-on time test circuit.

### *Turn-on test circuit*




## Typical Characteristics
$T_A$ = +25°C

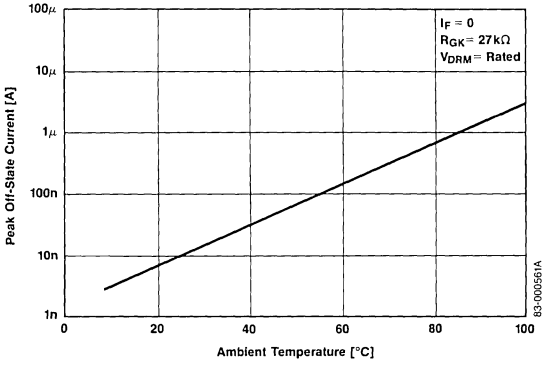


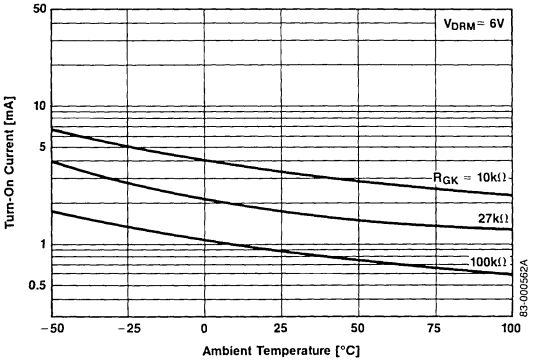
## Typical Characteristics (cont)

$T_A$ = +25°C

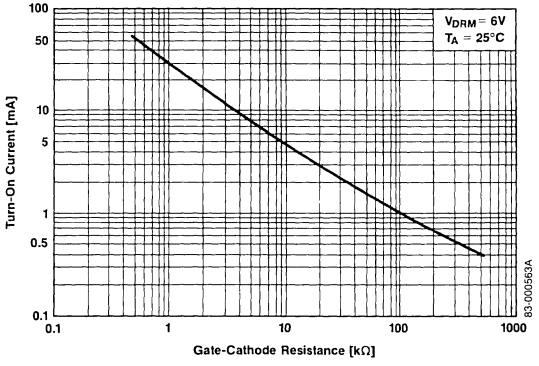
Peak Off-State Current vs Ambient Temperature




Turn-On Current vs Ambient Temperature




Turn-On Current vs Gate-Cathode Resistance

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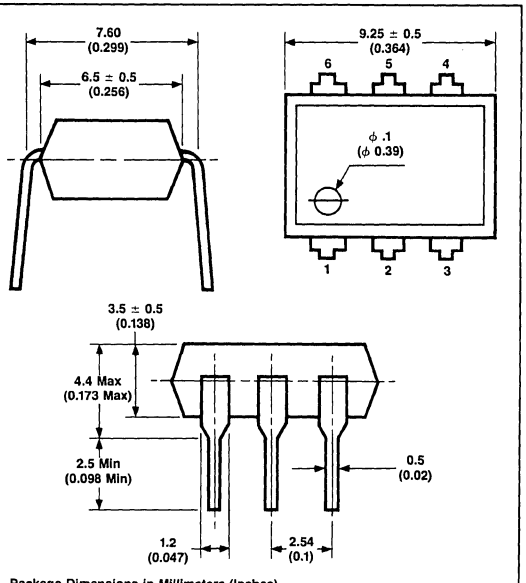
# PS3001(1)/2(1)
# SCR PHOTO COUPLERS
*NEPOC SERIES*

## Description

The PS3001(1) and PS3002(1) are optically coupled isolators containing a GaAs infrared emitting diode and a PNPN silicon photo SCR.

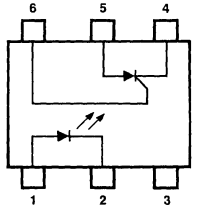
## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000421A

## Pin Connection




(Top View)

1. Anode
2. Cathode
3. NC
4. Cathode
5. Anode
6. Gate

83-000556A

## Features

- ☐ High voltage isolation: 2500$V_{AC}$ min
- ☐ Low turn-on current: 12mA max
- ☐ Plastic dual in-line package
- ☐ High-speed switching
- ☐ Economical, compact

## Applications

- ☐ Interface circuits for various instruments and control equipment
- ☐ Replacement for reed relays

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 6V |
| Forward Current (DC), $I_F$ | 80mA |
| Peak Forward Current, $I_{FP}$ | 3A |
| Power Dissipation, $P_D$ | 100mW |
| **SCR** | |
| Peak Off and Reverse Voltage, $V_{DRM}$, $V_{RRM}$ | PS3001(1) 200V |
| Peak Off and Reverse Voltage, $V_{DRM}$, $V_{RRM}$ | PS3002(1) 400V |
| Direct On-State Current, $I_T$ | 300mA |
| Peak Pulse Current[1], $I_{TP}$ | 3A |
| Peak Surge on Current, $I_{TSM}$ | 3A |
| Power Dissipation, $P_D$ | 350mW |
| Isolation Voltage[2], BV | 2500$V_{AC}$ |
| Storage Temperature, $T_{STG}$ | −55°C to +125°C |
| Operating Temperature, $T_{OPT}$ | −55°C to +100°C |
| Lead Soldering Time (at 260°C) | 10s |

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## Electrical Characteristics
$T_A$ = +25°C

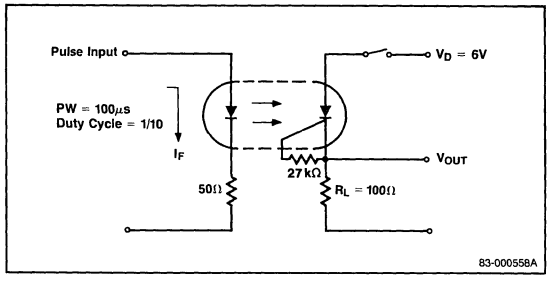
| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | 1.1 | 1.4 | V | $I_F$ = 20mA |
| Reverse Current | $I_R$ | | | 10 | μA | $V_R$ = 6V |
| Junction Capacitance | $C_T$ | | 50 | | pF | V = 0, f = 1.0MHz |
| **Photo SCR** | | | | | | |
| Peak Off-State Current | $I_{DRM}$ | | | 10 | μA | $V_{DRM}$ = rated, $R_{GK}$ = 27kΩ, $T_A$ = +100°C |
| Reverse Current | $I_{RRM}$ | | | 10 | μA | |
| On State Voltage | $V_{TM}$ | | | 1.3 | V | $I_T$ = 300ma |
| Holding Current | $I_H$ | | 0.2 | 1 | mA | $R_{GK}$ = 27kΩ, $V_D$ = 24V |
| Rate of Rise of Forward Blocking Voltage | dV/dt | 0.5 | 1.0 | | V/μs | $V_{DRM}$ = Rated, $R_{GK}$ = 27kΩ, $T_A$ = +100°C |
| **Coupled** | | | | | | |
| Turn on Current | $I_{FT}$ | | 5 | 12 | mA | $V_D$ = 6V, $R_{GK}$ = 27kΩ |
| Isolation Breakdown Voltage | $V_{1-2}$ | 2500 | | | $V_{DC}$ | DC/1 min |
| Isolation Resistance | $R_{1-2}$ | $10^{11}$ | | | Ω | $V_{IN-OUT}$ = 1.0kV |
| Isolation Capacitance | $C_{1-2}$ | | 0.8 | | pF | V = 0, f = 1.0MHz |
| Turn On Time[3] | $t_{ON}$ | | 10 | | μs | $I_{FT}$ = 50mA, $V_D$ = 6V, $R_{GK}$ = 27kΩ, $R_L$ = 100Ω |

**Notes:** 1. Pulse width = 100μs, repetition frequency = 100Hz.

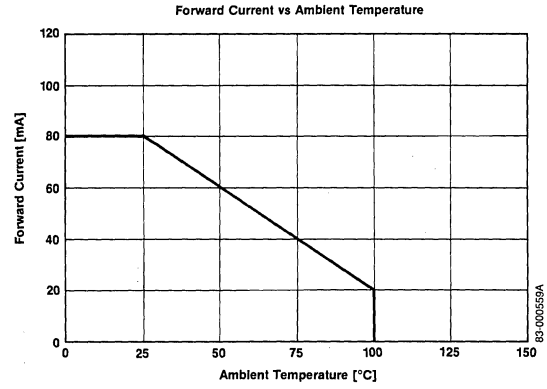
2. Measuring Conditions: DC voltage for 1 min at $T_A$ = +25°C; RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).

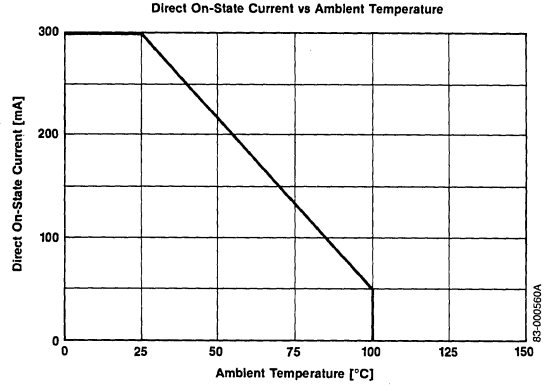
3. Turn-on time test circuit.

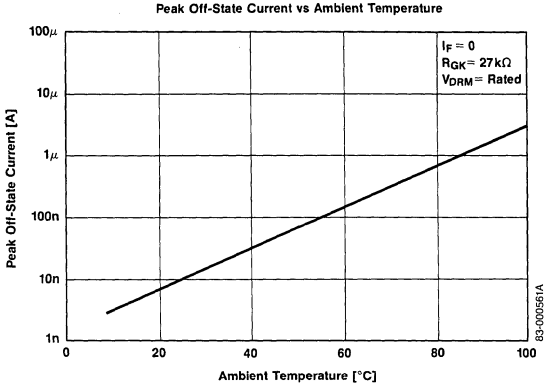
### *Turn-on test circuit*




## Typical Characteristics
$T_A$ = +25°C



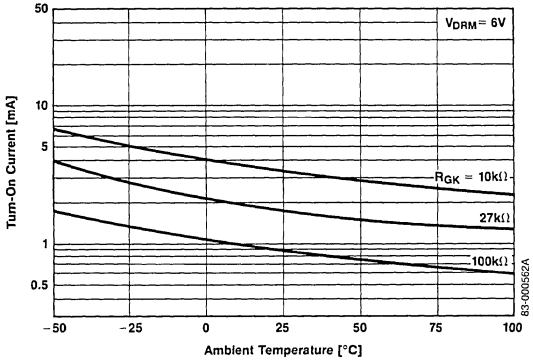



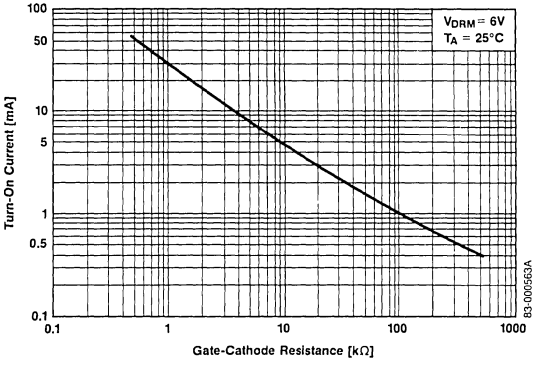
## Typical Characteristics (cont)

$T_A$ = +25°C

Turn-On Current vs Ambient Temperature




Turn-On Current vs Gate-Cathode Resistance




5

NEC

# PHOTO INTERRUPTERS 6

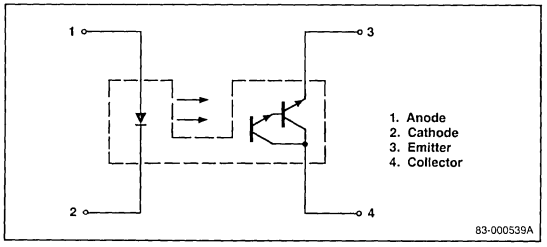
**Section 6 — Photo Interrupters**

# PS4001/3/5/7/9/10/11
# PHOTO INTERRUPTERS
*NEPOC SERIES*

## Description

The PS4001, PS4003, PS4005, PS4007, and PS4009 are photo coupled interrupter modules containing a GaAs light emitting diode and an NPN silicon Darlington connected photo transistor.

## Pin Connection




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

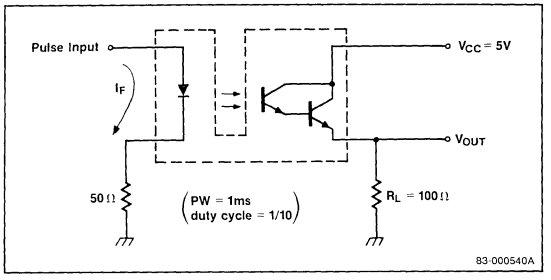
| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 5.0V |
| Forward Current, $I_F$ | 50mA |
| Power Dissipation, $P_D$ | 100mW |
| **Transistor** | |
| Collector to Emitter Voltage, $V_{CEO}$ | 30V |
| Collector Current, $I_C$ | 50mA |
| Power Dissipation, $P_D$ | 100mW |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |
| Operating Temperature, $T_{OPT}$ | −20°C to +80°C |

## Electrical Characteristics
$T_A$ = +25°C

| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | 1.1 | 1.4 | V | $I_F$ = 20mA |
| Reverse Current | $I_R$ | | | 20 | μA | $V_R$ = 4.0V |
| Junction Capacitance | C | | 100 | | pF | V = 0, f = 1.0MHz |
| **Transistor** | | | | | | |
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 400 | nA | $V_{CE}$ = 10V, $I_F$ = 0 |
| **Coupled** | | | | | | |
| Current Transfer Ratio | CTR ($I_C/I_F$) | 20[1] | | | % | $I_F$ = 10mA, $V_{CE}$ = 2.0V |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | | 1.2 | V | $I_F$ = 10mA, $I_C$ =0.5mA |
| Rise Time | $t_r$ | | 200 | | μs | $V_{CC}$ = 5.0V, $I_C$ = 2.0mA, $R_L$ = 100Ω[2] |
| Fall Time | $t_f$ | | 200 | | μs | $V_{CC}$ = 5.0V, $I_C$ = 2.0mA, $R_L$ = 100Ω[2] |

**Notes:** 1. PS4003: 15% min., others: 20% min.
2. Test circuit for switching time.

### *Test circuit for switching time*

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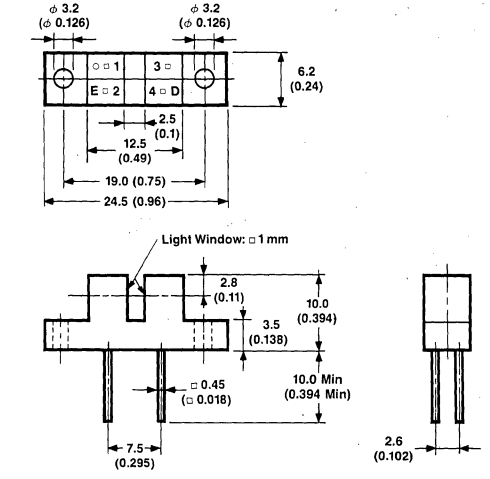
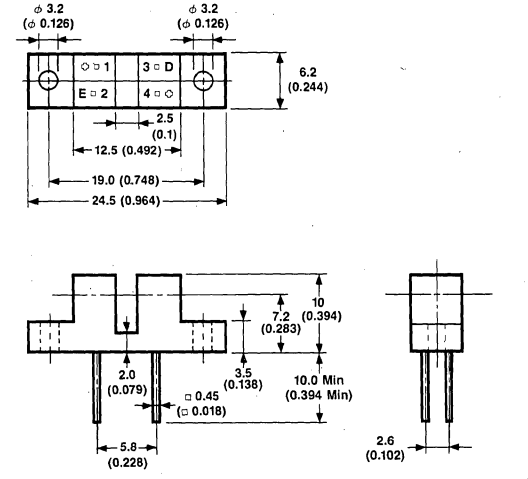
## Package Dimensions

PS4001



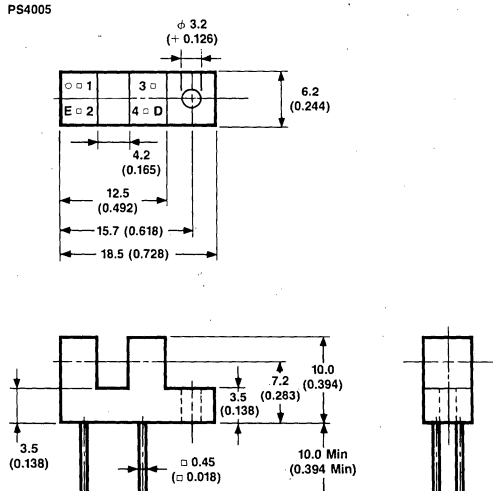

83-000541A

PS4003



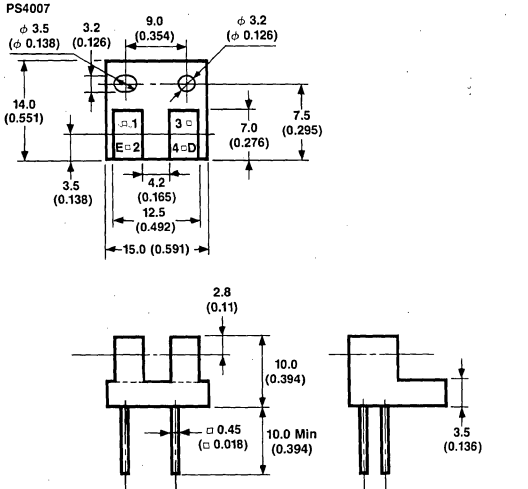

83-000542A

PS4005




83-000543A

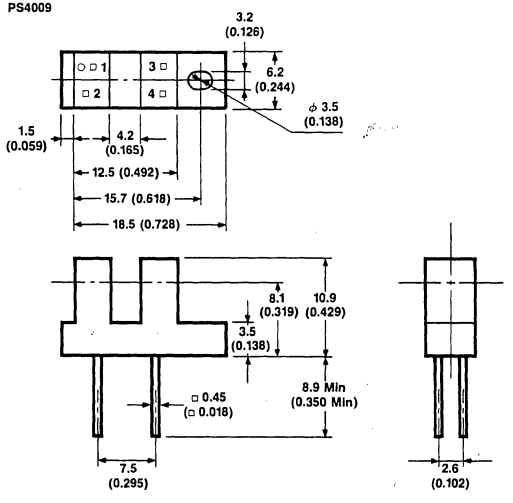
PS4007



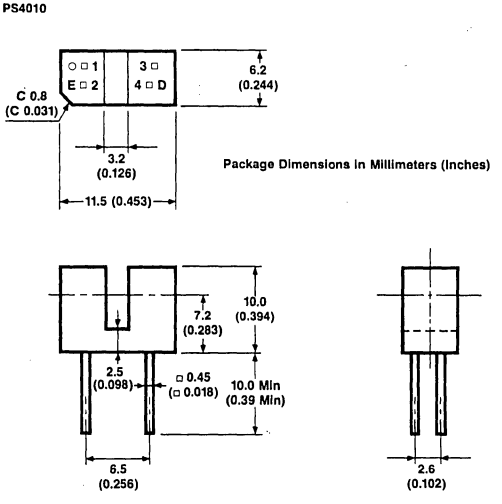

83-000544A

## Package Dimensions (cont)

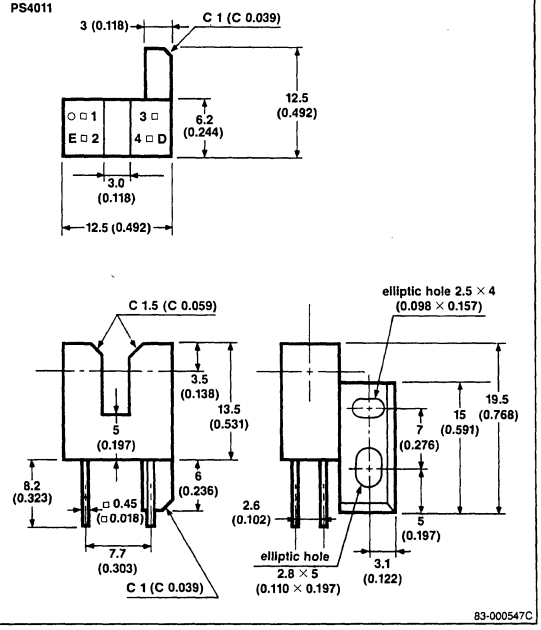
PS4009




PS4010




PS4011

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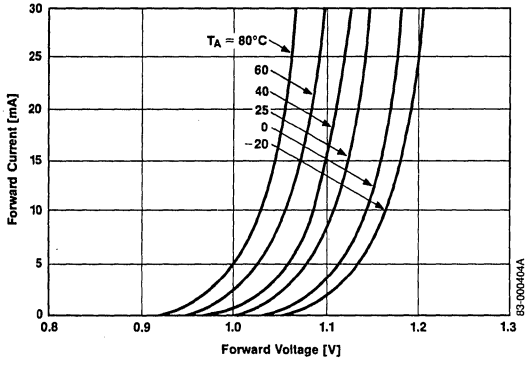
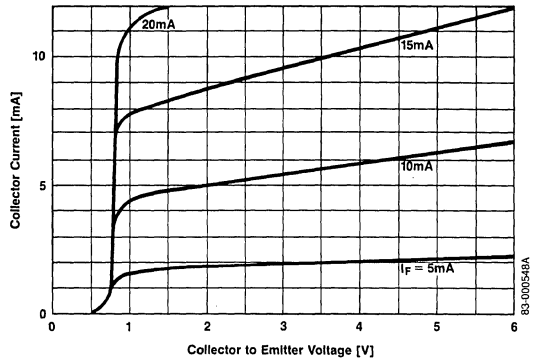
## Typical Characteristics
$T_A$ = +25°C

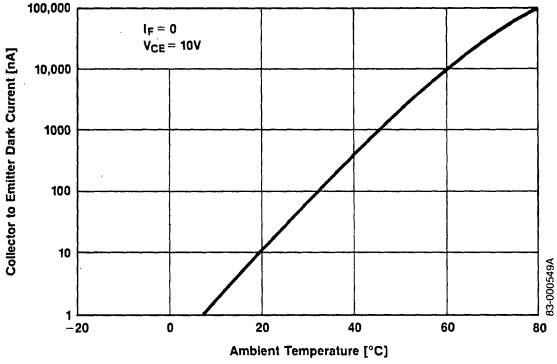
Forward Current vs Forward Voltage



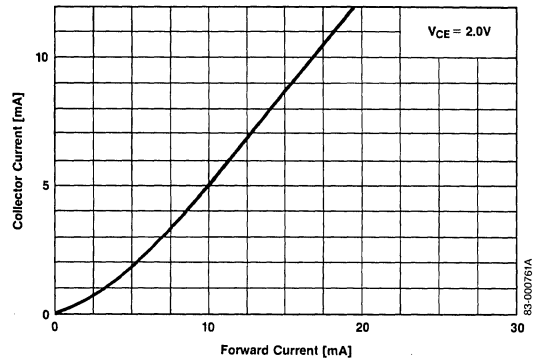

Collector Current vs Collector to Emitter Voltage



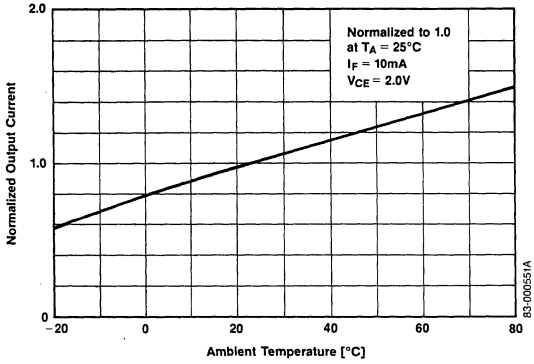

Collector to Emitter Dark Current vs Ambient Temperature



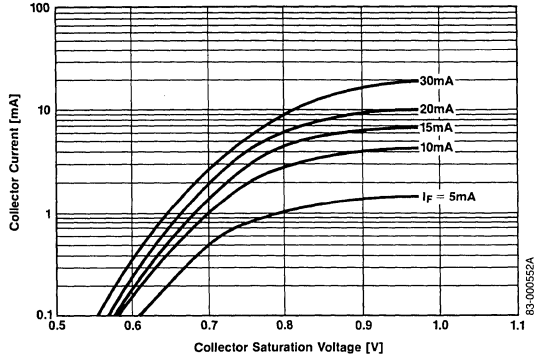

Collector Current vs Forward Current




Normalized Output Current vs Ambient Temperature



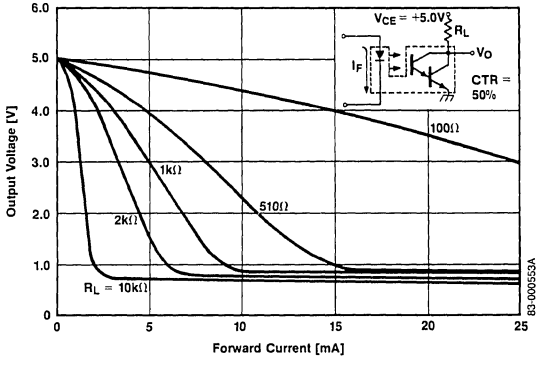

Collector Current vs Collector Saturation Voltage



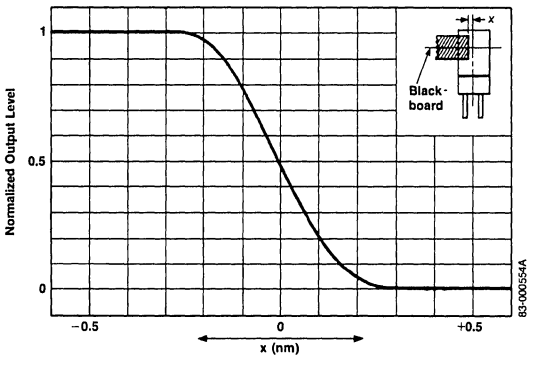
## Typical Characteristics (cont)

$T_A$ = +25°C

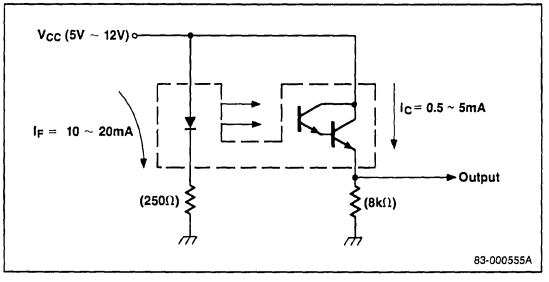
Output Voltage vs Forward Current




Output Characteristic




## Typical Applications

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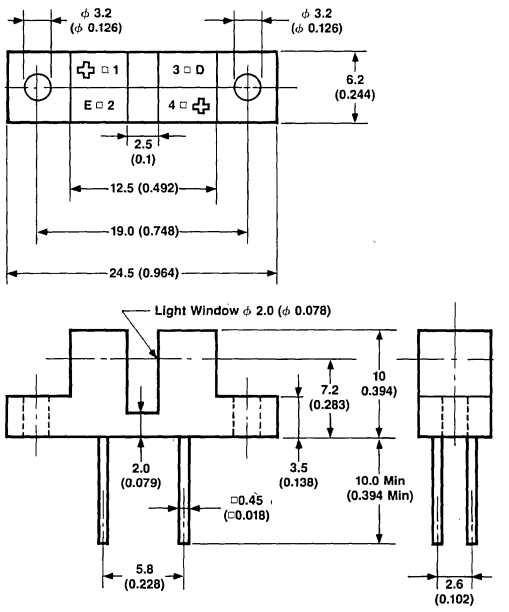
# PS4008
# PHOTO INTERRUPTER
*NEPOC SERIES*

## Description

The PS4008 is a photo coupled interrupter module containing a GaAs light emitting diode and an NPN silicon photo transistor.

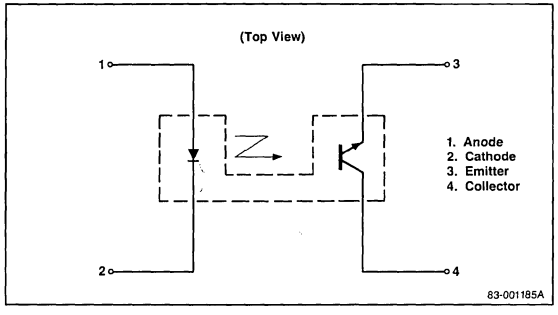
## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000564A

## Pin Connection




83-001185A

## Absolute Maximum Ratings

$T_A$ = +25°C

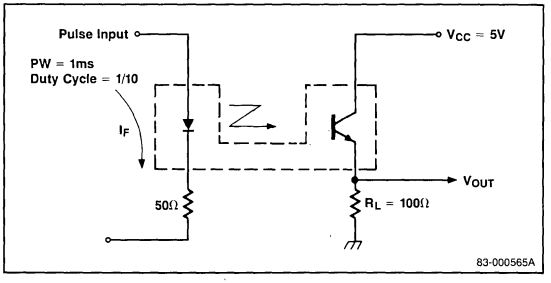
| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 5.0V |
| Forward Current, $I_F$ | 50mA |
| Power Dissipation, $P_D$ | 100mW |
| **Transistor** | |
| Collector to Emitter Voltage, $V_{CEO}$ | 30V |
| Collector Current, $I_C$ | 40mA |
| Power Dissipation, $P_D$ | 100mW |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |
| Operating Temperature, $T_{OPT}$ | −20°C to +80°C |

## Electrical Characteristics

$T_A$ = +25°C

| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | 1.1 | 1.4 | V | $I_F$ = 20mA |
| Reverse Current | $I_R$ | | | 20 | μA | $V_R$ = 4.0V |
| Junction Capacitance | C | | 100 | | pF | V = 0, f = 1.0MHz |
| **Transistor** | | | | | | |
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 100 | nA | $V_{CE}$ = 10V, $I_F$ = 0 |
| **Coupled** | | | | | | |
| Output Current | $I_C$ | 50 | 200 | | μA | $I_F$ = 10mA, $V_{CE}$ = 2.0V |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | | 0.3 | V | $I_F$ = 10mA, $I_C$ =50μA |
| Rise Time | $t_r$ | | 5 | | μs | $V_{CC}$ = 5.0V, $I_C$ = 50μA $R_L$ = 100Ω[1] |
| Fall Time | $t_f$ | | 5 | | μs | $V_{CC}$ = 5.0V, $I_C$ = 50μA $R_L$ = 100Ω[1] |

**Notes:** 1. Test circuit for switching time.




83-000565A

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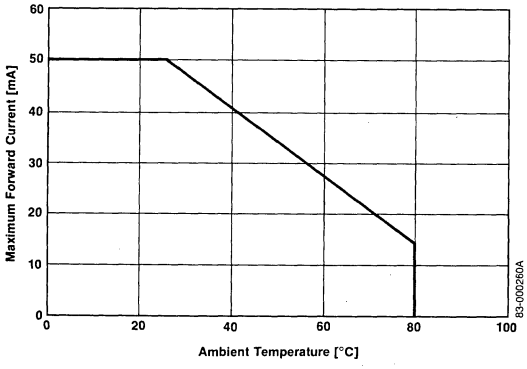
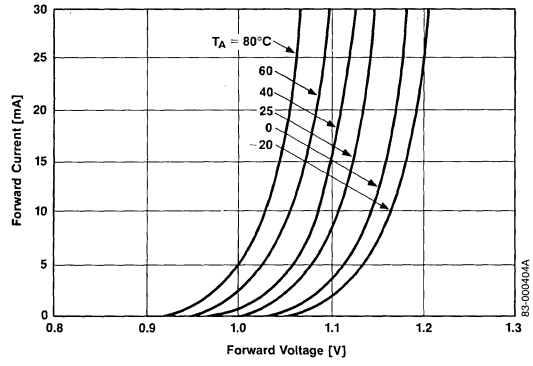
## Typical Characteristics

$T_A$ = +25°C

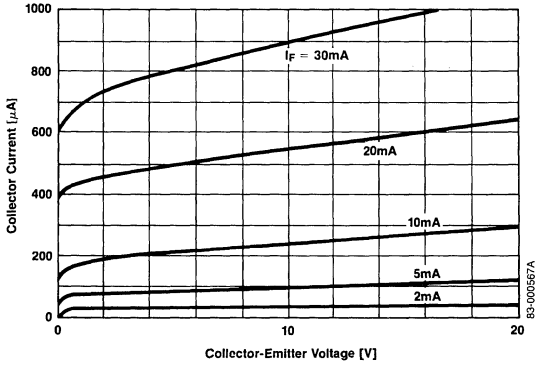
Maximum Forward Current vs Ambient Temperature



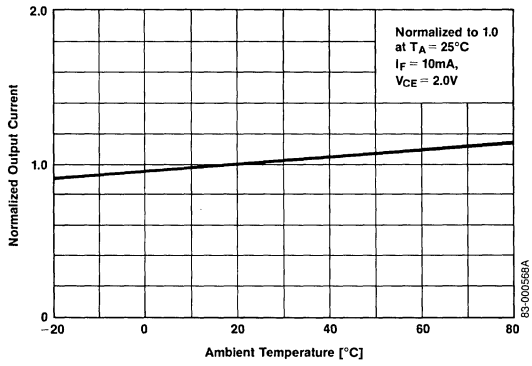

Forward Current vs Forward Voltage



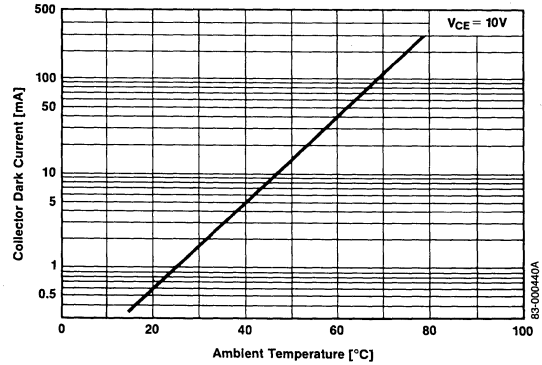

Collector Current vs Collector Emitter Voltage



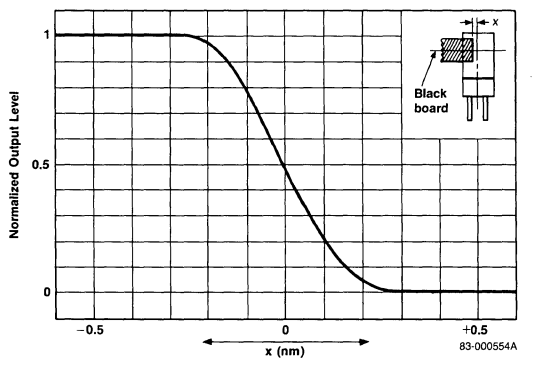

Normalized Output Current vs Ambient Temperature




Collector Dark Current vs Ambient Temperature




Output Characteristic

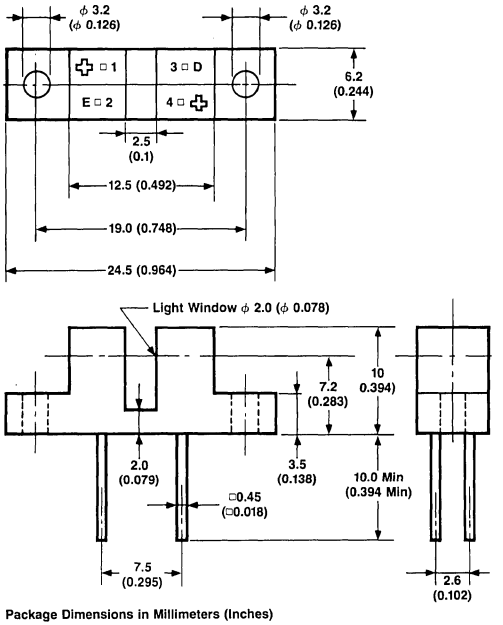


# PS4014
# PHOTO INTERRUPTER
*NEPOC SERIES*

## Description

The PS4014 is a photo coupled interrupter module containing a GaAs light emitting diode and an NPN silicon photo transistor.

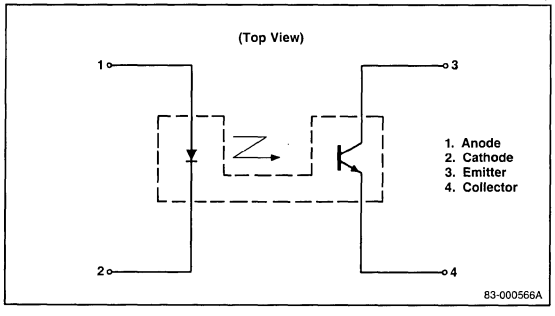
## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000564A

## Pin Connection




83-000566A

## Absolute Maximum Ratings

$T_A$ = +25°C

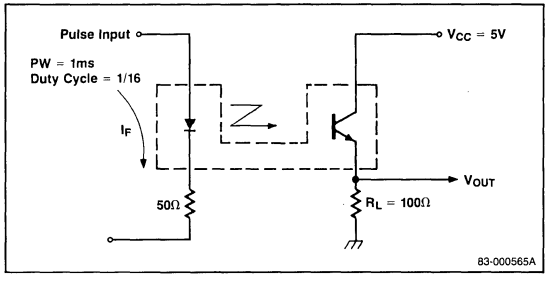
| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 5.0V |
| Forward Current, $I_F$ | 50mA |
| Power Dissipation, $P_D$ | 100mW |
| **Transistor** | |
| Collector to Emitter Voltage, $V_{CEO}$ | 30V |
| Collector Current, $I_C$ | 40mA |
| Power Dissipation, $P_D$ | 100mW |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |
| Operating Temperature, $T_{OPT}$ | −20°C to +80°C |

## Electrical Characteristics

$T_A$ = +25°C

| Parameter | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Diode** | | | | | | |
| Forward Voltage | $V_F$ | | 1.1 | 1.4 | V | $I_F$ = 20mA |
| Reverse Current | $I_R$ | | | 20 | μA | $V_R$ = 4.0V |
| Junction Capacitance | C | | 100 | | pF | V = 0, f = 1.0MHz |
| **Transistor** | | | | | | |
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 100 | nA | $V_{CE}$ = 10V, $I_F$ = 0 |
| **Coupled** | | | | | | |
| Output Current | $I_C$ | 200 | 500 | | μA | $I_F$ = 20mA, $V_{CE}$ = 5.0V |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | | 0.3 | V | $I_F$ = 10mA, $I_C$ = 50μA |
| Rise Time | $t_r$ | | 5 | | μs | $V_{CC}$ = 5.0V, $I_C$ = 50μA $R_L$ = 100Ω |
| Fall Time | $t_f$ | | 5 | | μs | $V_{CC}$ = 5.0V, $I_C$ = 50μA $R_L$ = 100Ω |

Note: 1. Test circuit for switching time




83-000565A

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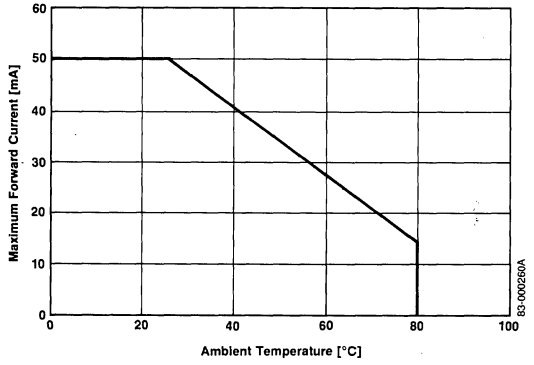
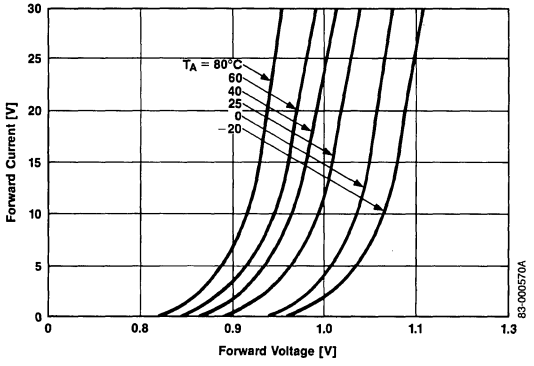
## Typical Characteristics
$T_A$ = +25°C

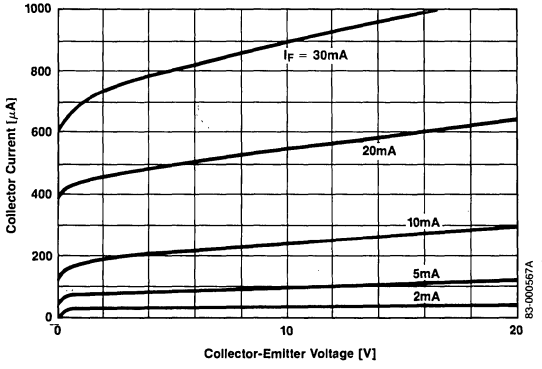
Forward Current vs Ambient Temperature



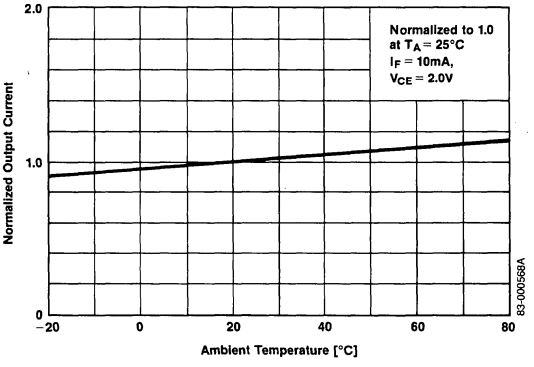

Forward Current vs Forward Voltage



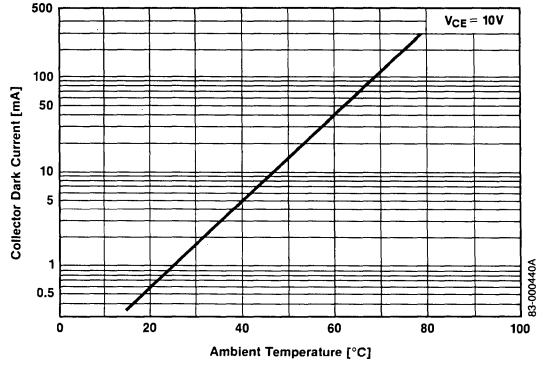

Collector Current vs Collector Emitter Voltage



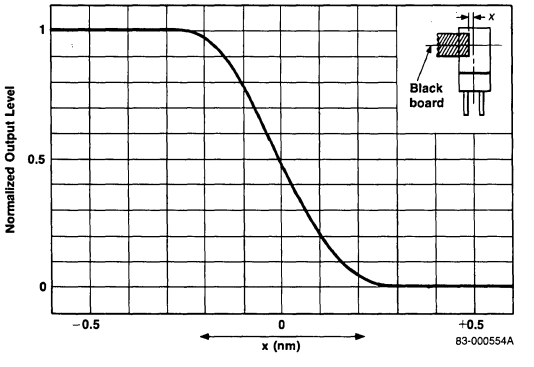

Normalized Output Current vs Ambient Temperature




Collector Dark Current vs Ambient Temperature




Output Characteristic



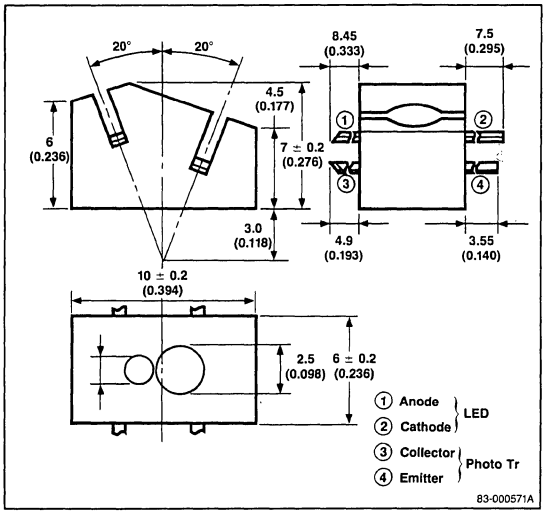
# PS6001A
# PHOTO REFLECTIVE SENSOR

*NEPOC SERIES*

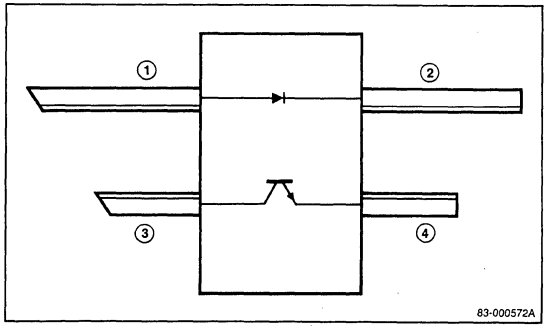
## Description

The PS6001A is a photo reflective sensor containing a GaAs light emitting diode and an NPN silicon photo transistor.

## Package Dimensions




## Pin Connection




## Absolute Maximum Ratings

$T_A$ = +25°C

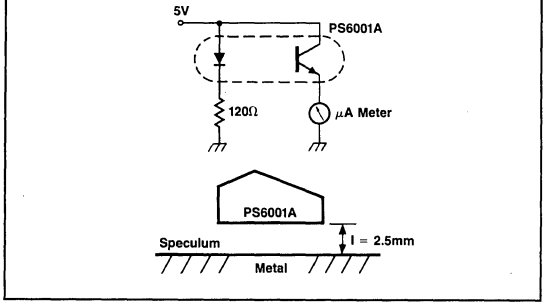
| | |
|---|---|
| **Diode** | |
| Reverse Voltage, $V_R$ | 3V |
| Forward Current, $I_F$ | 50mA |
| Power Dissipation, $P_D$ | 75mW |
| **Transistor** | |
| Collector to Emitter Voltage, $V_{CEO}$ | 30V |
| Collector Current, $I_C$ | 40mA |
| Power Dissipation, $P_D$ | 100mW |
| Junction Temperature, $T_J$ | 80°C |
| Storage Temperature, $T_{STG}$ | −30°C to +80°C |

## Electrical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 1.2 | 1.4 | V | $I_F$ = 30mA |
| Reverse Current | $I_R$ | | | 50 | μA | $V_R$ = 3V |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 940 | | nm | $I_F$ = 30mA |
| Collector Saturation Voltage | $V_{CE(SAT)}$ | | | 0.3 | V | $I_C$ = 20μA |
| Output Leak Current | $I_{LEAK}$ | | | 1.0 | μA | $I_F$ = 30mA, $V_{CE}$ = 5V, L = 0lx |
| Output Current | $I_C$ | 100 | 200 | | μA | Note 1 |

**Note 1:** Test circuit for switching time.

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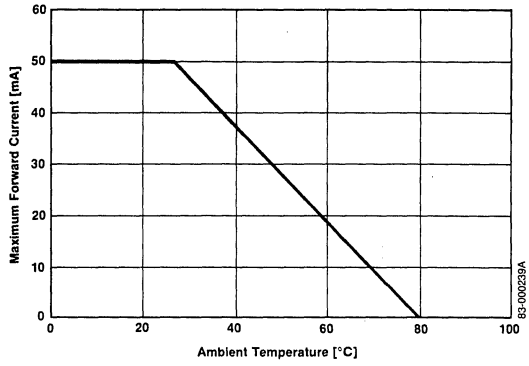
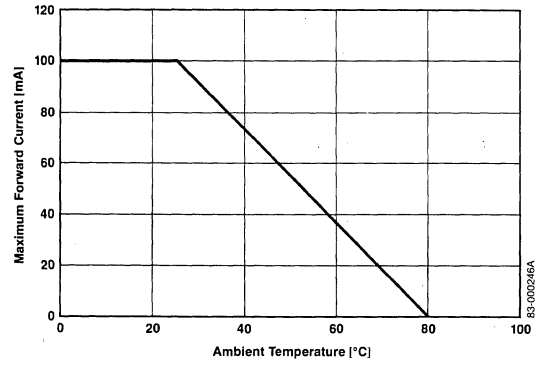
## Typical Characteristics

$T_A$ = +25°C

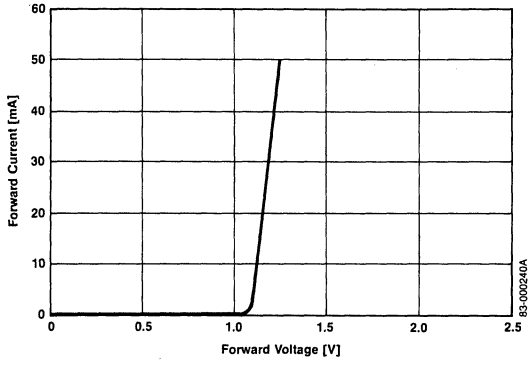
Maximum Forward Current vs Ambient Temperature



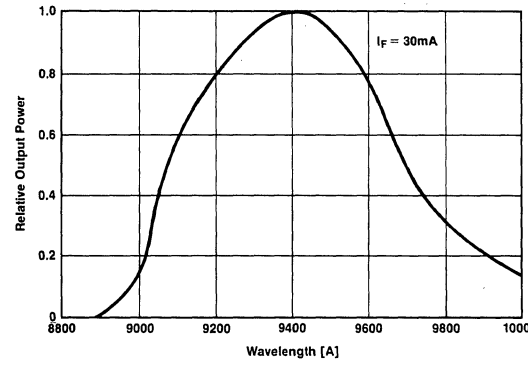

Maximum Forward Current vs Ambient Temperature



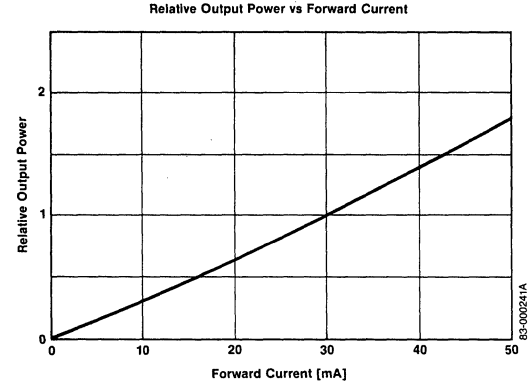

Forward Current vs Forward Voltage



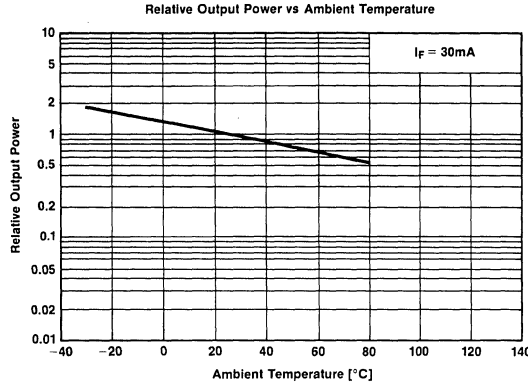

Spectral Distribution




Relative Output Power vs Forward Current



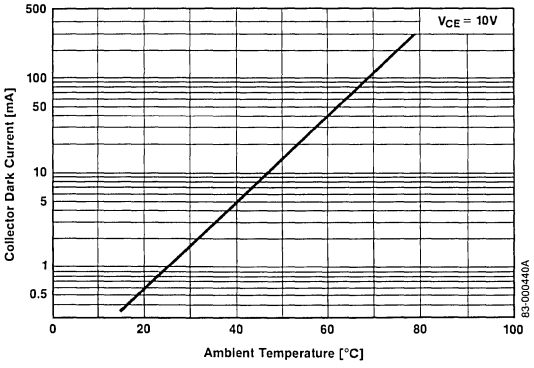

Relative Output Power vs Ambient Temperature



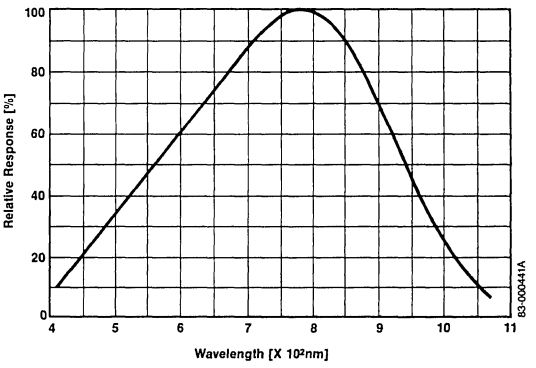
## Typical Characteristics (cont)

$T_A$ = +25°C

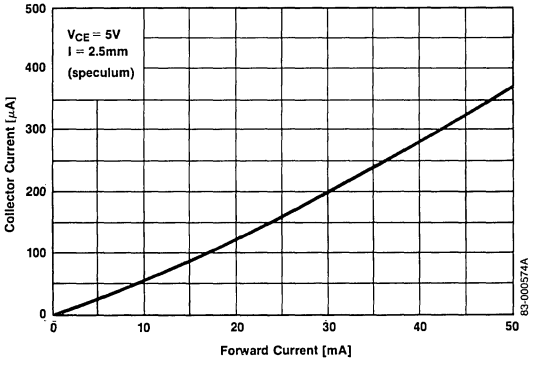
Collector Dark Current vs Ambient Temperature



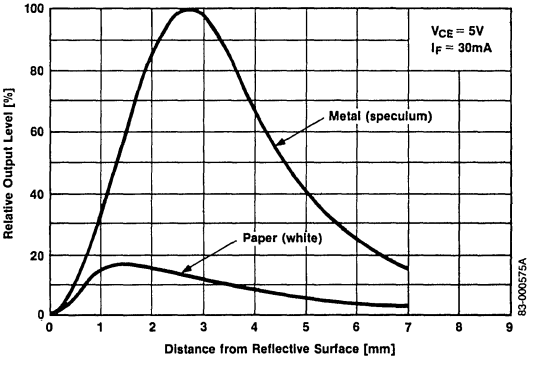

Spectral Response




Transfer Characteristics




Transfer Ratio vs Distance Between Reflection and Device

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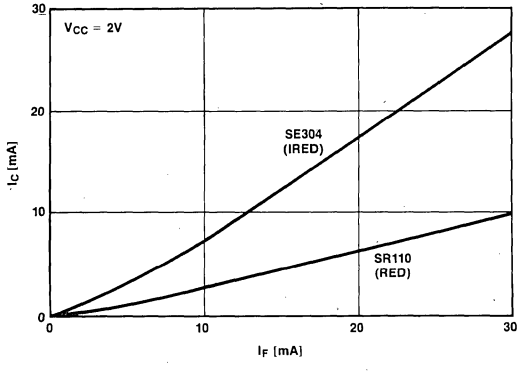
This application note is written for the designer of non-contact detector systems using photo interrupters, to choose the appropriate photo emitting and photo detecting elements.

## 1. Photo Emitter and Detector

The two photo emitters to be discussed in this note are the NEC SE304 (Infrared LED) and the SR110 (Red LED). The two photo detectors to be discussed are the NEC PH103 (Darlington Photo Transistor) and the PH104 (Photo Transistor). Other devices in these categories are available, but their use as photo detector elements is not recommended.

One of the most important electrical characteristics of photo interrupter devices is the efficiency of photo energy transfer from the emitter to the detector. Current Transfer Ratio (CTR) is generally measured at some given distance. In the graph of Figures 1 and 2 the distance from emitter to detector is 4.2mm (which matches that of the PS4001 photo interrupter device), using the SE304 Infrared LED and the SR110 Red LED as emitters and the PH103 and PH104 Photo transistors as detectors, respectively.

Infrared LEDs are more efficient as emitters, and NEC recommends the SE304 in combination with either the PH103 or PH104 in the majority of applications. All photo interrupters produced by NEC are designed by using one of these combinations because of their superior efficiency, stability, and operating characteristics.



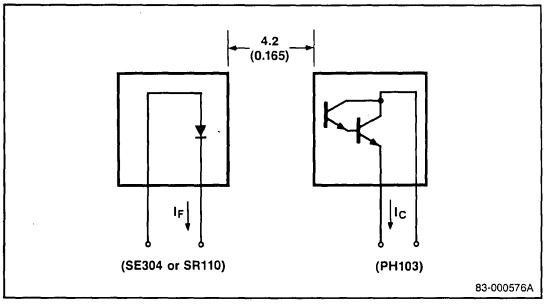
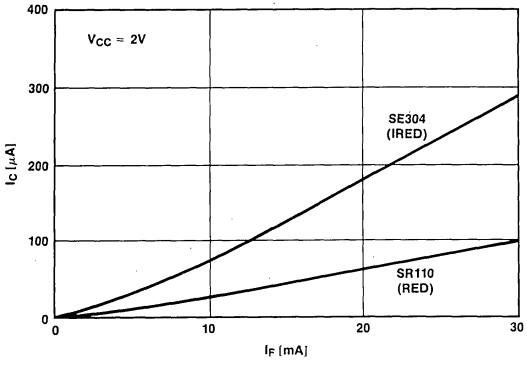




*Figure 1. CTR with the PH103 as a Photo Detector*



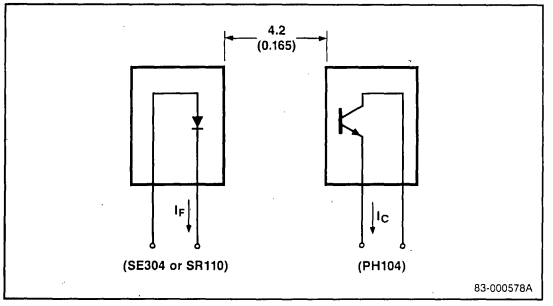
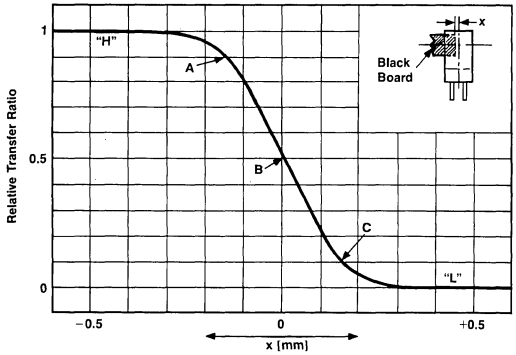




*Figure 2. CTR with the PH104 as a Photo Detector*

## 2. Light Receiving Characteristics of Photo Transistors

The shape and material used in manufacturing photo interrupters are major design considerations. The primary consideration is the relationship of output current of the photo transistor to the proportion of the sensitive area being masked. Figure 3 illustrates the characteristic curve of the PH103 with the surface views and schematic. As shown, just a 0.3mm displacement of the interrupter with respect to the detector die will shift the output level from 99% (A) to 10% (C).



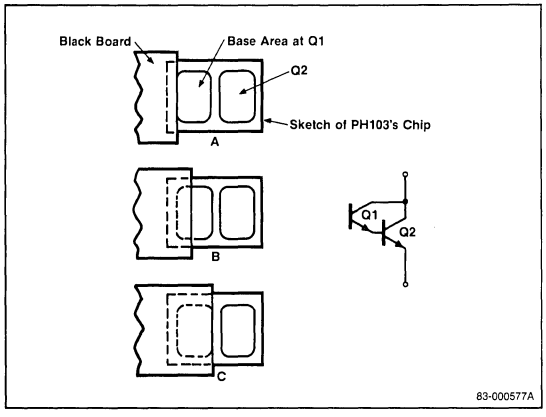




*Figure 3. Masking (Shade) Effect*

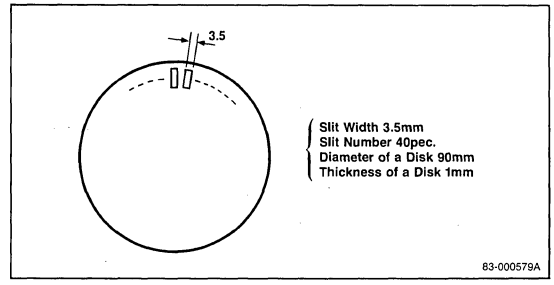



*Figure 4. Sketch of a Disk*

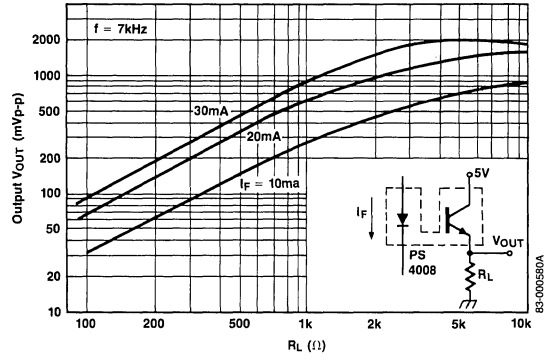



*Figure 5. PS4008 Switching Characteristics*

## 3. Using the PS4008 as a High-Speed Interrupter

This application deals with interrupters using a rotating disk as the interrupting element. Using a Darlington photo transistor (PH103 type) as the detector device, the frequency range of the transistor is generally the limiting factor. In this example the limit is about 1kHz. Since most of the applications for this type of interrupter involve frequencies below 1kHz, speed is not a problem. In applications requiring speeds greater than 1kHz, a single photo transistor (PH104) is recommended.

The PS4008 photo interrupter is used to illustrate the following application and its characteristics are shown in Figure 5.

The slotted disc shown in Figure 4 was rotated at 10,000 to 30,000RPM, and the output of the PS4008 was monitored on an oscilloscope. The output frequency ranged from 7kHz to 20kHz. At 7kHz and $I_F$ = 10mA, the photo transistor load $R_L$ could go as high as 10KΩ, and an output voltage of 900mV peak to peak could still be obtained. The data in Figure 5 shows the resulting data taken with the emitter loaded. Loading the collector would give similar results.

Figure 6 shows the output voltage to LED forward current ($I_F$) at 7kHz and a fixed load of 1.1KΩ.

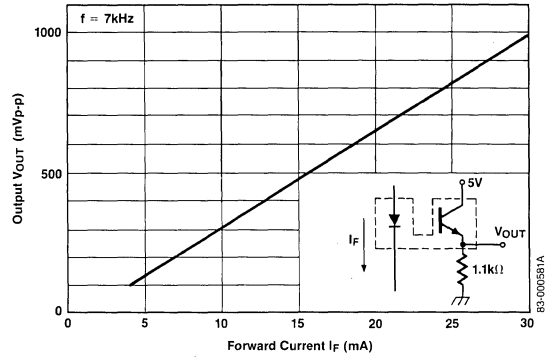



*Figure 6. $I_F$ -$V_{OUT}$ Characteristic*

Figure 7 illustrates the output voltage versus frequency characteristics when the output frequency range is from 7kHz to 20kHz and the load resistance is 1.1KΩ. The implementation of a mechanical interrupter at 20kHz generally is difficult, but most of the problems can be overcome by using the application circuit in Figure 8 and reshaping the output waveform with a precision comparator.

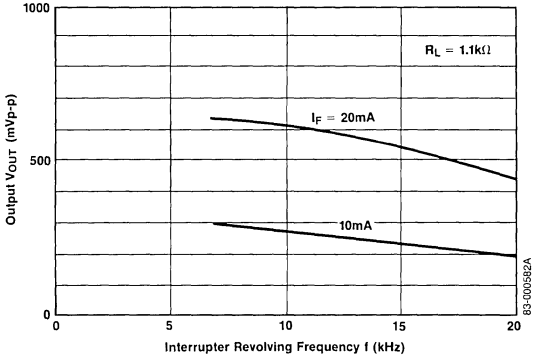



*Figure 7. PS4008 Frequency Characteristics*

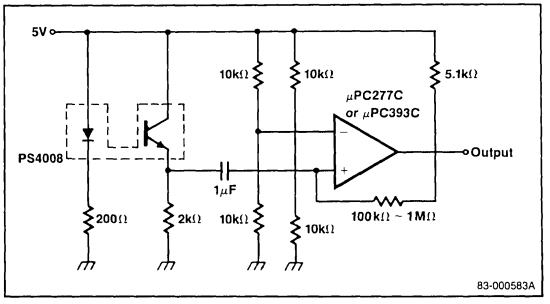



*Figure 8. PS4008 Application Circuit*

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# PHOTO TRANSISTORS AND PHOTO DIODES 7

**Section 7 — Photo Transistors and Photo Diodes**

NEC

NEC Electronics Inc.

# PH101
# NPN EPITAXIAL DARLINGTON PHOTO TRANSISTOR PHOTO DETECTOR

*NEPOC SERIES*

## Description

The PH101 is a miniature NPN silicon photo transistor having exceptionally stable characteristics and high illuminance sensitivity mounted in a two-terminal MICRODISK package. The spectral response, extending from 4000 to 10,000Å, is compatible with daylight, tungsten and gallium arsenide sources. The packaging of this unit permits close spacing in linear arrays. Its low cost and volume producibility open new areas of use anywhere a photo detector is desirable.

## Features

- ☐ Low cost
- ☐ Low leakage current
- ☐ Wide spectral response
- ☐ Convenient MICRODISK package
- ☐ Wide temperature range
- ☐ Compact, rugged, light-weight
- ☐ High sensitivity

## Applications

- ☐ Optical switching and encoding
- ☐ Intrusion alarms
- ☐ Tape and card reader sensors
- ☐ Level controls
- ☐ Motor governors

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Collector to Emitter Voltage, $V_{CEO}$ | 20V |
| Collector Current, $I_C$ | 50mA |
| Power Dissipation, $P_D$ | 100mW |
| Junction Temperature, $T_J$ | 80°C |
| Storage Temperature, $T_{STG}$ | −30°C to +80°C |

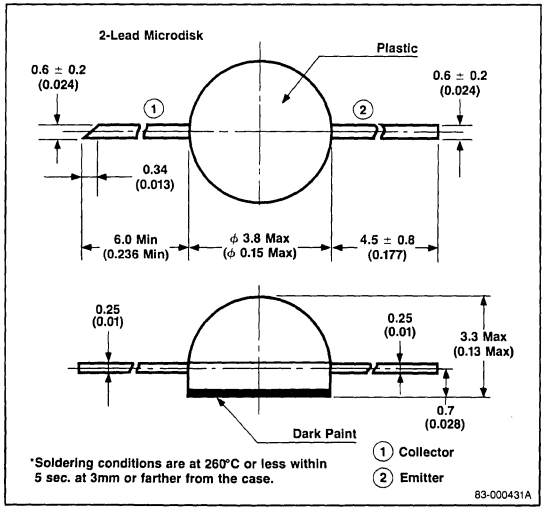
## Electro-Optical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Collector to Emitter Dark Current | $I_{CEO1}$ | | | 0.5 | μA | $V_{CE}$ = 15V, L = 0 |
| Collector to Emitter Dark Current | $I_{CEO2}$ | | | 500 | μA | $V_{CE}$ = 15V, L = 0, $T_A$ = +80°C |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | 0.7 | 1.5 | V | $I_C$ = 10mA, $L^1$ = 1000lx |
| Photo Current | $I_L$ | 4 | 12 | | mA | $V_{CE}$ = 2.0V, $L^1$ = 100lx |

**Note:** 1. Measured with a tungsten filament lamp operated at a color temperature of 2854K.

## Package Dimensions




7

## Typical Characteristics
$T_A$ = +25°C

Photo Current vs Collector to Emitter Voltage

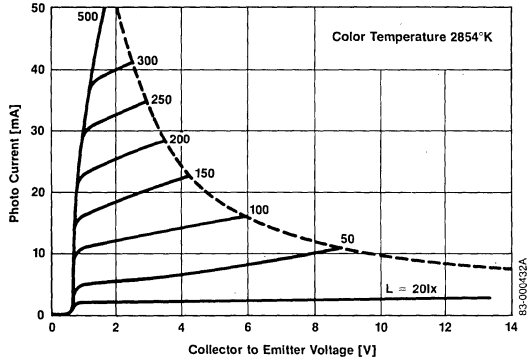
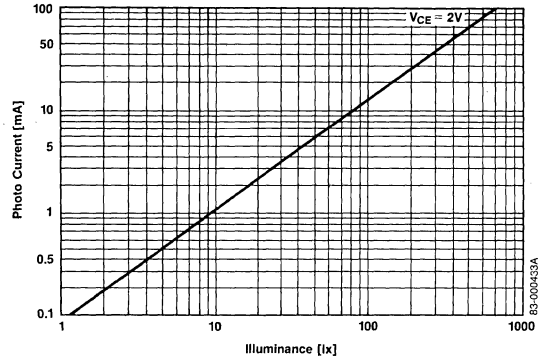
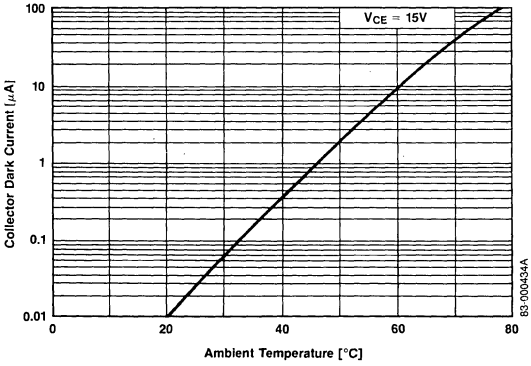


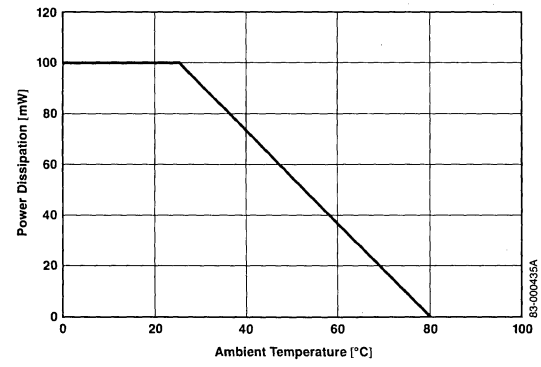

Photo Current vs Illuminance



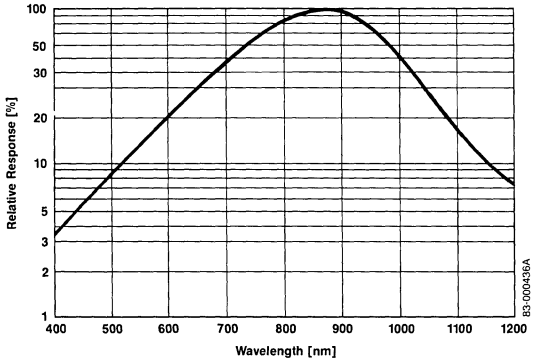

Collector Dark Current vs Ambient Temperature



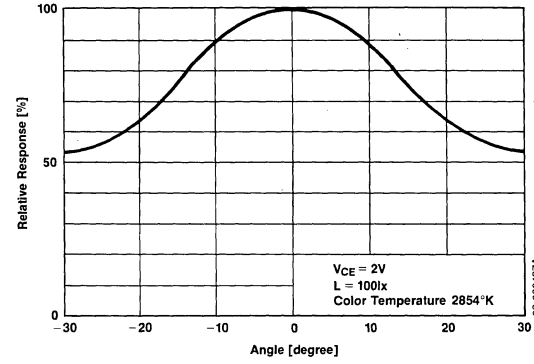

Power Dissipation vs Ambient Temperature




Spectral Response




Angular Response



NEC

NEC Electronics Inc.

# PH102
# NPN EPITAXIAL PHOTO TRANSISTOR PHOTO DETECTOR

*NEPOC SERIES*

## Description

The PH102 is a miniature NPN silicon photo transistor having exceptionally stable characteristics and is mounted in a two-terminal MICRODISK package. The spectral response, extending from 400 to 1000nm, is compatible with daylight, tungsten and gallium arsenide sources. The packaging of this unit permits close spacing in linear arrays. Its low cost and volume producibility open new areas of use anywhere a photo detector is desirable.

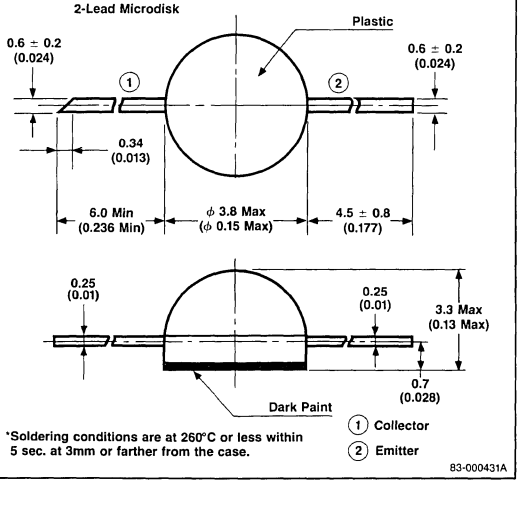
## Features

- ☐ High speed
- ☐ Low cost
- ☐ Low leakage current
- ☐ Wide spectral response
- ☐ Wide temperature range
- ☐ Compact, rugged, light-weight
- ☐ High sensitivity

## Applications

- ☐ Optical switching and encoding
- ☐ Intrusion alarms
- ☐ Tape and card reader sensors
- ☐ Level controls
- ☐ Motor governors

## Package Dimensions




## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Collector to Emitter Voltage, $V_{CEO}$ | 30V |
| Collector Current, $I_C$ | 40mA |
| Power Dissipation, $P_D$ | 100mW |
| Junction Temperature, $T_J$ | 80°C |
| Storage Temperature, $T_{STG}$ | −30°C to +80°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 200 | nA | $V_{CE}$ = 10V, L = 0lx |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | | 0.3 | V | $I_C$ = 0.5mA, $L^1$ = 1000lx |
| Photo Current | $I_L$ | 50 | 180 | | μA | $V_{CE}$ = 2.0V, $L^1$ = 100lx |
| Fall Time | $t_f$ | | 5 | | μs | $V_{CE}$ = 10V, $I_L$ = 2mA, $R_L$ = 100Ω |
| Rise Time | $t_r$ | | 5 | | μs | $V_{CE}$ = 10V, $I_L$ = 2mA, $R_L$ = 100Ω |

**Note:** 1. Measured with a tungsten filament lamp operated at a color temperature of 2854K.

7

## Typical Characteristics

$T_A$ = +25°C

Power Dissipation vs Ambient Temperature

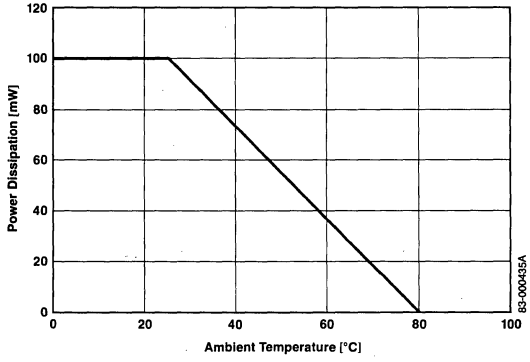



Photo Current vs Collector to Emitter Voltage

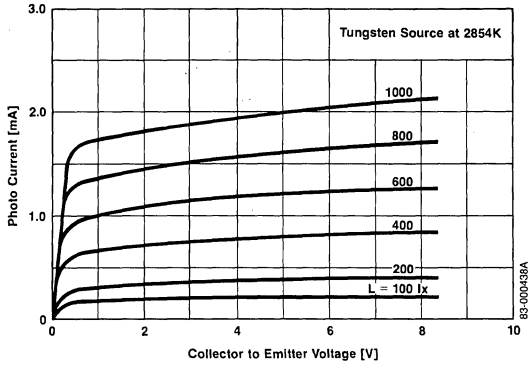
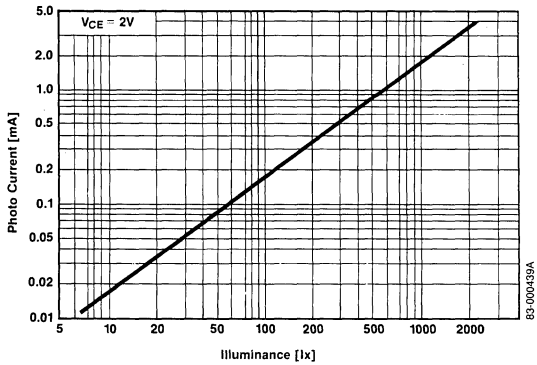
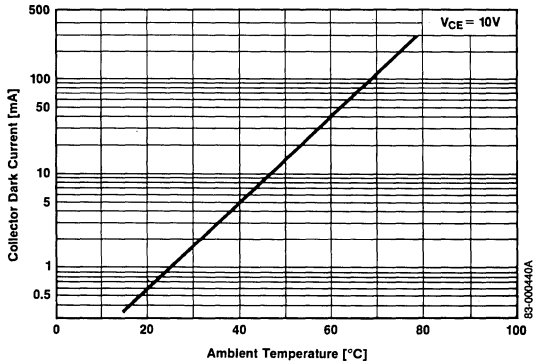


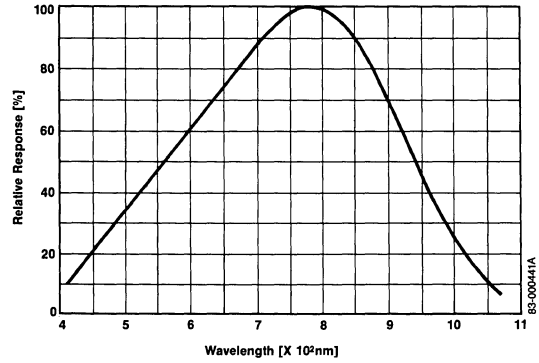

Photo Current vs Illuminance



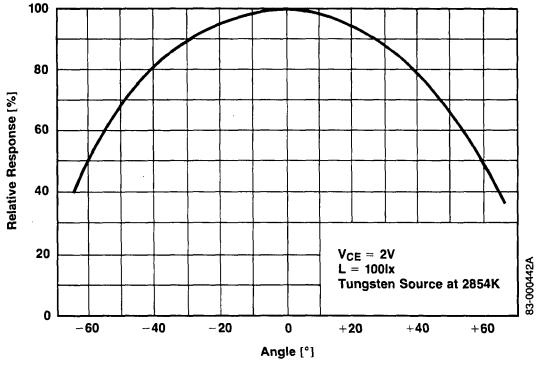

Collector Dark Current vs Ambient Temperature




Spectral Response




Angular Response



NEC
NEC Electronics Inc.

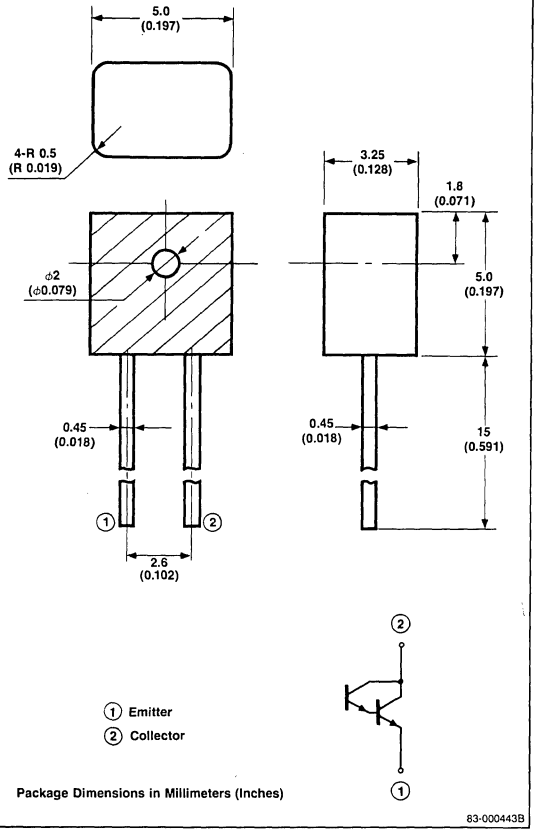
# PH103
# DARLINGTON
# PHOTO TRANSISTOR

*NEPOC SERIES*

## Description

The PH103 is a Darlington photo transistor in a plastic molded package, and is very suitable for a detector of a photo interrupter.

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000443B

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Collector to Emitter Voltage, $V_{CEO}$ | 30V |
| Collector Current, $I_C$ | 50mA |
| Power Dissipation, $P_D$ | 100mW |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electrical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Collector to Emitter Dark Current | $I_{CEO}$ | | 10 | 400 | nA | $V_{CE}$ = 10V, L = 0lx |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | 0.7 | 1.5 | V | $I_C$ = 10mA, L = 1000lx[1] |
| Photo Current | $I_L$ | 2.0 | | | mA | $V_{CE}$ = 2V, L = 100lx[1] |

**Note:** 1. Measured with a tungsten filament lamp operated at a color temperature of 2854K.

7

## Typical Characteristics
$T_A$ = +25°C

Photo Current vs Collector to Emitter Voltage

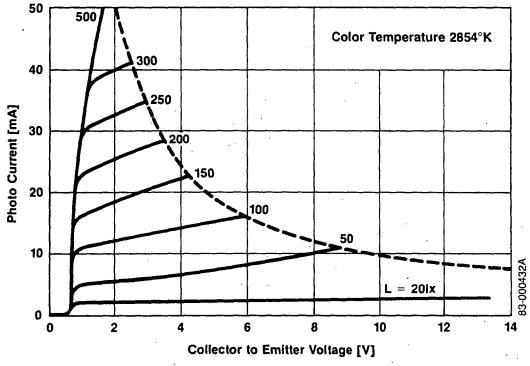
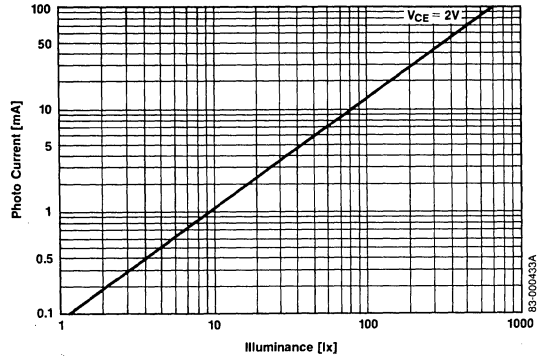
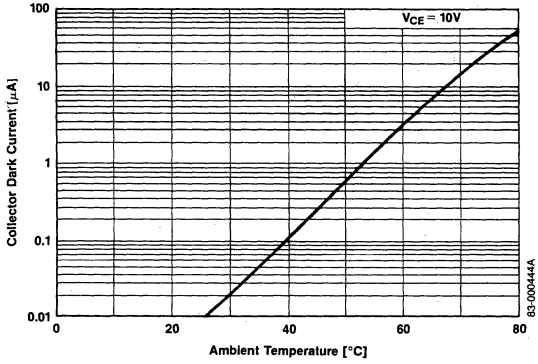


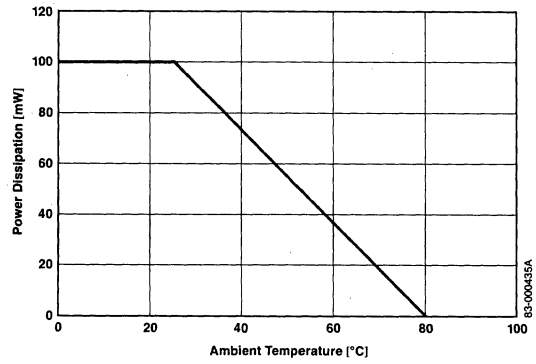

Photo Current vs Illuminance



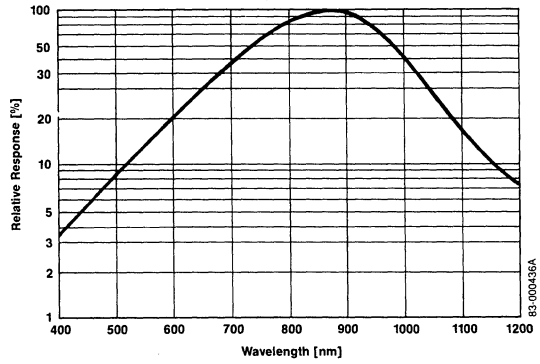

Collector Dark Current vs Ambient Temperature



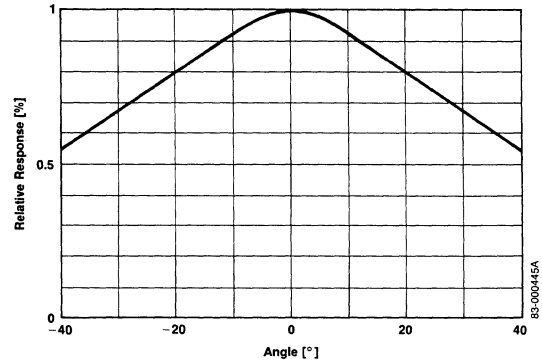

Power Dissipation vs Ambient Temperature




Spectral Response



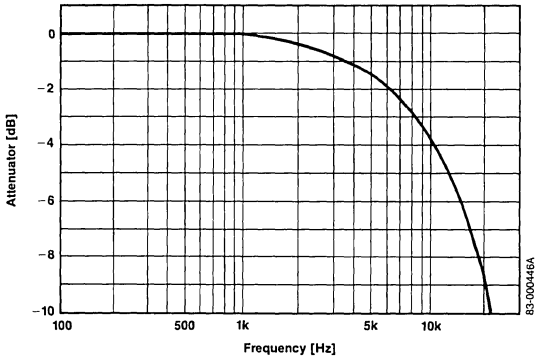

Spatial Distribution

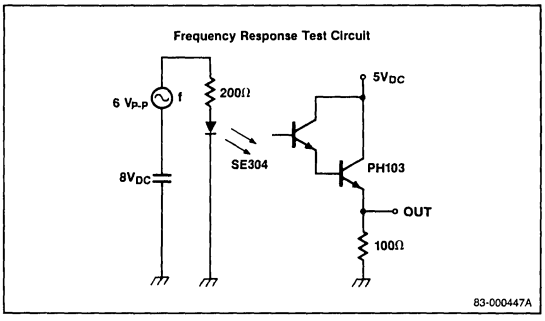


## Typical Characteristics (cont)

$T_A = +25°C$

Frequency Response



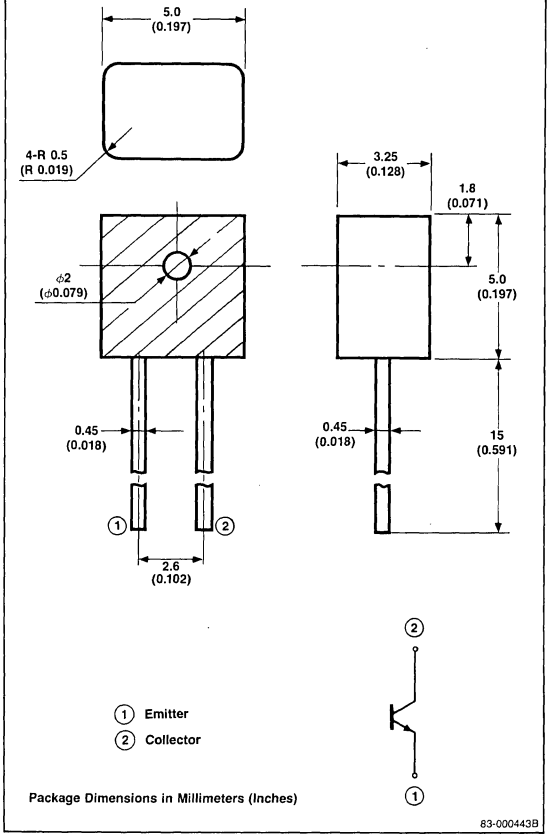

7

# PH104
# PHOTO TRANSISTOR
*NEPOC SERIES*

## Description

The H104 is a photo transistor in a plastic molded package, and is very suitable for use as a detector in a photo interrupter.

## Package Dimensions




## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Collector to Emitter Voltage, $V_{CEO}$ | 30V |
| Collector Current, $I_C$ | 40mA |
| Power Dissipation, $P_D$ | 100mW |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electrical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 100 | nA | $V_{CE}$ = 10V, L = 0lx |
| Collector Saturation Voltage | $V_{CE\ (sat)}$ | | | 0.3 | V | $I_C$ = 0.5mA, L = 1000lx[1] |
| Photo Current | $I_L$ | 20 | | | μA | $V_{CE}$ = 2.0V, L = 100lx[1] |
| Fall Time | $t_f$ | | 5 | | μs | $V_{CC}$ = 10V, $I_L$ = 2mA, $R_L$ = 100Ω |

**Note:** 1. Measured with a tungsten filament lamp operated a color temperature of 2854K.

7

## Typical Characteristics
$T_A$ = +25°C

Power Dissipation vs Ambient Temperature

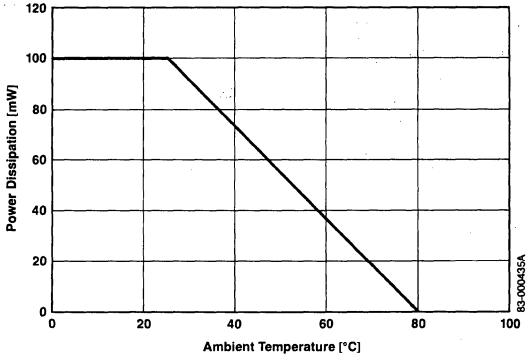



Photo Current vs Collector to Emitter Voltage

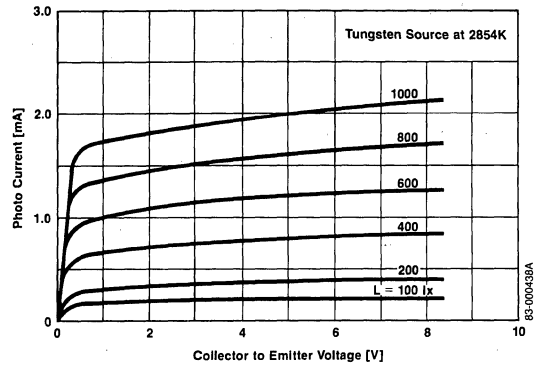
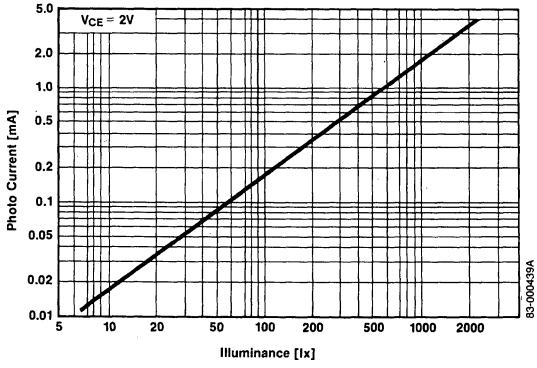
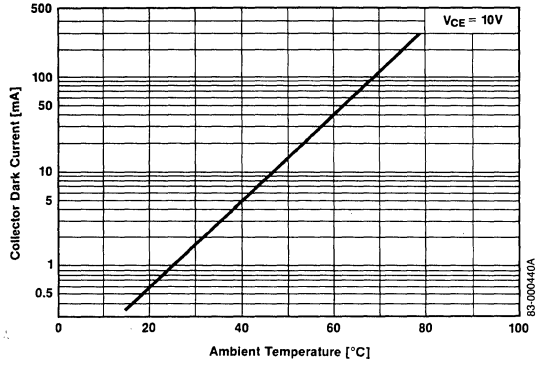


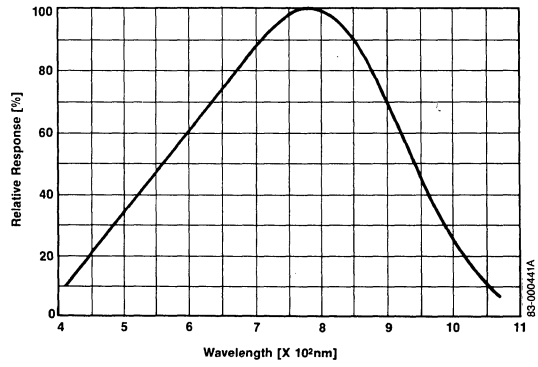

Photo Current vs Illuminance



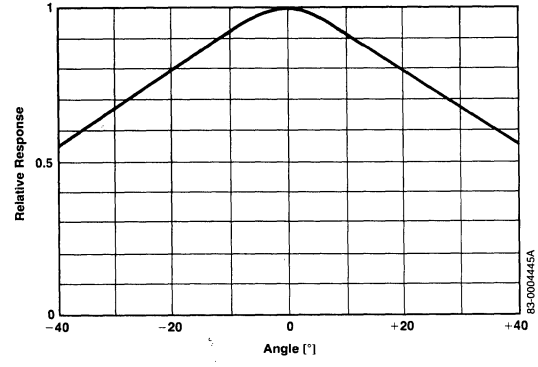

Collector Dark Current vs Ambient Temperature




Spectral Response



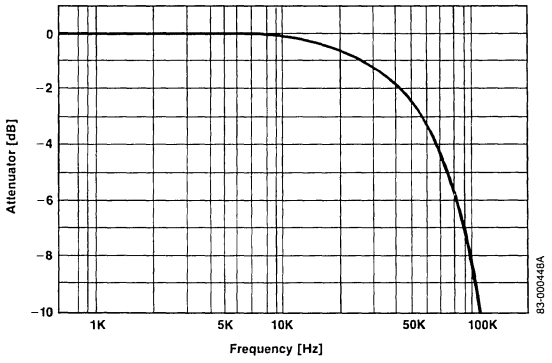

Spatial Distribution



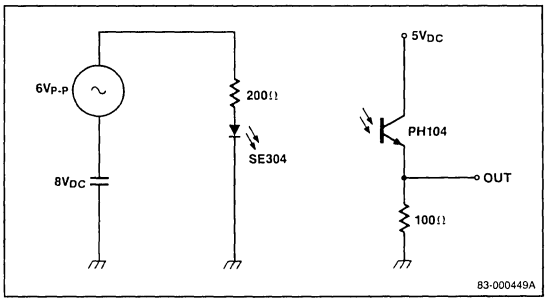
## Typical Characteristics (cont)

$T_A = +25°C$

Frequency Response




Frequency Response Test Circuit

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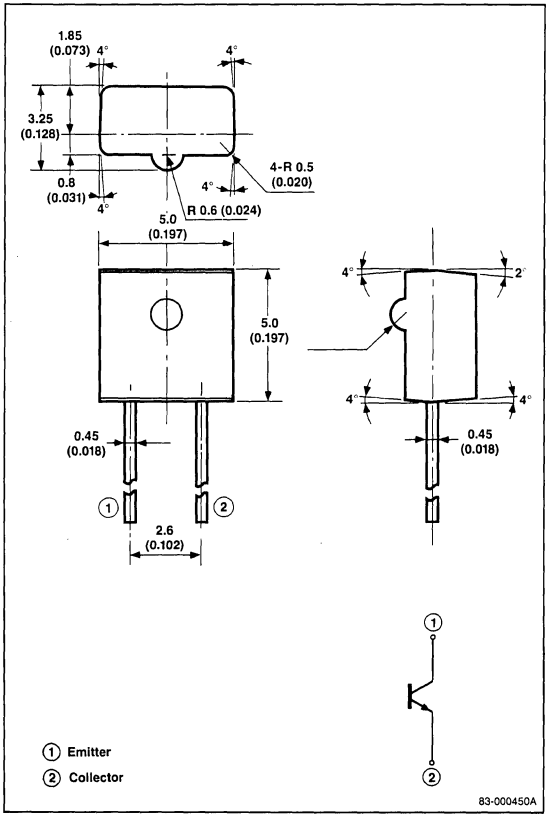
# PH106
# PHOTO TRANSISTOR
*NEPOC SERIES*

## Description

The PH106 is a photo transistor in a plastic molded package and is very suitable as a detector of a photo interrupter.

## Package Dimensions




## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Collector to Emitter Voltage, $V_{CEO}$ | 30V |
| Collector Current, $I_C$ | 40mA |
| Power Dissipation, $P_D$ | 100mW |
| Junction Temperature, $T_J$ | 100°C |
| Storage Temperature, $T_{STG}$ | −40°C to +100°C |

## Electrical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Collector to Emitter Dark Current | $I_{CEO}$ | | | 100 | nA | $V_{CE}$ = 10V, L = 0lx |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | | 0.3 | V | $I_C$ = 0.5mA, L = 1000lx[1] |
| Photo Current | $I_L$ | 100 | | | μA | $V_{CE}$ = 2.0V, L = 100lx[1] |
| Fall Time | $t_f$ | | 5 | | μs | $V_{CC}$ = 10V, $I_L$ = 0.5mA, $R_L$ = 100Ω |

**Note:** 1. Measured with a tungsten filament lamp operated at a color temperature of 2854K.

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## Typical Characteristics

$T_A$ = +25°C

Power Dissipation vs Ambient Temperature

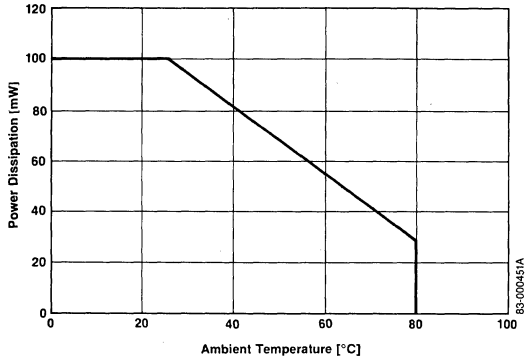
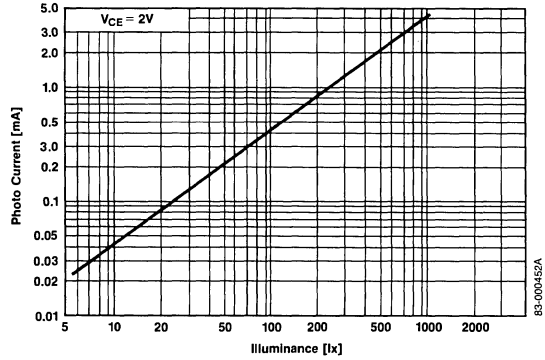
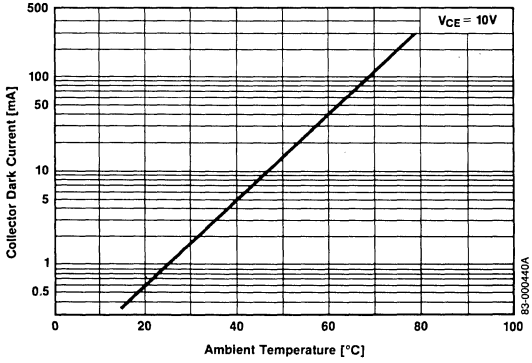


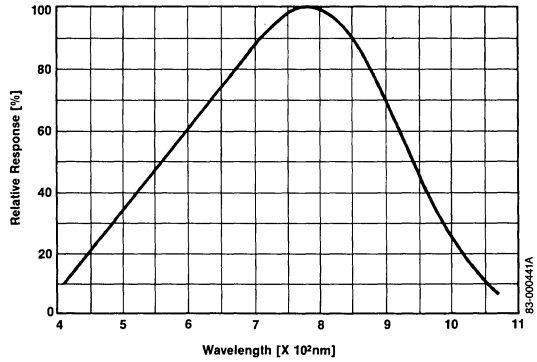

Photo Current vs Illuminance




Collector Dark Current vs Ambient Temperature




Spectral Response



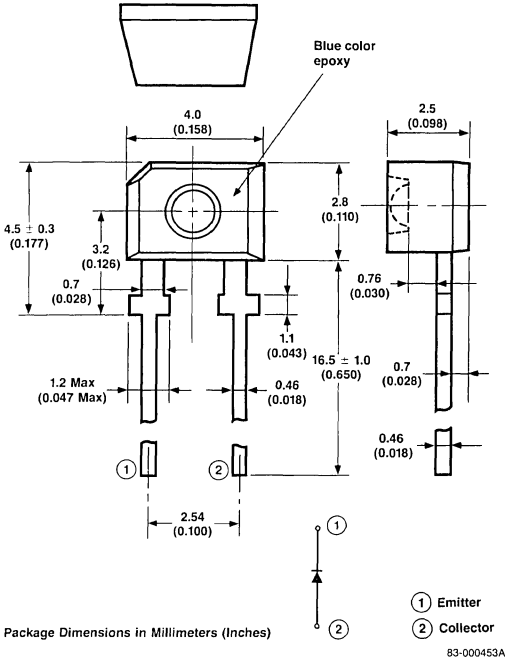
# PH108
# NPN SILICON EPITAXIAL TRANSISTOR

*NEPOC SERIES*

## Description

The PH108 is a highly sensitive photo transistor in a small plastic molded package and is suitable as a detector of a photo interrupter.

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000453A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Collector-Emitter Voltage, $V_{CEO}$ | 30V |
| Collector Current, $I_C$ | 40mA |
| Power Dissipation, $P_D$ | 100mW |
| Junction Temperature, $T_J$ | 100°C |
| Operating Temperature, $T_{OPT}$ | −20°C~ +80°C |
| Storage Temperature, $T_{STG}$ | −40°C~ +100°C |

## Electrical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Dark Current | $I_{CEO}$ | | | 100 | nA | $V_{CE}$ = 10V, H = 0mW/cm²* |
| Collector Saturation Voltage | $V_{CE(sat)}$ | | | 0.3 | V | $I_C$ = 0.5mA, H = 5mW/cm²* |
| Photo Current | $I_L$ | 0.3 | 0.9 | | mA | $V_{CE}$ = 5V, H = 0.5mW/cm²* |
| Rise and Fall Time | $t_r$, $t_f$ | | | 40 | μ | $V_{CC}$ = 10V, H = 0.5mW/cm²* $R_L$ = 1.0kΩ |
| 50% Response Angle | $I_{LO}/2$ | | 15 | | °C | Between 50% sensitivity points |

**Note:** *When exposed to infrared light of wavelength $\lambda_p$ = 940nm.

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## Typical Characteristics
$T_A$ = +25°C

Power Dissipation vs Ambient Temperature

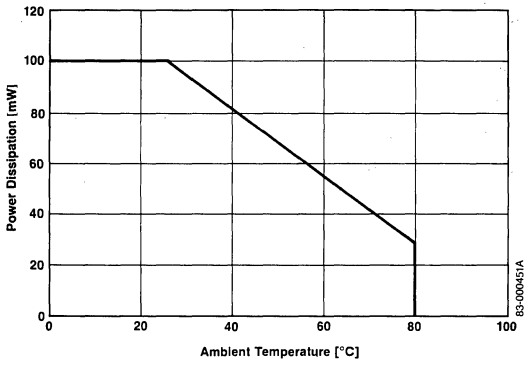
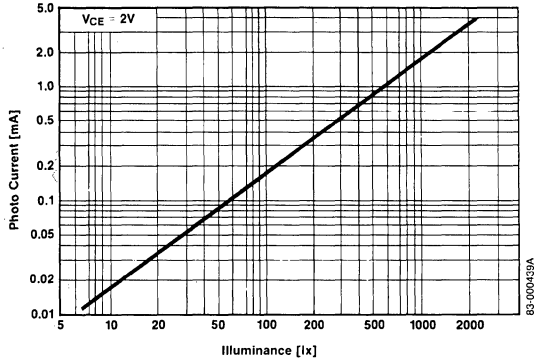
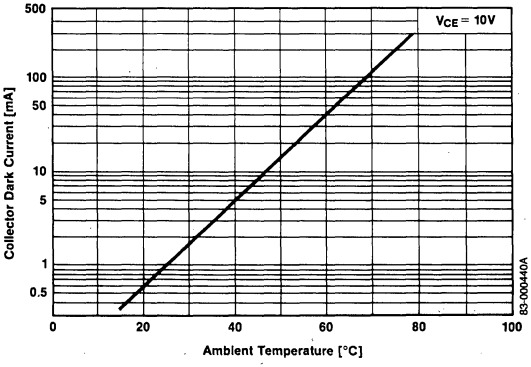



Photo Current vs Illuminance




Collector Dark Current vs Ambient Temperature



# PH201A
# PHOTO DETECTOR
# GaAsP PHOTO DIODE

*NEPOC SERIES*

## Description

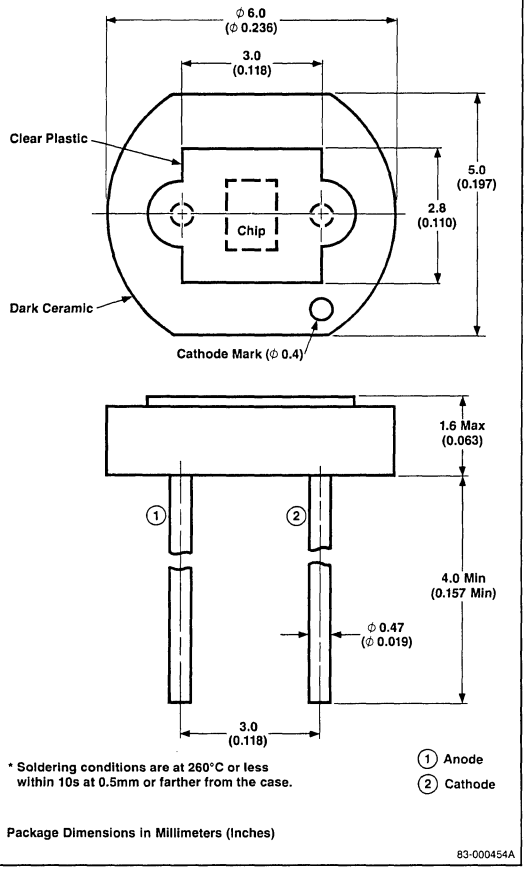
The PH201A is a GaAsP (Gallium Arsenide Phosphide) photo diode designed for use as a photo detector in electronic cameras.

It features a wide active area, spectral response close to that of the human eye and a wide photo current range.

## Features

- ☐ Suitable for photo detector application in cameras
- ☐ No filter is required, the spectral response matches that of the human eye
- ☐ Low dark current

## Package Dimensions




* Soldering conditions are at 260°C or less within 10s at 0.5mm or farther from the case.

Package Dimensions in Millimeters (Inches)

83-000454A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Reverse Voltage, $V_R$ | 5.0V |
| Forward Current, $I_F$ | 1.0mA |
| Operating Temperature, $T_{OPT}$ | −30°C to +60°C |
| Storage Temperature, $T_{STG}$ | −40°C to +80°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Photo Current | $I_{SH}$ | 60 | 90 | 120 | nA | 100lx[3] |
| Dark Current | $I_D$ | | 0.3 | 3.0 | pA | $V_R$ = 2.0V |
| Photo Current Ratio | R[1] | | $10^6$ | | | 0.001 ~ 1,000 lx[3] |
| Relative Spectral Response | | | See Fig.1 | | | |
| Rise Time | $t_r$ | | 150 | | μs | See rise time test circuit |
| Variation of Photo Current | Δ[2] | | 13 | | % | 100lx[3, 4] |

**Notes:** 1. $R = \frac{I_{SH} \text{ at } 1000 \text{ lx}}{I_{SH} \text{ at } 0.001 \text{ lx}}$

2. Δ = ($I_{SH}$ at a color temperature of 2854K − $I_{SH}$ at a color temperature of 4870K)/($I_{SH}$ at a color temperature of 2854K) × 100(%).
3. Measured with a tungsten filament lamp operated at a color temperature of 2854K.
4. Measured at a color temperature of 4870K.

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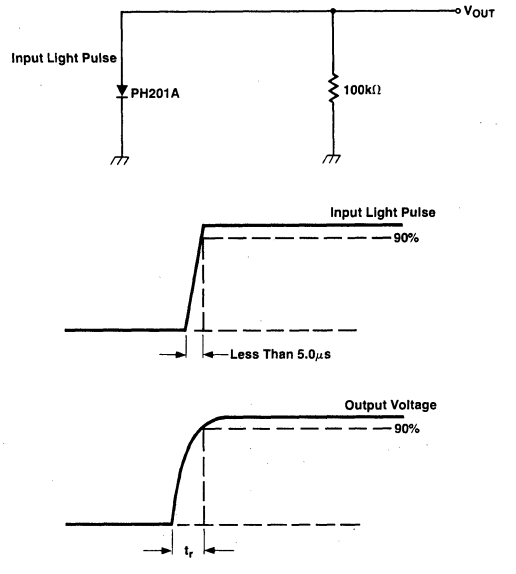
## Rise Time Test Circuit

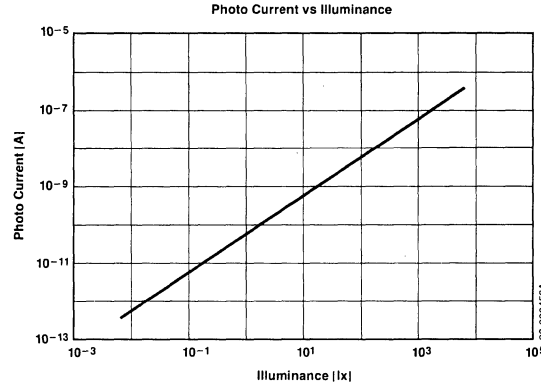


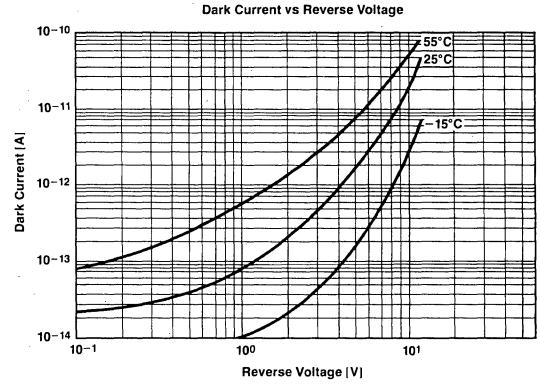

Note: Light source is an LED from which the PH201A gets 100lx illumination.

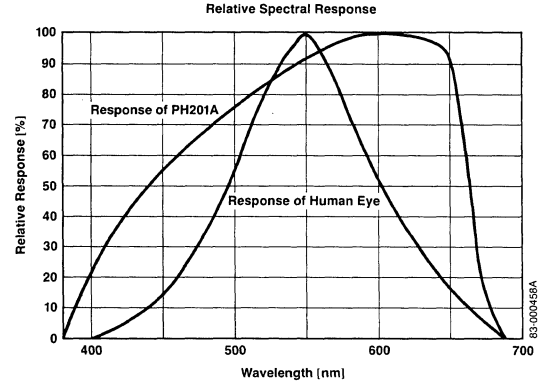
83-000455B

## Typical Characteristics

$T_A$ = +25°C



NEC
NEC Electronics Inc.

# PH302
# PLASTIC MOLDED PIN PHOTO DIODE

*NEPOC SERIES*

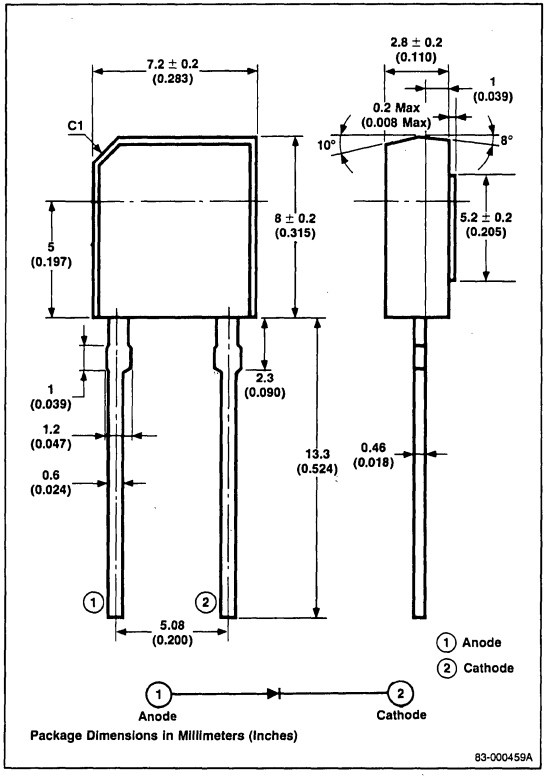
## Description

The PH302 is a photo diode with a PIN structure. It has a wide photo-receiving area and high-speed response enabling applications for various types of remote control equipment. The resin material used for the package has the filter effect of transmitting only infrared.

## Features

- ☐ Ultrahigh-speed response ($t_r$, $t_f$ = 50ns)
- ☐ The wavelength of maximum sensitivity matches that of an infrared LED ($\lambda_{S\text{-}MAX}$ = 940nm)
- ☐ High sensitivity (50nA/lx)
- ☐ Wide dynamic range

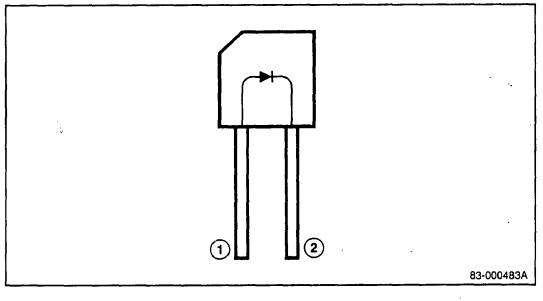
## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000459A

## Pin Connection



83-000483A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Reverse Voltage, $V_R$ | 32V |
| Power Dissipation, $P_D$ | 150mW |
| Junction Temperature, $T_J$ | 80°C |
| Storage Temperature, $T_{STG}$ | −40°C to +80°C |

## Electrical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Dark Current | $I_R$ | | | 30 | nA | $V_R$ = 10V |
| Maximum Sensitivity Wavelength | $\lambda_{MAX}$ | | 940 | | nm | |
| Quantum Efficiency | $\eta$ | | 0.88 | | | $\lambda$ = 940nm |
| Spectral Sensitivity | S | 35 | 50 | | nA/lx | $V_R$ = 5V |
| Spectral Sensitivity | S | | 0.6 | | A/W | $\lambda$ = 940nm |
| Open Circuit Voltage | $V_L$ | | 285 | | mV | $E_V$ = 100lx |
| Open Circuit Voltage | $V_L$ | | 365 | | mV | $E_V$ = 1000lx |
| Rise and Fall Time of the Photo Current from 10% to 90% and 90% to 10% of the Final Value | $t_r$, $t_f$ | | 125 | | ns | $R_L$ = 1kΩ, $V_R$ = 0V, $\lambda$ = 940nm |
| | $t_r$, $t_f$ | | 50 | | ns | $R_L$ = 1kΩ, $V_R$ = 5V, $\lambda$ = 940nm |
| Capacitance | $C_T$ | | 14 | | pF | $V_R$ = 5V, f = 1MHz |
| Radiant Sensitive Area | A | | 9 | | $mm^2$ | |
| Noise Equivalent Power | NEP | | $4.2 \times 10^{-14}$ | | $W/\sqrt{Hz}$ | $V_R$ = 10V |
| Detection Limit | D | | $6.6 \times 10^{12}$ | | $cm/\sqrt{Hz}/W$ | |

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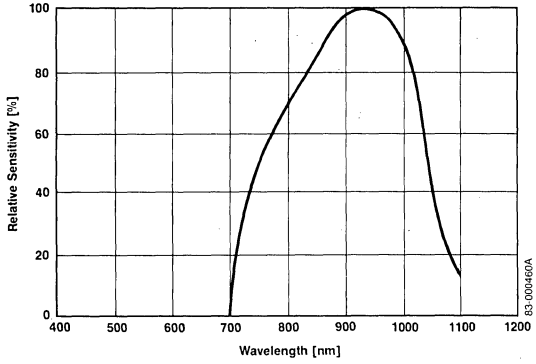
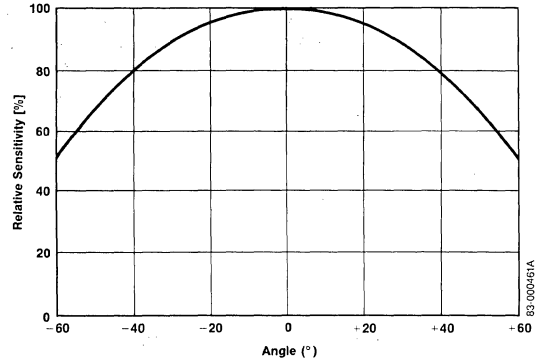
## Typical Characteristics

$T_A$ = +25°C

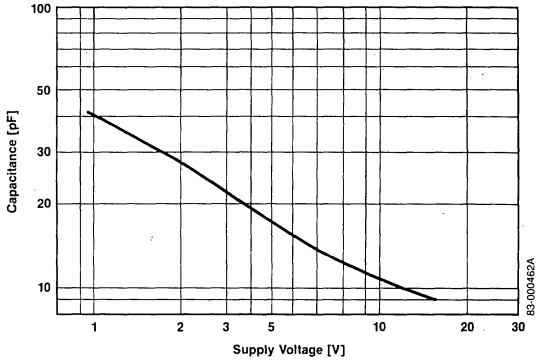
Wavelength Sensitivity



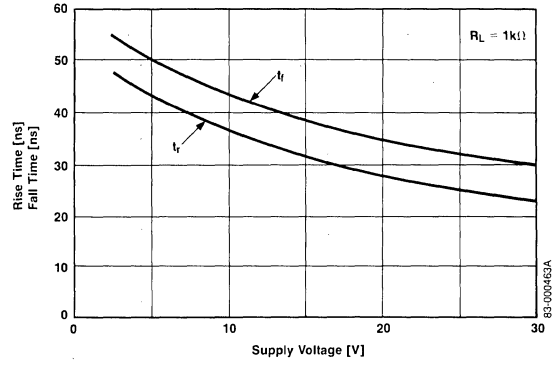

Directional Characteristic



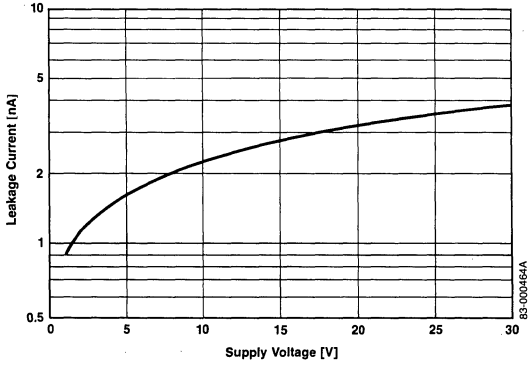

Capacitance vs Supply Voltage



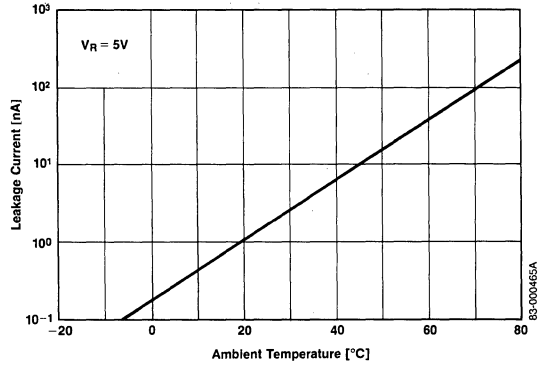

Rise Time/Fall Time vs Supply Voltage




Leakage Current vs Supply Voltage



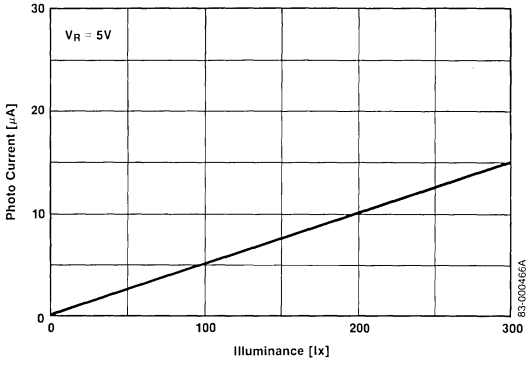

Leakage Current vs Ambient Temperature



## Typical Characteristics (cont)

$T_A = +25°C$

Photo Current vs Illuminance




Relative vs Ambient Temperature

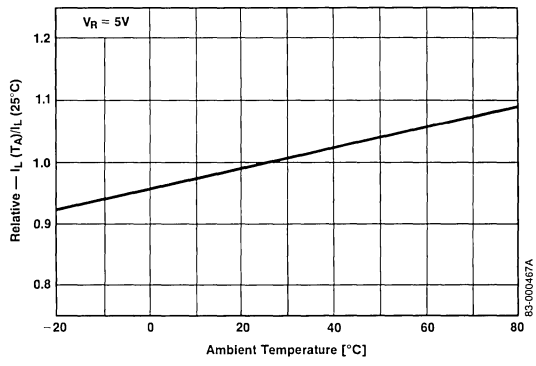



Photo Current vs Supply Voltage

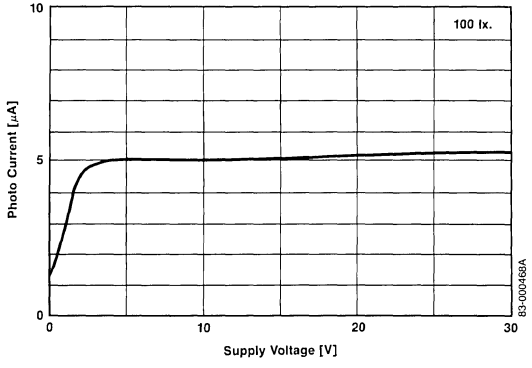
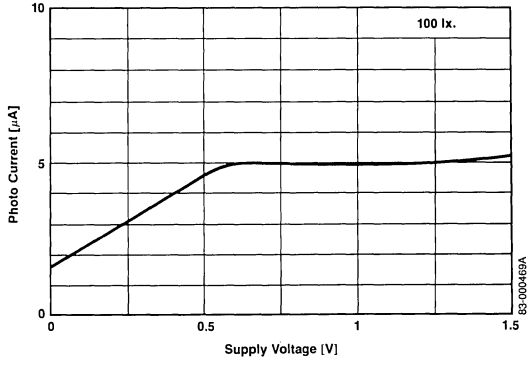
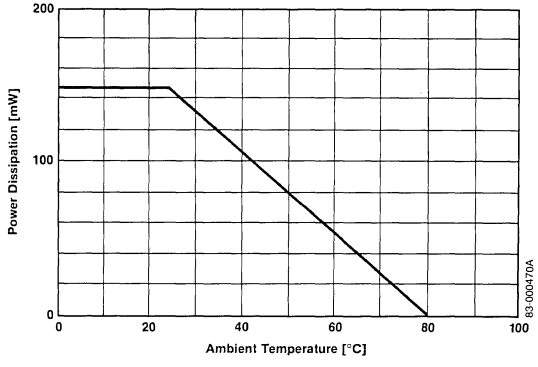



Photo Current vs Supply Voltage




Power Dissipation vs Ambient Temperature




7

# PH302B
# PIN PHOTO DIODE

*NEPOC SERIES*

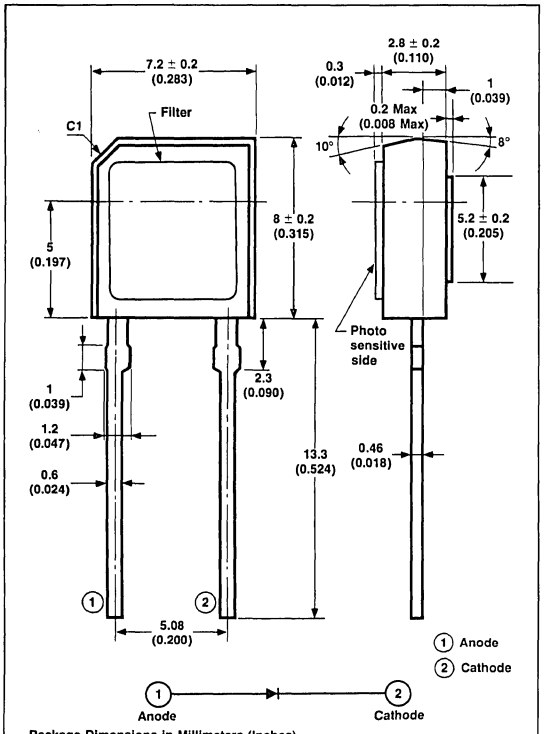
## Description

The PH302B is a PIN photo diode similar to the PH302 but with an added filter which filters out visible light. The narrow spectral response range beginning at 840nm prevents any malfunction under fluorescent light. The large sensitive area and fast response make it suitable for various remote control applications.

## Features

- ☐ Ultrahigh-speed response ($t_r$, $t_f$ = 50ns)
- ☐ The maximum sensitive wavelength matches that of an infrared LED ($\lambda_{S\text{-}MAX}$ = 940nm)
- ☐ High sensitivity (34nA/lx)
- ☐ Wide dynamic range
- ☐ Visible light filtration (minimum sensitive wavelength: 840nm)

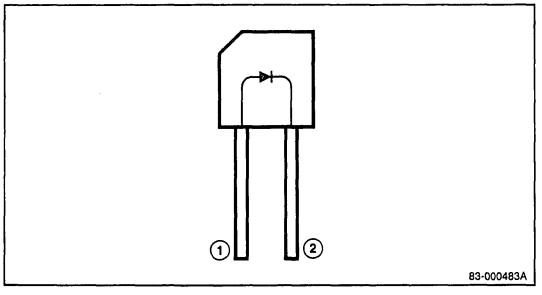
## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000471A

## Pin Connection



83-000483A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Reverse Voltage, $V_R$ | 32V |
| Power Dissipation, $P_D$ | 150mW |
| Junction Temperature, $T_J$[1] | 80°C |
| Storage Temperature, $T_{STG}$[1] | −40°C~ +80°C |

**Note:** 1. The maximum ratings of $T_J$ and $T_{STG}$ are those of the PH302. Because of the adhesive between the filter and diode, storage and operating temperature should be kept between −20°C and +60°C.

## Electrical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Dark Current | $I_R$ | | | 30 | nA | $V_R$ = 10V |
| Maximum Sensitivity Wavelength | $\lambda_{MAX}$ | | 940 | | nm | |
| Quantum Efficiency | $\eta$ | | 0.88 | | | λ = 940nm |
| Spectral Sensitivity | S | 22 | 32 | | nA/lx[1] | $V_R$ = 5V |
| Spectral Sensitivity | S | | 0.6 | | A/W | λ = 940nm |
| Rise and Fall Time | $t_r$, $t_f$ | | 125 | | ns | $R_L$ = kΩ, $V_R$ = 0, λ = 940nm |
| | $t_r$, $t_f$ | | 50 | | ns | $R_L$ = kΩ, $V_R$ = 5V, λ = 940nm |
| Capacitance | $C_T$ | | 14 | | pF | $V_R$ = 5V, f = 1MHz |
| Radiant Sensitive Area | A | | 9 | | $mm^2$ | |

**Note:** 1. Measured at a color temperature of 2854K.

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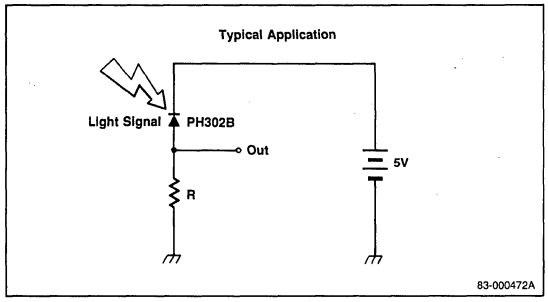
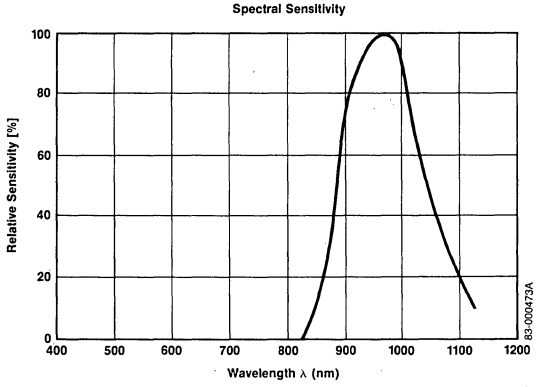
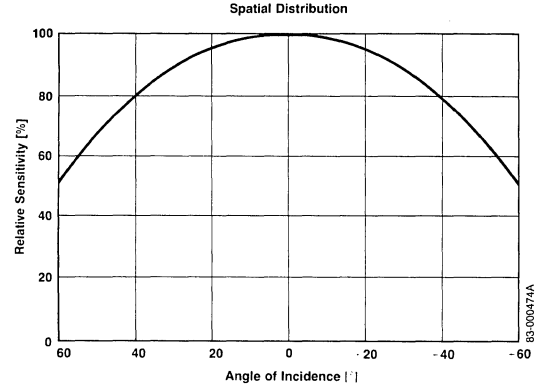
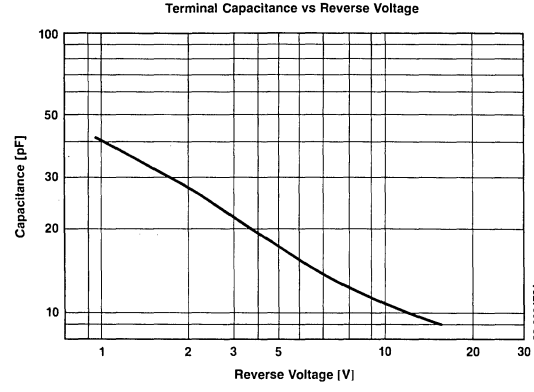


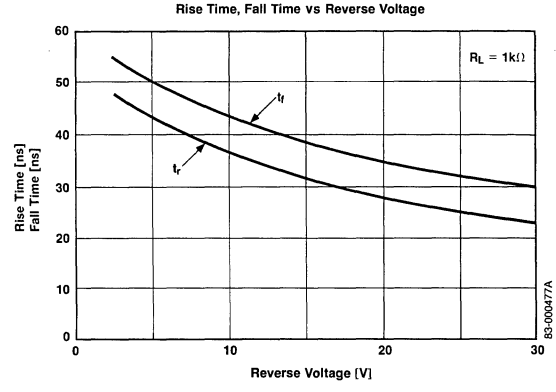

## Typical Characteristics

$T_A$ = +25°C



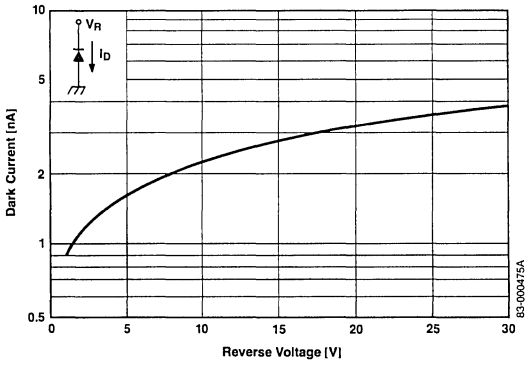



## Typical Characteristics (cont)

$T_A = +25°C$

Dark Current vs Reverse Voltage




Dark Current vs Ambient Temperature

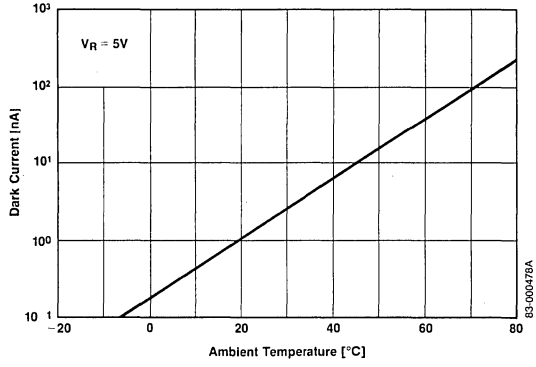



Photo Current vs Illumination

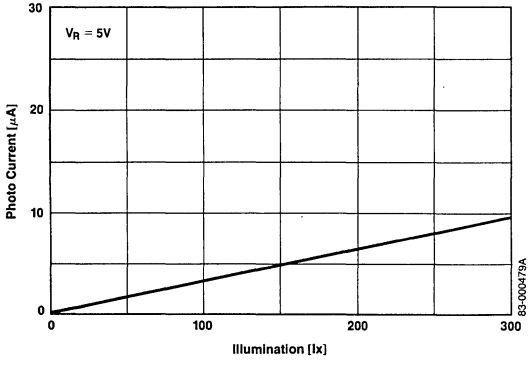



Photo Current vs Ambient Temperature

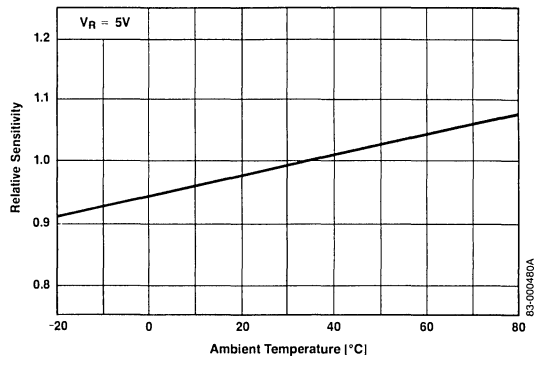



Photo Current vs Reverse Voltage

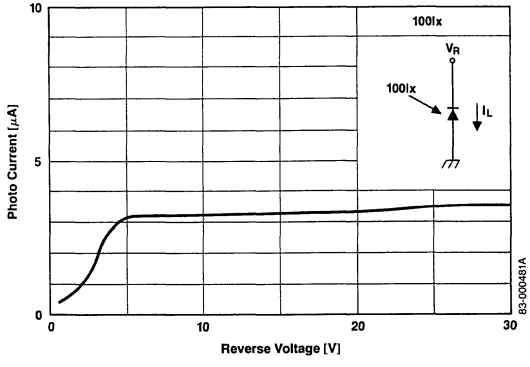
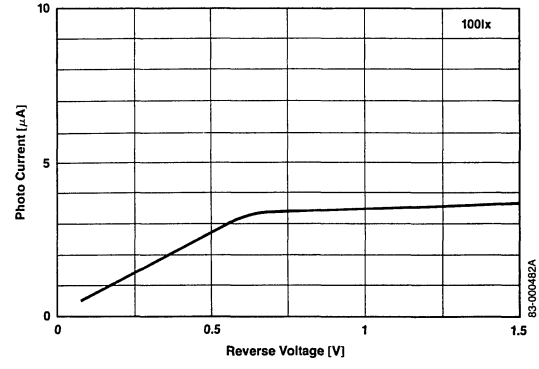



Photo Current vs Reverse Voltage

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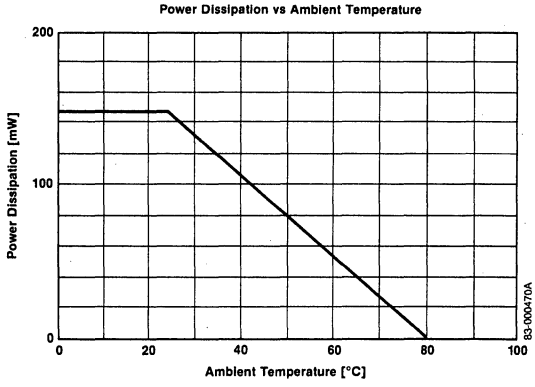
## Typical Characteristics (cont)

$T_A = +25°C$



NEC
NEC Electronics Inc.

# PH305
# PLASTIC MOLDED PIN PHOTO DIODE

*NEPOC SERIES*

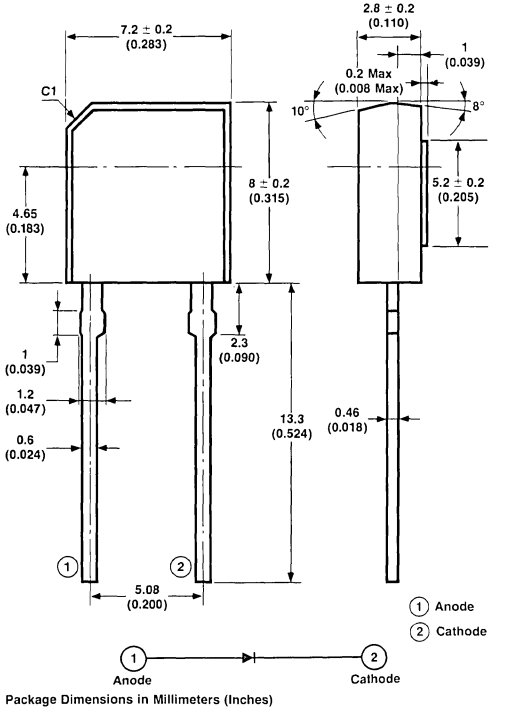
## Description

The PH305 is a photo diode with PIN structure. It is very suitable for a light detector with a 7-10m remote controller or a 0.3-5m opto-interrupter. The resin material used for the package has the filter effect of transmitting only infrared radiation.

## Features

- ☐ Ultrahigh-speed response ($t_r$, $t_f$ = 30ns)
- ☐ The wavelength of maximum sensitivity matches that of an infrared LED ($\lambda_{S\text{-}MAX}$ = 940nm)
- ☐ High sensitivity (32nA/lx)
- ☐ Wide dynamic range

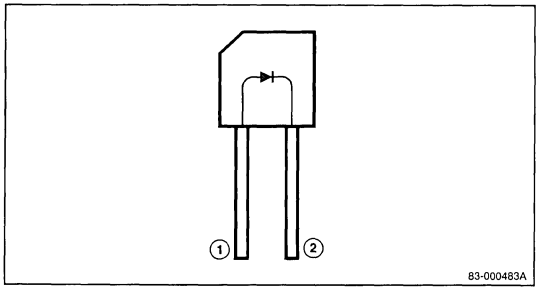
## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000484A

## Pin Connection



83-000483A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Reverse Voltage, $V_R$ | 20V |
| Power Dissipation, $P_D$ | 150mW |
| Junction Temperature, $T_J$ | 80°C |
| Storage Temperature, $T_{STG}$ | −40°C to +80°C |

## Electrical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Dark Current | $I_R$ | | | 30 | nA | $V_R$ = 10V |
| Wavelength of Maximum Sensitivity | $\lambda_{S\ MAX}$ | | 940 | | nm | |
| Quantum Efficiency | $\eta$ | | 0.88 | | | $\lambda$ = 940nm |
| Spectral Sensitivity | S | 23 | 32 | | nA/lx | $V_R$ = 5V |
| Spectral Sensitivity | S | | 0.6 | | A/W | $\lambda$ = 940nm |
| Rise and Fall Time of the Photo Current from 10% to 90% and 90% to 10% of the Fianl value | $t_r$, $t_f$ | | 125 | | ns | $R_L$ = 1kΩ, $V_R$ = 0V $\lambda$ = 940nm |
| | $t_r$, $t_f$ | | 50 | | ns | $R_L$ = 1kΩ, $V_R$ = 5V, $\lambda$ = 940nm |
| Capacitance | $C_T$ | | 11 | | pF | $V_R$ = 5V, f = 1MHz |
| Radiant Sensitive Area | A | | 5.3 | | $mm^2$ | |

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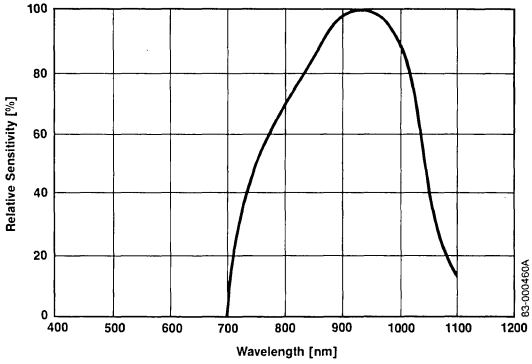
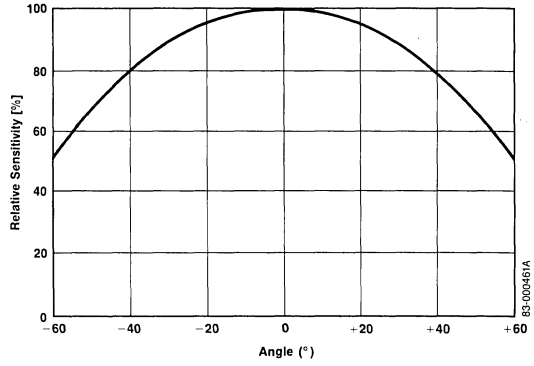
## Typical Characteristics
$T_A$ = +25°C

Wavelength Sensitivity




Directional Characteristic



# PH309
# PLASTIC MOLDED PIN PHOTO DIODE

*NEPOC SERIES*

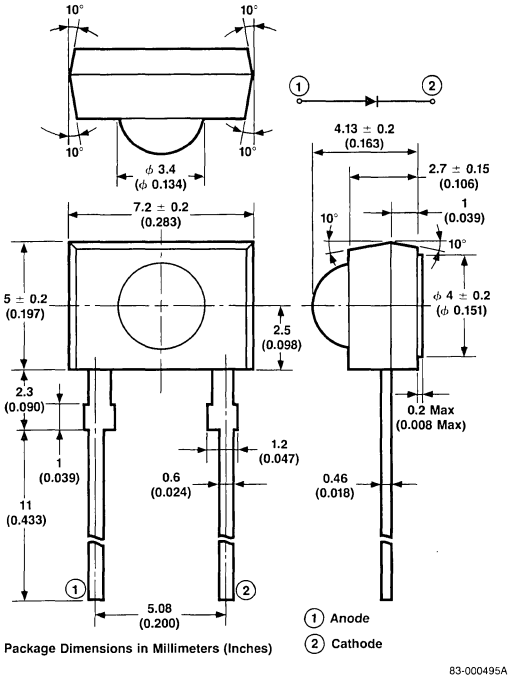
## Description

The PH309 is a photo diode with a PIN structure. It has a wide photo-receiving area and high-speed response enabling applications for various types of remote control equipment. The resin material used for the package has the filter effect of transmitting infrared radiation.

## Features

- ☐ Ultrahigh-speed response ($t_r$, $t_f$ = 30ns)
- ☐ The wavelength of maximum sensitivity matches that of an infrared LED ($\lambda_{S\text{-}MAX}$ = 940nm)
- ☐ High sensitivity (31nA/lx)
- ☐ Wide dynamic range

## Package Dimensions




Package Dimensions in Millimeters (Inches)

83-000495A

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Reverse Voltage, $V_R$ | 20V |
| Power Dissipation, $P_D$ | 150mW |
| Junction Temperature, $T_J$ | 80°C |
| Storage Temperature, $T_{STG}$ | −40°C to +80°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Dark Current | $I_R$ | | | 30 | nA | $V_R$ = 10V |
| Wavelength of Maximum Sensitivity | $\lambda_{MAX}$ | | 940 | | nm | |
| Quantum Yield | $\eta$ | | 0.88 | | | $\lambda$ = 940nm |
| Spectral Sensitivity | S | | 50 | | nA/lx | $V_R$ = 5V |
| Spectral Sensitivity | $S_{IR}$ | | 4.7 | | μA | $V_R$ = 5V, H = 0.1mW/cm²* |
| Rise and Fall Time of the Photo Current from 10% to 90% and 90% to 10% of the Final Value | $t_r$, $t_f$ | | 120 | | ns | $R_L$ = 1kΩ, $V_R$ = 0V, $\lambda$ = 940nm |
| | $t_r$, $t_f$ | | 30 | | ns | $R_L$ = 1kΩ, $V_R$ = 5V, $\lambda$ = 940nm |
| Capacitance | $C_T$ | | 11 | | pF | $V_R$ = 5V, f = 1MHz |
| Radiant Sensitive Area | A | | 5.3 | | mm² | |

*$\lambda$ = 940nm

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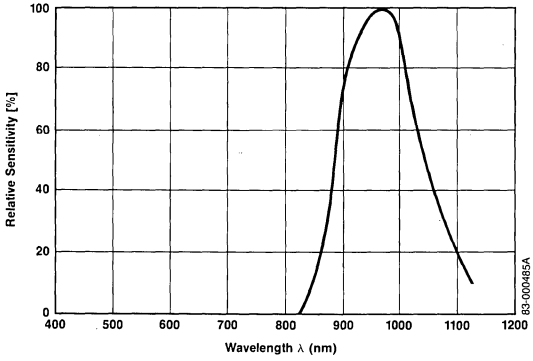
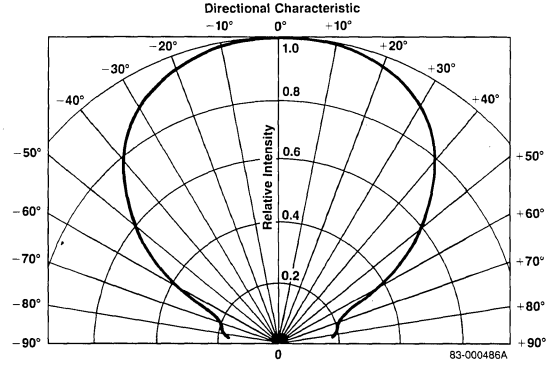
## Typical Characteristics

$T_A$ = +25°C

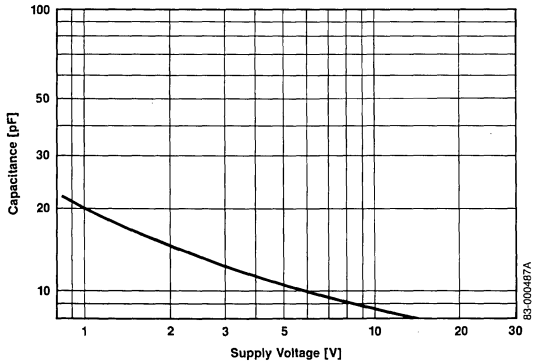
Wavelength Sensitivity



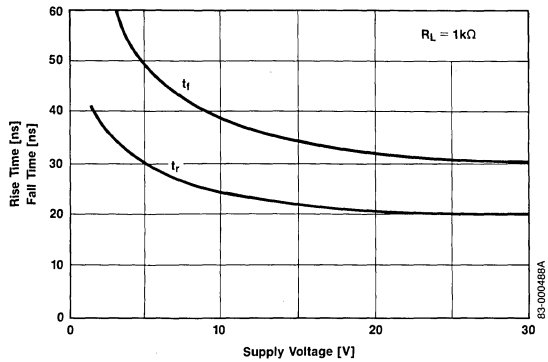

Directional Characteristic



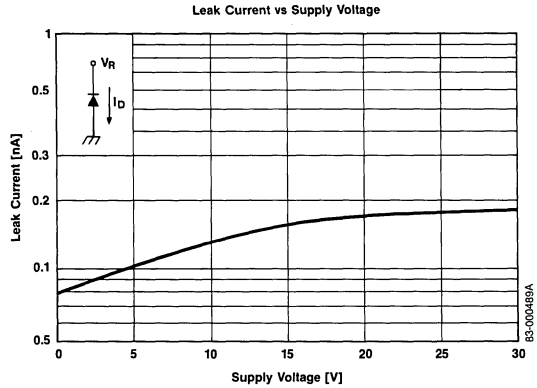

Capacitance vs Supply Voltage



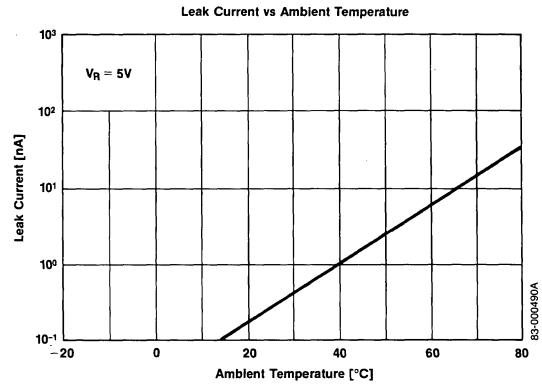

Rise Time and Fall Time vs Supply Voltage




Leak Current vs Supply Voltage



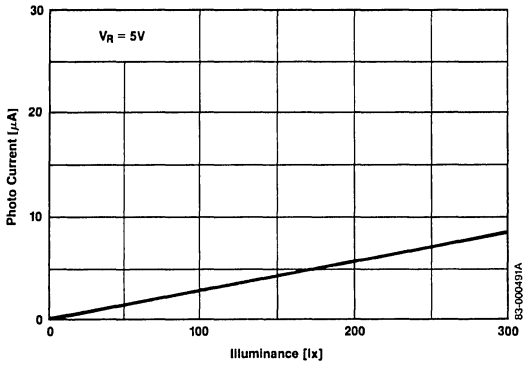

Leak Current vs Ambient Temperature



## Typical Characteristics (cont)

$T_A$ = +25°C

Photo Current vs Illuminance




Relative vs Ambient Temperature

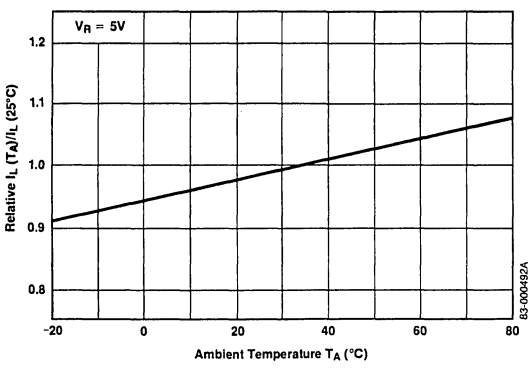



Photo Current vs Supply Voltage

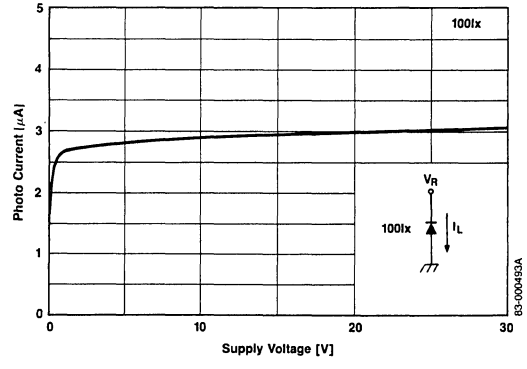
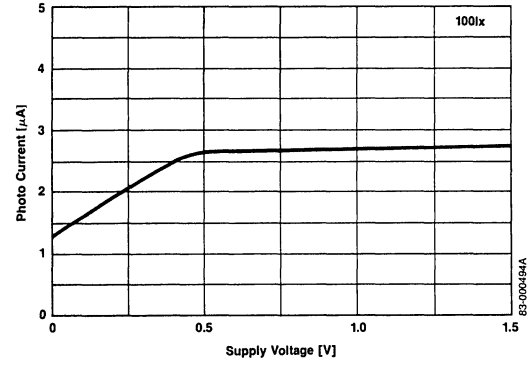
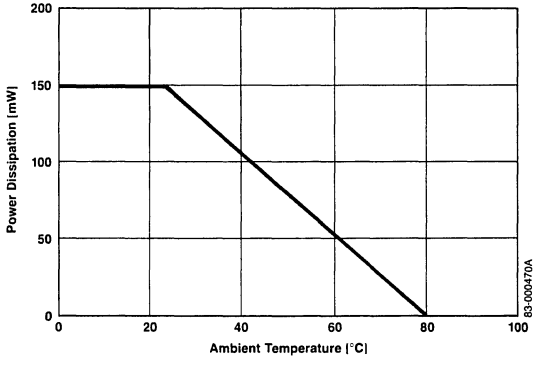



Photo Current vs Supply Voltage




Power Dissipation vs Ambient Temperature

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The basic photo interrupter is made up of two components: the emitter, which is generally a light emitting diode (LED) in the red or infrared light spectrum, and the detector, which is generally a photo transistor or photo Darlington structure.

Figure 1 illustrates the basic photo interrupter. Light in the visible or infrared region is emitted from an LED (D1). The light beam then travels some predetermined distance (usually less than 6mm) and arrives at the base of the photo transistor (Q1). The light energy creates a base current, which in turn forward biases the base emitter junction and turns the transistor on. When the light beam is broken, no base current is available and the photo transistor (Q1) is turned off.

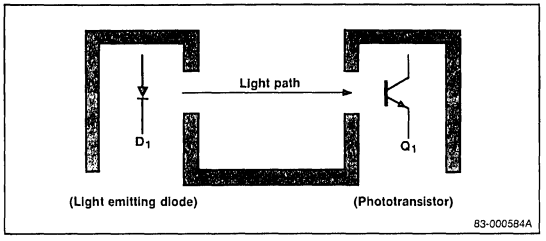



***Figure 1. Basic Configuration of a Photo Interrupter***

Prepackaged photo interrupter units have made the job of designing interrupter-based circuits simple and cost effective. As can be seen in Figure 2, the basic photo interrupter design is implemented in a one-piece assembly for mass production, and although the package and emitter/detector distance changes, the basic structure and electrical characteristics are very similar.

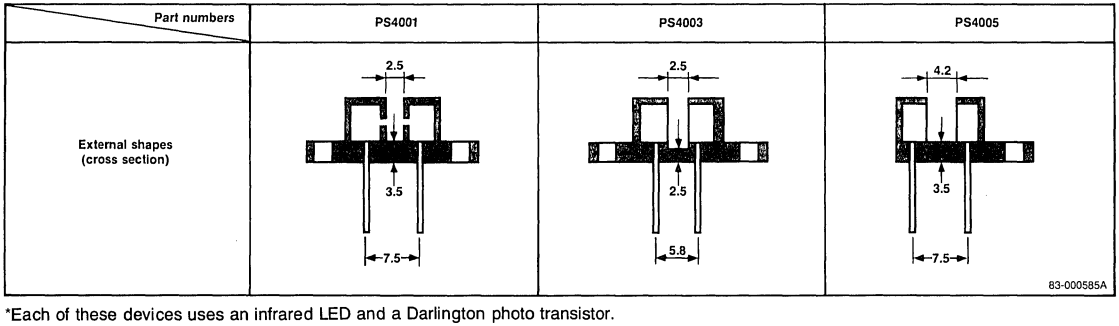
In applications where the one-piece photo interrupter cannot be used, an equivalent circuit can be implemented by using discrete devices. Figure 3 shows the same basic circuit that we saw in Figure 1, but in this case the two elements are discrete devices in the form of a photo diode and photo transistor and the distance between units can be varied. The distance between, and the alignment of, the emitter and detector units are critical factors in discrete designs. If the spacing between elements is small (less than 2mm), then a standard photo transistor will suffice. But for long distances (greater than 2.5mm), a Darlington photo transistor is recommended. In either case the emitting element should be in the infrared region to realize maximum energy transfer between emitter and detector.

Table 1 shows the discrete devices available from NEC which are recommended for photo interrupter applications.

| | | External Shape | ($\phi$2 ~ $\phi$3.8) | ($\phi$4.8) | ($^{F}$5) |
|---|---|---|---|---|---|
| A (Light Emitting) | Visible Red Light | | SR106C | SR503C SR603C | SR110 |
| | Infrared Light | | SE302A | *SE303 | SE304 |
| B (Light Receiving) | Single Photo Transistor | | PH102 | *PH105 | PH104 |
| | Darlington Photo Transistor | | PH101 | — | PH103 |

*Under development (for detailed specifications, please refer to catalog).

***Table 1. Discrete Devices for Photo Interrupters***




*Each of these devices uses an infrared LED and a Darlington photo transistor.

***Figure 2. One-Piece Photo Interrupters***

## Basic Photo Interrupter Design Hints

A critical consideration in the design of photo interrupter circuits is the current transfer ratio (CTR) of the circuit at a predetermined emitter/detector distance.

If the current through the LED (D1) is $I_F$ and the current through the photo transistor (Q1) is $I_C$, then the CTR can be calculated as shown in Figure 3.

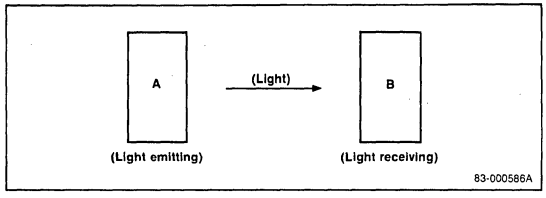



*Figure 3. Current Transfer Ratio (CTR)*

Photo emitters can be light emitting diodes (LEDs) in either the red or infrared light spectrum. At identical forward current ($I_F$), the infrared ($I_R$) emitter efficiency is three to five times that of the red emitter. At the same time, the spectral sensitivity of silicon photo transistors is two to three times greater in the infrared region (800 to 960nm) than in the red region (630 to 680 nm). The graph in Figure 4 illustrates the relative light sensitivity of a photo transistor.

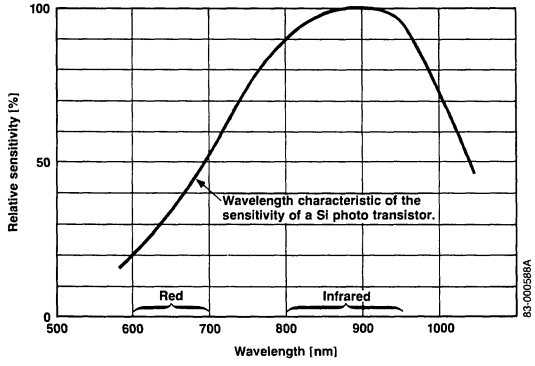



*Figure 4. Relative Sensitivity of Photo Transistor*

In Figure 5, the output voltage of the photo transistor in Figure 4 can be calculated by first finding the forward current ($I_F$), where:

$$I_F = \frac{V_1 - V_F}{R_1}$$

$V_F$ = LED forward voltage drop
$V_1$ = LED anode voltage
$R_1$ = LED cathode (current limit) resistor

Assuming that CTR is $\eta$ (%), the output level of the photo transistor in the on state is:

$I_C = I_F \times \eta$ . . . and $V_{OUT} = R_L \times I_C = R_L \times I_F \times \eta =$
$R_L \div I_F \times \eta =$

$$\frac{R_L}{R_1} \times (V_1 - V_F) \times \eta$$

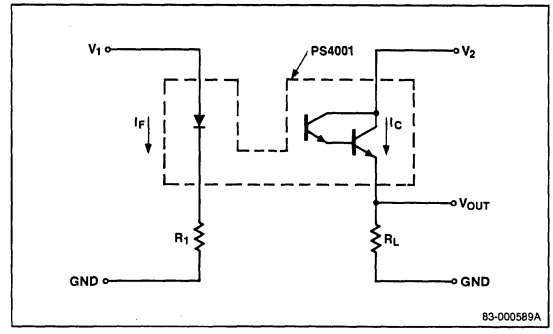



*Figure 5. Typical Photo Interrupter Circuit Calculating $V_O$*

If $R_1$ and $R_L$ are selected for $V_{OUT}$ greater than $V_2$, the transistor will be in saturation. But if $R_1$ and $R_L$ are chosen so that the output level $V_2 > V_{OUT} >$ ground, then the transistor will be in the unsaturated or linear mode. Since the CTR is prone to drift in the unsaturated linear mode, this type of operation is not recommended.

## Temperature

The temperature dependence of CTR is shown in Figure 6. At a constant current, the output power of LEDs decreases as the temperature increases. On the other hand, with a constant bias voltage the sensitivity of the photo transistor increases as the temperature increases. The graph in Figure 6 illustrates these characteristics using the SE304 Infrared LED with both the PH103 Darlington transistor and the PH104 single transistor.

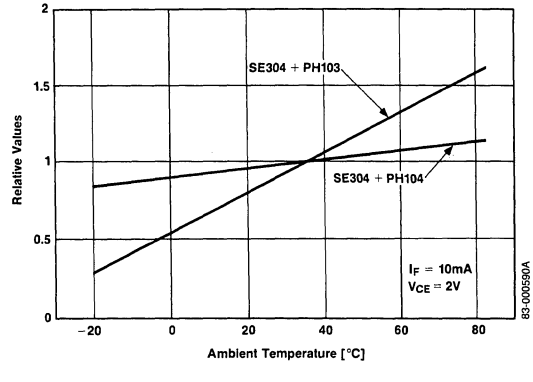



*Figure 6. Temperature Characteristics of CTR*

## Distance

Since the amount of light detected is inversely proportional to the distance between the light source and the detector, the effective sensitivity of the detector will be $1/\eta_2$ when the distance from a point light source is increased $\eta$-fold. If we use an LED as the point light source, and if the distance to the photo transistor is d, then:

$$d = \eta \text{ and } \ldots \text{ CTR } \frac{1}{d_2}$$

This characteristic is shown graphically in Figure 7 using the SE304 as the emitting device and the PH103 as the detecting device.

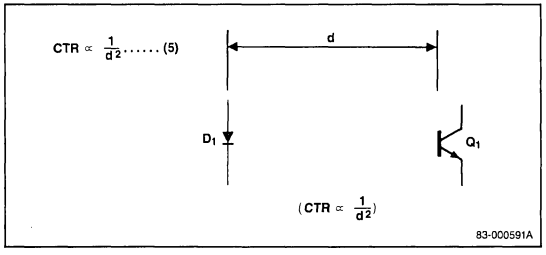



*Figure 7. CTR vs. Distance*

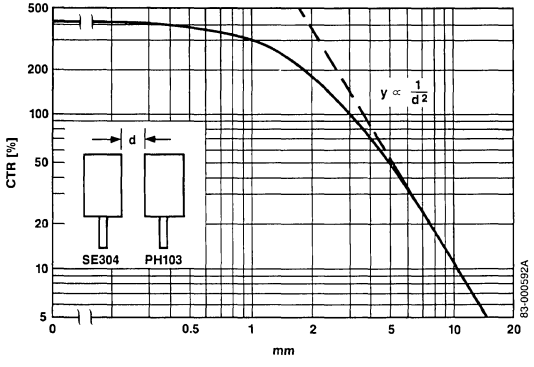



*Figure 8. CTR vs Distance Characteristic*

## Life Test

Highly reliable circuits cannot be designed without understanding the change in characteristics of the devices as they age. As is illustrated in Figures 9 through 12, the aging of photo interrupter devices has only a nominal effect on performance, with the exception of the CTR, which can easily be compensated for during the design cycle if necessary.

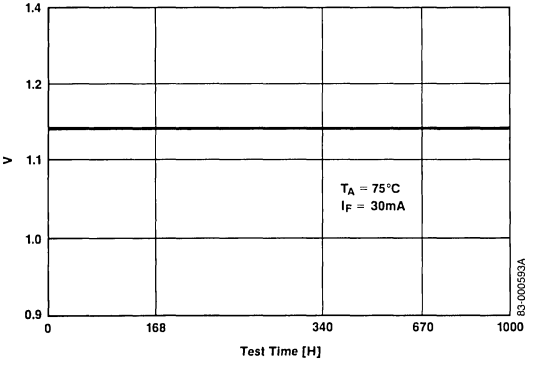



*Figure 9. $V_F$ Life Test*

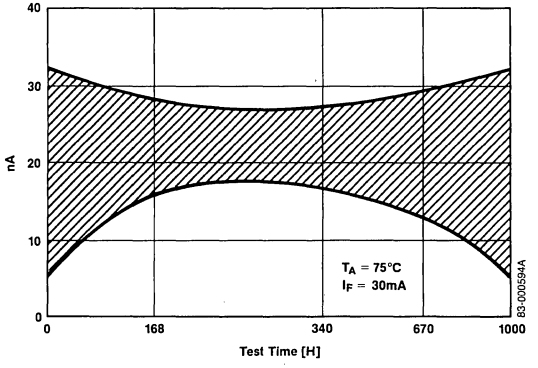



*Figure 10. $I_{CEO}$ Life Test*

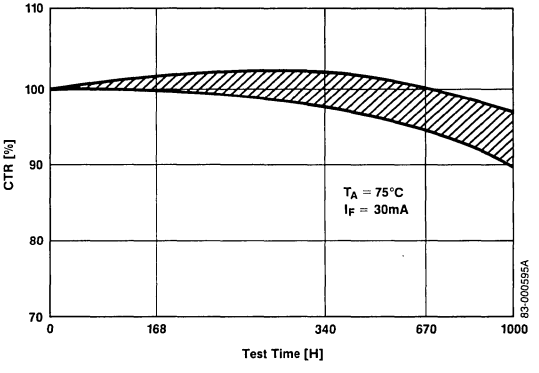



*Figure 11. CTR Life Test*

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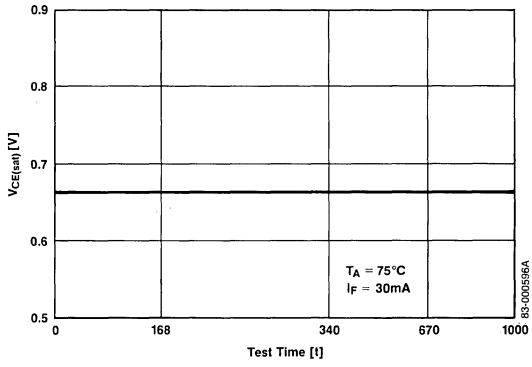



*Figure 12. $V_{CE(sat)}$ Life Test*

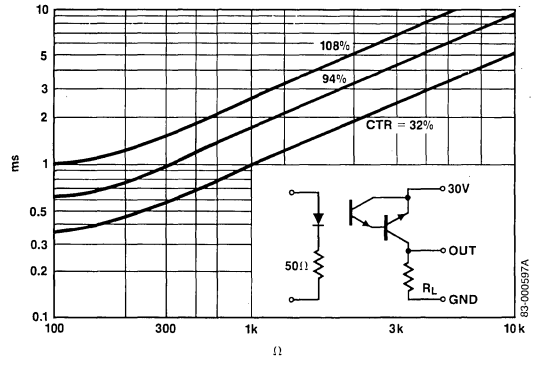
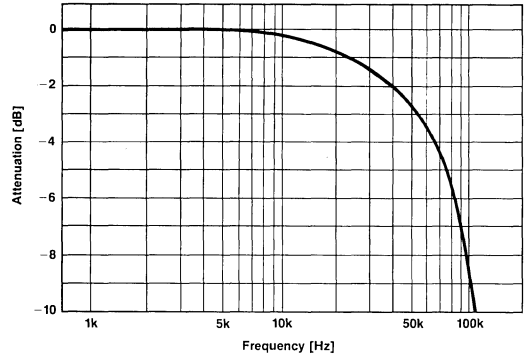


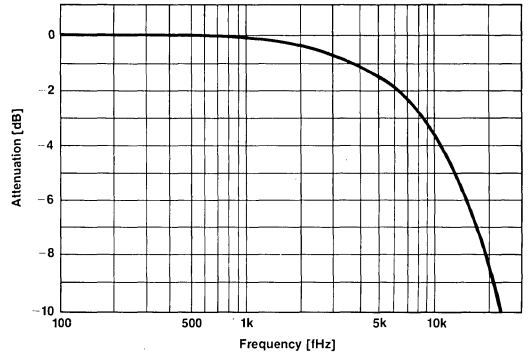

*Figure 13. $t_R$ vs $R_L$ of the PS4001*

## Switching Speed

The importance of switching speed in photo interrupters depends on the application. In mechanical interrupter systems where high-speed slotted disks are used to count or time events, high speed may be an important factor. The PH102 and PH104 have a rise time ($t_r$) and fall time ($t_f$) of 5$\mu$s with $R_L$ = 100Ω. The PH101 and PH103 Darlington devices have rise and fall times of 200 to 500$\mu$s at $R_L$ = 100Ω. This means that some trade-off of CTR versus speed will be necessary in high-speed designs, since single-transistor devices have a much lower CTR than the slower Darlingtons. This problem is generally overcome by adding a high-speed comparator, as a buffer stage, to the output of the photo transistor.

Figures 13, 14, and 15 show graphically the switching and frequency characteristics of the PS4001 photo interrupter, the PH104 single transistor, and the PH103 Darlington transistor under sinusoidal wave light.



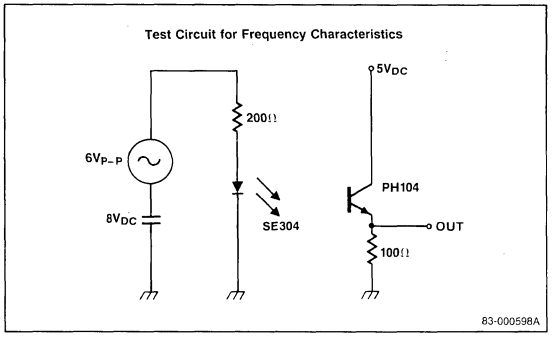




*Figure 14. Frequency Characteristics of the PH104 Single*

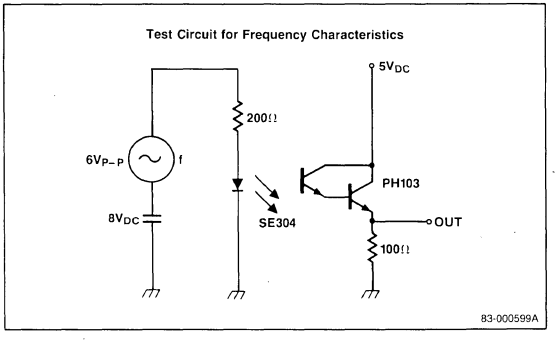



*Figure 15. Frequency Characteristics of the PH103 Darlington*

The relationship of the moving distance of the shielding object to the output voltage of the photo interrupter circuit when the interrupting device moves across the light path is critical to the proper design of high-speed systems. Figure 16 shows that the difference between high and low output level takes place in 0.5 to 0.6mm of movement.

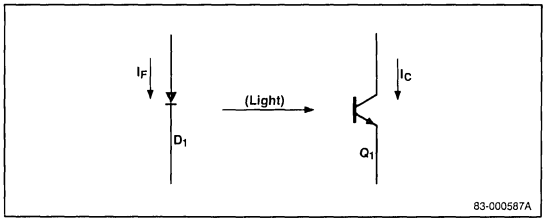



*Figure 16. Shielding Characteristics of the PS1004*

Figure 17 shows the characteristic difference between a flat surface photo transistor and the lens effect surface transistor. In the flat surface (plane) devices the output level will change over the distance b to c. For lens effect surfaces, the shielding object must move from a to d to change the output level. This means that although the lens devices have a larger CTR, the movement of the shielding device to interrupt the light path becomes longer.

### Ultrahigh-Speed Photo Interrupters

The typical switching speed of a single photo transistor is about 5$\mu$s at $R_L = 100\Omega$. Although the high-speed devices will suffice in the majority of applications, higher speeds can be attained by employing PIN photo diodes as the sensing elements. The switching speed for these devices is less than 100ns, making the circuit extremely fast. The drawback to using PIN photo diodes is their low photo sensitivity, which would require high gain amplification of the very small current or voltage generated.

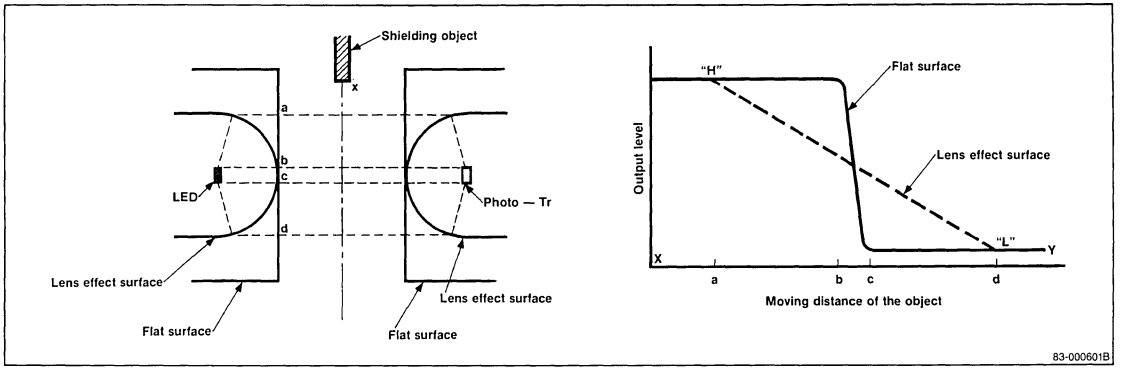



*Figure 17. Shielding Characteristics Caused by Surface Design*

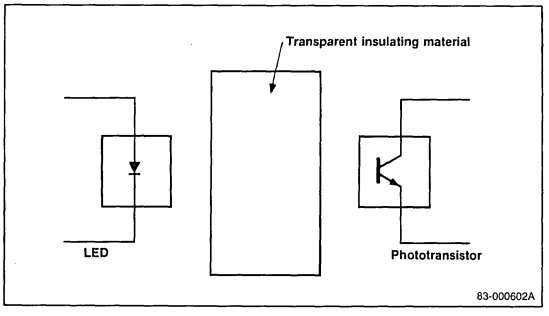



*Figure 18. Application to Ultrahigh Breakdown Voltage Photo Coupler*

Infrared transmitter/receiver circuits using a combination of LED and PIN diode devices have virtually replaced the ultrasonic and hard-wired remote control systems used for short-distance remote control. Some of the major advantages of IR systems are:

- Simple miniaturization
- Elimination of physical connections
- Fast response speed
- Limited Doppler-caused errors
- Limited effect on other equipment
- No effect on animals

This application note is designed to aid the designer of remote control systems using the SE303A IR LED and the PH302 PIN photo diode manufactured by NEC specifically for IR control systems.

The SE303A is a light emitting diode which emits infrared in the 940nm range. The SE303A is made by growing a p-n junction on a gallium arcenide (GaAs) crystal using the liquid phase epitaxial technique. Featuring high output and wide directional angle, the SE303A is ideal for use in consumer and industrial applications.

Table 1 is a listing of the absolute maximum ratings and the electro-optical characteristics of the SE303A.

The directional pattern of the SE303A is shown in Figure 1. This pattern shows the light output power as a function of the angle from the optical axis. If the optical axis relative power is assumed to be 1.0, then the half-power point is the angle at which the relative light output equals 0.5. We can see in Figure 1 that the maximum output is reached at approximately 5° to either side of zero and the half-power point is reached at about 28° either side of zero.

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Power Dissipation, $P_D$ | 150mW |
| Forward Current, $I_F$ | 100mA |
| Pulse Forward Current, $I_{FP}$[1] | 1.0A |
| Reverse Voltage, $V_R$ | 5V |
| Junction Temperature, $T_J$ | 80°C |
| Storage Temperature, $T_{STG}$ | −30°C to +80°C |

## Electro-Optical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 1.27 | 1.45 | V | $I_F$ = 50mA |
| Pulse Forward Voltage | $V_{FP}$[1] | | 2.45 | 3.0 | V | $I_{FP}$ = 1.0A |
| Terminal Capacitance | $C_T$ | | 40 | | pF | V = 0, f = 1.0MHz |
| Peak Emission Wavelength | $\lambda_{PEAK}$ | | 940 | | nm | $I_F$ = 50mA |
| Spectral Half Power Value | $\Delta\lambda$ | | 60 | | nm | $I_F$ = 50mA |
| Light Output Power | $P_O$ | 3.0 | 6 | | mW | $I_F$ = 40mA |
| Response Time | $t_{ON}$, $t_{OFF}$ | | 1 | | μs | |

**Note:** 1. f = 1kHz, duty cycle = 1%.

*Table 1.*

Figure 2 shows the relationship of the forward current ($I_F$) to the forward voltage ($V_F$). The majority of transmitter applications are hand-held units powered by dry cells in the 4.5 to 9.0V range, using two or three LEDs.

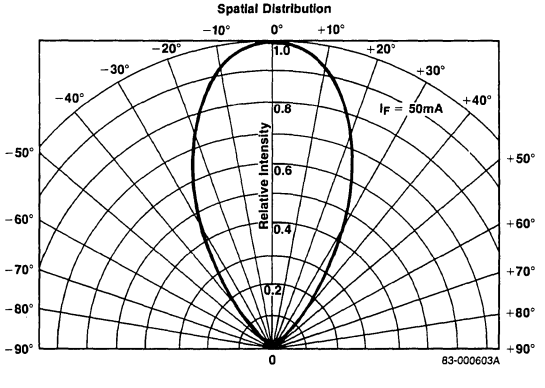



*Figure 1. Light Output Power Distribution*

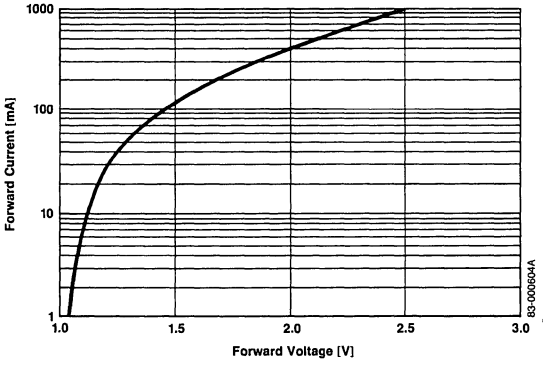



*Figure 2. Forward Current vs Forward Voltage*

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In this case, if $V_F$ is high, the current required exceeds the supply capability. The SE303A was designed so that when the pulsed forward current ($I_{FP}$) equals 1.0A at a pulse width of 350$\mu$s, $V_F$ is typically 2.45V, which is the ideal relationship to the typical voltage source.

For example, if one IR LED is used in the application, the pulsed forward current ($I_{FP}$) would be 300mA and the forward voltage ($V_F$) about 1.8V. A 3V supply would be sufficient for this design. On the other hand, if three LEDs are used, then $V_F$ becomes 1.8 × 3 or 5.4V and the required supply voltage would be 6.0 to 9.0V and allows the designer to use either four 1.5V cells or a single 9V battery. In any case, the extra voltage supplied allows for other voltage drops in the circuit.

The PH302 is a silicon PIN photo diode designed as a light sensing device for infrared remote control systems. Designed in an all resin-molded, vertical-contour package, the PH302 is ideal for low-cost, high-quality applications.

The PIN construction allows high-speed operation and the wide chip area allows high sensitivity. The molded resin is chosen for its selective filtering property, which only transmits infrared radiation above 700nm in wavelength, with maximum efficiency at 940nm. This cancels spurious light from fluorescent lamps, and gives the PH302 excellent noise-free characteristics. This feature eliminates the need for an external IR filter.

The absolute maximum ratings of the PH302 are shown in Table 2, and Figure 3 illustrates the light sensitivity characteristics.

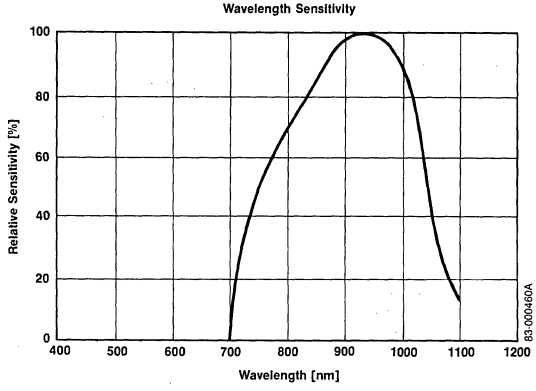


*Figure 3. Spectral Sensitivity Characteristic*

## Absolute Maximum Ratings

$T_A$ = +25°C

| | |
|---|---|
| Reverse Voltage, $V_R$ | 32V |
| Power Dissipation, $P_D$ | 150mW |
| Junction Temperature, $T_J$ | 80°C |
| Storage Temperature, $T_{STG}$ | −40°C to +80°C |

## Electrical Characteristics

$T_A$ = +25°C

| Parameters | Symbol | Limits Min | Typ | Max | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Dark Current | $I_R$ | | | 30 | nA | $V_R$ = 10V |
| Maximum Sensitivity Wavelength | $\lambda_{MAX}$ | | 940 | | nm | |
| Quantum Efficiency | $\eta$ | | 0.88 | | | $\lambda$ = 940nm |
| Sensitivity | S | 35 | 50 | | nA/lx[1] | $V_R$ = 5V |
| Energetic Sensitivity | S | | 0.6 | | A/W | $\lambda$ = 940nm |
| Open Voltage | $V_L$ | | 285 | | mV | $E_V$ = 100lx[1] |
| Open Voltage | $V_L$ | | 365 | | mV | $E_V$ = 1000lx[1] |
| Rise Time | $t_r$, $t_f$ | | 125 | | ns | $R_L$ = 1kΩ, $V_R$ = 0, $\lambda$ = 940nm |
| Fall Time | $t_r$, $t_f$ | | 50 | | ns | $R_L$ = 1kΩ $V_R$ = 5V, $\lambda$ = 940nm |
| Terminal Capacitance | $C_T$ | | 14 | | pF | $V_R$ = 5V, f = 1MHz |
| Light Sensitive Area | A | | 9 | | $mm^2$ | |
| Noise Equivalent Power Limit | NEP | | $4.2 \times 10^{-14}$ | | W/√Hz | $V_R$ = 10V |
| Detection Limit | D | | $6.6 \times 10^{-12}$ | | cm √Hz/W | |

**Note:** 1. Light source color temperature 2854°K.

*Table 2.*

## SE303A and PH302 Combined Characteristics

It is difficult to design a system on the basis of individual characteristics. The following illustrates several characteristics when two devices, the SE303A and the PH302, are combined.

Figure 4 shows the relative light output power and pulsed forward current of the PH303A when the pulse width is 300$\mu$s and duty cycle is 16%. Light output power is the relative value of light output, 1.0, when the forward current ($I_F$) is 50mA.

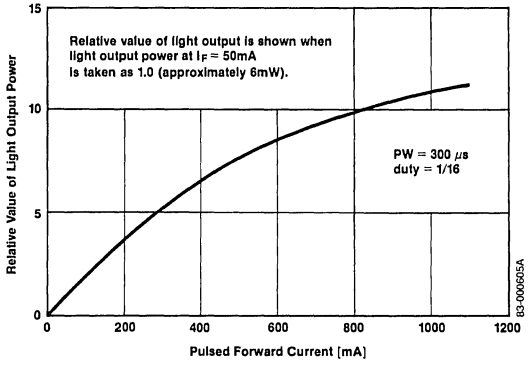


*Figure 4. SE303A Relative Value of Light Output — Pulsed Forward Current*

Figure 5 illustrates the photo current ($I_L$) and pulsed forward current ($I_{FP}$) characteristic. The photo current $I_L$ is generated in the PH302 when the pulsed forward current ($I_{FP}$) of the SE303A is at a maximum and pulsed for 300μs pulse width at 16% duty cycle. The LED and PIN diode are placed 30cm apart. The PH302 in this example has a light sensitivity of 50nA/lx, which is typical for the PH302. The dashed line in Figure 5 represents the minimum light output power of the SE303A (with $P_O$ = 3 mW and $I_F$ = 50mA), combined with the typical light sensitivity of the PH302 results in a light current ($I_L$) of 6nA minimum.

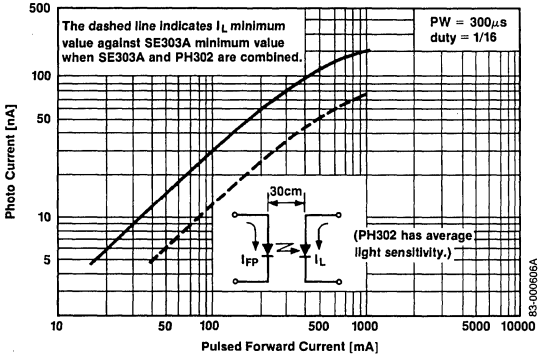


*Figure 5. SE303A-PH302 $I_L$–$I_{FP}$ Characteristic*

The radiation intensity of infrared radiation emitted from the SE303A decreases in inverse proportion to the square of the distance between the emitting and receiving devices. If the photo current generated by the PH302, combined with the SE303A, is $I_L$, and the distance is y, then:

$$I_L \propto \frac{1}{\gamma^2},$$

therefore

$$\log I_L \propto -2 \log \gamma$$

Figure 6 illustrates the $I_L$-y characteristic of the SE303A and PH302 when combined, and $I_{FP}$ is used as a parameter.

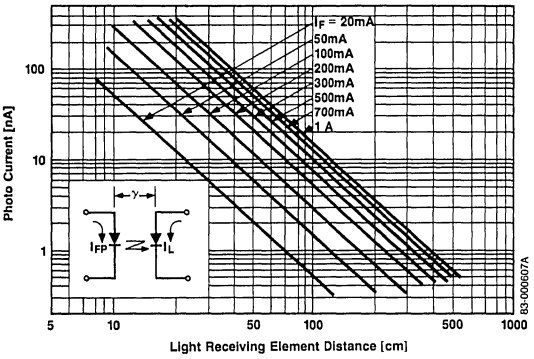


*Figure 6. SE303A-PH302 $I_L$–γ Characteristic*

## Designing an Infrared Remote Control System

When designing a remote control system, the first step is to decide how much photo current ($I_L$) can be generated at a given distance from the emitting source. In this case the PH302 is used as the receiver and the SE303A is the emitting source. From the information given in the preceding section, the drive conditions of pulsed forward current, the receiving amplifier gain and the photo current ($I_L$) are determined. Note at this point that high gain in the first stage of amplification should be avoided, as noise and spurious light are also amplified. Figure 7 shows a block diagram of normal design procedures.

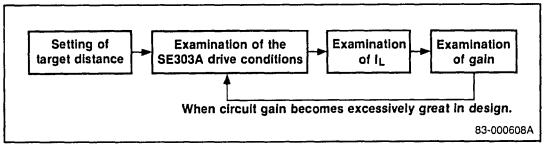


*Figure 7. Block Diagram*

## Circuit Examples

Shown in Figures 8 and 9 are examples of pulse driving using the SE303A and pulse receiving circuitry using the PH302.

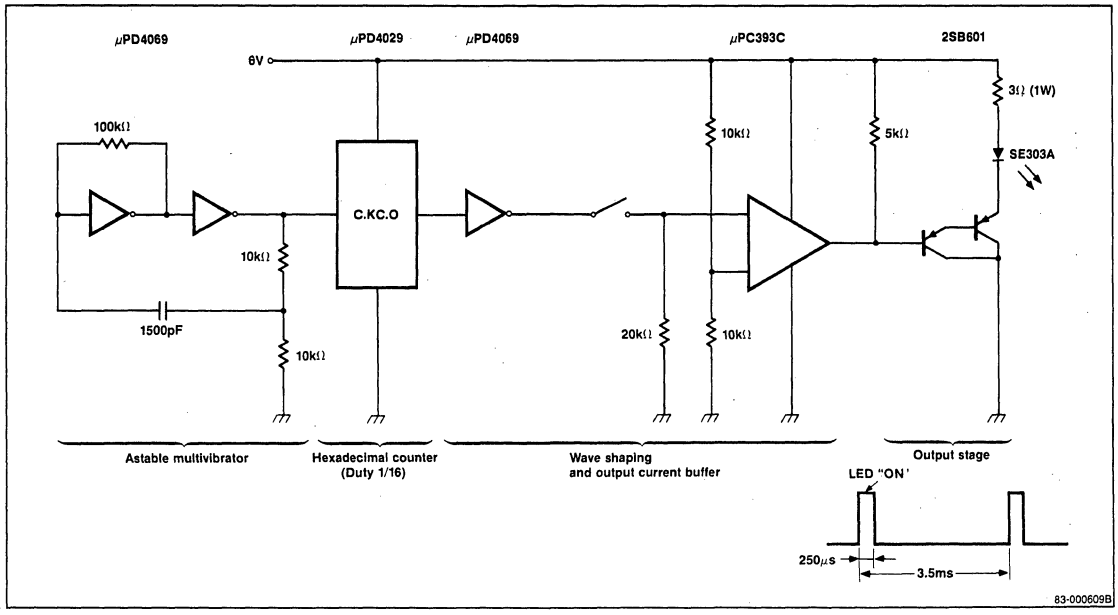


***Figure 8. SE303A Pulse Driving Circuit***

Figure 8 shows an astable multivibrator composed of a μPD4049C. The duty cycle of 1/16 is generated by a hex counter. The μPC393C provides wave shaping, and the 2SB601 is used as an output current buffer. The saturation voltage of the 2SB601 is about 1V and the forward voltage of the SE303A is about 2.5V, so the resultant pulsed forward current is about 800 to 900mA.

As shown in Figure 9, the light received by the PH302 is converted to current and is then amplified to 10 times the original current by a 2SK163 FET Preamplifier. The μPC4559C then amplifies the signal by 100. The signal is then passed to a μPC393C comparator, which drives a monostable multivibrator (one-shot). The output of the one-shot drives a 2SB560, which drives the output. The output loading can be changed by narrowing the pulse interval or changing the time constant of the one-shot. The 1000pF capacitor between the 2SK163 and the μPC4559 are used to eliminate 50 to 60Hz 1A line interference.

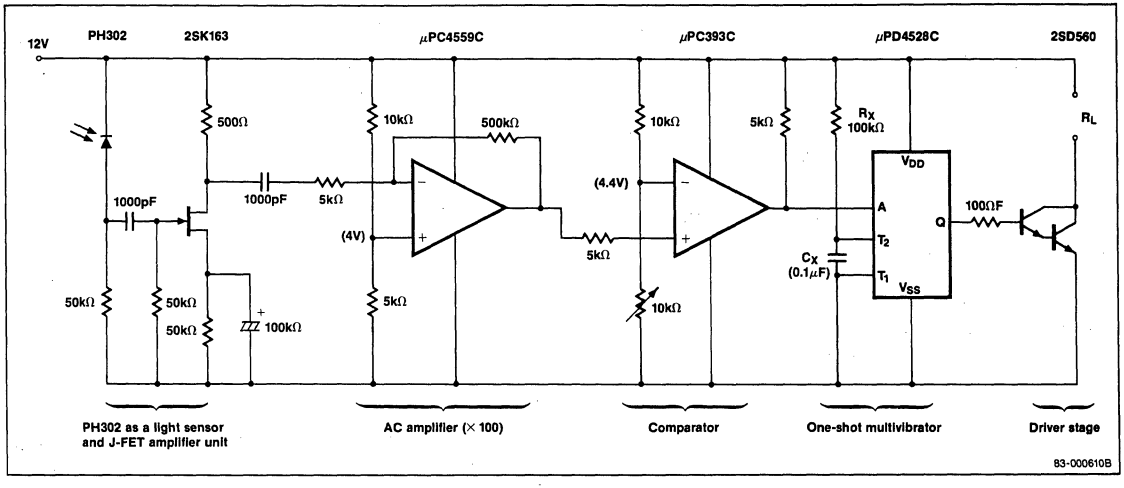


***Figure 9. PH302 Pulse Receiving Circuit***

Television remote control is the most popular use for infrared remote control circuits. Generally, the housekeeping and signal generation for these systems is provided by control ICs, which offer a wide variety of pulse modulation formats from manufacturer to manufacturer.

The following circuit employs the NEC μPC1986 IR transmitter and the μPD1987 receiver ICs shown in Figures 10 and 11. For details of the μPD1986 and μPD1987, please refer to the data sheets for these devices.

## Conclusion

Although the application of IR remote circuits is primarily for television and VCR applications, as the systems are improved and modified other longer-ranged systems may be developed. NEC is constantly striving to bring new technologies to the marketplace, and the devices used in this application not are only the beginning. For further information on other controllers and infrared emitting and receiving devices, contact: NEC Electronics Inc., 401 Ellis Street, P.O. Box 7241, Mountain View, CA 94039. Attention: Semiconductor Marketing/Applications.

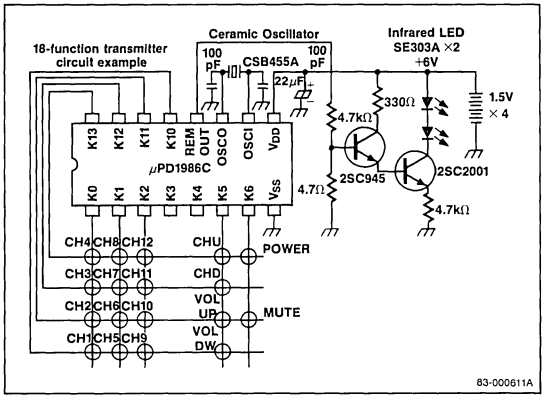


*Figure 10. TV Remote Control Transmitter Circuit*

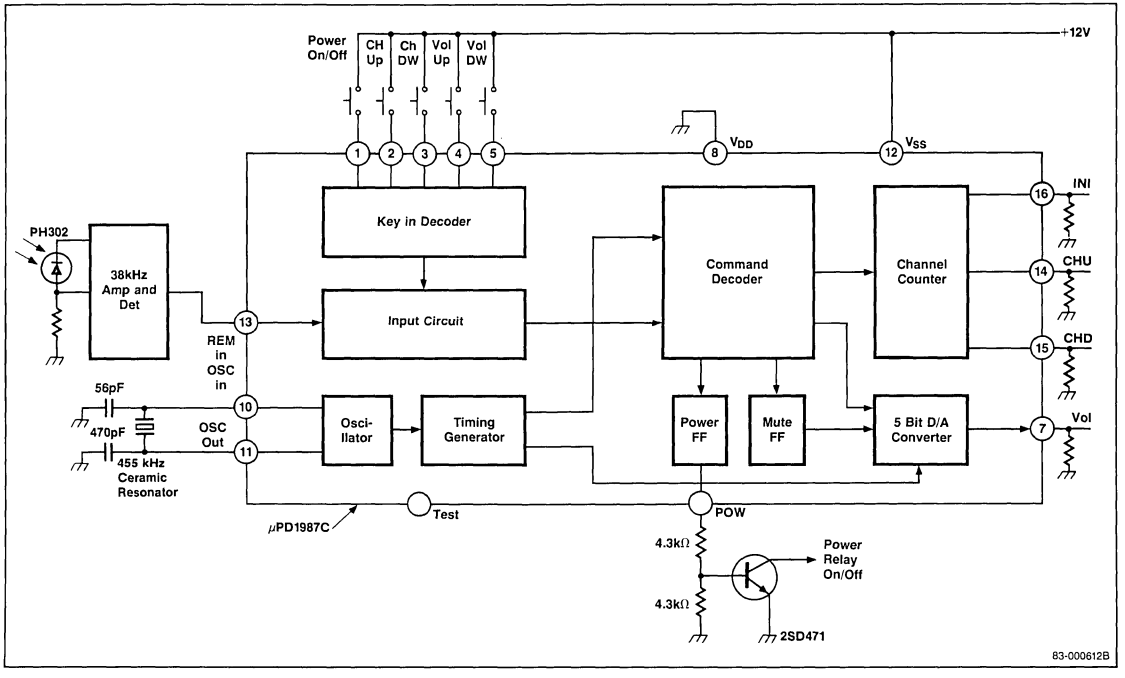


*Figure 11. TV Remote Control Receiver Circuit*

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## Introduction

Optical remote control systems are used extensively in television receivers, and also are gradually finding application in audio and video equipment and air conditioners.

A combination of an infrared light emitting diode and a PIN photo diode is used to implement an optical remote control. NEC now produces the SE303A infrared light emitting diodes (LEDs) and PH302 PIN photo diodes as remote control devices.

The data in this note, together with the NEC technical data in "Application Note for SE303A and PH302: Infrared Remote Control" (LEA-507), describes the allowable pulsed forward current, which is an important factor in the use of the SE303A and PH302 for remote control. The data here serves as reference information.

## 1. Allowable Pulsed Forward Current

In the design of a remote control circuit of a television receiver, a relatively high pulsed forward current must be supplied to the infrared light emitting diode. This is necessitated by the high signal-to-noise ratio and high photo current required, because control may be implemented from a distance of 10 to 20m. On the other hand, the pulsed forward current is limited by the power applied and by the allowable junction temperature of the IR LED. It therefore must be kept within the limits defined by these factors. Figure 1 shows the pulsed forward current versus the duty ratio characteristic of the SE303A. Figure 2 shows the pulsed forward current versus the pulse width characteristic.

See Section 3 for general information on how to determine the pulsed forward current $I_{FP}$, the duty ratio D, and the pulse width PW.

## 2. Degradation Change in Radiant Output Power of SE303A with Pulsed Forward Current

As described above, the allowable pulsed forward current value of a device indicates only the maximum curve of pulsed forward current tolerated before thermal breakdown of the device. In this case, no consideration is given to the degradation change in radiant output power. Figures 3(a) and 3(b) illustrate what degree of degradation change occurs in the radiant output power of a high current-pulsed SE303A.

In Figure 3, a very large degradation change can be seen at PW = 5ms and $I_{FP}$ = 1A. Suppose an SE303A is normally used for remote control in a TV receiver for about 10 years. Then the SE303A will have an actual operating time of around 200 to 300 hours. This will not pose a problem in practical use.

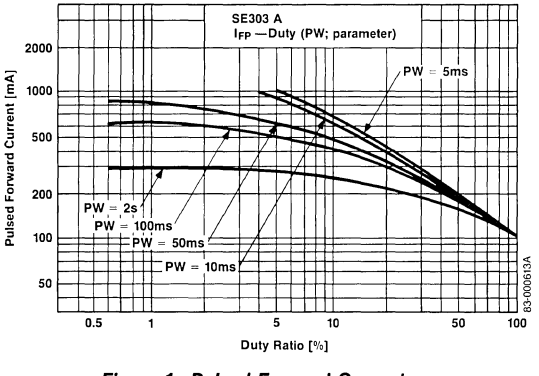


*Figure 1. Pulsed Forward Current vs. Duty Ratio Characteristic*

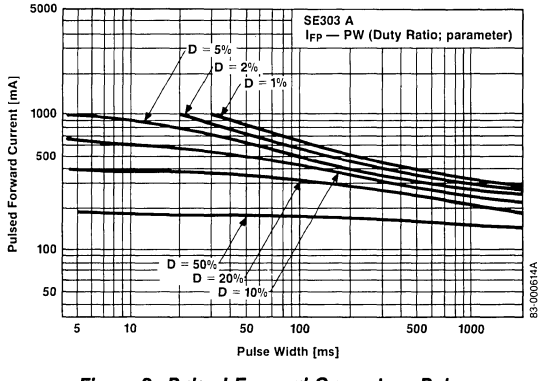


*Figure 2. Pulsed Forward Current vs. Pulse Width Characteristic*

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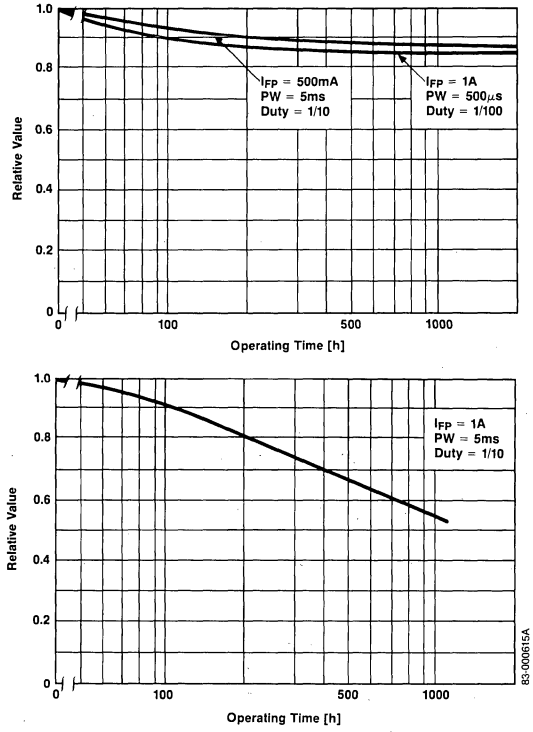


*Figure 3. Degration Change In Radiant Output Power of SE303A with Pulsed Forward Current*

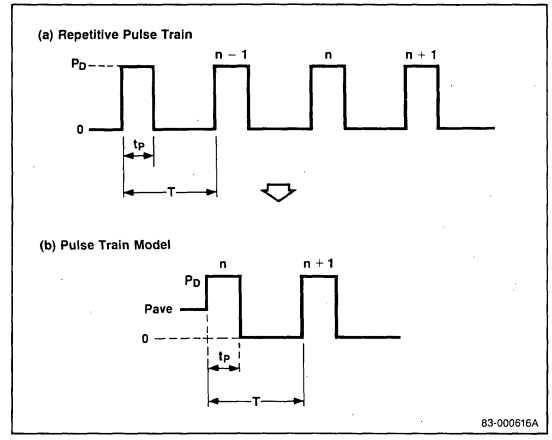


*Figure 4. Modeling of Repetitive Pulse Train*

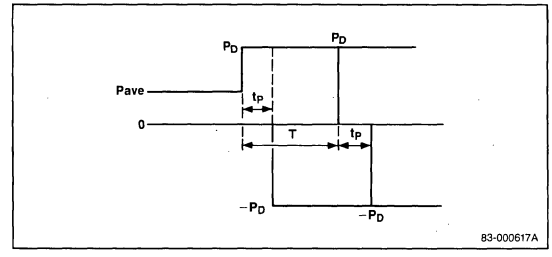


*Figure 5.*

## 3. How to Determine Allowable Pulsed Forward Current

The pulsed forward current can generally be determined by the average power method shown below. In this case, the repetitive pulse train of Figure 4(a) can be changed to the pulse train model of Figure 4(b).

Convert the train of power pulses up to the (n-1)th into the average power, and estimate to what value the junction temperature rises by the peak power at the nth or (n+1)th pulse, and then set the junction temperature so it is within the specified range. If T is the repetition period, $t_P$ for the pulse width, and $P_D$ for the applied power, the applied average power $P_{ave}$ is:

$$P_{ave} = \frac{t_P}{T} P_D$$

Using the superposition principle, decompose Figure 4(b) as shown in Figure 5 Pulses Decomposed by the Superposition Principle.

From Figure 5, the junction temperature $T_{JN}$ at the end of the nth pulse becomes:

$$T_{JN} = P_{ave} \cdot R_T + (P_D - P_{ave}) \cdot \gamma(t_P) + T_A \quad (1)$$

where: $T_{JN}$ is junction temperature at the end of nth pulse; $R_T$ the saturation thermal resistance; $t_P$ the pulse width; $\gamma(t_P)$ the transient thermal resistance for $t_P$; $T_A$ the ambient temperature.

Substituting $t_P/T = D$ (duty ratio) into eq. (1) gives:

$$T_{JN} = D \cdot R_T + (1 - D) \cdot \gamma(t_P) \cdot P_D + T_A \quad (2)$$

At the end of the (n+1)th pulse, the junction temperature $T_{JN+1}$ is:

$$T_{JN+1} = P_{ave} \cdot R_T + (P_D - P_{ave}) \cdot \gamma(T + t_P) - P_D \cdot \gamma(T) + P_D \cdot \gamma(t_P) + T_A$$

$$= P_D \left(\frac{t_P}{T}\right) \cdot R_T + \left(1 - \frac{t_P}{T}\right) \cdot \gamma(T + t_P) - \gamma(T) + \gamma(t_P) + T_A$$

$$= P_D \; D \cdot R_T + (1 - D) \cdot \gamma(T + t_P) - \gamma(T) + \gamma(t_P) + T_A \quad (3)$$

where $\gamma(t_P)$ is the transient thermal resistance for $t = 0 \sim t_P$; $\gamma(T)$ the transient thermal resistance for $t = 0 \sim T$; $\gamma(T + t_P)$ the transient thermal resistance for $t = 0 \sim (T + t_P)$.

The junction temperature given by eq. (3) is slightly lower and is closer to the actual value than that given by eq. (2), but eq. (2) generally is used because it is simpler than eq. (3). Moreover, eq. (2) estimates the junction temperature with a value higher than the actual value, leaving a margin for the allowable value. Since $P_D = I_F \cdot V_F$, eq. (2) becomes:

$$T_J - T_A = I_F \cdot V_F \quad D \cdot R_T + (1 - D) \cdot \gamma (t_P) \qquad (4)$$

When $t_P$ and T are known, $\gamma (t_P)$ can be determined from transient thermal resistance data. Therefore, $I_F \cdot V_F$ is:

$$I_F \cdot V_F = \frac{D \cdot R_T + (1 - D) \cdot \gamma (t_P)}{T_J - T_A} \qquad (5)$$

$I_F$ can be determined from the $I_F$ vs. $I_F \cdot V_F$ characteristic data.

Figure 6 illustrates the transient thermal resistance vs. pulse width characteristic of the SE303A, and Figure 7 shows the pulsed forward current vs pulsed forward current with forward voltage characteristic of the SE303A.

For example, when $T_J = 80°C$, $T_A = 25°C$, D = 10%, $t_P$ = 0.1s, and $R_T$ = 280°C/W, $r(t_P = 0.1s)$ = 30°C/W. Therefore,

$$I_F \cdot V_F = \frac{80 - 25}{0.1 \times 280 + (1 - 0.1) \times 30} = 1$$

From the $I_F$ vs. $I_F \cdot V_F$ characteristic graph, $I_F$ = 530mA.

The pulsed forward current thus calculated should be derated for safety. In general, it is usual to allow a 20% margin.

Reference data: F.W. Gutzwiller, T.P. Sylvan. "Power Semiconductor Ratings Under Transient and Intermittent Loads," *AIEE Transactions*, vol. 79, Jan. 1961.

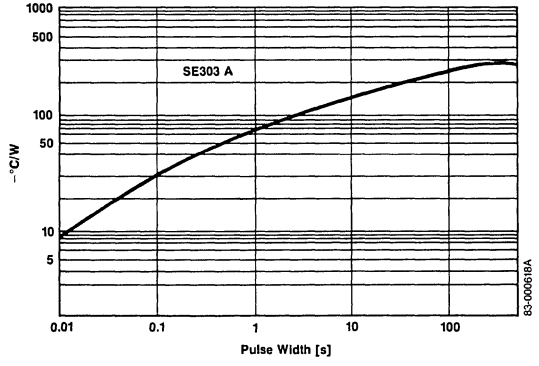


***Figure 6. Transient Thermal Resistance vs. Pulse Width Characteristic***

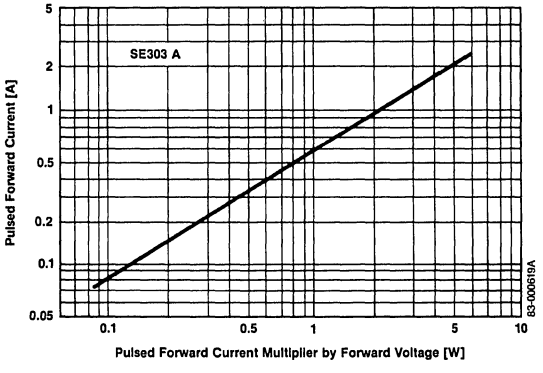


***Figure 7. Pulsed Forward Current vs. Pulsed Forward Current by Forward Voltage Characteristic***

## 4. Measurement of the Radiant Output Power of an Infrared Light Emitting Diode

A photo conductive cell, photo diode, photo multiplier or solar cell can be used to detect the radiant output power of an infrared light emitting diode (IR LED). The reason for this is that solar cells with a wide detecting area are stable in their characteristics for long periods of time, and have excellent spectrum matching with IR LEDs, good frequency response, and good reproducibility. They also are inexpensive and easy to use.

If the output of a solar cell (the voltage across a resistor connected in parallel with the solar cell) is calibrated in milliwatts of radiant output power, the radiant power output can be determined simply by measuring the solar cell output.

Figure 8 shows a simple, convenient radiant output power detector using a solar cell.

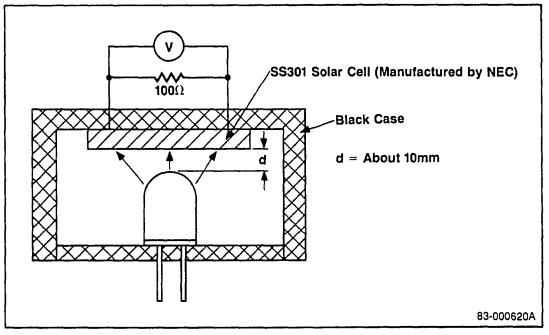


***Figure 8. Radiant Output Power Measuring Instrument***

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## 5. Example of Application of SE303A

### 5.1 Simple remote control circuit using the SE303A and PH302

Figure 9 shows a simple remote control circuit using a SE303A and a PH302. The infrared radiation emitted from the SE303A is received by the PH302 and then amplified. The μPC1373H is a preamplifier manufactured specifically for infrared light remote control. For details of the μPC1373H, refer to the data sheet.

### 5.2 Application to TV remote control

Figure 10 is an example of a circuit used for TV remote control. The μPD1913C/μPD1943G is an exclusive IC used for the remote control system on the transmission side. The infrared light from the SE303A is received by the PH302, and then amplified by the μPC1373H preamplifier (used only for remote control) before being processed as signals by the μPD550C 4-bit microcomputer.

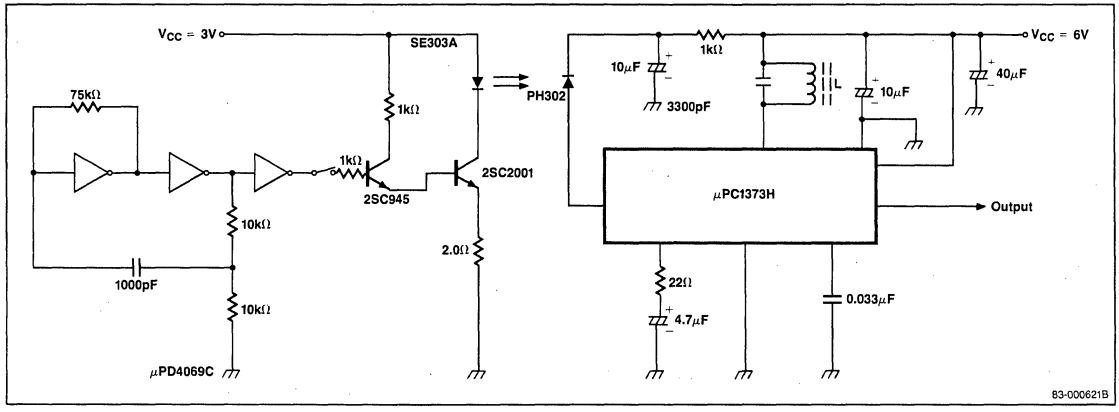


*Figure 9. Simple Remote Control Circuit Using SE303A and PH302*

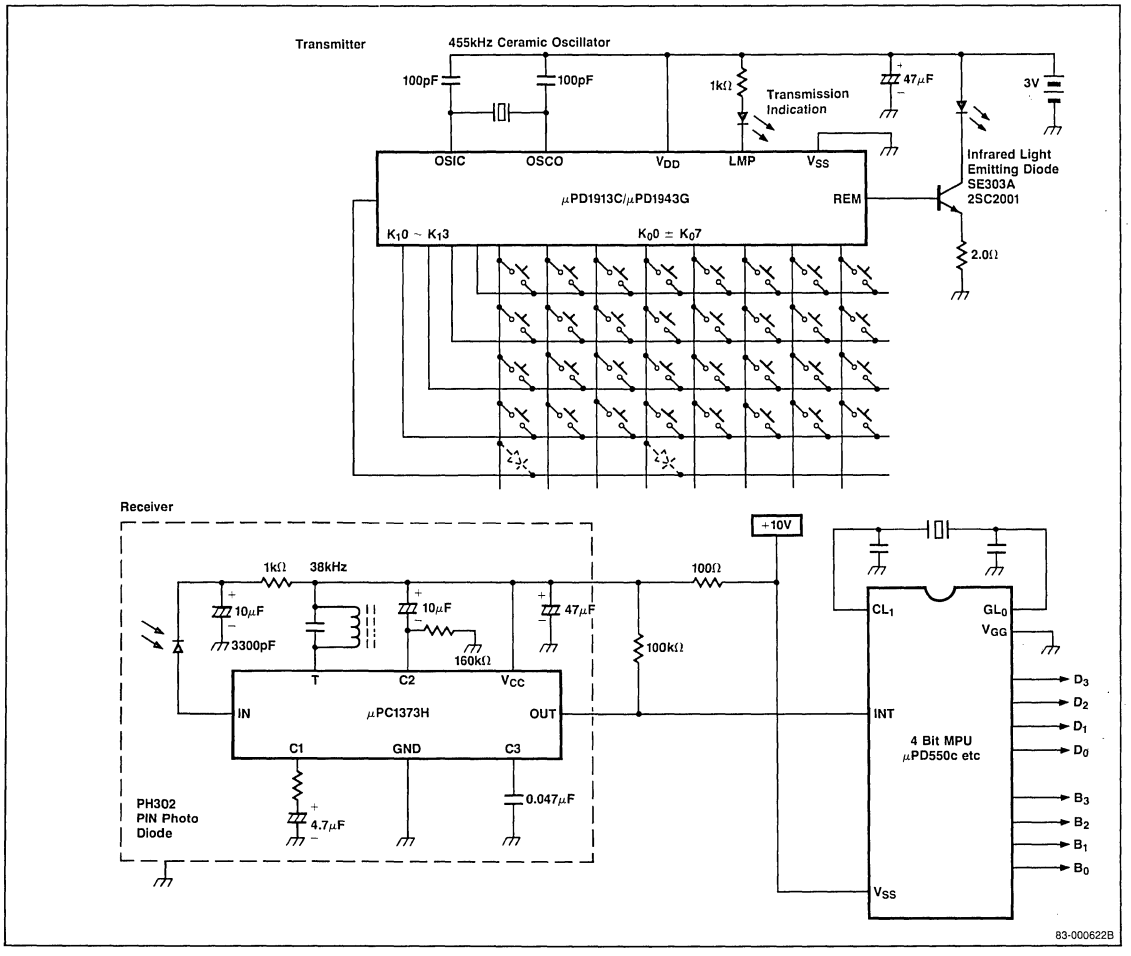


*Figure 10. Application to TV Remote Control*

The above circuit examples and the circuit constants used are not designed for mass production. Accordingly, no consideration is given to the tolerances or temperature characteristics of each part of the circuits. NEC makes no representations as to any patents on the circuits.

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