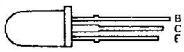
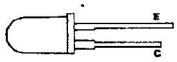
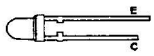
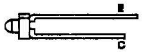
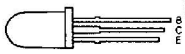
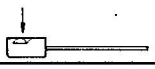
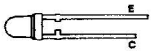
# Photo Detectors

T-41-61

## Phototransistors in Clear Plastic Package

| Package<br>Dimensions see page 49-51 | Type | Photo sensitive area<br>mm² | Characteristics<br>φ | $I_{ca}$ $V_{CE}$=5V<br>mA | $E_e$ λ=950 nm<br>mW/cm² | $V_{(BR)CEO}$ $I_C$=1 mA<br>V | $I_{CEO}$ at<br>nA | $V_{CE}$<br>V | $\lambda_p/\lambda_{0.5}$<br>nm | $t_r$ and<br>µs | $f_g$ at $I_C$ and $R_L$ $V_{CE}$=5V, λ=820 nm<br>kHz | mA | kΩ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T-1¾, ⌀ 5 mm, Fig 22  | BPV 11 | 0.36 | ±15° | 10 (>3) | 1 | >70 | 3 (<50) | 10 | 800/ 600...1050 | 3.3 | – | 5 | 0.1 |
| T-1¾, ⌀ 5 mm, Fig. 17  | BPW 96A | 0.18 | ±20° | 1.5...4.5 | 1 | >70 | 10 (<200) | 20 | 830/ 560...980 | 1,5 | 180 | 5 | 0,1 |
| | BPW 96B | | | 2.5...7.5 | | | | | | | | | |
| | BPW 96C | | | 4.5...15 | | | | | | | | | |
| T-1, ⌀ 3 mm, Fig. 8  | BPW 85A | 0,18 | ±25° | 0.8...2.5 | 1 | >70 | 10 (<200) | 20 | 830/ 560...980 | 1.5 | 180 | 5 | 0.1 |
| | BPW 85B | | | 1.5...4.0 | | | | | | | | | |
| | BPW 85C | | | 3.0...8.0 | | | | | | | | | |
| T-¾, ⌀ 1.8 mm, Fig 3 | BPW 16N | 0.36 | ±40° | 0.14(>0.07) | 1 | >32 | 10 (<200) | 20 | 780/ 520...950 | 3.7 | 120 | 5 | 0.1 |
| T-¾, ⌀ 1.8 mm, Fig. 5  | BPW 17 N | 0.36 | ±12.5° | 1.0 (>0.5) | 1 | >32 | 10 (<200) | 20 | 780/ 520...950 | 3.7 | 120 | 5 | 0.1 |

## Phototransistors with Filter Matched for GaAs IREDs in Plastic Package

| Package<br>Dimensions see page 49-52 | Type | Photo sensitive area<br>mm² | Characteristics<br>φ | $I_{ca}$ $V_{CE}$=5V<br>mA | $E_e$ λ=950 nm<br>mW/cm² | $V_{(BR)CEO}$ $I_C$=1 mA<br>V | $I_{CEO}$<br>nA | $V_{CE}$<br>V | $\lambda_p/\lambda_{0.5}$<br>nm | $t_r$ and<br>µs | $f_g$ at $I_C$ and $R_L$ $V_{CE}$=5V, λ=820 nm<br>kHz | mA | kΩ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T-1¾, ⌀ 5 mm, Fig. 22  | BPV 11 F | 0.36 | ±15° | 9 (>3) | 1 | >70 | 3 (<50) | 10 | 900/ 730...1050 | 3.3 | – | 5 | 0.1 |
| T-¾, ⌀ 1.8 mm, Fig. 3 | S 350 P | 0.36 | ±40° | 1.0(>0.2) | 1 | >32 | 10(<200) | 20 | 900/ 730...1050 | 3.7 | 170 | 5 | 0.1 |
| Side view, Fig. 33  | BPW 78 A | 0.36 | ±25° | 1...3.0 | 1 | >32 | 10(<100) | 20 | 880/ 790...1000 | 3.8 | 110 | 5 | 0.1 |
| | BPW 78 B | | | 4(>2.0) | | | | | | | | | |
| T1, ⌀ 3 mm, Fig. 8  | S 289 P | 0.21 | ±25° | 15(>4) | 0.3 | >32 | 10(<200) | 20 | 900/ 820...1000 | 80 | 5 | 5 | 0.1 |

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## Phototransistors in Hermetically Sealed Package

| Package<br>Dimensions see page 55 | Type | Photo sensitive area<br>mm² | Characteristics<br>φ | $I_{ca}$ $V_{CE}=5$ V<br>mA | $E_e$ λ = 950 nm<br>mW/cm² | $V_{(BR)CEO}$ $I_C=1$ mA<br>V | $I_{CEO}$ $V_{CE}=20$ V<br>nA | $\lambda_p/\lambda_{0.5}$<br>nm | $t_r$ and $f_g$ at $I_C$ and $R_L$ $V_{CE}=5$ V, λ=820 nm<br>μs | kHz | mA | kΩ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TO 18, Fig. 56 | BPW 47 A | 0.28 (⌀0.6)[4] | ±40° | 0.32...0.63 | 1 | >70 | 10 (<100) | 800/ 600...1050 | 1.3 | 150 | 5 | 0.1 |
| | BPW 47 B | | | 0.5...1.0 | | | | | | | | |
| | BPW 47 C | | | 0.8...1.6 | | | | | | | | |
| | BPW 76 A | 0.36 | ±40° | 0.4...0.6 | 1 | >70 | 10 (<100) | 800/ 600...1050 | 3.8 | 110 | 5 | 0.1 |
| | BPW 76 B | | | 1.2(>0.6) | | | | | | | | |
| | BPX 38 | 0.76 | ±40° | >0.2 | 0.5 | >70 | 10 (<200) | 950/ 630...1040 | | | 1 | 1 |
| | BPX 38-2 | | | 0.2...0.4 | | | | | 10 | | | |
| | BPX 38-3 | | | 0.32...0.63 | | | | | 12 | | | |
| | BPX 38-4 | | | 0.5...1.0 | | | | | 15 | | | |
| | BPX 38-5 | | | 0.8...1.6 | | | | | 20 | | | |
| | BPX 38-6 | | | >1.25 | | | | | 25 | | | |
| TO 18, Fig 58 | BPW 77 NA | 0.36 | ±10° | 7.5...15 | 1 | >70 | 10 (<100) | 800/ 600...1050 | 3.8 | 110 | 5 | 0.1 |
| | BPW 77 NB | | | 20 (>10) | | | | | | | | |
| | S 252 P (L14G1) | 0.18 | ±10° | >1.5 | 1 | >45 | 10 (<100) | 780/ 520...950 | 1.7 | 170 | 5 | 0.1 |
| | S 253 P (L14G2) | | | >0.75 | | | | | | | | |
| | S 254 P (L14G3) | | | >3.0 | | | | | | | | |
| TO 18, Fig 57 | BPX 43 | 0.76 | ±15° | >0.8 | 0.5 | >70 | 10 (<200) | 950/ 630...1040 | – | | 1 | 1 |
| | BPX 43-2 | | | 0.8...1.6 | | | | | 10 | | | |
| | BPX 43-3 | | | 1.25...2.5 | | | | | 12 | | | |
| | BPX 43-4 | | | 2.0...4.0 | | | | | 15 | | | |
| | BPX 43-5 | | | 3.2...6.3 | | | | | 20 | | | |
| | BPX 43-6 | | | >5 | | | | | 25 | | | |
| TO 52, Fig 55<br>Photodarlington | BPX 99 R-2 | 0.21 | ±12.5° | 10 (>4) | 0.3 | >32 | 10 (<200) | 800/ 600...900 | 80 | 5 | 5 | 0.1 |
| | BPX 99 R-3 | | | 20 (>10) | | | | | | | | |

## Photo PIN Diodes in Clear Plastic Package

| Package<br>Dimensions see page 50-53 | Type | Photo sensitive area<br>mm² | Characteristics<br>φ | $I_{ra}$ and $V_o$ at λ $E_e=1$ mW/cm² $V_R=5$ V<br>μA | mV | nm | $V_{(BR)}$ $I_R=100$ μA<br>V | $I_{ro}$ $V_R=10$ V<br>nA | $s_{(\lambda)}$ $V_R=5$ V λ=870 nm<br>A/W | $\lambda_p/\lambda_{0.5}$<br>nm | $t_{on}/t_{off}$ at $V_R$ and $R_L$ λ=820 nm<br>ns | V | Ω |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Top view, Fig 42 | BPW 34 | 7.5 | ±65° | 50(>40) | 350 | 950 | >60 | 2 (<30) | 0.6 | 900/ 530...1050 | 100 | 10 | 1000 |
| Side view, Fig 36 | BPW 46 | 7.5 | ±65° | 50(>40) | 350 | 950 | >60 | 2 (<30) | 0.6 | 900/ 530...1050 | 100 | 10 | 1000 |
| T-1¾, ⌀5 mm, Fig 14 | BPW 43 | 0.25 | ±25° | 8 (>4) | 300 | 950 | >60 | 1 (<10) | 0.6 | 900/ 500...1000 | 4[1] | 10 | 50 |
| T-1¾, ⌀5 mm, Fig 15 | BPV 10 | 0.78 (⌀1 mm) | ±17.5° | 65 (>38) | 450 | 950 | >60 | 1 (<5)[2] | 0.55[3] | 950/ 630...1050 | 2.5[1] | 50 | 50 |

[1] $t_r$, $t_f$; [2] $V_R=20$ V; [3] λ = 950 nm; [4] No bond in photo sensitive area

## Photo PIN Diodes with Filter matched for GaAlAs IREDs in Plastic Package

| Package<br>Dimensions see page 53 | Type | Photo sensitive area<br>mm² | Characteristics<br>φ | $I_{ra}$ and $V_o$<br>$E_e$=1 mW/cm², λ=870 nm<br>$V_R$=5 V<br>µA | mV | $V_{(BR)}$<br>$I_R$=<br>100 µA<br>V | $I_{ro}$ at $V_R$<br>nA | V | $s_{(\lambda)}$<br>$V_R$=5 V<br>λ=870 nm<br>A/W | $\lambda_p/\lambda_{0.5}$<br>nm | $t_{on}/t_{off}$ at $V_R$ and $R_L$<br>λ=820 nm<br>ns | V | Ω |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Top view, Fig. 35 | BPW 82 | 7.5 | ±65° | 48 (>41) | 350 | >60 | 2 (<30) | 10 | 0.6 | 920/<br>750...1040 | 100 | 10 | 1000 |
| Side view, Fig. 36 | BPW 83 | 7.5 | ±65° | 50 (>41) | 350 | >60 | 2 (<30) | 10 | 0.6 | 920/<br>750...1040 | 100 | 10 | 1000 |
| Side view, Fig. 37 | BPW 84 | 7.5 | ±65° | 48 (>41) | 350 | >60 | 2 (<30) | 10 | 0.6 | 920/<br>750...1040 | 100 | 10 | 1000 |

## Photo PIN Diodes with Filter matched for GaAs IREDs in Plastic Package

| Package<br>Dimensions see page 50-53 | Type | Photo sensitive area<br>mm² | Characteristics<br>φ | $I_{ra}$ and $V_o$<br>$E_e$=1 mW/cm², λ=950 nm<br>$V_R$=5 V<br>µA | mV | $V_{(BR)}$<br>$I_R$=<br>100 µA<br>V | $I_{ro}$ at $V_R$<br>nA | V | $s_{(\lambda)}$<br>$V_R$=5 V<br>λ=950 nm<br>A/W | $\lambda_p/\lambda_{0.5}$<br>nm | $t_{on}/t_{off}$ at $V_R$ and $R_L$<br>λ=820 nm<br>ns | V | Ω |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Top view, Fig. 42 | BP 104 | 7.5 | ±65° | 45 (>40) | 350 | >60 | 2 (<30) | 10 | 0.6 | 925/<br>800...1000 | 100 | 10 | 1000 |
| Side view, Fig. 35 | BPW 41 N | 7.5 | ±65° | 45 (>41) | 350 | >60 | 2 (<30) | 10 | 0.6 | 950/<br>820...1040 | 100 | 10 | 1000 |
| Side view, Fig. 36 | S 186 P | 7.5 | ±65° | 45 (>41) | 350 | >60 | 2 (<30) | 10 | 0.6 | 920/<br>820...1040 | 100 | 10 | 1000 |
| Side view, Fig. 37 | BPW 75 | 7.5 | ±65° | 48 (>41) | 350 | >60 | 2 (<30) | 10 | 0.6 | 950/<br>820...1040 | 100 | 10 | 1000 |
| Side view, Fig. 38 | BPV 20 F | 7.5 | ±65° | 60 (>40) | 350 | >60 | 2 (<30) | 10 | 0.6 | 950/<br>830...1050 | 100 | 10 | 1000 |
| Cylindrical lens | BPV 21 F | 5.7 | ±65° | 38 (>27) | 350 | >60 | 2 (<30) | 10 | 0.6 | 950/<br>830...1050 | 70 | 10 | 1000 |
| Side view, Fig. 40 | BPV 22 F | 7.5 | ±60° | 80 (>55) | 350 | >60 | 2 (<30) | 10 | 0.6 | 950/<br>830...1050 | 100 | 10 | 1000 |
| Spherical lens | BPV 23 F | 5.7 | ±60° | 63 (>45) | 350 | >60 | 2 (<30) | 10 | 0.6 | 950/<br>830...1050 | 70 | 10 | 1000 |
| Side view, Fig. 38<br>Spherical lens | S 288 P | 0.78 | ±15° | 50 (>30) | 450 | >60 | 2 (<30) | 5 | 0.6 | 930/<br>820...1040 | 2.5[1] | 50 | 50 |
| T-1¾, ø 5 mm, Fig. 15 | BPV 10 F | 0.78 | ±17.5° | 60 (>30) | 450 | >60 | 1 (<5) | 20 | 0.6 | 950/<br>820...1040 | 2.5[1] | 50 | 50 |

[1] $t_r$, $t_f$.

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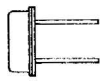
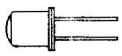
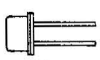
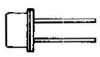
## Photo PIN Diodes in Hermetically Sealed Package for Standard Applications

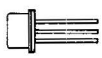
| Package<br>Dimensions see page 54 | Type | Photo sensitive area<br>mm² | φ | Characteristics<br>$I_{ra}$ at $V_R$, $E_e$=1 mW/cm², λ=950 nm<br>μA | V | $V_o$, $E_A$=1 klx<br>mV | $V_{(BR)}$, $I_R$=100 μA<br>V | $I_{ro}$ at $V_R$<br>nA | V | $s_{(\lambda)}$, $V_R$=5 V, λ=870 nm<br>A/W | $\lambda_p$/$\lambda_{0.5}$<br>nm | $t_{on}$/$t_{off}$ at $V_R$ and $R_L$<br>ns | V | Ω |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ≈TO 56, Fig 52  | S 153 P | 7.5 | ±50° | 50 (>40) | 5 | 350 | >50 | 2 (<30) | 10 | 0.6 | 900/<br>530...1050 | 100 | 10 | 1000 |
| TO 18, Fig 48  | BPW 24R | 0.78 | ±12° | 65 (>45) | 20 | 350 | >60 | 1 (<5) | 50 | 0.6 | 900/<br>550...1100 | 7[1] | 20 | 50 |

[1] $t_r$, $t_f$

## Photo PIN Diodes in Hermetically Sealed Package for High Speed Applications

| Package<br>Dimensions see page 54 | Type | NA | Photo sensitive area<br>mm² | Characteristics<br>φ | $I_{ra}$<br>$V_R$=50 V, $E_e$ 1 mW/cm², λ=870 nm<br>μA | $V_{(BR)}$<br>$I_R$=100 μA<br>V | $I_{ro}$<br>$V_R$=50 V<br>nA | $s_{(\lambda)}$<br>$V_R$=5 V, λ=870 nm<br>A/W | $\lambda_p$<br>nm | $C_D$<br>$V_R$=50 V, f=1 MHz<br>pF | $t_r$, $t_f$ at λ and $f_g$<br>at $V_R$=50 V, $R_L$=50 Ω<br>ns | nm | λ=820 nm<br>GHz |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TO 18, Fig 43  High precision flat window | BPW 48 | 0.45 | 0.78 (ø 1.0) | ±55° | 4.5 (>4) | >60 | 1 (< 5) | 0.6 | 930 | 3 | 2.5 | 850 | 0.2 |
| | BPW 86 | 0.24 | 0.25 (0.5x0.5) | ±55° | 2.5 (>2) | >60 | 1 (< 5) | 0.6 | 930 | 1.2 | 2.5 | 850 | 0.2 |
| | BPW 87 | 0.24 | 0.25 (0.5x0.5) | ±55° | 1.3 (>1) | >60 | 1 (< 5) | 0.5 | 810 | 2 | 0.6 | 850 | 1 |
| | BPW 88 | 0.45 | 0.78 (ø 1.0) | ±55° | 6.5 (>4) | >60 | 1 (< 5) | 0.6 | 930 | 1.6 | 2.5 | 850 | 0.2 |
| | BPW 89 | 0.45 | 0.78 (ø 1.0) | ±55° | 4.5 (>3) | >60 | 1 (< 5) | 0.5 | 810 | 4.5 | 0.6 | 850 | 1 |
| | S 191 P | 0.37 | 0.64 (0.8x0.8) | ±55° | 8.0 (>6) | >60 | 2 (<10) | 0.6 | 900 | 2.5 | 2.5 | 820 | 1 |
| TO 18, Fig. 44  High precision flat window | S 203 P | 0.1 | 0.03 (ø 0.2) | ±55° | 0.25 (>0.15) | >110 | 1 (< 5) | 0.29 | 750 | 1.8 | 0.4 | 810 | 1 |
| | S 213 P | 0.15 | 0.07 (ø 0.3) | ±55° | 0.4 (>0.3) | >110 | 1 (< 5) | 0.3 | 750 | 1.8 | 0.4 | 810 | 1 |

## Photo PIN Diodes in Hermetically Sealed Package for High Speed Applications (Anode and Cathode Insulated from Case)

| Package<br>Dimensions see page 55 | Type | NA | Photo sensitive area<br>mm² | Characteristics<br>φ | $I_{ra}$<br>$V_R$=50 V, $E_e$=1 mW/cm², λ=870 nm<br>μA | $V_{(BR)}$<br>$I_R$=100 μA<br>V | $I_{ro}$<br>$V_R$=50 V<br>nA | $s_{(\lambda)}$<br>$V_R$=5 V, λ=870 nm<br>A/W | $\lambda_p$<br>nm | $C_D$ at $V_R$<br>f=1 MHz<br>pF | V | $t_r$, $t_f$ at λ and $f_g$<br>at $V_R$=50 V, $R_L$=50 Ω<br>ns | nm | 820 nm<br>GHz |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TO 18, Fig. 54  High precision flat window | BPW 97 | 0.24 | 0.25 (0.5x0.5) | ±55° | 1.3 (>1) | >60 | 1 (< 5) | 0.5 | 810 | 2 | 50 | 0.6 | 850 | 1 |
| | BPW 98 | 0.45 | 0.78 (ø 1mm) | ±55° | 4.5 (>4) | >60 | 1 (< 5) | 0.6 | 930 | 4.5 | 12 | 2.5 | 850 | 0.2 |

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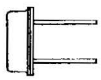
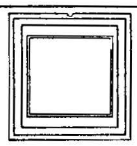
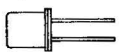
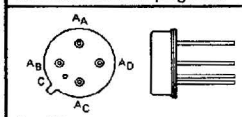
## Photo Diodes for Special Applications

| Package<br>Dimensions see page 54/55 | Type | Photo sensitive area<br>mm² | Characteristics<br>φ | $V_o$ and $I_k$ and $I_{ra}$ at $E_A$=1 klx<br>mV | $R_L$<100Ω<br>μA | $V_R$=5 V<br>μA | $V_{BR}$<br>$I_R$=100 μA<br>V | $I_{ro}$ at $V_R$<br>nA | V | $C_j$ at $V_R$<br>f=1 MHz<br>pF | V | $t_r/t_f$<br>$I_{ph}$=100 μA<br>$R_L$=1 kΩ<br>μs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ≈TO 39, Fig 52  | BPW 20 R | 7.5 | ±50° | 500 (>330) | 61 (>20) | 61 (>20) | >10 | 2 (<30) | 5 | 400 | 5 | 3.5 |
| | BPW 21 R with V(λ)-filter | 7.5 | ±50° | 450 (>280) | 9 (>4.5) | 9 (>4.5) | >10 | 2 (<30) | 5 | 400 | 5 | 3.5 |
|  Ceramic package, Fig 65 | S 284 P | 100 | ±60° | 390 | 800 | 800 | 30 | 3 (<100) | 10 | 280 | 5 | 2.3 |

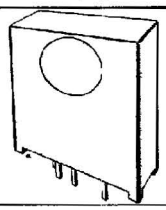
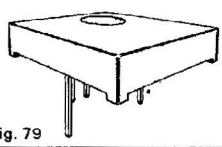
## Avalanche Photo Diodes

| Package<br>Dimensions see page 54 | Type | Photo sensitive area<br>mm² | Characteristics<br>φ | $P_V$<br>mW | $V_{(BR)}$<br>V | η<br>λ=910 nm<br>% | $G_B$<br>GHz | $I_{ro}$<br>M=100<br>nA | $C_D$<br>$V_R$=100 V, f=1 MHz<br>pF |
|---|---|---|---|---|---|---|---|---|---|
| TO 18, Fig 47  | BPW 28 | ø0.2 | ±35° | 100 | 140...200 | >20 | >200 | 1 (<5) | 1 (<1.2) |

## Photo Quadrant Detector

| Package<br>Dimensions see page 55 | Type | Photo sensitive area<br>mm² | Gap size<br>μm | Characteristics<br>$I_{ra}$ per quadrant<br>$V_R$=12 V, $E_e$=1 mW/cm²<br>λ=870 nm<br>μA | $I_{ro}$<br>nA | s(λ)<br>$V_R$=12 V<br>λ=850 nm<br>A/W | $\lambda_p$<br>nm | $C_j$<br>$V_R$=12 V<br>1 MHz<br>pF | $t_r/t_f$<br>$V_R$=12 V<br>$R_L$=1 kΩ<br>λ=830 nm<br>ns |
|---|---|---|---|---|---|---|---|---|---|
|   Fig. 59 | S 239 P | 4x2.25 | 10 | 15 (>10) | 1 (<25) | 0.50 | 880 | 16 | 150 |

## Photo Modules for Remote Control Systems

| Package<br>Dimensions see page 57 | Type | Photo sensitive area<br>mm² | Characteristics<br>φ | λ<br>nm | $V_S$<br>V | $E_{emin}$<br>mW/m² |
|---|---|---|---|---|---|---|
|  Fig. 78 | TFMS 4...0 | 7.5 | ±70° | 950 | 5 | 0.5 |
|  Fig. 79 | TFMT 4...0 | | | | | |

**Features:**

- Photo detector and preamplifier in one package
- Package designed as IR filter and shield
- Internal filter for carrier frequency
- Available for following carrier frequencies: 30, 36, 38, 40 and 56 kHz (see "Designation Systems")
- Integrating output