<table>
<thead>
<tr>
<th>Photosensitive diodes and transistors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light emitting diodes</td>
</tr>
<tr>
<td>Photocouplers</td>
</tr>
<tr>
<td>Infrared sensitive devices</td>
</tr>
<tr>
<td>Photoconductive devices</td>
</tr>
</tbody>
</table>
INDEX AND MAINTENANCE TYPE LIST

GENERAL

PHOTOSENSITIVE DIODES AND TRANSISTORS

LIGHT EMITTING DIODES

PHOTOCOUPLERS

INFRARED SENSITIVE DEVICES

PHOTOCONDUCTIVE DEVICES
DATA HANDBOOK SYSTEM

Our Data Handbook System is a comprehensive source of information on electronic components, sub-assemblies and materials; it is made up of three series of handbooks each comprising several parts.

ELECTRON TUBES BLUE

SEMICONDUCTORS AND INTEGRATED CIRCUITS RED

COMPONENTS AND MATERIALS GREEN

The several parts contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

Where ratings or specifications differ from those published in the preceding edition they are pointed out by arrows. Where application information is given it is advisory and does not form part of the product specification.

If you need confirmation that the published data about any of our products are the latest available, please contact our representative. He is at your service and will be glad to answer your inquiries.

This information is furnished for guidance, and with no guarantee as to its accuracy or completeness; its publication conveys no licence under any patent or other right, nor does the publisher assume liability for any consequence of its use; specifications and availability of goods mentioned in it are subject to change without notice; it is not to be reproduced in any way, in whole or in part without the written consent of the publisher.
ELECTRON TUBES (BLUE SERIES)

Part 1a December 1975 ET1a 12-75 Transmitting tubes for communication, tubes for r.f. heating Types PE05/25 to TBW15/25

Part 1b August 1977 ET1b 08-77 Transmitting tubes for communication, tubes for r.f. heating, amplifier circuit assemblies

Part 2a November 1977 ET2a 11-77 Microwave tubes Communication magnetrons, magnetrons for microwave heating, klystrons, travelling-wave tubes, diodes, triodes T-R switches

Part 2b May 1978 ET2b 05-78 Microwave semiconductors and components Gunn, Impatt and noise diodes, mixer and detector diodes, backward diodes, varactor diodes, Gunn oscillators, sub-assemblies, circulators and isolators

Part 3 January 1975 ET3 01-75 Special Quality tubes, miscellaneous devices

Part 4 March 1975 ET4 03-75 Receiving tubes

Part 5a March 1978 ET5a 03-78 Cathode-ray tubes Instrument tubes, monitor and display tubes, C.R. tubes for special applications

Part 5b May 1975 ET5b 05-75 Camera tubes, image intensifier tubes

Part 6 January 1977 ET6 01-77 Products for nuclear technology Channel electron multipliers, neutron tubes, Geiger-Müller tubes

Part 7a March 1977 ET7a 03-77 Gas-filled tubes Thyratrons, industrial rectifying tubes, ignitrons, high-voltage rectifying tubes

Part 7b March 1977 ET7b 03-77 Gas-filled tubes Segment indicator tubes, indicator tubes, switching diodes, dry reed contact units

Part 8 May 1977 ET8 05-77 TV picture tubes

Part 9 March 1978 ET9 03-78 Photomultiplier tubes; phototubes
<table>
<thead>
<tr>
<th>Part</th>
<th>Issue Date</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1a</td>
<td>August 1978</td>
<td>SC1a 08-78</td>
<td>Rectifier diodes, thyristors, triacs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rectifier diodes, voltage regulator diodes ($&gt;1.5$ W), transient suppressor diodes, rectifier stacks, thyristors, triacs</td>
</tr>
<tr>
<td>Part 1b</td>
<td>May 1977</td>
<td>SC1b 05-77</td>
<td>Diodes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Small signal germanium diodes, small signal silicon diodes, special diodes, voltage regulator diodes ($&lt;1.5$ W), voltage reference diodes, tuner diodes</td>
</tr>
<tr>
<td>Part 2</td>
<td>November 1977</td>
<td>SC2 11-77</td>
<td>Low-frequency and dual transistors</td>
</tr>
<tr>
<td>Part 3</td>
<td>January 1978</td>
<td>SC3 01-78</td>
<td>High-frequency, switching and field-effect transistors</td>
</tr>
<tr>
<td>Part 4a</td>
<td>June 1976</td>
<td>SC4a 06-76</td>
<td>Special semiconductors*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Transmitting transistors, field-effect transistors, dual transistors, microminiature devices for thick and thin-film circuits</td>
</tr>
<tr>
<td>Part 4b</td>
<td>September 1978</td>
<td>SC4b 09-78</td>
<td>Devices for optoelectronics</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Photosensitive diodes and transistors, light emitting diodes, photocouplers, infrared sensitive devices, photoconductive devices</td>
</tr>
<tr>
<td>Part 4c</td>
<td>July 1978</td>
<td>SC4c 07-78</td>
<td>Discrete semiconductors for hybrid thick and thin-film circuits</td>
</tr>
<tr>
<td>Part 5a</td>
<td>November 1976</td>
<td>SC5a 11-76</td>
<td>Professional analogue integrated circuits</td>
</tr>
<tr>
<td>Part 5b</td>
<td>March 1977</td>
<td>SC5b 03-77</td>
<td>Consumer integrated circuits</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Radio-audio, television</td>
</tr>
<tr>
<td>Part 6</td>
<td>October 1977</td>
<td>SC6 10-77</td>
<td>Digital integrated circuits</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LOCMOS HE4000B family</td>
</tr>
<tr>
<td>Signetics</td>
<td></td>
<td></td>
<td>Signetics integrated circuits 1978</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bipolar and MOS memories</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bipolar and MOS microprocessors</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Analogue circuits</td>
</tr>
</tbody>
</table>

* The most recent information on field-effect transistors can be found in SC3 01-78, on dual transistors in SC2 11-77, and on microminiature devices in SC4c 07-78.
## COMPONENTS AND MATERIALS (GREEN SERIES)

<table>
<thead>
<tr>
<th>Part</th>
<th>Date</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1</td>
<td>June 1977</td>
<td>CM1 06-77</td>
<td>Assemblies for industrial use High noise immunity logic FZ/30-series, counter modules 50-series, NORbits 60-series, 61-series, circuit blocks 90-series, circuit block CSA70(L), PLC modules, input/output devices, hybrid circuits, peripheral devices, ferrite core memory products</td>
</tr>
<tr>
<td>Part 2a</td>
<td>October 1977</td>
<td>CM2a 10-77</td>
<td>Resistors Fixed resistors, variable resistors, voltage dependent resistors (VDR), light dependent resistors (LDR), negative temperature coefficient thermistors (NTC), positive temperature coefficient thermistors (PTC), test switches</td>
</tr>
<tr>
<td>Part 2b</td>
<td>February 1978</td>
<td>CM2b 02-78</td>
<td>Capacitors Electrolytic and solid capacitors, film capacitors, ceramic capacitors, variable capacitors</td>
</tr>
<tr>
<td>Part 3</td>
<td>January 1977</td>
<td>CM3 01-77</td>
<td>Radio, audio, television Loudspeakers, components for black and white television, components for colour television</td>
</tr>
<tr>
<td>Part 3a</td>
<td>September 1978</td>
<td>CM3a 09-78</td>
<td>FM tuners, television tuners, surface acoustic wave filters</td>
</tr>
<tr>
<td>Part 4a</td>
<td>September 1978</td>
<td>CM4a 09-78</td>
<td>Soft ferrites Ferrites for radio, audio and television, beads and chokes, Ferroxcube potcores and square cores, Ferroxcube transformer cores</td>
</tr>
<tr>
<td>Part 4b</td>
<td>December 1976</td>
<td>CM4b 12-76</td>
<td>Piezoelectric ceramics, permanent magnet materials</td>
</tr>
<tr>
<td>Part 6</td>
<td>April 1977</td>
<td>CM6 04-77</td>
<td>Electric motors and accessories Small synchronous motors, stepper motors, miniature direct current motors</td>
</tr>
<tr>
<td>Part 7</td>
<td>September 1971</td>
<td>CM7 09-71</td>
<td>Circuit blocks Circuit blocks 100 kHz-series, circuit blocks 1-series, circuit blocks 10-series, circuit blocks for ferrite core memory drive</td>
</tr>
<tr>
<td>Part 8</td>
<td>February 1977</td>
<td>CM8 02-77</td>
<td>Variable mains transformers</td>
</tr>
<tr>
<td>Part 9</td>
<td>March 1976</td>
<td>CM9 03-76</td>
<td>Piezoelectric quartz devices</td>
</tr>
<tr>
<td>Part 10</td>
<td>April 1978</td>
<td>CM10 04-78</td>
<td>Connectors</td>
</tr>
</tbody>
</table>
INDEX OF TYPE NUMBERS

Data Handbooks SC1a to SC4c

The inclusion of a type number in this publication does not necessarily imply its availability.

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Part</th>
<th>Section</th>
<th>Type No.</th>
<th>Part</th>
<th>Section</th>
<th>Type No.</th>
<th>Part</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA119</td>
<td>1b</td>
<td>PC</td>
<td>BA217</td>
<td>1b</td>
<td>WD</td>
<td>BA62</td>
<td>1b</td>
<td>WD</td>
</tr>
<tr>
<td>AA125</td>
<td>2</td>
<td>LF</td>
<td>BA218</td>
<td>1b</td>
<td>WD</td>
<td>BAX12</td>
<td>1b</td>
<td>WD</td>
</tr>
<tr>
<td>AA127</td>
<td>2</td>
<td>LF</td>
<td>BA219</td>
<td>1b</td>
<td>WD</td>
<td>BAX12A</td>
<td>1b</td>
<td>WD</td>
</tr>
<tr>
<td>AA128</td>
<td>2</td>
<td>LF</td>
<td>BA220</td>
<td>1b</td>
<td>WD</td>
<td>BAX13</td>
<td>1b</td>
<td>WD</td>
</tr>
<tr>
<td>AC126</td>
<td>2</td>
<td>LF</td>
<td>BA221</td>
<td>1b</td>
<td>WD</td>
<td>BAX14</td>
<td>1b</td>
<td>WD</td>
</tr>
<tr>
<td>AC127</td>
<td>2</td>
<td>LF</td>
<td>BA222</td>
<td>1b</td>
<td>WD</td>
<td>BAX14A</td>
<td>1b</td>
<td>WD</td>
</tr>
<tr>
<td>AC128</td>
<td>2</td>
<td>LF</td>
<td>BA243</td>
<td>1b</td>
<td>T</td>
<td>BAX15</td>
<td>1b</td>
<td>WD</td>
</tr>
<tr>
<td>AC128/01</td>
<td>2</td>
<td>LF</td>
<td>BA244</td>
<td>1b</td>
<td>T</td>
<td>BAX16</td>
<td>1b</td>
<td>WD</td>
</tr>
<tr>
<td>AC132</td>
<td>2</td>
<td>LF</td>
<td>BA280</td>
<td>1b</td>
<td>T</td>
<td>BAX17</td>
<td>1b</td>
<td>WD</td>
</tr>
<tr>
<td>AC187</td>
<td>2</td>
<td>LF</td>
<td>BA314A</td>
<td>1b</td>
<td>Vrg</td>
<td>BAX18</td>
<td>1b</td>
<td>WD</td>
</tr>
<tr>
<td>AC187/01</td>
<td>2</td>
<td>LF</td>
<td>BA315</td>
<td>1b</td>
<td>Vrg</td>
<td>BB105A</td>
<td>1b</td>
<td>T</td>
</tr>
<tr>
<td>AC188</td>
<td>2</td>
<td>LF</td>
<td>BA316</td>
<td>1b</td>
<td>WD</td>
<td>BB105B</td>
<td>1b</td>
<td>T</td>
</tr>
<tr>
<td>AC188/01</td>
<td>2</td>
<td>LF</td>
<td>BA317</td>
<td>1b</td>
<td>WD</td>
<td>BB105G</td>
<td>1b</td>
<td>T</td>
</tr>
<tr>
<td>AD161</td>
<td>2</td>
<td>P</td>
<td>BA318</td>
<td>1b</td>
<td>WD</td>
<td>BB106</td>
<td>1b</td>
<td>T</td>
</tr>
<tr>
<td>AD162</td>
<td>2</td>
<td>P</td>
<td>BA379</td>
<td>1b</td>
<td>T</td>
<td>BB110B</td>
<td>1b</td>
<td>T</td>
</tr>
<tr>
<td>AF367</td>
<td>3</td>
<td>HFSW</td>
<td>BAS16</td>
<td>4c</td>
<td>Mm</td>
<td>BB110G</td>
<td>1b</td>
<td>T</td>
</tr>
<tr>
<td>ASZ15</td>
<td>2</td>
<td>P</td>
<td>BAT17</td>
<td>4c</td>
<td>Mm</td>
<td>BB117</td>
<td>1b</td>
<td>T</td>
</tr>
<tr>
<td>ASZ16</td>
<td>2</td>
<td>P</td>
<td>BAT18</td>
<td>4c</td>
<td>Mm</td>
<td>BB119</td>
<td>1b</td>
<td>T</td>
</tr>
<tr>
<td>ASZ17</td>
<td>2</td>
<td>P</td>
<td>BAV10</td>
<td>1b</td>
<td>WD</td>
<td>BB204B</td>
<td>1b</td>
<td>T</td>
</tr>
<tr>
<td>ASZ18</td>
<td>2</td>
<td>P</td>
<td>BAV18</td>
<td>1b</td>
<td>WD</td>
<td>BB204G</td>
<td>1b</td>
<td>T</td>
</tr>
<tr>
<td>BA100</td>
<td>1b</td>
<td>AD</td>
<td>BAV19</td>
<td>1b</td>
<td>WD</td>
<td>BB205A</td>
<td>1b</td>
<td>T</td>
</tr>
<tr>
<td>BA102</td>
<td>1b</td>
<td>T</td>
<td>BAV20</td>
<td>1b</td>
<td>WD</td>
<td>BB205B</td>
<td>1b</td>
<td>T</td>
</tr>
<tr>
<td>BA145</td>
<td>1a</td>
<td>R</td>
<td>BAV21</td>
<td>1b</td>
<td>WD</td>
<td>BB205G</td>
<td>1b</td>
<td>T</td>
</tr>
<tr>
<td>BA148</td>
<td>1a</td>
<td>R</td>
<td>BAV45</td>
<td>1b</td>
<td>Sp</td>
<td>BBY31</td>
<td>4c</td>
<td>Mm</td>
</tr>
<tr>
<td>BA157</td>
<td>1a</td>
<td>R</td>
<td>BAV70</td>
<td>4c</td>
<td>Mm</td>
<td>BC107</td>
<td>2</td>
<td>LF</td>
</tr>
<tr>
<td>BA158</td>
<td>1a</td>
<td>R</td>
<td>BAV99</td>
<td>4c</td>
<td>Mm</td>
<td>BC108</td>
<td>2</td>
<td>LF</td>
</tr>
<tr>
<td>BA159</td>
<td>1a</td>
<td>R</td>
<td>BAW21A</td>
<td>1b</td>
<td>WD</td>
<td>BC109</td>
<td>2</td>
<td>LF</td>
</tr>
<tr>
<td>BA182</td>
<td>1b</td>
<td>T</td>
<td>BAW21B</td>
<td>1b</td>
<td>WD</td>
<td>BC140</td>
<td>2</td>
<td>LF</td>
</tr>
<tr>
<td>BA216</td>
<td>1b</td>
<td>WD</td>
<td>BAW56</td>
<td>4c</td>
<td>Mm</td>
<td>BC141</td>
<td>2</td>
<td>LF</td>
</tr>
</tbody>
</table>

AD = Silicon alloyed diodes
GB = Germanium gold bonded diodes
HFSW = High-frequency and switching transistors
LF = Low-frequency transistors
Mm = Discrete semiconductors for hybrid thick and thin-film circuits
P = Low-frequency power transistors
PC = Germanium point contact diodes
R = Rectifier diodes
Sp = Special diodes
T = Tuner diodes
Vrg = Voltage regulator diodes
WD = Silicon whiskerless diodes

August 1978
<table>
<thead>
<tr>
<th>type no.</th>
<th>part</th>
<th>section</th>
<th>type no.</th>
<th>part</th>
<th>section</th>
<th>type no.</th>
<th>part</th>
<th>section</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC146</td>
<td>2</td>
<td>LF</td>
<td>BCW30;R</td>
<td>4c</td>
<td>Mm</td>
<td>BD135</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC147</td>
<td>2</td>
<td>LF</td>
<td>BCW31;R</td>
<td>4c</td>
<td>Mm</td>
<td>BD136</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC148</td>
<td>2</td>
<td>LF</td>
<td>BCW32;R</td>
<td>4c</td>
<td>Mm</td>
<td>BD137</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC149</td>
<td>2</td>
<td>LF</td>
<td>BCW33;R</td>
<td>4c</td>
<td>Mm</td>
<td>BD138</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC157</td>
<td>2</td>
<td>LF</td>
<td>BCW69;R</td>
<td>4c</td>
<td>Mm</td>
<td>BD139</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC158</td>
<td>2</td>
<td>LF</td>
<td>BCW70;R</td>
<td>4c</td>
<td>Mm</td>
<td>BD140</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC159</td>
<td>2</td>
<td>LF</td>
<td>BCW71;R</td>
<td>4c</td>
<td>Mm</td>
<td>BD181</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC160</td>
<td>2</td>
<td>LF</td>
<td>BCW72;R</td>
<td>4c</td>
<td>Mm</td>
<td>BD182</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC161</td>
<td>2</td>
<td>LF</td>
<td>BCX17;R</td>
<td>4c</td>
<td>Mm</td>
<td>BD183</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC177</td>
<td>2</td>
<td>LF</td>
<td>BCX18;R</td>
<td>4c</td>
<td>Mm</td>
<td>BD201</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC178</td>
<td>2</td>
<td>LF</td>
<td>BCX19;R</td>
<td>4c</td>
<td>Mm</td>
<td>BD202</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC179</td>
<td>2</td>
<td>LF</td>
<td>BCX20;R</td>
<td>4c</td>
<td>Mm</td>
<td>BD203</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC200</td>
<td>2</td>
<td>LF</td>
<td>BCX51</td>
<td>4c</td>
<td>Mm</td>
<td>BD204</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC264A</td>
<td>3</td>
<td>FET</td>
<td>BCX52</td>
<td>4c</td>
<td>Mm</td>
<td>BD226</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC264B</td>
<td>3</td>
<td>FET</td>
<td>BCX53</td>
<td>4c</td>
<td>Mm</td>
<td>BD227</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC264C</td>
<td>3</td>
<td>FET</td>
<td>BCX54</td>
<td>4c</td>
<td>Mm</td>
<td>BD228</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC264D</td>
<td>3</td>
<td>FET</td>
<td>BCX55</td>
<td>4c</td>
<td>Mm</td>
<td>BD229</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC327</td>
<td>2</td>
<td>LF</td>
<td>BCX56</td>
<td>4c</td>
<td>Mm</td>
<td>BD230</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC328</td>
<td>2</td>
<td>LF</td>
<td>BCY30A</td>
<td>2</td>
<td>LF</td>
<td>BD231</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC337</td>
<td>2</td>
<td>LF</td>
<td>BCY31A</td>
<td>2</td>
<td>LF</td>
<td>BD232</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC338</td>
<td>2</td>
<td>LF</td>
<td>BCY32A</td>
<td>2</td>
<td>LF</td>
<td>BD233</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC368</td>
<td>2</td>
<td>LF</td>
<td>BCY33A</td>
<td>2</td>
<td>LF</td>
<td>BD234</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC369</td>
<td>2</td>
<td>LF</td>
<td>BCY34A</td>
<td>2</td>
<td>LF</td>
<td>BD235</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC546</td>
<td>2</td>
<td>LF</td>
<td>BCY55</td>
<td>2</td>
<td>DT</td>
<td>BD236</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC547</td>
<td>2</td>
<td>LF</td>
<td>BCY56</td>
<td>2</td>
<td>LF</td>
<td>BD237</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC548</td>
<td>2</td>
<td>LF</td>
<td>BCY57</td>
<td>2</td>
<td>LF</td>
<td>BD238</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC549</td>
<td>2</td>
<td>LF</td>
<td>BCY58</td>
<td>2</td>
<td>LF</td>
<td>BD262</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC550</td>
<td>2</td>
<td>LF</td>
<td>BCY59</td>
<td>2</td>
<td>LF</td>
<td>BD262A</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC556</td>
<td>2</td>
<td>LF</td>
<td>BCY70</td>
<td>2</td>
<td>LF</td>
<td>BD262B</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC557</td>
<td>2</td>
<td>LF</td>
<td>BCY71</td>
<td>2</td>
<td>LF</td>
<td>BD263</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC558</td>
<td>2</td>
<td>LF</td>
<td>BCY72</td>
<td>2</td>
<td>LF</td>
<td>BD263A</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC559</td>
<td>2</td>
<td>LF</td>
<td>BCY78</td>
<td>2</td>
<td>LF</td>
<td>BD263B</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC560</td>
<td>2</td>
<td>LF</td>
<td>BCY79</td>
<td>2</td>
<td>LF</td>
<td>BD266</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC635</td>
<td>2</td>
<td>LF</td>
<td>BCY87</td>
<td>2</td>
<td>DT</td>
<td>BD266A</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC636</td>
<td>2</td>
<td>LF</td>
<td>BCY88</td>
<td>2</td>
<td>DT</td>
<td>BD266B</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC637</td>
<td>2</td>
<td>LF</td>
<td>BCY89</td>
<td>2</td>
<td>DT</td>
<td>BD267</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC638</td>
<td>2</td>
<td>LF</td>
<td>BD115</td>
<td>2</td>
<td>P</td>
<td>BD267A</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC639</td>
<td>2</td>
<td>LF</td>
<td>BD131</td>
<td>2</td>
<td>P</td>
<td>BD267B</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BC640</td>
<td>2</td>
<td>LF</td>
<td>BD132</td>
<td>2</td>
<td>P</td>
<td>BD291</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BCW29;R</td>
<td>4c</td>
<td>Mm</td>
<td>BD133</td>
<td>2</td>
<td>P</td>
<td>BD292</td>
<td>2</td>
<td>P</td>
</tr>
</tbody>
</table>

DT  = Dual transistors  
FET = Field-effect transistors  
Mm = Discrete semiconductors for hybrid thick and thin-film circuits  
LF  = Low-frequency transistors  
P   = Low-frequency power transistors
<table>
<thead>
<tr>
<th>type no.</th>
<th>part</th>
<th>section</th>
<th>type no.</th>
<th>part</th>
<th>section</th>
<th>type no.</th>
<th>part</th>
<th>section</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD293</td>
<td>2</td>
<td>P</td>
<td>BDX64A</td>
<td>2</td>
<td>P</td>
<td>BF195</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD294</td>
<td>2</td>
<td>P</td>
<td>BDX64B</td>
<td>2</td>
<td>P</td>
<td>BF196</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD329</td>
<td>2</td>
<td>P</td>
<td>BDX65</td>
<td>2</td>
<td>P</td>
<td>BF197</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD330</td>
<td>2</td>
<td>P</td>
<td>BDX65A</td>
<td>2</td>
<td>P</td>
<td>BF198</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD331</td>
<td>2</td>
<td>P</td>
<td>BDX65B</td>
<td>2</td>
<td>P</td>
<td>BF199</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD332</td>
<td>2</td>
<td>P</td>
<td>BDX66</td>
<td>2</td>
<td>P</td>
<td>BF200</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD333</td>
<td>2</td>
<td>P</td>
<td>BDX66A</td>
<td>2</td>
<td>P</td>
<td>BF240</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD334</td>
<td>2</td>
<td>P</td>
<td>BDX66B</td>
<td>2</td>
<td>P</td>
<td>BF241</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD335</td>
<td>2</td>
<td>P</td>
<td>BDX67</td>
<td>2</td>
<td>P</td>
<td>BF245A</td>
<td>3</td>
<td>FET</td>
</tr>
<tr>
<td>BD336</td>
<td>2</td>
<td>P</td>
<td>BDX67A</td>
<td>2</td>
<td>P</td>
<td>BF245B</td>
<td>3</td>
<td>FET</td>
</tr>
<tr>
<td>BD433</td>
<td>2</td>
<td>P</td>
<td>BDX67B</td>
<td>2</td>
<td>P</td>
<td>BF245C</td>
<td>3</td>
<td>FET</td>
</tr>
<tr>
<td>BD434</td>
<td>2</td>
<td>P</td>
<td>BDX77</td>
<td>2</td>
<td>P</td>
<td>BF256A</td>
<td>3</td>
<td>FET</td>
</tr>
<tr>
<td>BD435</td>
<td>2</td>
<td>P</td>
<td>BDX78</td>
<td>2</td>
<td>P</td>
<td>BF256B</td>
<td>3</td>
<td>FET</td>
</tr>
<tr>
<td>BD436</td>
<td>2</td>
<td>P</td>
<td>BDX91</td>
<td>2</td>
<td>P</td>
<td>BF256C</td>
<td>3</td>
<td>FET</td>
</tr>
<tr>
<td>BD437</td>
<td>2</td>
<td>P</td>
<td>BDX92</td>
<td>2</td>
<td>P</td>
<td>BF324</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD438</td>
<td>2</td>
<td>P</td>
<td>BDX93</td>
<td>2</td>
<td>P</td>
<td>BF327</td>
<td>3</td>
<td>FET</td>
</tr>
<tr>
<td>BD645</td>
<td>2</td>
<td>P</td>
<td>BDX94</td>
<td>2</td>
<td>P</td>
<td>BF336</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD646</td>
<td>2</td>
<td>P</td>
<td>BDX95</td>
<td>2</td>
<td>P</td>
<td>BF337</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD647</td>
<td>2</td>
<td>P</td>
<td>BDX96</td>
<td>2</td>
<td>P</td>
<td>BF338</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD648</td>
<td>2</td>
<td>P</td>
<td>BDY20</td>
<td>2</td>
<td>P</td>
<td>BF362</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD649</td>
<td>2</td>
<td>P</td>
<td>BDY90</td>
<td>2</td>
<td>P</td>
<td>BF363</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD650</td>
<td>2</td>
<td>P</td>
<td>BDY91</td>
<td>2</td>
<td>P</td>
<td>BF422</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD675</td>
<td>2</td>
<td>P</td>
<td>BDY92</td>
<td>2</td>
<td>P</td>
<td>BF423</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD676</td>
<td>2</td>
<td>P</td>
<td>BDY93</td>
<td>2</td>
<td>P</td>
<td>BF450</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD677</td>
<td>2</td>
<td>P</td>
<td>BDY94</td>
<td>2</td>
<td>P</td>
<td>BF451</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD678</td>
<td>2</td>
<td>P</td>
<td>BDY96</td>
<td>2</td>
<td>P</td>
<td>BF457</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD679</td>
<td>2</td>
<td>P</td>
<td>BDY97</td>
<td>2</td>
<td>P</td>
<td>BF458</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD680</td>
<td>2</td>
<td>P</td>
<td>BF115</td>
<td>3</td>
<td>HFSW</td>
<td>BF459</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD681</td>
<td>2</td>
<td>P</td>
<td>BF167</td>
<td>3</td>
<td>HFSW</td>
<td>BF480</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BD682</td>
<td>2</td>
<td>P</td>
<td>BF173</td>
<td>3</td>
<td>HFSW</td>
<td>BF494</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BDX35</td>
<td>2</td>
<td>P</td>
<td>BF177</td>
<td>3</td>
<td>HFSW</td>
<td>BF495</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>BDX36</td>
<td>2</td>
<td>P</td>
<td>BF178</td>
<td>3</td>
<td>HFSW</td>
<td>BF550</td>
<td>4c</td>
<td>Mm</td>
</tr>
<tr>
<td>BDX37</td>
<td>2</td>
<td>P</td>
<td>BF179</td>
<td>3</td>
<td>HFSW</td>
<td>BF622</td>
<td>4c</td>
<td>Mm</td>
</tr>
<tr>
<td>BDX62</td>
<td>2</td>
<td>P</td>
<td>BF180</td>
<td>3</td>
<td>HFSW</td>
<td>BF623</td>
<td>4c</td>
<td>Mm</td>
</tr>
<tr>
<td>BDX62A</td>
<td>2</td>
<td>P</td>
<td>BF181</td>
<td>3</td>
<td>HFSW</td>
<td>BFQ10</td>
<td>3</td>
<td>FET</td>
</tr>
<tr>
<td>BDX62B</td>
<td>2</td>
<td>P</td>
<td>BF182</td>
<td>3</td>
<td>HFSW</td>
<td>BFQ11</td>
<td>3</td>
<td>FET</td>
</tr>
<tr>
<td>BDX63</td>
<td>2</td>
<td>P</td>
<td>BF183</td>
<td>3</td>
<td>HFSW</td>
<td>BFQ12</td>
<td>3</td>
<td>FET</td>
</tr>
<tr>
<td>BDX63A</td>
<td>2</td>
<td>P</td>
<td>BF184</td>
<td>3</td>
<td>HFSW</td>
<td>BFQ13</td>
<td>3</td>
<td>FET</td>
</tr>
<tr>
<td>BDX63B</td>
<td>2</td>
<td>P</td>
<td>BF185</td>
<td>3</td>
<td>HFSW</td>
<td>BFQ14</td>
<td>3</td>
<td>FET</td>
</tr>
<tr>
<td>BDX64</td>
<td>2</td>
<td>P</td>
<td>BF194</td>
<td>3</td>
<td>HFSW</td>
<td>BFQ15</td>
<td>3</td>
<td>FET</td>
</tr>
</tbody>
</table>

FET = Field-effect transistors
HFSW = High-frequency and switching transistors
Mm = Discrete semiconductors for hybrid thick and thin-film circuits
P = Low-frequency power transistors

August 1978 3
<table>
<thead>
<tr>
<th>type no.</th>
<th>part</th>
<th>section</th>
<th>type no.</th>
<th>part</th>
<th>section</th>
<th>type no.</th>
<th>part</th>
<th>section</th>
</tr>
</thead>
<tbody>
<tr>
<td>BFQ16</td>
<td>3 FET</td>
<td></td>
<td>BFQ11</td>
<td>3 FET</td>
<td></td>
<td>BLW64</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFQ17</td>
<td>4c Mm</td>
<td></td>
<td>BFQ12</td>
<td>3 FET</td>
<td></td>
<td>BLW75</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFQ18A</td>
<td>4c Mm</td>
<td></td>
<td>BFQ13</td>
<td>3 FET</td>
<td></td>
<td>BLX13</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFQ19</td>
<td>4c Mm</td>
<td></td>
<td>BFQ16A</td>
<td>3 HFSW</td>
<td></td>
<td>BLX14</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFQ23</td>
<td>3 HFSW</td>
<td></td>
<td>BFQ17A</td>
<td>3 HFSW</td>
<td></td>
<td>BLX15</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFQ24</td>
<td>3 HFSW</td>
<td></td>
<td>BFQ20</td>
<td>3 HFSW</td>
<td></td>
<td>BLX55</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFQ32</td>
<td>3 HFSW</td>
<td></td>
<td>BFQ21</td>
<td>3 FET</td>
<td></td>
<td>BLX65</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFQ34</td>
<td>3 HFSW</td>
<td></td>
<td>BFQ22</td>
<td>3 HFSW</td>
<td></td>
<td>BLX66</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFR29</td>
<td>3 FET</td>
<td></td>
<td>BFQ23</td>
<td>3 HFSW</td>
<td></td>
<td>BLX67</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFR30</td>
<td>4c Mm</td>
<td></td>
<td>BFQ24</td>
<td>3 HFSW</td>
<td></td>
<td>BLX68</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFR31</td>
<td>4c Mm</td>
<td></td>
<td>BFQ25</td>
<td>3 HFSW</td>
<td></td>
<td>BLX69</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFR49</td>
<td>3 HFSW</td>
<td></td>
<td>BFQ31</td>
<td>3 HFSW</td>
<td></td>
<td>BX91A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFR51</td>
<td>3 HFSW</td>
<td></td>
<td>BFQ80</td>
<td>3 HFSW</td>
<td></td>
<td>BX92A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFR64</td>
<td>3 HFSW</td>
<td></td>
<td>BFQ81</td>
<td>3 HFSW</td>
<td></td>
<td>BX93A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFR65</td>
<td>3 HFSW</td>
<td></td>
<td>BFQ82</td>
<td>3 HFSW</td>
<td></td>
<td>BX94A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFR84</td>
<td>3 FET</td>
<td></td>
<td>BFQ83</td>
<td>3 HFSW</td>
<td></td>
<td>BX95A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFR90</td>
<td>3 HFSW</td>
<td></td>
<td>BFQ84</td>
<td>3 HFSW</td>
<td></td>
<td>BX96A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFR91</td>
<td>3 HFSW</td>
<td></td>
<td>BFQ85</td>
<td>3 HFSW</td>
<td></td>
<td>BLX97</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFR92</td>
<td>4c Mm</td>
<td></td>
<td>BFQ86</td>
<td>3 HFSW</td>
<td></td>
<td>BLX98</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFR93</td>
<td>4c Mm</td>
<td></td>
<td>BFQ87</td>
<td>3 HFSW</td>
<td></td>
<td>BLY87A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFR94</td>
<td>3 HFSW</td>
<td></td>
<td>BFQ90</td>
<td>3 HFSW</td>
<td></td>
<td>BLY88A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFR95</td>
<td>3 HFSW</td>
<td></td>
<td>BFQ91</td>
<td>3 HFSW</td>
<td></td>
<td>BLY90</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFR96</td>
<td>3 HFSW</td>
<td></td>
<td>BFQ92</td>
<td>3 HFSW</td>
<td></td>
<td>BLY91A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFS17</td>
<td>4c Mm</td>
<td></td>
<td>BFQ93</td>
<td>3 HFSW</td>
<td></td>
<td>BLY92A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFS18</td>
<td>4c Mm</td>
<td></td>
<td>BFQ94</td>
<td>3 HFSW</td>
<td></td>
<td>BLY93A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFS19</td>
<td>4c Mm</td>
<td></td>
<td>BFQ95</td>
<td>3 HFSW</td>
<td></td>
<td>BLY94A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFS20</td>
<td>4c Mm</td>
<td></td>
<td>BFQ96</td>
<td>3 HFSW</td>
<td></td>
<td>BLY95A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFS21</td>
<td>3 FET</td>
<td></td>
<td>BFQ97</td>
<td>3 HFSW</td>
<td></td>
<td>BLY96A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFS21A</td>
<td>3 FET</td>
<td></td>
<td>BFQ98</td>
<td>3 HFSW</td>
<td></td>
<td>BLY97A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFS22</td>
<td>4a Tra</td>
<td></td>
<td>BG1895-</td>
<td>541 1a R</td>
<td></td>
<td>BLY98A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFS23A</td>
<td>4a Tra</td>
<td></td>
<td>BG1895-</td>
<td>641 1a R</td>
<td></td>
<td>BLY99A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFS28</td>
<td>3 FET</td>
<td></td>
<td>BG1897-</td>
<td>541 1a R</td>
<td></td>
<td>BLY9A</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFT24</td>
<td>3 HFSW</td>
<td></td>
<td>BG1897-</td>
<td>641 1a R</td>
<td></td>
<td>BLX9B</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFT25</td>
<td>4c Mm</td>
<td></td>
<td>BG1897-</td>
<td>541 1a R</td>
<td></td>
<td>BLX9C</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFT44</td>
<td>3 HFSW</td>
<td></td>
<td>BG1898-</td>
<td>541 1a R</td>
<td></td>
<td>BLX9D</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFT45</td>
<td>3 HFSW</td>
<td></td>
<td>BG1898-</td>
<td>641 1a R</td>
<td></td>
<td>BLX9E</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFT46</td>
<td>4c Mm</td>
<td></td>
<td>BGX37</td>
<td>3 HFSW</td>
<td></td>
<td>BLX9F</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFT92</td>
<td>4c Mm</td>
<td></td>
<td>BLY60</td>
<td>4a Tra</td>
<td></td>
<td>BLX9G</td>
<td>4a Tra</td>
<td></td>
</tr>
<tr>
<td>BFT93</td>
<td>4c Mm</td>
<td></td>
<td>BR100</td>
<td>1a Th</td>
<td></td>
<td>BLX9H</td>
<td>4a Tra</td>
<td></td>
</tr>
</tbody>
</table>

**FET** = Field-effect transistors  
**HFSW** = High-frequency and switching transistors  
**Mm** = Discrete semiconductors for hybrid thick and thin-film circuits  
**PDT** = Photodiodes or transistors  
**R** = Rectifier diodes  
**Th** = Thyristors  
**Tra** = Transmitting transistors
<table>
<thead>
<tr>
<th>type no.</th>
<th>part</th>
<th>section</th>
<th>type no.</th>
<th>part</th>
<th>section</th>
<th>type no.</th>
<th>part</th>
<th>section</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR101</td>
<td>3</td>
<td>HFSW</td>
<td>BSW68</td>
<td>3</td>
<td>HFSW</td>
<td>BU133</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BRY39</td>
<td>1a</td>
<td>Th</td>
<td>BSX19</td>
<td>3</td>
<td>HFSW</td>
<td>BU204</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BRY39</td>
<td></td>
<td>(SCS)</td>
<td>BSX20</td>
<td>3</td>
<td>HFSW</td>
<td>BU205</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BRY39</td>
<td></td>
<td></td>
<td>BSX21</td>
<td>3</td>
<td>HFSW</td>
<td>BU206</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>BSX45</td>
<td>3</td>
<td>HFSW</td>
<td>BU207A</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BRY39</td>
<td></td>
<td>(PUT)</td>
<td>BSX46</td>
<td>3</td>
<td>HFSW</td>
<td>BU208A</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BRY61</td>
<td>4c</td>
<td>Mm</td>
<td>BSX47</td>
<td>3</td>
<td>HFSW</td>
<td>BU209A</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BSR12;R</td>
<td>4c</td>
<td>Mm</td>
<td>BSX59</td>
<td>3</td>
<td>HFSW</td>
<td>BU326A</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BSR30</td>
<td>4c</td>
<td>Mm</td>
<td>BSX60</td>
<td>3</td>
<td>HFSW</td>
<td>BU80</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BSR31</td>
<td>4c</td>
<td>Mm</td>
<td>BSX61</td>
<td>3</td>
<td>HFSW</td>
<td>BU81</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BSR32</td>
<td>4c</td>
<td>Mm</td>
<td>BT126</td>
<td>1a</td>
<td>Th</td>
<td>BU82</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BSR33</td>
<td>4c</td>
<td>Mm</td>
<td>BT128 +</td>
<td>1a</td>
<td>Th</td>
<td>BU83</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BSR40</td>
<td>4c</td>
<td>Mm</td>
<td>BT129 +</td>
<td>1a</td>
<td>Th</td>
<td>BU84</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BSR41</td>
<td>4c</td>
<td>Mm</td>
<td>BT137 +</td>
<td>1a</td>
<td>Tri</td>
<td>BU85</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BSR42</td>
<td>4c</td>
<td>Mm</td>
<td>BT138 +</td>
<td>1a</td>
<td>Tri</td>
<td>BU86</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BSR43</td>
<td>4c</td>
<td>Mm</td>
<td>BT139 +</td>
<td>1a</td>
<td>Tri</td>
<td>BU87</td>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>BSR56</td>
<td>4c</td>
<td>Mm</td>
<td>BT151 +</td>
<td>1a</td>
<td>Th</td>
<td>BY126</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSR57</td>
<td>4c</td>
<td>Mm</td>
<td>BTW23 +</td>
<td>1a</td>
<td>Th</td>
<td>BY127</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSR58</td>
<td>4c</td>
<td>Mm</td>
<td>BTW24 +</td>
<td>1a</td>
<td>Th</td>
<td>BY164</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSS38</td>
<td>3</td>
<td>HFSW</td>
<td>BTW30 +</td>
<td>1a</td>
<td>Th</td>
<td>BY176</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSS50</td>
<td>3</td>
<td>HFSW</td>
<td>BTW31 +</td>
<td>1a</td>
<td>Th</td>
<td>BY179</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSS51</td>
<td>3</td>
<td>HFSW</td>
<td>BTW33 +</td>
<td>1a</td>
<td>Th</td>
<td>BY184</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSS52</td>
<td>3</td>
<td>HFSW</td>
<td>BTW34 +</td>
<td>1a</td>
<td>Tri</td>
<td>BY187</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSS60</td>
<td>3</td>
<td>HFSW</td>
<td>BTW38 +</td>
<td>1a</td>
<td>Th</td>
<td>BY188 + 1a</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>BSS61</td>
<td>3</td>
<td>HFSW</td>
<td>BTW40 +</td>
<td>1a</td>
<td>Th</td>
<td>BY206</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSS63;R</td>
<td>4c</td>
<td>Mm</td>
<td>BTW41 +</td>
<td>1a</td>
<td>Tri</td>
<td>BY207</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSS64;R</td>
<td>4c</td>
<td>Mm</td>
<td>BTW42 +</td>
<td>1a</td>
<td>Th</td>
<td>BY208 + 1a</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>BSS68</td>
<td>3</td>
<td>HFSW</td>
<td>BTW43 +</td>
<td>1a</td>
<td>Tri</td>
<td>BY209</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSV15</td>
<td>3</td>
<td>HFSW</td>
<td>BTW45 +</td>
<td>1a</td>
<td>Th</td>
<td>BY223</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSV16</td>
<td>3</td>
<td>HFSW</td>
<td>BTW47 +</td>
<td>1a</td>
<td>Th</td>
<td>BY224 + 1a</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>BSV17</td>
<td>3</td>
<td>HFSW</td>
<td>BTW92 +</td>
<td>1a</td>
<td>Th</td>
<td>BY225 + 1a</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>BSV52;R</td>
<td>4c</td>
<td>Mm</td>
<td>BTX18 +</td>
<td>1a</td>
<td>Th</td>
<td>BY226</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSV64</td>
<td>3</td>
<td>HFSW</td>
<td>BTX94 +</td>
<td>1a</td>
<td>Tri</td>
<td>BY227</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSV78</td>
<td>3</td>
<td>FET</td>
<td>BY79</td>
<td>1a</td>
<td>Th</td>
<td>BY228</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSV79</td>
<td>3</td>
<td>FET</td>
<td>BY87</td>
<td>1a</td>
<td>Th</td>
<td>BY277 + 1a</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>BSV80</td>
<td>3</td>
<td>FET</td>
<td>BTP91</td>
<td>1a</td>
<td>Th</td>
<td>BY406</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSV81</td>
<td>3</td>
<td>FET</td>
<td>BU105</td>
<td>2</td>
<td>P</td>
<td>BY407</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSW41A</td>
<td>3</td>
<td>HFSW</td>
<td>BU108</td>
<td>2</td>
<td>P</td>
<td>BY409</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSW66</td>
<td>3</td>
<td>HFSW</td>
<td>BU126</td>
<td>2</td>
<td>P</td>
<td>BY409A</td>
<td>1a</td>
<td>R</td>
</tr>
<tr>
<td>BSW67</td>
<td>3</td>
<td>HFSW</td>
<td>BU132</td>
<td>2</td>
<td>P</td>
<td>BY476</td>
<td>1a</td>
<td>R</td>
</tr>
</tbody>
</table>

+ = series.

**FET** = Field-effect transistors

**HFSW** = High-frequency and switching transistors

**Th** = Thyristors

**Tri** = Triacs

**Mm** = Discrete semiconductors for hybrid thick and thin-film circuits

**P** = Low-frequency power transistors

**R** = Rectifier diodes
<table>
<thead>
<tr>
<th>type no.</th>
<th>part</th>
<th>section</th>
<th>type no.</th>
<th>part</th>
<th>section</th>
<th>type no.</th>
<th>part</th>
<th>section</th>
</tr>
</thead>
<tbody>
<tr>
<td>BY476A</td>
<td>1a</td>
<td>R</td>
<td>BZV14</td>
<td>1a</td>
<td>Vrf</td>
<td>BZZ27</td>
<td>1a</td>
<td>Vrg</td>
</tr>
<tr>
<td>BY477</td>
<td>1a</td>
<td>R</td>
<td>BZV15</td>
<td>1a</td>
<td>Vrg</td>
<td>BZZ28</td>
<td>1a</td>
<td>Vrg</td>
</tr>
<tr>
<td>BY478</td>
<td>1a</td>
<td>R</td>
<td>BZV38</td>
<td>1b</td>
<td>Vrf</td>
<td>BZZ29</td>
<td>1a</td>
<td>Vrg</td>
</tr>
<tr>
<td>BYW19 +</td>
<td>1a</td>
<td>R</td>
<td>BZW10</td>
<td>1a</td>
<td>TS</td>
<td>CNY22</td>
<td>4b</td>
<td>PhC</td>
</tr>
<tr>
<td>BYW29 +</td>
<td>1a</td>
<td>R</td>
<td>BZW70</td>
<td>1a</td>
<td>TS</td>
<td>CNY23</td>
<td>4b</td>
<td>PhC</td>
</tr>
<tr>
<td>BYW30 +</td>
<td>1a</td>
<td>R</td>
<td>BZW66</td>
<td>1a</td>
<td>TS</td>
<td>CNY42</td>
<td>4b</td>
<td>PhC</td>
</tr>
<tr>
<td>BYW31 +</td>
<td>1a</td>
<td>R</td>
<td>BZW93</td>
<td>1a</td>
<td>TS</td>
<td>CNY43</td>
<td>4b</td>
<td>PhC</td>
</tr>
<tr>
<td>BYW54</td>
<td>1a</td>
<td>R</td>
<td>BZW95</td>
<td>1a</td>
<td>TS</td>
<td>CNY44</td>
<td>4b</td>
<td>PhC</td>
</tr>
<tr>
<td>BYW55</td>
<td>1a</td>
<td>R</td>
<td>BZW96</td>
<td>1a</td>
<td>TS</td>
<td>CNY46</td>
<td>4b</td>
<td>PhC</td>
</tr>
<tr>
<td>BYW56</td>
<td>1a</td>
<td>R</td>
<td>BZX55</td>
<td>1b</td>
<td>Vrg</td>
<td>CNY47A</td>
<td>4b</td>
<td>PhC</td>
</tr>
<tr>
<td>BYW92 +</td>
<td>1a</td>
<td>R</td>
<td>BZX84</td>
<td>4c</td>
<td>Mn</td>
<td>CQY11B</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BZX30 +</td>
<td>1a</td>
<td>R</td>
<td>BZX86</td>
<td>1a</td>
<td>TS</td>
<td>CQY11C</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BZX32 +</td>
<td>1a</td>
<td>R</td>
<td>BZX90</td>
<td>1b</td>
<td>Vrf</td>
<td>CQY24A</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BZX35</td>
<td>1a</td>
<td>R</td>
<td>BZX91</td>
<td>1b</td>
<td>Vrf</td>
<td>CQY46A</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BZX36 +</td>
<td>1a</td>
<td>R</td>
<td>BZX92</td>
<td>1b</td>
<td>Vrf</td>
<td>CQY47A</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BZX39 +</td>
<td>1a</td>
<td>R</td>
<td>BZX93</td>
<td>1b</td>
<td>Vrf</td>
<td>CQY49B</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BZX42 +</td>
<td>1a</td>
<td>R</td>
<td>BZY78</td>
<td>1b</td>
<td>Vrf</td>
<td>CQY49C</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BZX45 +</td>
<td>1a</td>
<td>R</td>
<td>BZY88</td>
<td>1b</td>
<td>Vrg</td>
<td>CQY50</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BZX46 +</td>
<td>1a</td>
<td>R</td>
<td>BZY91</td>
<td>1a</td>
<td>Vrg</td>
<td>CQY52</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BZX49 +</td>
<td>1a</td>
<td>R</td>
<td>BZY93</td>
<td>1a</td>
<td>Vrg</td>
<td>CQY54</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BXX30 +</td>
<td>1a</td>
<td>R</td>
<td>BZY95</td>
<td>1a</td>
<td>Vrg</td>
<td>CQY58</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BXX32 +</td>
<td>1a</td>
<td>R</td>
<td>BZY96</td>
<td>1a</td>
<td>Vrg</td>
<td>CQY88</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BXX35</td>
<td>1a</td>
<td>R</td>
<td>BZZ14</td>
<td>1a</td>
<td>Vrg</td>
<td>CQY89</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BXX55 +</td>
<td>1a</td>
<td>R</td>
<td>BZZ15</td>
<td>1a</td>
<td>Vrg</td>
<td>CQY94</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BXX56 +</td>
<td>1a</td>
<td>R</td>
<td>BZZ16</td>
<td>1a</td>
<td>Vrg</td>
<td>CQY95</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BXX71</td>
<td>1a</td>
<td>R</td>
<td>BZZ20</td>
<td>1a</td>
<td>Vrg</td>
<td>CQY96</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BXX90</td>
<td>1a</td>
<td>R</td>
<td>BZZ21</td>
<td>1a</td>
<td>Vrg</td>
<td>CQY97</td>
<td>4b</td>
<td>LED</td>
</tr>
<tr>
<td>BXX91 +</td>
<td>1a</td>
<td>R</td>
<td>BZZ22</td>
<td>1a</td>
<td>Vrg</td>
<td>OA47</td>
<td>1b</td>
<td>GB</td>
</tr>
<tr>
<td>BXX96 +</td>
<td>1a</td>
<td>R</td>
<td>BZZ23</td>
<td>1a</td>
<td>Vrg</td>
<td>OA47</td>
<td>1b</td>
<td>GB</td>
</tr>
<tr>
<td>BXX97 +</td>
<td>1a</td>
<td>R</td>
<td>BZZ24</td>
<td>1a</td>
<td>Vrg</td>
<td>OA47</td>
<td>1b</td>
<td>GB</td>
</tr>
<tr>
<td>BXX99 +</td>
<td>1a</td>
<td>R</td>
<td>BZZ25</td>
<td>1a</td>
<td>Vrg</td>
<td>OA47</td>
<td>1b</td>
<td>GB</td>
</tr>
<tr>
<td>BZX13</td>
<td>1b</td>
<td>Vrf</td>
<td>BZZ26</td>
<td>1a</td>
<td>Vrg</td>
<td>OA47</td>
<td>1b</td>
<td>GB</td>
</tr>
</tbody>
</table>

+ = series.

GB = Germanium gold bonded diodes
LED = Light-emitting diodes
Mm = Discrete semiconductors for hybrid thick and thin-film circuits
PhC = Photocouplers
R = Rectifier diodes
TS = Transient suppressor diodes
Vrf = Voltage reference diodes
Vrg = Voltage regulator diodes
<table>
<thead>
<tr>
<th>type no.</th>
<th>part</th>
<th>section</th>
<th>type no.</th>
<th>part</th>
<th>section</th>
<th>type no.</th>
<th>part</th>
<th>section</th>
</tr>
</thead>
<tbody>
<tr>
<td>OA90</td>
<td>1b</td>
<td>PC</td>
<td>1N827</td>
<td>1b</td>
<td>Vrf</td>
<td>1N5744B</td>
<td>1b</td>
<td>Vrg</td>
</tr>
<tr>
<td>OA91</td>
<td>1b</td>
<td>PC</td>
<td>1N829</td>
<td>1b</td>
<td>Vrf</td>
<td>1N5745B</td>
<td>1b</td>
<td>Vrg</td>
</tr>
<tr>
<td>OA95</td>
<td>1b</td>
<td>PC</td>
<td>1N914</td>
<td>1b</td>
<td>WD</td>
<td>1N5746B</td>
<td>1b</td>
<td>Vrg</td>
</tr>
<tr>
<td>OA200</td>
<td>1b</td>
<td>AD</td>
<td>1N914A</td>
<td>1b</td>
<td>WD</td>
<td>1N5747B</td>
<td>1b</td>
<td>Vrg</td>
</tr>
<tr>
<td>ORP10</td>
<td>4b</td>
<td>I</td>
<td>1N916A</td>
<td>1b</td>
<td>WD</td>
<td>1N5748B</td>
<td>1b</td>
<td>Vrg</td>
</tr>
<tr>
<td>ORP13</td>
<td>4b</td>
<td>I</td>
<td>1N916B</td>
<td>1b</td>
<td>WD</td>
<td>1N5749B</td>
<td>1b</td>
<td>Vrg</td>
</tr>
<tr>
<td>ORP23</td>
<td>4b</td>
<td>Ph</td>
<td>1N3879</td>
<td>1a</td>
<td>R</td>
<td>1N5750B</td>
<td>1b</td>
<td>Vrg</td>
</tr>
<tr>
<td>ORP52</td>
<td>4b</td>
<td>Ph</td>
<td>1N3880</td>
<td>1a</td>
<td>R</td>
<td>1N5751B</td>
<td>1b</td>
<td>Vrg</td>
</tr>
<tr>
<td>ORP60</td>
<td>4b</td>
<td>Ph</td>
<td>1N3881</td>
<td>1a</td>
<td>R</td>
<td>1N5752B</td>
<td>1b</td>
<td>Vrg</td>
</tr>
<tr>
<td>ORP69</td>
<td>4b</td>
<td>Ph</td>
<td>1N3882</td>
<td>1a</td>
<td>R</td>
<td>1N5753B</td>
<td>1b</td>
<td>Vrg</td>
</tr>
<tr>
<td>OSB9110</td>
<td>1a</td>
<td>St</td>
<td>1N4009</td>
<td>1b</td>
<td>WD</td>
<td>2N918</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>OSB9210</td>
<td>1a</td>
<td>St</td>
<td>1N4148</td>
<td>1b</td>
<td>WD</td>
<td>2N929</td>
<td>2</td>
<td>LF</td>
</tr>
<tr>
<td>OSB9310</td>
<td>1a</td>
<td>St</td>
<td>1N4150</td>
<td>1b</td>
<td>WD</td>
<td>2N930</td>
<td>2</td>
<td>LF</td>
</tr>
<tr>
<td>OSB9410</td>
<td>1a</td>
<td>St</td>
<td>1N4151</td>
<td>1b</td>
<td>WD</td>
<td>2N1613</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>OSB9510</td>
<td>1a</td>
<td>St</td>
<td>1N4154</td>
<td>1b</td>
<td>WD</td>
<td>2N1711</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>ORP9210</td>
<td>1a</td>
<td>St</td>
<td>1N4446</td>
<td>1b</td>
<td>WD</td>
<td>2N1893</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>ORP9310</td>
<td>1a</td>
<td>St</td>
<td>1N4448</td>
<td>1b</td>
<td>WD</td>
<td>2N2218</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>ORP9410</td>
<td>1a</td>
<td>St</td>
<td>1N5060</td>
<td>1a</td>
<td>R</td>
<td>2N2218A</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>OSF9910</td>
<td>1a</td>
<td>St</td>
<td>1N5061</td>
<td>1a</td>
<td>R</td>
<td>2N2219</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>OSS9210</td>
<td>1a</td>
<td>St</td>
<td>1N5062</td>
<td>1a</td>
<td>R</td>
<td>2N219A</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>OSS9310</td>
<td>1a</td>
<td>St</td>
<td>1N5729B</td>
<td>1b</td>
<td>Vrg</td>
<td>2N2211</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>OSS9410</td>
<td>1a</td>
<td>St</td>
<td>1N5730B</td>
<td>1b</td>
<td>Vrg</td>
<td>2N2221</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>RPY82</td>
<td>4b</td>
<td>Ph</td>
<td>1N5731B</td>
<td>1b</td>
<td>Vrg</td>
<td>2N2222A</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>RPY71</td>
<td>4b</td>
<td>Ph</td>
<td>1N5732B</td>
<td>1b</td>
<td>Vrg</td>
<td>2N2222</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>RPY76A</td>
<td>4b</td>
<td>I</td>
<td>1N5733B</td>
<td>1b</td>
<td>Vrg</td>
<td>2N2297</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>RPY84</td>
<td>4b</td>
<td>Ph</td>
<td>1N5734B</td>
<td>1b</td>
<td>Vrg</td>
<td>2N2368</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>RPY85</td>
<td>4b</td>
<td>Ph</td>
<td>1N5735B</td>
<td>1b</td>
<td>Vrg</td>
<td>2N2369</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>RPY86</td>
<td>4b</td>
<td>I</td>
<td>1N5736B</td>
<td>1b</td>
<td>Vrg</td>
<td>2N2369A</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>RPY87</td>
<td>4b</td>
<td>I</td>
<td>1N5737B</td>
<td>1b</td>
<td>Vrg</td>
<td>2N2483</td>
<td>2</td>
<td>LF</td>
</tr>
<tr>
<td>RPY88</td>
<td>4b</td>
<td>I</td>
<td>1N5738B</td>
<td>1b</td>
<td>Vrg</td>
<td>2N2484</td>
<td>2</td>
<td>LF</td>
</tr>
<tr>
<td>RPY89</td>
<td>4b</td>
<td>I</td>
<td>1N5739B</td>
<td>1b</td>
<td>Vrg</td>
<td>2N2894</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>1N821</td>
<td>1b</td>
<td>Vrf</td>
<td>1N5741B</td>
<td>1b</td>
<td>Vrg</td>
<td>2N2894A</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>1N823</td>
<td>1b</td>
<td>Vrf</td>
<td>1N5742B</td>
<td>1b</td>
<td>Vrg</td>
<td>2N2904</td>
<td>3</td>
<td>HFSW</td>
</tr>
<tr>
<td>1N825</td>
<td>1b</td>
<td>Vrf</td>
<td>1N5743B</td>
<td>1b</td>
<td>Vrg</td>
<td>2N2904A</td>
<td>3</td>
<td>HFSW</td>
</tr>
</tbody>
</table>

AD = Silicon alloyed diodes  
HFSW = High-frequency and switching transistors  
I = Infrared devices  
LF = Low-frequency transistors  
PC = Germanium point contact diodes  
Ph = Photoconductive devices  
R = Rectifier diodes  
St = Rectifier stacks  
Vrf = Voltage reference diodes  
Vrg = Voltage regulator diodes  
WD = Silicon whiskerless diodes
<table>
<thead>
<tr>
<th>type no.</th>
<th>part</th>
<th>section</th>
<th>type no.</th>
<th>part</th>
<th>section</th>
<th>type no.</th>
<th>part</th>
<th>section</th>
</tr>
</thead>
<tbody>
<tr>
<td>2N2906</td>
<td>3</td>
<td>HFSW</td>
<td>40835</td>
<td>3</td>
<td>HFSW</td>
<td>56315</td>
<td>1a</td>
<td>DH</td>
</tr>
<tr>
<td>2N2906A</td>
<td>3</td>
<td>HFSW</td>
<td>40838</td>
<td>3</td>
<td>HFSW</td>
<td>56316</td>
<td>1a</td>
<td>A</td>
</tr>
<tr>
<td>2N2907</td>
<td>3</td>
<td>HFSW</td>
<td>56200</td>
<td>2,3,</td>
<td>HFSW</td>
<td>56318</td>
<td>1a</td>
<td>DH</td>
</tr>
<tr>
<td>2N2907A</td>
<td>3</td>
<td>HFSW</td>
<td>4a</td>
<td>A</td>
<td>2N2908</td>
<td>3</td>
<td>HFSW</td>
<td>56319</td>
</tr>
<tr>
<td>2N3019</td>
<td>3</td>
<td>HFSW</td>
<td>56201</td>
<td>2</td>
<td>A</td>
<td>56326</td>
<td>2,3</td>
<td>A</td>
</tr>
<tr>
<td>2N3020</td>
<td>3</td>
<td>HFSW</td>
<td>56201c</td>
<td>2</td>
<td>A</td>
<td>56333</td>
<td>2,3</td>
<td>A</td>
</tr>
<tr>
<td>2N3055</td>
<td>2</td>
<td>P</td>
<td>56201d</td>
<td>2</td>
<td>A</td>
<td>56334</td>
<td>1a</td>
<td>DH</td>
</tr>
<tr>
<td>2N3375</td>
<td>4a</td>
<td>Tra</td>
<td>56201j</td>
<td>2</td>
<td>A</td>
<td>56337</td>
<td>1a</td>
<td>A</td>
</tr>
<tr>
<td>2N3442</td>
<td>2</td>
<td>P</td>
<td>56203</td>
<td>2</td>
<td>A</td>
<td>56339</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>2N3553</td>
<td>4a</td>
<td>Tra</td>
<td>56218</td>
<td>2,3,</td>
<td>1a</td>
<td>56348</td>
<td>1a</td>
<td>DH</td>
</tr>
<tr>
<td>2N3632</td>
<td>4a</td>
<td>Tra</td>
<td>56245</td>
<td>2,3,</td>
<td>4a</td>
<td>56349</td>
<td>1a</td>
<td>DH</td>
</tr>
<tr>
<td>2N3632</td>
<td>4a</td>
<td>Tra</td>
<td>56246</td>
<td>1a</td>
<td>4a A</td>
<td>56350</td>
<td>1a</td>
<td>DH</td>
</tr>
<tr>
<td>2N3866</td>
<td>4a</td>
<td>Tra</td>
<td>56246</td>
<td>1a</td>
<td>4a A</td>
<td>56350</td>
<td>1a</td>
<td>DH</td>
</tr>
<tr>
<td>2N3924</td>
<td>4a</td>
<td>Tra</td>
<td>56253</td>
<td>1a</td>
<td>DH</td>
<td>56352</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>2N3926</td>
<td>4a</td>
<td>Tra</td>
<td>56253</td>
<td>1a</td>
<td>DH</td>
<td>56352</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>2N3927</td>
<td>4a</td>
<td>Tra</td>
<td>56256</td>
<td>1a</td>
<td>DH</td>
<td>56354</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>2N3966</td>
<td>3</td>
<td>FET</td>
<td>56261</td>
<td>2</td>
<td>A</td>
<td>56356</td>
<td>2,3</td>
<td>A</td>
</tr>
<tr>
<td>2N4030</td>
<td>3</td>
<td>HFSW</td>
<td>56261a</td>
<td>2</td>
<td>A</td>
<td>56358</td>
<td>1a</td>
<td>A</td>
</tr>
<tr>
<td>2N4031</td>
<td>3</td>
<td>HFSW</td>
<td>56262</td>
<td>1a</td>
<td>A</td>
<td>56359</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>2N4032</td>
<td>3</td>
<td>HFSW</td>
<td>56262A</td>
<td>1a</td>
<td>A</td>
<td>56359a</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>2N4033</td>
<td>3</td>
<td>HFSW</td>
<td>56263</td>
<td>1a</td>
<td>A</td>
<td>56360</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>2N4036</td>
<td>3</td>
<td>HFSW</td>
<td>56263</td>
<td>1a</td>
<td>A</td>
<td>56360a</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>2N4091</td>
<td>3</td>
<td>FET</td>
<td>56263</td>
<td>1a</td>
<td>to 4a A</td>
<td>56363</td>
<td>1a,2</td>
<td>A</td>
</tr>
<tr>
<td>2N4092</td>
<td>3</td>
<td>FET</td>
<td>56263</td>
<td>1a</td>
<td>A</td>
<td>56364</td>
<td>1a,2</td>
<td>A</td>
</tr>
<tr>
<td>2N4093</td>
<td>3</td>
<td>FET</td>
<td>56263</td>
<td>1a</td>
<td>A</td>
<td>56366</td>
<td>1a</td>
<td>A</td>
</tr>
<tr>
<td>2N4347</td>
<td>2</td>
<td>P</td>
<td>56266</td>
<td>1a</td>
<td>A</td>
<td>56367</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>2N4391</td>
<td>3</td>
<td>FET</td>
<td>56266</td>
<td>1a</td>
<td>A</td>
<td>56368</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>2N4392</td>
<td>3</td>
<td>FET</td>
<td>56266</td>
<td>1a</td>
<td>A</td>
<td>56369</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>2N4427</td>
<td>4a</td>
<td>Tra</td>
<td>56271</td>
<td>1a</td>
<td>DH</td>
<td>56370</td>
<td>1a</td>
<td>DH</td>
</tr>
<tr>
<td>2N4856</td>
<td>3</td>
<td>FET</td>
<td>56271</td>
<td>1a</td>
<td>DH</td>
<td>56371</td>
<td>1a</td>
<td>DH</td>
</tr>
<tr>
<td>2N4858</td>
<td>3</td>
<td>FET</td>
<td>56271</td>
<td>1a</td>
<td>DH</td>
<td>56372</td>
<td>1a</td>
<td>DH</td>
</tr>
<tr>
<td>2N4859</td>
<td>3</td>
<td>FET</td>
<td>56271</td>
<td>1a</td>
<td>DH</td>
<td>56373</td>
<td>1a</td>
<td>DH</td>
</tr>
<tr>
<td>2N4860</td>
<td>3</td>
<td>FET</td>
<td>56271</td>
<td>1a</td>
<td>DH</td>
<td>56373a</td>
<td>1a</td>
<td>DH</td>
</tr>
<tr>
<td>2N4861</td>
<td>3</td>
<td>FET</td>
<td>56280</td>
<td>1a</td>
<td>DH</td>
<td>56374</td>
<td>1a</td>
<td>DH</td>
</tr>
<tr>
<td>2N5415</td>
<td>3</td>
<td>HFSW</td>
<td>56290</td>
<td>1a</td>
<td>HE</td>
<td>56375</td>
<td>1a</td>
<td>HE</td>
</tr>
<tr>
<td>2N5416</td>
<td>3</td>
<td>HFSW</td>
<td>56290</td>
<td>1a</td>
<td>HE</td>
<td>56375a</td>
<td>1a</td>
<td>HE</td>
</tr>
<tr>
<td>615V</td>
<td>4b</td>
<td>I</td>
<td>56293</td>
<td>1a</td>
<td>A</td>
<td>56376</td>
<td>1a</td>
<td>A</td>
</tr>
<tr>
<td>40820</td>
<td>3</td>
<td>HFSW</td>
<td>56313</td>
<td>1a</td>
<td>DH</td>
<td>56376a</td>
<td>1a</td>
<td>DH</td>
</tr>
</tbody>
</table>

A = Accessories  
DH = Diecast heatsinks  
FET = Field-effect transistors  
HE = Heatsink extrusions  
HFSW = High-frequency and switching transistors  
I = Infrared devices  
P = Low-frequency power transistors  
Tra = Transmitting transistors
MAINTENANCE TYPE LIST

The type numbers listed below are not included in this handbook except for those marked with an asterisk.

Detailed information will be supplied on request.

BPX66P
OAP12
OCP70
* ORP23
* ORP52
RPY13
GENERAL

Type designation
Rating systems
Letter symbols
Definitions applying to photosensitive devices
PRO ELECTRON TYPE DESIGNATION CODE
FOR SEMICONDUCTOR DEVICES

This type designation code applies to discrete semiconductor devices — as opposed to integrated circuits —, multiples of such devices and semiconductor chips.

A basic type number consists of:

TWO LETTERS FOLLOWED BY A SERIAL NUMBER

FIRST LETTER

The first letter gives information about the material used for the active part of the devices.

A. GERMANIUM or other material with band gap of 0.6 to 1.0 eV.
B. SILICON or other material with band gap of 1.0 to 1.3 eV.
C. GALLIUM-ARSENIDE or other material with band gap of 1.3 eV or more.
R. COMPOUND MATERIALS (e.g. Cadmium-Sulphide).

SECOND LETTER

The second letter indicates the function for which the device is primarily designed.

A. DIODE; signal, low power
B. DIODE; variable capacitance
C. TRANSISTOR; low power, audio frequency (R_{th j-mb} > 15 \text{ OC/W})
D. TRANSISTOR; power, audio frequency (R_{th j-mb} < 15 \text{ OC/W})
E. DIODE; tunnel
F. TRANSISTOR; low power, high frequency (R_{th j-mb} > 15 \text{ OC/W})
G. MULTIPLE OF DISSIMILAR DEVICES — MISCELLANEOUS; e.g. oscillator
H. DIODE; magnetic sensitive
L. TRANSISTOR; power, high frequency (R_{th j-mb} < 15 \text{ OC/W})
N. PHOTO-COUPLER
P. RADIATION DETECTOR; e.g. high sensitivity phototransistor
Q. RADIATION GENERATOR; e.g. light-emitting diode (LED)
R. CONTROL AND SWITCHING DEVICE; e.g. thyristor, low power (R_{th j-mb} > 15 \text{ OC/W})
S. TRANSISTOR; low power, switching (R_{th j-mb} > 15 \text{ OC/W})
T. CONTROL AND SWITCHING DEVICE; e.g. thyristor, power (R_{th j-mb} < 15 \text{ OC/W})
U. TRANSISTOR; power, switching (R_{th j-mb} < 15 \text{ OC/W})
X. DIODE: multiplier, e.g. varactor, step recovery
Y. DIODE; rectifying, booster
Z. DIODE; voltage reference or regulator (transient suppressor diode, with third letter W)
SERIAL NUMBER

Three figures, running from 100 to 999, for devices primarily intended for consumer equipment. One letter (Z, Y, X, etc.) and two figures, running from 10 to 99, for devices primarily intended for industrial/professional equipment. This letter has no fixed meaning except W, which is used for transient suppressor diodes.

VERSION LETTER

It indicates a minor variant of the basic type either electrically or mechanically. The letter never has a fixed meaning, except letter R, indicating reverse voltage, e.g. collector to case or anode to stud.

SUFFIX

Sub-classification can be used for devices supplied in a wide range of variants called associated types. Following sub-coding suffixes are in use:

1. VOLTAGE REFERENCE and VOLTAGE REGULATOR DIODES: **ONE LETTER and ONE NUMBER**
   The LETTER indicates the nominal tolerance of the Zener (regulation, working or reference) voltage
   A. 1% (according to IEC 63: series E96)
   B. 2% (according to IEC 63: series E48)
   C. 5% (according to IEC 63: series E24)
   D. 10% (according to IEC 63: series E12)
   E. 20% (according to IEC 63: series E6)
   The number denotes the typical operating (Zener) voltage related to the nominal current rating for the whole range.
   The letter ‘V’ is used instead of the decimal point.

2. TRANSIENT SUPPRESSOR DIODES: **ONE NUMBER**
   The NUMBER indicates the maximum recommended continuous reversed (stand-off) voltage $V_R$. The letter ‘V’ is used as above.

3. CONVENTIONAL and CONTROLLED AVALANCHE RECTIFIER DIODES and THYRISTORS: **ONE NUMBER**
   The NUMBER indicates the rated maximum repetitive peak reverse voltage ($V_{RRM}$) or the rated repetitive peak off-state voltage ($V_{DRM}$), whichever is the lower. Reversed polarity is indicated by letter R, immediately after the number.

4. RADIATION DETECTORS: **ONE NUMBER**, preceded by a hyphen (—)
   The NUMBER indicates the depletion layer in µm. The resolution is indicated by a version LETTER.

5. ARRAY OF RADIATION DETECTORS and GENERATORS: **ONE NUMBER**, preceded by a stroke (/).
   The NUMBER indicates how many basic devices are assembled into the array.
RATING SYSTEMS

The rating systems described are those recommended by the International Electrotechnical Commission (IEC) in its Publication 134.

DEFINITIONS OF TERMS USED

Electronic device. An electronic tube or valve, transistor or other semiconductor device.

Note
This definition excludes inductors, capacitors, resistors and similar components.

Characteristic. A characteristic is an inherent and measurable property of a device. Such a property may be electrical, mechanical, thermal, hydraulic, electro-magnetic, or nuclear, and can be expressed as a value for stated or recognized conditions. A characteristic may also be a set of related values, usually shown in graphical form.

Bogey electronic device. An electronic device whose characteristics have the published nominal values for the type. A bogey electronic device for any particular application can be obtained by considering only those characteristics which are directly related to the application.

Rating. A value which establishes either a limiting capability or a limiting condition for an electronic device. It is determined for specified values of environment and operation, and may be stated in any suitable terms.

Note
Limiting conditions may be either maxima or minima.

Rating system. The set of principles upon which ratings are established and which determine their interpretation.

Note
The rating system indicates the division of responsibility between the device manufacturer and the circuit designer, with the object of ensuring that the working conditions do not exceed the ratings.

ABSOLUTE MAXIMUM RATING SYSTEM

Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any electronic device of a specified type as defined by its published data, which should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the device under consideration and of all other electronic devices in the equipment.

The equipment manufacturer should design so that, initially and throughout life, no absolute maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variations, signal variation, environmental conditions, and variations in characteristics of the device under consideration and of all other electronic devices in the equipment.
DESIGN MAXIMUM RATING SYSTEM

Design maximum ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking responsibility for the effects of changes in operating conditions due to variations in the characteristics of the electronic device under consideration.

The equipment manufacturer should design so that, initially and throughout life, no design maximum value for the intended service is exceeded with a bogey device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, variation in characteristics of all other devices in the equipment, equipment control adjustment, load variation, signal variation and environmental conditions.

DESIGN CENTRE RATING SYSTEM

Design centre ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under normal conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device in average applications, taking responsibility for normal changes in operating conditions due to rated supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of all electronic devices.

The equipment manufacturer should design so that, initially, no design centre value for the intended service is exceeded with a bogey electronic device in equipment operating at the stated normal supply voltage.
LETTER SYMBOLS FOR TRANSISTORS AND SIGNAL DIODES

based on IEC Publication 148

LETTER SYMBOLS FOR CURRENTS, VOLTAGES AND POWERS

Basic letters

The basic letters to be used are:

\[ I, \ i = \text{current} \]
\[ V, \ v = \text{voltage} \]
\[ P, \ p = \text{power}. \]

Lower-case basic letters shall be used for the representation of instantaneous values which vary with time.

In all other instances upper-case basic letters shall be used.

Subscripts

<table>
<thead>
<tr>
<th>Subscript</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, a</td>
<td>Anode terminal</td>
</tr>
<tr>
<td>(AV), (av)</td>
<td>Average value</td>
</tr>
<tr>
<td>B, b</td>
<td>Base terminal, for MOS devices: Substrate</td>
</tr>
<tr>
<td>(BR)</td>
<td>Breakdown</td>
</tr>
<tr>
<td>C, c</td>
<td>Collector terminal</td>
</tr>
<tr>
<td>D, d</td>
<td>Drain terminal</td>
</tr>
<tr>
<td>E, e</td>
<td>Emitter terminal</td>
</tr>
<tr>
<td>F, f</td>
<td>Forward</td>
</tr>
<tr>
<td>G, g</td>
<td>Gate terminal</td>
</tr>
<tr>
<td>K, k</td>
<td>Cathode terminal</td>
</tr>
<tr>
<td>M, m</td>
<td>Peak value</td>
</tr>
<tr>
<td>O, o</td>
<td>As third subscript: The terminal not mentioned is open circuited</td>
</tr>
<tr>
<td>R, r</td>
<td>As first subscript: Reverse. As second subscript: Repetitive. As third subscript: With a specified resistance between the terminal not mentioned and the reference terminal.</td>
</tr>
<tr>
<td>(RMS), (rms)</td>
<td>R.M.S. value</td>
</tr>
<tr>
<td>S, s</td>
<td>As first or second subscript: Source terminal (for FETS only) As second subscript: Non-repetitive (not for FETS) As third subscript: Short circuit between the terminal not mentioned and the reference terminal</td>
</tr>
<tr>
<td>X, x</td>
<td>Specified circuit</td>
</tr>
<tr>
<td>Z, z</td>
<td>Replaces R to indicate the actual working voltage, current or power of voltage reference and voltage regulator diodes.</td>
</tr>
</tbody>
</table>

Note: No additional subscript is used for d.c. values.
Upper-case subscripts shall be used for the indication of:

a) continuous (d.c.) values (without signal)  
   Example $I_B$

b) instantaneous total values  
   Example $i_B$

c) average total values  
   Example $I_B(AV)$

d) peak total values  
   Example $I_{BM}$

e) root-mean-square total values  
   Example $I_B(RMS)$

Lower-case subscripts shall be used for the indication of values applying to the varying component alone:

a) instantaneous values  
   Example $i_p$

b) root-mean-square values  
   Example $I_{p(rms)}$

c) peak values  
   Example $I_{p_m}$

d) average values  
   Example $I_{p(av)}$

Note: If more than one subscript is used, subscript for which both styles exist shall either be all upper-case or all lower-case.

Additional rules for subscripts

Subscripts for currents

Transistors: If it is necessary to indicate the terminal carrying the current, this should be done by the first subscript (conventional current flow from the external circuit into the terminal is positive).

Examples: $I_B, i_B, i_p, I_{p_m}$

Diodes: To indicate a forward current (conventional current flow into the anode terminal) the subscript F or f should be used; for a reverse current (conventional current flow out of the anode terminal) the subscript R or r should be used.

Examples: $I_F, I_R, i_F, I_{F(rms)}$
Subscripts for voltages

Transistors: If it is necessary to indicate the points between which a voltage is measured, this should be done by the first two subscripts. The first subscript indicates the terminal at which the voltage is measured and the second the reference terminal or the circuit node. Where there is no possibility of confusion, the second subscript may be omitted.

Examples: $V_{BE}$, $v_{BE}$, $v_{be}$, $V_{bem}$

Diodes: To indicate a forward voltage (anode positive with respect to cathode), the subscript $F$ or $f$ should be used; for a reverse voltage (anode negative with respect to cathode) the subscript $R$ or $r$ should be used.

Examples: $V_F$, $V_R$, $v_F$, $V_{rm}$

Subscripts for supply voltages or supply currents

Supply voltages or supply currents shall be indicated by repeating the appropriate terminal subscript.

Examples: $V_{CC}$, $I_{EE}$

Note: If it is necessary to indicate a reference terminal, this should be done by a third subscript

Example: $V_{CCE}$

Subscripts for devices having more than one terminal of the same kind

If a device has more than one terminal of the same kind, the subscript is formed by the appropriate letter for the terminal followed by a number; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

Examples: $I_{B2}$ = continuous (d.c.) current flowing into the second base terminal

$V_{B2-E}$ = continuous (d.c.) voltage between the terminals of second base and emitter

Subscripts for multiple devices

For multiple unit devices, the subscripts are modified by a number preceding the letter subscript; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

Examples: $I_{2C}$ = continuous (d.c.) current flowing into the collector terminal of the second unit

$V_{1C-2C}$ = continuous (d.c.) voltage between the collector terminals of the first and the second unit.
Application of the rules

The figure below represents a transistor collector current as a function of time. It consists of a continuous (d.c.) current and a varying component.

**LETTER SYMBOLS FOR ELECTRICAL PARAMETERS**

Definition

For the purpose of this Publication, the term "electrical parameter" applies to four-pole matrix parameters, elements of electrical equivalent circuits, electrical impedances and admittances, inductances and capacitances.

Basic letters

The following is a list of the most important basic letters used for electrical parameters of semiconductor devices.

- $B, b =$ susceptance; imaginary part of an admittance
- $C =$ capacitance
- $G, g =$ conductance; real part of an admittance
- $H, h =$ hybrid parameter
- $L =$ inductance
- $R, r =$ resistance; real part of an impedance
- $X, x =$ reactance; imaginary part of an impedance
- $Y, y =$ admittance;
- $Z, z =$ impedance;
Upper-case letters shall be used for the representation of:

a) electrical parameters of external circuits and of circuits in which the device forms only a part;

b) all inductances and capacitances.

Lower-case letters shall be used for the representation of electrical parameters inherent in the device (with the exception of inductances and capacitances).

Subscripts

General subscripts

The following is a list of the most important general subscripts used for electrical parameters of semiconductor devices:

- \( F, f \) = forward; forward transfer
- \( I, i \) (or \( 1 \)) = input
- \( L, l \) = load
- \( O, o \) (or \( 2 \)) = output
- \( R, r \) = reverse; reverse transfer
- \( S, s \) = source

Examples: \( Z_S, h_I, h_F \)

The upper-case variant of a subscript shall be used for the designation of static (d.c.) values.

Examples: \( h_{FE} \) = static value of forward current transfer ratio in common-emitter configuration (d.c. current gain)

\( R_E \) = d.c. value of the external emitter resistance.

Note: The static value is the slope of the line from the origin to the operating point on the appropriate characteristic curve, i.e. the quotient of the appropriate electrical quantities at the operating point.

The lower-case variant of a subscript shall be used for the designation of small-signal values.

Examples: \( h_{fe} \) = small-signal value of the short-circuit forward current transfer ratio in common-emitter configuration

\( Z_e = R_e + jX_e \) = small-signal value of the external impedance

Note: If more than one subscript is used, subscripts for which both styles exist shall either be all upper-case or all lower-case.

Examples: \( h_{FE}', y_{RE}', h_{fe} \)
Subscripts for four-pole matrix parameters

The first letter subscript (or double numeric subscript) indicates input, output, forward transfer or reverse transfer.

Examples: \( h_1 \) (or \( h_{11} \)), \( h_2 \) (or \( h_{22} \)), \( h_1 \) (or \( h_{21} \)), \( h_r \) (or \( h_{12} \)).

A further subscript is used for the identification of the circuit configuration. When no confusion is possible, this further subscript may be omitted.

Examples: \( h_{fe} \) (or \( h_{21e} \)), \( h_{FE} \) (or \( h_{21E} \)).

Distinction between real and imaginary parts

If it is necessary to distinguish between real and imaginary parts of electrical parameters, no additional subscripts should be used. If basic symbols for the real and imaginary parts exist, these may be used.

Examples: \( Z_1 = R_1 + jX_1 \), \( y_{fe} = g_{fe} + jb_{fe} \).

If such symbols do not exist or if they are not suitable, the following notation shall be used:

Examples: \( \text{Re}(h_{ib}) \) etc. for the real part of \( h_{ib} \), \( \text{Im}(h_{ib}) \) etc. for the imaginary part of \( h_{ib} \).
DEFINITIONS APPLYING TO PHOTOSENSITIVE DEVICES
to IEC 306

DEFINITIONS AND UNITS OF RADIATION AND LIGHT QUANTITIES

Radiant flux: radiant power
Power emitted, transferred or received in the form of radiation.

Symbols: $\phi_e$, $\phi$, $P$

$$ \phi_e = \frac{dQ_e}{dt}; \text{ unit: watt, W.} $$

Radiant intensity
The radiant intensity of a source in a given direction is the quotient of (1) the radiant flux leaving the source propagated in an element of solid angle containing the given direction, by (2) the element of solid angle.

Symbols: $I_e$, $I$

$$ I_e = \frac{d\phi_e}{d\Omega}; \text{ unit: watt per steradian, W/sr.} $$

Irradiance
The irradiance at a point of a surface is the quotient of (1) the radiant flux incident on an element of the surface containing the point, by (2) the area of that element.

Symbols: $E_e$, $E$

$$ E_e = \frac{d\phi_e}{dA}; \text{ unit: watt per square metre, W/m}^2. $$

Light
Radiation capable of stimulating the organ of vision. 1)

Luminous flux
Quantity derived from radiant flux by evaluating the radiation according to its action upon a selective receptor, the spectral sensitivity of which is defined by the standard spectral luminous efficiency.

Symbols: $\phi_V$, $\phi$; unit: lumen, lm.

Lumen
SI unit of luminous flux: luminous flux emitted within unit solid angle (one steradian) by a point source having a uniform intensity of 1 candela. (An isotropic source of intensity 1 candela emits $4\pi$ lumens of luminous flux.)

Symbol: lm.

1) For convenience, exceptions from this definition are made in the data sheets, e.g. dark and light currents (excluding and including respectively near infrared radiation) of a phototransistor, light rise time of a near-infrared light emitting diode.
Luminous intensity

The luminous intensity of a source in a given direction is the quotient of (1) the luminous flux leaving the source propagated in an element of solid angle containing the given direction, by (2) the element of solid angle.

Symbols: \( I_V, I \)

\[ I_V = \frac{d\phi_V}{d\Omega} \]; unit: candela, cd.

Candela

SI unit of luminous intensity: Luminous intensity, in the perpendicular direction, of a surface of 1/600 000 square metre of a blackbody at the temperature of freezing platinum under a pressure of 101325 newtons per square metre.

Symbols: cd; 1 cd = 1 lm/sr.

Illuminance

At a point of a surface, the quotient of (1) the luminous flux incident on an element of the surface containing the point, by (2) the area of that element.

Symbols: \( E_V, E \)

\[ E_V = \frac{d\phi_V}{dA} \]; unit: lux, lx.

Lux; lumen per square metre

SI unit of illuminance: illuminance produced by a luminous flux of 1 lumen uniformly distributed over a surface of area 1 square metre.

Symbol: lx; 1 lx = 1 lm/m².

Distribution temperature

Temperature of the full radiator for which the ordinates of the spectral distribution curve of its radiance are proportional, in the visible region, to those of the distribution curve of the radiation considered.

The unit of measurement is degree Kelvin (K).

Colour temperature

For the purpose of this Recommendation, colour temperature is the distribution temperature of the radiation source.

The unit of measurement is degree Kelvin.
DEFINITIONS OF ELECTRICAL QUANTITIES

Photocurrent
The change in output current from the photocathode caused by incident radiation.

Frequency response characteristic
Relation, usually shown by a graph, between the radiant (or luminous) dynamic sensitivity and the modulation frequency of the incident radiation.

Dark current
The current flowing in a photoelectric device in the absence of irradiation.

Equivalent dark-current irradiation
The incident radiation required to give a d.c. signal output current equal to the dark current.

Equivalent noise irradiation
The value of incident radiation which, when modulated in a stated manner, produces a signal output power equal to the noise power, both in a stated bandwidth.

Quantum efficiency
The ratio of (1) the number of emitted photoelectrons to (2) the number of incident photons.

Quantum efficiency (Q.E.) at a given wavelength of incident radiation may be computed from:

\[ Q.E. = \frac{\text{const.} \times s_k}{\lambda} \]

where:
- \( s_k \) = spectral sensitivity (amperes per watt) at wavelength \( \lambda \)
- \( \lambda \) = wavelength of incident radiation (nanometres)
- const. = \( \frac{hc_0}{e} \) = 1.24 x 10^3 W.nm/A
- \( h \) = Planck constant
- \( c_0 \) = speed of propagation of electromagnetic waves in vacuo
- \( e \) = elementary charge

Saturation voltage
The lowest operating voltage which causes no change, or only a slight change, of the photocurrent when this voltage is increased under conditions of given constant radiation.

Saturation current
The output current of a photosensitive device which is not changed, or only insignificantly changed, by an increase of either:
- a) the irradiance under constant operating conditions; or
- b) the operating voltage under constant irradiance.

Note. — The context should make clear which definition is applicable.
DEFINITIONS OF SENSITIVITY

These definitions apply more directly to photocathode sensitivity. For devices in which it is necessary to define the anode (over-all) sensitivity, signal output current should be considered instead of photocurrent.

Radiant sensitivity
a) The quotient of (1) the photocurrent of the device by (2) the incident radiant power, expressed in amperes per watt.
b) The quotient of (1) the photocurrent of the device by (2) the incident irradiance, expressed in amperes per watt/m².

Absolute spectral sensitivity
The radiant sensitivity for monochromatic radiation of a stated wavelength.

Relative spectral sensitivity
The ratio of (1) the radiant sensitivity at any considered wavelength to (2) the radiant sensitivity at a certain wavelength taken as reference, usually the wavelength of maximum response.

Note. — For non-linear detectors, it is necessary to refer to constant photocurrent at all wavelengths.

Luminous sensitivity
a) The quotient of (1) the photocurrent of the device by (2) the incident luminous flux, expressed in amperes per lumen.
b) The quotient of (1) the photocurrent of the device by (2) the incident illuminance, expressed in amperes per lux.

Dynamic sensitivity
Under stated conditions of operation, the quotient of (1) the variation of the photocurrent of the device by (2) the initiating small variation of the incident radiant power (or luminous)

Note. — Distinction is made between "luminous dynamic sensitivity" and "radiant sensitivity."

Spectral sensitivity characteristic
The relation, usually shown by a graph, between wavelength and absolute or relative spectral sensitivity.

Absolute spectral sensitivity characteristic
The relation, usually shown by a graph, between wavelength and absolute spectral sensitivity.

Relative spectral sensitivity characteristic
The relation between wavelength and relative spectral sensitivity.

Quantum efficiency characteristic
The relation, usually shown by a graph, between wavelength and quantum efficiency.
DEFINITIONS OF TIME QUANTITIES

Rise time
The time required for the photocurrent to rise from a stated low percentage to a stated higher percentage of the maximum value when a steady state of radiation is instantaneously applied.

It is usual to consider the 10% and 90% levels.

Fall time
The time required for the photocurrent to fall from a stated high percentage to a stated lower percentage of the maximum value when the steady state of radiation is instantaneously removed.

It is usual to consider the 90% and 10% levels.

SAFETY
The most modern high technology materials have been used in these components to ensure the highest performance for the user. Some of them are toxic to man but the quantity used in a single device is so small that the risk of toxic effects are negligible even in extreme circumstances.
PHOTORESPONSIVE DIODES AND TRANSISTORS
SILICON PHOTOTRANSISTOR

N-P-N silicon phototransistor in epoxy resin encapsulation intended to be used in combination with the infrared LED CQY58. The base is inaccessible.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25 , ^\circ C$</td>
</tr>
<tr>
<td>Collector dark current</td>
</tr>
<tr>
<td>$V_{CE} = 20 , V; , E = 0$</td>
</tr>
<tr>
<td>Collector light current</td>
</tr>
<tr>
<td>$V_{CE} = 5 , V; , E = 5 , mW/cm^2; , \lambda_{pk} = 875 , nm$</td>
</tr>
<tr>
<td>Wavelength at peak response</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

SOD-53D

Dimensions in mm

March 1978
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage
- Collector-emitter voltage
  $V_{CEO}$ max. 30 V
- Emitter-collector voltage
  $V_{EBO}$ max. 5 V

Current
- Collector current (d.c.)
  $I_C$ max. 25 mA
- Collector current (peak value)
  $I_{CM}$ max. 50 mA

Power dissipation
- Total power dissipation up to $T_{amb} = 25$ °C
  $P_{tot}$ max. 50 mW

Temperature
- Storage temperature
  $T_{stg}$ -55 to +100 °C
- Junction temperature
  $T_j$ max. 100 °C
- Lead soldering temperature
  > 3 mm from the body; $t_{sld} < 7$ s
  $T_{sld}$ max. 230 °C

THERMAL RESISTANCE
From junction to ambient, device mounted on printed-circuit board

\[ R_{th j-a} = 1.5 \, \text{°C/mW} \]

![Graph showing $P_{tot}$ max vs $T_{amb}$]

June 1975
CHARACTERISTICS

Collector dark current

\[ V_{CE} = 20 \, \text{V}; \, E = 0 \]

\[ I_{CEO(D)} < 100 \, \text{nA} \]

Collector light current

\[ V_{CE} = 5 \, \text{V}; \, E_e = 5 \, \text{mW/cm}^2; \, \lambda_{pk} = 875 \, \text{nm} \]

\[ I_{CEO(L)} > 6 \, \text{mA} \]

Collector-emitter saturation voltage

\[ I_C = 4 \, \text{mA}; \, E_e = 5 \, \text{mW/cm}^2; \, \lambda_{pk} = 875 \, \text{nm} \]

\[ V_{CE_{sat}} < 0.4 \, \text{V} \]

Wavelength at peak response

\[ \lambda_{pk} \text{ typ.} \, 800 \, \text{nm} \]

Bandwidth at half height

\[ B_{50\%} \text{ typ.} \, 400 \, \text{nm} \]

Beamwidth between half sensitivity directions

\[ \alpha_{50\%} \text{ typ.} \, 10^\circ \]

Switching times (circuit below)

\[ I_{Con} = 1 \, \text{mA}; \, V_{CC} = 20 \, \text{V}; \, R_E = 1 \, \text{k}\Omega; \, T_{amb} = 25 \, \text{°C} \]

Rise time

\[ t_r \text{ typ.} \, 7.5 \, \mu s \]

Fall time

\[ t_f \text{ typ.} \, 7.5 \, \mu s \]

LED = CQY58

T. U. T. = BPW22

---

1) Measured with pulsed GaAs light source.
BPW22

**Typical Values**

- **$V_{CE} = 5V$**
- **$I_F = 50\,mA$**
- **$I_F = 20\,mA$**
- **$I_F = 10\,mA$**

**Typo Values**

- **$V_{CE} = 5V$**
- **$T_{amb} = 25^\circ C$**

**Characteristics**

1. **$I_{CM}$ (mA)** vs. **$\lambda (\text{nm})$**
2. **$I_C$ (mA)** vs. **$d (\text{mm})$**
3. **$I_C$ (mA)** vs. **$T_{amb}(^\circ C)$**

**Notes**

- **$t_p = 10\,\mu s (I_{FM})$**
- **$T = 1\,\text{ms}$**
- **$T_{amb} = 25^\circ C$**

**June 1975**
SILICON PHOTODIODE

Silicon planar photodiode for infrared remote control, infrared sound transmission, and general purposes. The rectangular shape of its envelope, the square sensitive area of 2.75 mm x 2.75 mm, and the pin distance of 5.08 mm, render it suitable for use on a printed-circuit board.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max. 32 V</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25$ °C</td>
<td>$P_{tot}$ max. 150 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max. 90 °C</td>
</tr>
<tr>
<td>Dark reverse current</td>
<td>$I_{RD} &lt;$ 30 nA</td>
</tr>
<tr>
<td>Light sensitivity</td>
<td>$N &gt;$ 50 nA/lx</td>
</tr>
<tr>
<td>Wavelength at peak response</td>
<td>$\lambda_{pk}$ typ. 850 nm</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOD-62A.

Dimensions in mm
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)
Continuous reverse voltage \( V_R \) max. 32 V
Total power dissipation up to \( T_{amb} = 25 ^\circ C \) \( P_{tot} \) max. 150 mW
Storage temperature \( T_{stg} \) -30 to +90 \( ^\circ C \)
Junction temperature \( T_j \) max. 90 \( ^\circ C \)

THERMAL RESISTANCE
From junction to ambient \( R_{thj-a} = 435 \, ^\circ C/W \)

CHARACTERISTICS
\( T_{amb} = 25 ^\circ C \) unless otherwise specified
Dark reverse current \( V_R = 10 \, V; \, E_V = 0 \)
\( I_{R(D)} \) typ. 2 nA
Light reverse current \( V_R = 0; \, E_V = 100 \, Lx; \, T_C = 2856 \, K \) *
\( I_{R(L)} \) typ. 6.5 \( \mu A \)
Photovoltaic mode at \( T_C = 2856 \, K \) *
Open-circuit voltage (light forward voltage)
\( I = 0; \, E_V = 100 \, Lx \)
\( V_{F(L)} \) typ. 240 mV
\( I = 0; \, E_V = 1000 \, Lx \)
\( V_{F(L)} \) typ. 350 mV
Temperature coefficient of open-circuit voltage \( \frac{\Delta V_{F(L)}}{\Delta T_{amb}} \) typ. -2.6 mV/\( ^\circ C \)
Temperature coefficient of short-circuit current \( \frac{\Delta I_{R(L)}}{\Delta T_{amb}} \) typ. 0.2 \%/\( ^\circ C \)
Light sensitivity with external voltage \( V_R = 5 \, V; \, E_V = 1000 \, Lx; \, T_C = 2856 \, K \) *
\( N \) typ. > 50 nA/Lx
Wavelength at peak response \( V_R = 5 \, V \)
\( \lambda_{pk} \) typ. 850 nm
Diode capacitance \( V_R = 3 \, V \)
\( C_d \) typ. 25 pF
\( V_R = 0 \)
\( C_d \) typ. < 40 pF
Light switching times (see Figs 2 and 3)
Rise time and fall time \( V_{KK} = 5 \, V; \, R_A = 1 \, k\Omega \) **
\( t_{r,f} \) typ. 50 ns
\( V_{KK} = 0; \, R_A = 1 \, k\Omega \) **
\( t_{r,f} \) typ. 125 ns

* Unfiltered tungsten filament lamp source.
** \( V_{KK} \) is cathode supply voltage; \( R_A \) is anode series resistance.
Fig. 2. Switching circuit.

Fig. 3 Input and output switching waveforms.

Fig. 2 $E = 0; \ T_{amb} = 25 \degree C$.

Fig. 4 $I = 0; \ T_{amb} = 25 \degree C$.

Fig. 3 Typical values; $E = 0$.

Fig. 5 $T_{amb} = 25 \degree C$. 

Silicon photodiode

BPW34
Fig. 6  $E = 0; \ T_{amb} = 25 ^\circ C$.

Fig. 7  Typical values; $E = 0$.

Fig. 8  $V_R = 5 \ \text{V}; \ T_{amb} = 25 ^\circ C$. 
Fig. 9 \( V_R = 5 \text{ V}; \ E_V = 1000 \text{ lx}. \)

Fig. 10.

Fig. 11.
SILICON PLANAR EPITAXIAL PHOTOTRANSISTORS

General purpose n-p-n silicon phototransistors in TO-18. The BPX25 has a lens, the BPX29 has a plane window.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>V_{CEO} max. 32 V</td>
</tr>
<tr>
<td>Collector current (peak value)</td>
<td>I_{CM} max. 200 mA</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{j} max. 150 °C</td>
</tr>
<tr>
<td>Collector dark current</td>
<td>I_{CEO(D)} &lt; 500 nA</td>
</tr>
<tr>
<td>Collector light current</td>
<td>I_{CEO(L)} typ. 13 0,8 mA</td>
</tr>
<tr>
<td>Wavelength at peak response</td>
<td>\lambda_{pk} typ. 800 nm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MECHANICAL DATA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BPX25 TO-18, except for lens</td>
<td></td>
</tr>
<tr>
<td>Collector connected to case</td>
<td></td>
</tr>
<tr>
<td>BPX29 TO-18, except for window</td>
<td></td>
</tr>
<tr>
<td>Collector connected to case</td>
<td></td>
</tr>
</tbody>
</table>

April 1978
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Collector-base voltage (open emitter)  $V_{CBO}$ max. 32 V
Collector-emitter voltage (open base)  $V_{CEO}$ max. 32 V
Emitter-base voltage (open collector)  $V_{EBO}$ max. 5 V

Current

Collector current (d.c.)  $I_C$ max. 100 mA
Collector current (peak value)  $I_{CM}$ max. 200 mA

Power dissipation

Total power dissipation up to $T_{amb} = 25 \, ^\circ C$  $P_{tot}$ max. 300 mW

Temperatures

Storage temperature  $T_{stg}$ -65 to +150 °C
Junction temperature  $T_j$ max. 150 °C

THERMAL RESISTANCE

From junction to ambient in free air
From junction to case

$R_{th \, j-a} = 0.4 \, ^\circ C/mW$
$R_{th \, j-c} = 0.15 \, ^\circ C/mW$

CHARACTERISTICS

Collector dark current

$I_B = 0; \, V_{CE} = 24 \, V$
$I_C$ typ. 100 nA

$I_B = 0; \, V_{CE} = 24 \, V; \, T_{amb} = 100 \, ^\circ C$
$I_{CEO(D)} < 500 \, nA$

Collector light current

$I_B = 0; \, V_{CE} = 6 \, V; \, $ tungsten filament lamp source with $T_C = 2700 \, K$;
$E_v = 1000 \, lx \,(7.7 \, mW/cm^2)$
$I_{CEO(L)}$ typ. 15 µA

D.C. current gain

$I_C = 2 \, mA; \, V_{CE} = 6 \, V$
$h_{FE}$ typ. 500

Cut-off frequency

Source : modulated GaAs; 0.4 mW/cm²
Load : optimum (50 Ω); $V_{CE} = 24 \, V$
$f_{CO}$ typ. 200 kHz

BPX25 | BPX29
---|---
$I_{CEO(L)}$ typ. 13 | 0.25 mA
$h_{FE}$ typ. 500 | 500
$f_{CO}$ typ. 200 | 150 kHz

September 1974
CHARACTERISTICS (continued)

Switching times 1)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>BPX25</th>
<th>BPX29</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>\( t_d \)</code> typ.</td>
<td>1.0</td>
<td>2.5 μs</td>
</tr>
<tr>
<td><code>\( t_d \)</code> &lt;</td>
<td>3.0</td>
<td>5.0 μs</td>
</tr>
<tr>
<td><code>\( t_r \)</code> typ.</td>
<td>1.5</td>
<td>2.5 μs</td>
</tr>
<tr>
<td><code>\( t_r \)</code> &lt;</td>
<td>3.0</td>
<td>5.0 μs</td>
</tr>
<tr>
<td><code>\( t_s \)</code> typ.</td>
<td>0.2</td>
<td>0.2 μs</td>
</tr>
<tr>
<td><code>\( t_s \)</code> &lt;</td>
<td>0.4</td>
<td>0.4 μs</td>
</tr>
<tr>
<td><code>\( t_f \)</code> typ.</td>
<td>1.5</td>
<td>3.5 μs</td>
</tr>
<tr>
<td><code>\( t_f \)</code> &lt;</td>
<td>4.0</td>
<td>8.0 μs</td>
</tr>
<tr>
<td><code>\( \lambda_{pk} \)</code> typ.</td>
<td>800</td>
<td>800 nm</td>
</tr>
</tbody>
</table>

1) Source: modulated GaAs: 0.4 mW/cm²
Load: optimum (50 Ω)
\( V_{CE} = 24 \) V
Improved switching times can be obtained by a quiescent bias current.
I.e. \( I_B = 2 \) μA: \( t_d < 0.2 \) μs.

October 1973
BPX25
BPX29

Source colour temp. = 2700 K
I_B = 0  T_amb = 25 °C
typical values

I_{CEO}(L) (mA)

illumination =
1500 lx
1000 lx
500 lx
200 lx
100 lx

V_{CE} (V) 40

BPX25

I_{CEO}(L) (mA)

illumination =
7000 lx
6000 lx
5000 lx
4000 lx
3000 lx
2000 lx
1000 lx

V_{CE} (V) 40

BPX29

I_{CEO}(L) (mA)

illumination = 1000 lx
T_c = 2700 K; I_B = 0
V_{CE} = 6 V
typ. values

BPX25

P_{tot max}

I_{CEO}(D) (μA)

I_B = 0
V_{CE} = 24 V
typ

BPX29

T_amb (°C)

October 1973
BPX25
BPX29

October 1973
SILICON PLANAR PHOTODIODE

- Unencapsulated photodiode for general purpose applications.

### QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse voltage</td>
<td>VR</td>
<td>max. 18 V</td>
</tr>
<tr>
<td>Luminous sensitivity</td>
<td>N</td>
<td>typ. 14 nA/lx</td>
</tr>
<tr>
<td>Dark reverse current at VR = 15 V</td>
<td>Id</td>
<td>&lt; 0.5 μA</td>
</tr>
<tr>
<td>Wavelength at peak response</td>
<td>λpk</td>
<td>typ. 800 nm</td>
</tr>
</tbody>
</table>

### MECHANICAL DATA

Dimensions in mm:

- Slice thickness 0.27 mm
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage
Reverse voltage

Currents
Forward current
Dark reverse current

Temperatures
Storage temperature
Junction temperature

THERMAL RESISTANCE
From junction to ambient in free air

CHARACTERISTICS
Dark reverse current
Photovoltaic mode

Luminous sensitivity with external voltage 1)

Wavelength at peak response

Diode capacitance; f = 500 kHz

Cut-off frequency (modulated GaAs source)

1) The value of light current increases with temperature by an amount approximately equal to the increase in dark current.
typical values

\( T_{\text{amb}} = 25 \, ^\circ\text{C} \)
\( T_C = 2700 \, \text{K} \)

\( E = 5000 \, \text{lx} \)
\( 2000 \, \text{lx} \)
\( 1000 \, \text{lx} \)
\( 500 \, \text{lx} \)

\( I_f \) (\( \mu\text{A} \))

\( V_F \) (mV)

March 1972
March 1972
**SILICON PLANAR PHOTODIODE**

Unencapsulated photodiode for general purpose applications.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse voltage</td>
</tr>
<tr>
<td>Luminous sensitivity</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Dark reverse current at $V_R = 15 \text{ V}$</td>
</tr>
<tr>
<td>Wavelength at peak response</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Dimensions in mm

Slice thickness 0.27 mm

April 1976
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage
Reverse voltage

<table>
<thead>
<tr>
<th>$V_R$</th>
<th>max.</th>
<th>18 V</th>
</tr>
</thead>
</table>

Currents
Forward current

<table>
<thead>
<tr>
<th>$I_F$</th>
<th>max.</th>
<th>10 mA</th>
</tr>
</thead>
</table>

Dark reverse current

<table>
<thead>
<tr>
<th>$I_R$</th>
<th>max.</th>
<th>5 mA</th>
</tr>
</thead>
</table>

Temperatures
Storage temperature

<table>
<thead>
<tr>
<th>$T_{stg}$</th>
<th>-65 to +125 °C</th>
</tr>
</thead>
</table>

Junction temperature

<table>
<thead>
<tr>
<th>$T_j$</th>
<th>max.</th>
<th>125 °C</th>
</tr>
</thead>
</table>

THERMAL RESISTANCE
From junction to ambient in free air

<table>
<thead>
<tr>
<th>$R_{th j-a}$</th>
<th>= 0.5 °C/mW</th>
</tr>
</thead>
</table>

CHARACTERISTICS

$T_{amb} = 25$ °C unless otherwise specified

Dark reverse current

<table>
<thead>
<tr>
<th>$V_R$</th>
<th>15 V</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$I_d$</th>
<th>typ.</th>
<th>0.02 μA</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$V_R = 15$ V; $T_{amb} = 100$ °C</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$I_d$</th>
<th>typ.</th>
<th>1.2 μA</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$V_R$</th>
<th>15 V</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$V_F$</th>
<th>&gt; 330 mV</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$N$</th>
<th>typ.</th>
<th>31 nA/lx</th>
</tr>
</thead>
</table>

Photovoltaic mode

$E = 1000$ lx; $T_c = 2700$ K (equivalent to 7.7 mW/cm²)

<table>
<thead>
<tr>
<th>$I_1$</th>
<th>typ.</th>
<th>38 μA</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$V_R = 15$ V; $E = 1000$ lx; $T_c = 2700$ K (equivalent to 7.7 mW/cm²)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$N$</th>
<th>typ.</th>
<th>40 nA/lx</th>
</tr>
</thead>
</table>

Luminous sensitivity with external voltage

<table>
<thead>
<tr>
<th>$V_R$</th>
<th>15 V</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$N$</th>
<th>typ.</th>
<th>31 nA/lx</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$V_R = 15$ V; $E = 1000$ lx; $T_c = 2700$ K</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$N$</th>
<th>typ.</th>
<th>40 nA/lx</th>
</tr>
</thead>
</table>

Wavelength at peak response

<table>
<thead>
<tr>
<th>$\lambda_{pk}$</th>
<th>typ.</th>
<th>800 nm</th>
</tr>
</thead>
</table>

Diode capacitance; $f = 500$ kHz

<table>
<thead>
<tr>
<th>$V_R$</th>
<th>15 V</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$C_d$</th>
<th>typ.</th>
<th>250 pF</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$V_R = 0$</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$C_d$</th>
<th>typ.</th>
<th>800 pF</th>
</tr>
</thead>
</table>

Cut-off frequency (modulated GaAs source)

<table>
<thead>
<tr>
<th>$f_{co}$</th>
<th>typ.</th>
<th>500 kHz</th>
</tr>
</thead>
</table>

1) The value of light current increases with temperature by an amount approximately equal to the increase in dark current.
II

BPX41

7Z62603

II

I

I

~

otih III~

typical values

$T_{\text{amb}} = 25 \, ^\circ\text{C}$

$T_C = 2700 \, \text{K}$

10$^2$

10$

10$

10$

10$

10$

10$

10$

$E = 5000 \, \text{lx}$

2000 \, \text{lx}

1000 \, \text{lx}

500 \, \text{lx}

$10^3$

$10^2$

$10^1$

$10^{-1}$

$10^{-2}$

$10^{-3}$

$I_f$

(\(\mu\text{A}\))

V$_F$ (mV)

$R_L$ (\(\Omega\))

March 1972
SILICON PLANAR PHOTODIODE

Unencapsulated photodiode for general purpose applications.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse voltage</td>
</tr>
<tr>
<td>Luminous sensitivity</td>
</tr>
<tr>
<td>$V_R = 10$ V; $E = 1000$ lx</td>
</tr>
<tr>
<td>Dark reverse current at $V_R = 10$ V</td>
</tr>
<tr>
<td>Wavelength at peak response</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Slice thickness 0.27 mm
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage

Reverse voltage

<table>
<thead>
<tr>
<th>VR</th>
<th>max.</th>
<th>12 V</th>
</tr>
</thead>
</table>

Currents

Forward current

<table>
<thead>
<tr>
<th>IF</th>
<th>max.</th>
<th>50 mA</th>
</tr>
</thead>
</table>

Dark reverse current

<table>
<thead>
<tr>
<th>IR</th>
<th>max.</th>
<th>20 mA</th>
</tr>
</thead>
</table>

Temperatures

Storage temperature

<table>
<thead>
<tr>
<th>Tstg</th>
<th>-65 to + 125 °C</th>
</tr>
</thead>
</table>

Junction temperature

<table>
<thead>
<tr>
<th>Tj</th>
<th>max.</th>
<th>125 °C</th>
</tr>
</thead>
</table>

THERMAL RESISTANCE

From junction to ambient in free air

<table>
<thead>
<tr>
<th>Rth j-a</th>
<th>= 0.3 °C/mW</th>
</tr>
</thead>
</table>

CHARACTERISTICS

Tamb = 25 °C unless otherwise specified

Dark reverse current

<table>
<thead>
<tr>
<th>VR</th>
<th>10 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Id</td>
<td>typ.</td>
</tr>
<tr>
<td></td>
<td>&lt;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VR</th>
<th>10 V; Tamb = 100 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Id</td>
<td>typ.</td>
</tr>
<tr>
<td></td>
<td>&lt;</td>
</tr>
</tbody>
</table>

Photovoltaic mode

E = 1000 lx; Tc = 2700 K (equivalent to 7.7 mW/cm²)

Light reverse current; V = 0

<table>
<thead>
<tr>
<th>IL</th>
<th>typ.</th>
<th>110</th>
<th>μA</th>
</tr>
</thead>
</table>

Forward voltage; I = 0

<table>
<thead>
<tr>
<th>VF</th>
<th>typ.</th>
<th>330</th>
<th>mV</th>
</tr>
</thead>
</table>

Luminous sensitivity with external voltage 1)

<table>
<thead>
<tr>
<th>VR</th>
<th>10 V; E = 1000 lx; Tc = 2700 K</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>typ.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Wavelength at peak response

<table>
<thead>
<tr>
<th>λpk</th>
<th>typ.</th>
<th>800</th>
<th>nm</th>
</tr>
</thead>
</table>

Diode capacitance; f = 500 kHz

<table>
<thead>
<tr>
<th>VR</th>
<th>10 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cd</td>
<td>typ.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VR</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cd</td>
<td>typ.</td>
</tr>
</tbody>
</table>

Cut-off frequency (modulated GaAs source)

<table>
<thead>
<tr>
<th>fco</th>
<th>typ.</th>
<th>500</th>
<th>kHz</th>
</tr>
</thead>
</table>

1) The value of light current increases with temperature by an amount approximately equal to the increase in dark current.
March 1972
TERRESTRIAL SOLAR MODULE

Module for direct conversion of solar energy into electrical energy. The module contains 34 series-connected solar cells of 57 mm diameter, moulded in transparent resin and mounted between two glass plates. The transparent structure ensures low heating by solar radiation, which maintains efficiency. The module is suitable for use under severe environmental conditions.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>At $E_e = 1 \text{ kW/m}^2$ (irradiance from the sun at sea level) and 25 °C:</td>
</tr>
<tr>
<td>Optimum power output at 15,5 V</td>
</tr>
<tr>
<td>Output voltage at optimum operation</td>
</tr>
<tr>
<td>Output current at optimum operation</td>
</tr>
<tr>
<td>Dimensions</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Panel thickness 15 mm

Cable
- length 1 m
- diameter 5,5 mm
- collar diameter 17 mm
- core diameter (two wires) 1,8 mm

Polarity indications:
- black = -
- red = +

Mass: 2,4 kg

For mechanical detail see page 2.
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

Storage temperature  $T_{stg}$  -40 to +85 °C

CHARACTERISTICS at $E_e = 1$ kW/m$^2$ (irradiance from the sun at sea level; A.M. 1)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell temperature</td>
<td>$T_{cell}$  0  25  60 °C</td>
</tr>
<tr>
<td>Optimum output power</td>
<td>$P_{Lopt}$  typ.  12  11  9,7 W</td>
</tr>
<tr>
<td>Voltage</td>
<td>$V_{opt}$  typ.  18  15,5  14,3 V</td>
</tr>
<tr>
<td>Current</td>
<td>$I_{opt}$  typ.  665  &gt;645  700  680 mA</td>
</tr>
<tr>
<td>Open-circuit voltage</td>
<td>$V_{oc}$  typ.  22,2  20,5  18,2 V</td>
</tr>
<tr>
<td>Short-circuit current</td>
<td>$I_{sc}$  typ.  700  720  740 mA</td>
</tr>
<tr>
<td>Temperature coefficient of</td>
<td>$dV_{oc}/dT$  typ.  -74 mV/°C</td>
</tr>
<tr>
<td>open-circuit voltage</td>
<td></td>
</tr>
<tr>
<td>Temperature coefficient of</td>
<td>$dI_{sc}/dT$  typ.  0,64 mA/°C</td>
</tr>
<tr>
<td>short-circuit current</td>
<td></td>
</tr>
</tbody>
</table>

TYPICAL OPERATION BPX47A coupled to a 12 V battery

Irradiance from the sun  $E_e$  1 kW/m$^2$

Operating voltage

(12 V nominal lead-acid battery; end-of-charge voltage 13,5 V; +0,8 V for blocking diode)

At an irradiance of 1 kW/m$^2$ the cell temperature rise is 15 °C

At an ambient temperature of 45 °C (cell temperature = 45 + 15 = 60 °C) the module can supply a current of 680 mA to the load.

Dimensions in mm
ENVIRONMENTAL TESTS

The modules are subjected to the following IEC tests and some additional tests:

<table>
<thead>
<tr>
<th>Test</th>
<th>In accordance with</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold</td>
<td>IAC68-2-1, test Ab</td>
<td>Temperature: -40 °C, duration: 16 h</td>
</tr>
<tr>
<td>Rapid change of temperature</td>
<td>IEC68-2-14, test Na</td>
<td>Low temperature: -40 °C, High temperature: +85 °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of cycles: 10, Duration of exposures: 30 min</td>
</tr>
<tr>
<td>Dry heat</td>
<td>IEC68-2-2, test Bb</td>
<td>Temperature: +85 °C, Duration: 16 h</td>
</tr>
<tr>
<td>Composite temperature/</td>
<td>IEC68-2-38, test Z/AD</td>
<td>10 cycles, +25 °C, +65 °C, -10 °C</td>
</tr>
<tr>
<td>humidity cyclic test</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Graph showing temperature cycles](image)

1 cycle of IEC 68-2-38, test Z/AD

<table>
<thead>
<tr>
<th>Test</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt mist</td>
<td>Temperature: +35 °C, Duration: 48 h</td>
</tr>
<tr>
<td>Wind</td>
<td>Pressure equivalent to an air velocity of 280 km/h</td>
</tr>
<tr>
<td>Sand blown</td>
<td>AIR 7, 303</td>
</tr>
<tr>
<td>Frost with water</td>
<td>High temperature: +25 °C, Low temperature: -40 °C, Duration: 16 h</td>
</tr>
</tbody>
</table>

MOUNTING INSTRUCTIONS

1. The solar panel should be mounted in a metal frame in such a way that only its four metal sides are used for clamping and not the rubber corners. The panel should be electrically insulated from the mounting frame to prevent corrosion.

2. Installation should allow at least a 50 cm space behind the panel to permit a free circulation of air for cooling.

3. The panel should not be installed above hot objects such as roofs.

October 1976
MOUNTING INSTRUCTIONS (continued)

4. Diode protection is imperative in the series connection of a chain of panels to prevent voltage inversion due to partial shadowing effects.

![Diagram of diode protection in series connection]

5. If series-connected chains are joined in parallel and diode protected, a matrix interconnection is necessary.

![Diagram of matrix interconnection with 6x BPX47A]

6. A charge regulator containing a series protection diode must be used when connecting panels to a lead-acid battery.

![Diagram of charge regulator with diode protection]
The diagrams show the relationship between current (I) and voltage (V) for different power densities (P) at various temperatures.

- **Top Diagram:**
  - The graph displays curves for different power densities: 1000 W/m², 750 W/m², 500 W/m².
  - Each curve represents a different power density level.

- **Bottom Diagram:**
  - The graph includes curves for different power efficiencies (η) and power levels (P).
  - The curves are labeled with power levels in watts (W)
  - The graph also shows temperature values: 60°C, 25°C, 0°C.

The graphs are labeled with the symbol $E_e = 1 \text{ kW/m}^2$.
PHOTOTRANSISTOR

General purpose n-p-n silicon phototransistor with a plastic lens.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage (open base) ( V_{CEO} ) max. 30 V</td>
</tr>
<tr>
<td>Collector current (d.c.) ( I_C ) max. 25 mA</td>
</tr>
<tr>
<td>Junction temperature ( T_j ) max. 125 °C</td>
</tr>
<tr>
<td>Collector dark current (open base) ( I_d ) &lt; 100 nA</td>
</tr>
<tr>
<td>Collector light current (open base) ( I_l )</td>
</tr>
<tr>
<td>( V_{CE} = 20 ) V</td>
</tr>
<tr>
<td>( V_{CE} = 5 ) V; ( E = 1000 ) lx (4,75 mW/cm²)</td>
</tr>
<tr>
<td>BPX70 ( I_l ) 100 to 700 µA</td>
</tr>
<tr>
<td>BPX70C ( I_l ) 100 to 300 µA</td>
</tr>
<tr>
<td>BPX70D ( I_l ) 200 to 400 µA</td>
</tr>
<tr>
<td>BPX70E ( I_l ) 300 to 700 µA</td>
</tr>
<tr>
<td>Wavelength at peak response ( \lambda_{pk} ) typ. 800 nm</td>
</tr>
<tr>
<td>Angle between half-sensitivity directions ( \alpha_{50%} ) typ. 120°</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

SOT-70

Dimensions in mm

Max. lead diameter is guaranteed only for 12.7 mm

March 1978
BPX70

RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Collector-base voltage (open emitter) \( V_{CBD} \) max. 40 V
Collector-emitter voltage (open base) \( V_{CEO} \) max. 30 V
Emitter-collector voltage (open base) \( V_{EEO} \) max. 6 V

Currents

Collector current (d.c.) \( I_C \) max. 25 mA
Collector current (peak value) \( I_{CM} \) max. 50 mA

Power dissipation

Total power dissipation up to \( T_{amb} = 25 ^\circ C \) \( P_{tot} \) max. 180 mW

Temperatures

Storage temperature \( T_{stg} \) -40 to +125 \( ^\circ C \)
Junction temperature \( T_j \) max. 125 \( ^\circ C \)

THERMAL RESISTANCE

From junction to ambient in free air \( R_{th j-a} \) = 0.55 \( ^\circ C/mW \)

CHARACTERISTICS

\( I_B = 0; T_{amb} = 25 ^\circ C \) unless otherwise specified

Collector dark current

\( V_{CE} = 20 V \)
\( I_d \) typ. 10 nA

\( V_{CE} = 20 V; T_j = 100 ^\circ C \)
\( I_d \) typ. 10 \( \mu A \)

Collector light current

\( V_{CE} = 5 V \); tungsten filament lamp
source with colour temperature 2856 K;
\( E_v = 1000 \text{ lx} \) \( (E_e = 4.75 \text{ mW/cm}^2) \)
\( I_1 \) 100 to 700 \( \mu A \)

\( E_v = 2500 \text{ lx} \) \( (E_e = 12 \text{ mW/cm}^2) \)
\( I_1 \) > 300 \( \mu A \)

1) Available selections: BPX70C: 100 to 300 \( \mu A \)
BPX70D: 200 to 400 \( \mu A \)
BPX70E: 300 to 700 \( \mu A \)

September 1974
CHARACTERISTICS (continued)

Breakdown voltages

Collector-base voltage
\[ E = 0; I_C = 0, 1 \text{ mA} \]
\[ V_{(BR)CEO} > 40 \text{ V} \]

Collector-emitter voltage
\[ E = 0; I_C = 1 \text{ mA} \]
\[ V_{(BR)ECO} > 30 \text{ V} \]

Emitter-collector voltage
\[ E = 0; I_C = 0, 1 \text{ mA} \]
\[ V_{(BR)ECO} > 6 \text{ V} \]

Collector capacitance
\[ I_E = I_e = 0; V_{CB} = 20\text{ V} \]
\[ C_C \text{ typ. } 3.5 \text{ pF} \]

Wavelength at peak response
\[ \lambda_{pk} \text{ typ. } 800 \text{ nm} \]

Bandwidth at half height
\[ B_{50\%} \text{ typ. } 300 \text{ nm} \]

Switching times
\[ I_{Con} = 1 \text{ mA}; V_{CC} = 5 \text{ V}; R_L = 100 \Omega \]

Delay time
\[ t_d \text{ typ. } < 1.5 \text{ } \mu s \]
\[ t_d \text{ typ. } < 3.0 \text{ } \mu s \]

Rise time
\[ t_r \text{ typ. } < 3.0 \text{ } \mu s \]
\[ t_r \text{ typ. } < 10 \text{ } \mu s \]

Storage time
\[ t_s \text{ typ. } < 1.5 \text{ } \mu s \]
\[ t_s \text{ typ. } < 3.0 \text{ } \mu s \]

Fall time
\[ t_f \text{ typ. } < 2.0 \text{ } \mu s \]
\[ t_f \text{ typ. } < 10 \text{ } \mu s \]

Light input pulse:
\[ t_r = t_f = 20 \text{ ns} \]
\[ t_p = 20 \text{ } \mu s \]
\[ f = 500 \text{ Hz} \]
\[ \lambda = 800 \text{ nm} \]
BPX70

![Graphs showing typical values for different light intensities and voltages with typical values for different temperatures and light intensities.]

- **Typical Values**
  - $V_{CE} = 5\text{V}$
  - $T_{\text{amb}} = 25^\circ\text{C}$
  - $T_e = 2856\text{K}$

- **Graphs**
  - Graph on the left showing $I_l$ vs. $V_{CE}$ with typical values.
  - Graph on the right showing $I_l$ vs. $E$ (lx) with typical values.
polar response of relative sensitivity

$T_{amb} = 25^\circ C$

- Relative response (%)
- Wavelength ($\lambda$ nm)
- Capacitance ($C_C$ pF)
- Collector Voltage ($V_{CB}$ V)

- Frequency ($f = 1$ MHz)
- Collector Current ($I_C = I_e = 0$)
- Junction Temperature ($T_j = 25^\circ C$)
PHOTOTRANSISTOR

General purpose n-p-n silicon phototransistor with a glass lens. Inaccessible base.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
</tr>
<tr>
<td>Junction temperature</td>
</tr>
<tr>
<td>Collector dark current</td>
</tr>
<tr>
<td>Collector light current</td>
</tr>
<tr>
<td>Wavelength at peak response</td>
</tr>
<tr>
<td>Angle between half-sensitivity directions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>V_{CEO} max.</th>
<th>I_C max.</th>
<th>T_j max.</th>
<th>I_d &lt;</th>
<th>\lambda_{pk} typ.</th>
<th>\alpha_{50^\circ} typ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage</td>
<td>50 V</td>
<td></td>
<td></td>
<td></td>
<td>800 nm</td>
<td>40°</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td></td>
<td>20 mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td></td>
<td></td>
<td>150 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector dark current</td>
<td></td>
<td></td>
<td></td>
<td>25 nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector light current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector light current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wavelength at peak response</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angle between half-sensitivity directions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

DO-31

Dimensions in mm

September 1974
BPX71

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

 Voltages
 Collector-emitter voltage
 Collector-emitter voltage
 Emitter-collector voltage

 Currents
 Collector current (d.c.)
 Collector current (peak value)
 Collector current (peak value)

 Power dissipation
 Total power dissipation up to \( T_{amb} = 50 \, ^\circ C \) up to \( T_{mb} = 55 \, ^\circ C \)
 Power dissipation

 Temperatures
 Storage temperature
 Junction temperature

 THERMAL RESISTANCE
 From junction to ambient in free air
 From junction to mounting base

 CHARACTERISTICS
 Collector dark current
 Collector dark current
 Collector light current
 Collector light current

 CHARACTERISTICS
 Collector dark current
 Collector dark current
 Collector light current
 Collector light current

 CHARACTERISTICS
 Collector dark current
 Collector dark current
 Collector light current
 Collector light current


1) Available selections: BPX71-201: 0.5 to 3 mA
BPX71-202: 2 to 5 mA
BPX71-203: 4 to 8 mA
BPX71-204: 7 to 15 mA
CHARACTERISTICS (continued)

Breakdown voltages

Collector-emitter voltage
\[ E = 0; \quad I_C = 0.5 \text{ mA} \]

Emitter-collector voltage
\[ E = 0; \quad I_C = 0.1 \text{ mA} \]

Collector-emitter light saturation voltage
\[ I_C = 0.4 \text{ mA}; \quad E_e = 20 \text{ mW/cm}^2; \quad T_c = 2856 \text{ K} \]

Wavelength at peak response
\[ \lambda_{pk} \quad \text{typ.} \quad 800 \text{ nm} \]

Bandwidth at half height
\[ B_{50\%} \quad \text{typ.} \quad 400 \text{ nm} \]

Switching times
\[ I_{Con} = 0.8 \text{ mA}; \quad V_{CC} = 35 \text{ V}; \quad R_L = 1 \text{ k}\Omega \]

Delay time
\[ t_d \quad \text{typ.} \quad < \quad 2.0 \mu s \]

Rise time
\[ t_r \quad \text{typ.} \quad < \quad 3.0 \mu s \]

Storage time
\[ t_s \quad \text{typ.} \quad < \quad 0.1 \mu s \]

Fall time
\[ t_f \quad \text{typ.} \quad < \quad 2.5 \mu s \]

Light input pulse:
\[ t_r = t_f = 20 \text{ ns} \]
\[ t_p = 20 \mu s \]
\[ f = 500 \text{ Hz} \]
\[ \lambda = 800 \text{ nm} \]
BPX71

Typical values; $T_{\text{amb}} = 25\, ^\circ\text{C}$.

$V_{CE} = 5\, \text{V}; \, T_{\text{amb}} = 25\, ^\circ\text{C}$.

$V_{CE} = 5\, \text{V}; \, T_{\text{amb}} = 25\, ^\circ\text{C}$.
polar response of relative sensitivity

$T_{amb} = 25^\circ C$
PHOTOTRANSISTOR

General purpose n-p-n silicon phototransistor with a plastic lens.

### QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$V_{CEO}$ max.</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>$I_C$ max.</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max.</td>
</tr>
<tr>
<td>Collector dark current (open base) $V_{CE} = 20$ V</td>
<td>$I_d$ &lt;</td>
</tr>
<tr>
<td>Collector light current (open base) $V_{CE} = 5$ V; $E = 1000$ lx (4.75 mW/cm²)</td>
<td>$I_1$</td>
</tr>
<tr>
<td></td>
<td>BPX72C</td>
</tr>
<tr>
<td></td>
<td>BPX72D</td>
</tr>
<tr>
<td></td>
<td>BPX72E</td>
</tr>
<tr>
<td>Wavelength at peak response</td>
<td>$λ_{pk}$ typ.</td>
</tr>
<tr>
<td>Angle between half-sensitivity directions</td>
<td>$α_{50%}$ typ.</td>
</tr>
</tbody>
</table>

### MECHANICAL DATA

SOT-70

Dimensions in mm

Max. lead diameter is guaranteed only for 12.7 mm
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Collector-base voltage (open emitter) \( V_{CEO} \) max. 40 V
Collector-emitter voltage (open base) \( V_{CEO} \) max. 30 V
Emitter-collector voltage (open base) \( V_{ECO} \) max. 6 V

Currents

Collector current (d.c.) \( I_C \) max. 25 mA
Collector current (peak value) \( t_p \leq 50 \mu s; \delta \leq 0.1 \) \( I_{CM} \) max. 50 mA

Power dissipation

Total power dissipation up to \( T_{amb} = 25 \) °C \( P_{tot} \) max. 180 mW

Temperatures

Storage temperature \( T_{stg} \) -40 to +125 °C
Junction temperature \( T_j \) max. 125 °C

THERMAL RESISTANCE

From junction to ambient in free air \( R_{th j-a} = 0.55 \) °C/mW

CHARACTERISTICS

Collector dark current

\( V_{CE} = 20 \) V
\( I_d \) typ. \( < 100 \) nA
\( V_{CE} = 20 \) V; \( T_j = 100 \) °C
\( I_d \) typ. \( < 100 \) μA

Collector light current

\( V_{CE} = 5 \) V; tungsten filament lamp source with colour temperature 2856 K;
\( E_V = 1000 \) lx (\( E_e = 4.75 \) mW/cm²)
\( E_V = 2500 \) lx (\( E_e = 12 \) mW/cm²)

\( I_l \) typ. \( 500 \) to 3000 μA

1) Available selections: BPX72C: 500 to 1200 μA
BPX72D: 850 to 2000 μA
BPX72E: 1400 to 3000 μA
CHARACTERISTICS (continued)

Breakdown voltages

Collector-base voltage
E = 0; I_C = 0, 1 mA
V_{BR}CBO > 40 V

Collector-emitter voltage
E = 0; I_C = 1 mA
V_{BR}CEO > 30 V

Emitter-collector voltage
E = 0; I_C = 0, 1 mA
V_{BR}ECO > 6 V

Collector capacitance
I_E = I_e = 0; V_{CB} = 20 V
C_c typ. 3.5 pF

Wavelength at peak response
\lambda_{pk} typ. 800 nm

Bandwidth at half height
B_{50\%} typ. 300 nm

Switching times
I_{Con} = 1 mA; V_{CC} = 5 V; R_L = 100 \Omega

delay time
\tau_d typ. 3.0 \mu s

rise time
\tau_r typ. 6.0 \mu s

storage time
\tau_s typ. 1.5 \mu s

fall time
\tau_f typ. 4.0 \mu s

Light input pulse:
\tau_r = \tau_f = 20 ns
\tau_p = 20 \mu s
f = 500 Hz
\lambda = 800 nm
polar response of relative sensitivity
$T_{amb} = 25^\circ C$
SILICON PHOTODIODE

Silicon photodiode with low N.E.P. for detection of very low light levels; for use in conjunction with an operational amplifier.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
</tr>
<tr>
<td>Dark reverse current ($V_R = 1$ V)</td>
</tr>
<tr>
<td>Luminous sensitivity</td>
</tr>
<tr>
<td>$V_R = 0$; $T_C = 2700$ K</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Wavelength at peak response</td>
</tr>
<tr>
<td>Beamwidth between half-sensitivity directions</td>
</tr>
<tr>
<td>Sensitive area</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

TO-18, except for window
Cathode connected to case

Sensitive area 1,2 mm x 1,2 mm

Dimensions in mm
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Continuous reverse voltage \( V_R \) max. 18 V
Total power dissipation up to \( T_{amb} = 25 \) °C \( P_{tot} \) max. 300 mW
Storage temperature \( T_{stg} \) -65 to +150 °C
Junction temperature \( T_j \) max. 150 °C

CHARACTERISTICS

Dark reverse current
\( V_R = 1 \) V \( i_{R(D)} \) typ. 100 pA

Luminous sensitivity (in photovoltaic mode)
\( V_R = 0; T_C = 2700 \) K 1) \( N \) typ. 8 nA/lx
\( V_R = 0; \lambda = 780 \) nm \( N \) typ. 1 \( \mu A/mW/cm^2 \)

Wavelength at peak response \( \lambda_{pk} \) typ. 800 nm

Beamwidth between half-sensitivity directions \( \alpha_{50\%} \) typ. 63 °

Diode capacitance
\( V_R = 0 \) \( C_d \) typ. 200 pF
\( V_R = 15 \) V \( C_d \) typ. 45 pF

---

1) Unfiltered tungsten lamp.
APPLICATION INFORMATION

Owing to the improvement over the last few years in the properties of both devices, the photodiode/op amp sensor has become a powerful competitor of the photomultiplier tube. Benefits over the latter are:

- greater range of incident light intensity over which non-linearity is 1% or less: nine decades, as compared to seven decades for the photomultiplier.
- drift in sensitivity over six months about 0.5%, as against 1% to 2% for photomultipliers selected for low drift.
- wide range of spectral response (400 nm to 1200 nm) covered with a single detector: better ability to withstand over-current due to excessive radiation.
- high shock and vibration resistance.
- cheaper power supply (15 V unstabilized as compared to an accurately stabilized high-voltage supply - 1000 V - for photomultiplier.

It has been found that the following circuit with an operational amplifier and a balanced pre-amplifier FET stage is suitable for measuring very low light levels:

![Circuit Diagram]

This is an example of an extremely sensitive circuit. Where the amplification may be lower, the value of R8 can be reduced. The output voltage drops 3 dB at 1 kHz.
SILICON PLANAR EPITAXIAL PHOTOTRANSISTOR

N-P-N phototransistor designed for use as detector. Clear epoxy encapsulation.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>V_{CEO} max. 30 V</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>I_{C} max. 25 mA</td>
</tr>
<tr>
<td>Total power dissipation up to T_{amb} = 25 °C</td>
<td>P_{tot} max. 100 mW</td>
</tr>
<tr>
<td>Collector light (cut-off) current</td>
<td>I_{CEO(L)} &gt; 5 mA</td>
</tr>
<tr>
<td>V_{CE} = 5 V; E_{V} = 1000 lx</td>
<td>\lambda_{pk} typ. 800 nm</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOD-63.

Dimensions in mm:
- 7Z69275.2A
- 5,08 mm
- 4,70 mm
- 9,5 mm
- 8,5 mm
- 3,5 mm
- 2,0 mm
- 12,7 min
- 14,7 min

June 1978
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-emitter voltage (open base) \( V_{CEO} \) max. 30 V
Emitter-collector voltage (open base) \( V_{ECC} \) max. 5 V
Collector current (d.c.) \( I_C \) max. 25 mA
Collector current (peak value) \( I_{CM} \) max. 50 mA
Total power dissipation up to \( T_{amb} = 25 \) °C \( P_{tot} \) max. 100 mW
Storage temperature \( T_{stg} \) -40 to +100 °C
Junction temperature \( T_j \) max. 100 °C
Lead soldering temperature \( T_{sl} \) max. 240 °C

THERMAL RESISTANCE
From junction to ambient \( R_{thj-a} \) = 0.75 °C/mW
From junction to ambient, device mounted on a printed-circuit board (note 1) \( R_{thj-a} \) = 0.50 °C/mW

CHARACTERISTICS
\( T_j = 25 \) °C unless otherwise specified
Collector dark (cut-off) current \( V_{CE} = 20 \) V
Collector light (cut-off) current at \( T_{amb} = 25 \) °C \( V_{CE} = 5 \) V; \( E_v = 1000 \) lx; \( T_C = 2854 \) K (note 2)
Collector-emitter saturation voltage \( I_C = 3 \) mA; \( E_v = 1000 \) lx; \( T_C = 2854 \) K (note 2)
Wavelength at peak response \( \lambda_{pk} \) typ. 800 nm
Bandwidth at half height \( B_{50}\% \) typ. 400 nm
Angle between half-sensitivity directions (note 3) \( \alpha_{50}\% \) typ. 25°
Receiving area typ. 1 mm²

Notes
1. With copper island rings of 0.8 mm and 1.3 mm diameters on both sides of 1.6 mm glass-epoxy printed-circuit board; thickness of copper 35 μm.
2. Unfiltered tungsten filament lamp.
3. Measured at \( I_C = 1 \) mA; \( E_v = 1000 \) lx.
Silicon planar epitaxial phototransistor

Switching times (see Figs 2 and 3)

$I_{on} = 1 \text{ mA}; V_{CC} = 5 \text{ V}; R_E = 100 \Omega; T_{amb} = 25 ^\circ \text{C}$

Light current rise time
Light current fall time

$t_r \quad \text{typ.} \quad 3 \mu\text{s}$
$t_f \quad \text{typ.} \quad 2 \mu\text{s}$

Fig. 2 Switching circuit.
Pulse generator:
$f = 500 \text{ Hz}$
$t_p = 20 \mu\text{s}$
$t_r = t_f = 20 \text{ ns}$

Fig. 3 Input and output switching waveforms.

Fig. 4

Fig. 5
Fig. 6.

$T_J = 25 \, ^\circ C$

$V_{CE} = 5 \, V$

$T_{amb} = 25 \, ^\circ C$

Fig. 7.

$I_{CEO(D)} (\mu A)$

Max

Typ

Fig. 8.

$I_{CEO(L)} (mA)$

Typ

Fig. 9.

$E_v = 1200 \, lx$

$E_v = 1000 \, lx$

$E_v = 800 \, lx$

$E_v = 600 \, lx$

$E_v = 400 \, lx$

$E_v = 200 \, lx$

Fig. 9.

$E_v = 1000 \, lx$

$E_v = 800 \, lx$

$E_v = 600 \, lx$

$E_v = 400 \, lx$

$E_v = 200 \, lx$

June 1978
Silicon planar epitaxial phototransistor

Fig. 10.

Fig. 11.
LIGHT EMITTING DIODES
GaAs LIGHT EMITTING DIODE

Gallium arsenide light emitting diode intended for optical coupling and encoding. It emits radiation in the near infrared when forward biased. The diode is provided with a flat glass window.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
</tr>
<tr>
<td>Forward current (peak value)</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 95 , ^\circ C$</td>
</tr>
<tr>
<td>Total radiant power at $I_F = 20 , mA$</td>
</tr>
<tr>
<td>Radiant intensity (on-axis) at $I_F = 20 , mA$</td>
</tr>
<tr>
<td>Light rise time at $I_{F , on} = 20 , mA$</td>
</tr>
<tr>
<td>Light fall time at $I_{F , on} = 20 , mA$</td>
</tr>
<tr>
<td>Wavelength at peak emission</td>
</tr>
<tr>
<td>Thermal resistance from junction to ambient</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

TO-18, except for window

Max. lead diameter is guaranteed only for 12,7 mm
## RATINGS

**Limiting values in accordance with the Absolute Maximum System (IEC 134)**

### Voltage

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$</td>
<td>max. 2 V</td>
</tr>
</tbody>
</table>

### Current

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward current (d.c.)</td>
<td>$I_F$</td>
<td>max. 30 mA</td>
</tr>
<tr>
<td>Forward current (peak value)</td>
<td>$I_{FM}$</td>
<td>max. 200 mA</td>
</tr>
<tr>
<td>$t_p = 100 \mu s; \delta = 0,1$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Power dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total power dissipation up to $T_{amb} = 95 , ^\circ C$</td>
<td>$P_{tot}$</td>
<td>max. 50 mW</td>
</tr>
</tbody>
</table>

### Temperature

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td>-55 to +150 °C</td>
</tr>
<tr>
<td>Operating junction temperature</td>
<td>$T_j$</td>
<td>max. 125 °C</td>
</tr>
</tbody>
</table>

### THERMAL RESISTANCE

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to ambient in free air</td>
<td>$R_{th , j-a}$</td>
<td>0,6 °C/mW</td>
</tr>
<tr>
<td>From junction to case</td>
<td>$R_{th , j-c}$</td>
<td>0,22 °C/mW</td>
</tr>
</tbody>
</table>

### CHARACTERISTICS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward voltage at $I_F = 30$ mA</td>
<td>$V_F$</td>
<td>typ. 1,3 V</td>
</tr>
<tr>
<td>$I_{FM} = 0,2$ A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse current at $V_R = 2$ V</td>
<td>$I_R$</td>
<td>&lt; 0,5 mA</td>
</tr>
<tr>
<td>Diode capacitance at $f = 1$ MHz; $V_R = 0$</td>
<td>$C_d$</td>
<td>typ. 65 pF</td>
</tr>
</tbody>
</table>

$T_{amb} = 25 \, ^\circ C$ unless otherwise specified
CHARACTERISTICS (continued)  

Radiant output power at $I_F = 20$ mA  

$I_F = 20$ mA; $T_j = 100$ °C  
$I_F = 200$ mA  

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Phi_e$ (typ.)</td>
<td></td>
<td>60 $\mu$W</td>
</tr>
<tr>
<td>$\Phi_e$ (typ.)</td>
<td></td>
<td>100 $\mu$W</td>
</tr>
<tr>
<td>$\Phi_e$ (typ.)</td>
<td></td>
<td>50 $\mu$W</td>
</tr>
<tr>
<td>$\Phi_e$ (typ.)</td>
<td></td>
<td>1,16 mW</td>
</tr>
</tbody>
</table>

Radiant intensity (on-axis) at $I_F = 20$ mA  

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_e$ (typ.)</td>
<td></td>
<td>64 $\mu$W/sr</td>
</tr>
</tbody>
</table>

Radiance at $I_F = 20$ mA  

$L_e$ (typ.) $= 1,6$ mW/mm$^2$sr  
$L_e$ (typ.) $= 15$ mW/mm$^2$sr  

Emissive area  

$A_e$ (typ.) $= 0,04$ mm$^2$  

Wavelength at peak emission  

$\lambda_{pk}$ (typ.) $= 880$ nm  

Bandwidth at half height  

$\Delta \lambda$ (typ.) $= 40$ nm  

Light rise time at $I_{Fon} = 20$ mA  

$t_r$ (typ.) $< 30$ ns  
$t_r$ (typ.) $< 100$ ns  

Light fall time at $I_{Fon} = 20$ mA  

$t_f$ (typ.) $< 30$ ns  
$t_f$ (typ.) $< 100$ ns  

---

$T_{amb} = 25$ °C unless otherwise specified

---

1) $t_p = 100 \mu$s; $\delta = 0,1$.  

September 1974
\[ P_{\text{peak max}} = \frac{220}{Z_{\text{th j-c}}} P_{\text{tot max}} \]

\[ T_{\text{amb}} = 25 \, ^\circ\text{C} \]

\[ I_F (\text{mA}) \]

\[ V_F, I_F \]

\[ \phi_e \] (mW)

\[ I_F, \phi_e \]

\[ T_j = 25 \, ^\circ\text{C} \]

July 1972
GALLIUM ARSENIDE LIGHT EMITTING DIODE

Gallium arsenide light emitting diode intended for optical coupling and encoding. It emits radiation in the near infrared when forward biased. Suitable for combination with phototransistor BPX25 or BPX72.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max. 2 V</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td>$I_F$ max. 30 mA</td>
</tr>
<tr>
<td>Forward current (peak value)</td>
<td>$I_{FM}$ max. 200 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 95 , ^\circ C$</td>
<td>$P_{tot}$ max. 50 mW</td>
</tr>
<tr>
<td>Total radiant power at $I_F = 20 , mA$</td>
<td>$\phi_e$ typ. 50 $\mu W$</td>
</tr>
<tr>
<td>Radiant intensity (on-axis) at $I_F = 20 , mA$</td>
<td>$I_e$ typ. 1,25 mW/sr</td>
</tr>
<tr>
<td>Light rise time at $I_{Fon} = 20 , mA$</td>
<td>$t_r$ &lt; 100 ns</td>
</tr>
<tr>
<td>Light fall time at $I_{Fon} = 20 , mA$</td>
<td>$t_f$ &lt; 100 ns</td>
</tr>
<tr>
<td>Wavelength at peak emission</td>
<td>$\lambda_{pk}$ typ. 880 nm</td>
</tr>
<tr>
<td>Thermal resistance from junction to ambient</td>
<td>$R_{th j-a}$ = 0,6 $^\circ C/mW$</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

TO-18, except for lens

March 1978
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage
Continuous reverse voltage
\[ V_R \text{ max.} = 2 \text{ V} \]

Current
Forward current (d.c.)
\[ I_F \text{ max.} = 30 \text{ mA} \]
Forward current (peak value)
\[ I_{FM} \text{ max.} = 200 \text{ mA} \]

Power dissipation
Total power dissipation up to
\[ P_{tot} \text{ max.} = 50 \text{ mW} \]

Temperature
Storage temperature
\[ T_{stg} = -55 \text{ to } +150 \text{ °C} \]
Junction temperature
\[ T_j \text{ max.} = 125 \text{ °C} \]

THERMAL RESISTANCE
From junction to ambient in free air
\[ R_{th j-a} = 0.6 \text{ °C/mW} \]
From junction to case
\[ R_{th j-c} = 0.22 \text{ °C/mW} \]

CHARACTERISTICS
Forward voltage
\[ I_F = 30 \text{ mA} \]
\[ I_{FM} = 200 \text{ mA} \]
\[ V_F \text{ typ.} = 1.3 \text{ V} \]
\[ V_F < 1.6 \text{ V} \]

Reverse current
\[ V_R = 2 \text{ V} \]
\[ I_R < 0.5 \text{ mA} \]

Diode capacitance
\[ V_R = 0; f = 20 \text{ MHz} \]
\[ C_d \text{ typ.} = 25 \text{ pF} \]

Total radiant power
\[ I_F = 20 \text{ mA} \]
\[ \phi_e \text{ typ.} = 50 \text{ µW} \]

Radiant intensity (on-axis)
\[ I_F = 20 \text{ mA} \]
\[ I_e \text{ typ.} = 1.25 \text{ mW/sr} \]
CHARACTERISTICS (continued)

Mean irradiance

on a receiving area with \( D = 2 \) mm at a

distance \( a = 10 \) mm and at \( I_L = 20 \) mA,

measured as below

\[
F_e > 0.28 \text{ mW/cm}^2 \quad \text{typ.} \quad 0.50 \text{ mW/cm}^2 \quad 1)
\]

\[
\frac{\Delta \phi_e}{\Delta T_j} \quad \text{typ.} \quad 0.7 \%/\degree C
\]

Cross section of the radiant beam

between 0 to 10 mm from the lens

\[
A_{\text{beam}} \quad \text{typ.} \quad 7 \text{ mm}^2
\]

Angle between optical and mechanical axis

\[
\theta \quad \text{typ.} \quad 6^\circ
\]

Wavelength at peak emission

\[
\lambda_{pk} \quad \text{typ.} \quad 880 \text{ nm}
\]

Bandwidth at half height

\[
B_{50\%} \quad \text{typ.} \quad 40 \text{ nm}
\]

Light rise time at \( I_{\text{Fon}} = 20 \) mA

\[
t_r \quad \text{typ.} \quad < 100 \text{ ns}
\]

Light fall time at \( I_{\text{Fon}} = 20 \) mA

\[
t_f \quad \text{typ.} \quad < 100 \text{ ns}
\]

1) This corresponds typically with \( I_{\text{CEO}}(L) = 0.4 \) mA in a phototransistor BPX25 and with

200 \( \mu \)A in a phototransistor BPX72.
CQY11C

$Z_{th j-c}$

$\frac{\text{°C/mW}}{\text{°C/mW}}$

$\delta = 1$

$0.5$

$0.2$

$0.1$

$0.1$

$t_p = 30 \mu s$

$\delta = 0.1$

$T_{amb} = 25 \text{ °C}$

$I_{FM}$ (mA)

$I_F$ (mA)

$V_{FM}$ (V)

$\phi_e$ (µW)

$T_{amb} = 25 \text{ °C}$

September 197
IFM = 20 mA
$\tau_p = 5 \mu s$
$\delta = 0.0025$

$E_{em} (\text{mW/cm}^2)$
$a = 10 \text{ mm}$
$D = 2 \text{ mm}$
$\tau_p = 5 \mu s$
$\delta = 0.0025$
$T_{amb} = 25 \degree C$

$E_e / I_F (\text{mW/cm}^2/A)$
$a = 10 \text{ mm}$
$D = 2 \text{ mm}$
$T_{amb} = 25 \degree C$
Fig. 1

- D = 2 mm
- D = 3.5 mm

$T_{\text{amb}} = 25 \, ^\circ\text{C}$

typ. values

$E_e$ (mW/cm$^2$)

$I_e = 30$ mA

$a$ (mm)

September 1974
GaAsP RED LIGHT EMITTING DIODE

Gallium arsenide phosphide light emitting diode which emits visible red light when forward biased. The envelope is of light-diffusing red plastic, and has been designed for high-density arrays.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage $V_R$ max. 3 V</td>
</tr>
<tr>
<td>Forward current (d.c.) $I_F$ max. 50 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 37.5$ °C $P_{tot}$ max. 100 mW</td>
</tr>
<tr>
<td>Luminous intensity (on-axis) $I_F = 20$ mA</td>
</tr>
<tr>
<td>CQY24A $I_V &gt; 0.3$ mcd</td>
</tr>
<tr>
<td>CQY24A-I $I_V 0.7$ to 1.6 mcd</td>
</tr>
<tr>
<td>CQY24A-II $I_V$ 1 to 2.2 mcd</td>
</tr>
<tr>
<td>CQY24A-III $I_V &gt; 1.6$ mcd</td>
</tr>
<tr>
<td>Wavelength at peak emission $\lambda_{pk}$ typ. 650 nm</td>
</tr>
<tr>
<td>Beamwidth between half-intensity directions $\alpha_{50%}$ typ. 70°</td>
</tr>
<tr>
<td>Thermal resistance from junction to ambient $R_{th j-a} = 0.625$ °C/mW</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOD-39C.

Dimensions in mm
Accessories for panel mounting (panel thickness < 4 mm)

Plastic clip and ring, black: type RTC757
colourless: type RTC758

Hole diameter 6.4 mm for panel thickness < 3 mm
6.5 mm for panel thickness > 3 mm
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage
Continuous reverse voltage

| VR | max. | 3 V |

Current
Forward current (d.c.)

| IF | max. | 50 mA |

Forward current (peak value)

\[ t_p = 1 \mu s; f = 300 \text{ Hz} \]

| IFM | max. | 1 A |

Temperature
Storage temperature

| Tstg | -55 to +100 °C |

Junction temperature

| TJ | max. | 100 °C |

Lead soldering temperature

up to seating plane; t_sld < 10 s

| T_sld | max. | 260 °C |

Power dissipation

Total power dissipation up to \( T_{\text{amb}} = 37.5^\circ \text{C} \)

| Ptot | max. | 100 mW |

THERMAL RESISTANCE

From junction to ambient,
in free air

\[ R_{\text{th j-a}} = 0.625 \degree \text{C/mW} \]

mounted on printed-circuit board

\[ R_{\text{th j-a}} = 0.500 \degree \text{C/mW} \]
CHARACTERISTICS

Forward voltage

\[ I_F = 20 \, mA \]

Negative temperature coefficient of \( V_F \)

\[ \frac{-\Delta V_F}{\Delta T_j} \] typ. \[ 1,6 \, \text{mV/}^\circ\text{C} \]

Reverse current

\[ V_R = 3 \, V \]

\[ I_R < 100 \, \mu A \]

Luminous intensity (on-axis)

\[ I_F = 20 \, mA \]

<table>
<thead>
<tr>
<th></th>
<th>CQY24A</th>
<th>CQY24A-I</th>
<th>CQY24A-II</th>
<th>CQY24A-III</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I_V )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;</td>
<td>&gt; 0,3 mcd</td>
<td>&gt; 1 to 2,2 mcd</td>
<td>&gt; 1,6 mcd</td>
</tr>
</tbody>
</table>

Diode capacitance

\[ V_R = 0; \, f = 1 \, \text{MHz} \]

\[ C_d \] typ. \[ 60 \, \text{pF} \]

Wavelength at peak emission

\[ \lambda_{pk} \] typ. \[ 650 \, \text{nm} \]

Bandwidth at half height

\[ B_{50\%} \] typ. \[ 20 \, \text{nm} \]

Beamwidth between half-intensity directions

\[ \alpha_{50\%} \] typ. \[ 70^\circ \]

\( T_j = 25 \, ^\circ\text{C} \) unless otherwise specified
GaAsP RED LIGHT EMITTING DIODES

Gallium arsenide phosphide light emitting diodes which emit visible red light when forward biased.
The envelopes are of clear, non-diffusing resin: red for CQY46A, colourless for CQY47A, both showing
a clearly defined point of light.
CQY46A has better contrast, CQY47A shows no red reflections from sunlight or incandescent light
sources.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CQY46A</th>
<th>CQY47A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage (d.c.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward current (max. I_F)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total power dissipation up to T_amb = 37,5 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal resistance from junction to ambient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luminous intensity (on-axis) at I_F = 20 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angle between half-intensity directions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wavelength at peak emission</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOD-39D

Dimensions in mm
Accessories for panel mounting (panel thickness < 4 mm)

Plastic clip and ring,
- black: type RTC757
- colourless: type RTC758

Hole diameter
- 6,4 mm for panel thickness < 3 mm
- 6,5 mm for panel thickness > 3 mm

Fig. 2.

Fig. 3.

Fig. 4.
GaAsP red light emitting diodes

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Continuous reverse voltage
Forward current (d.c.)
Forward current (peak value)
Power dissipation up to T_{amb} = 37.5 °C
Storage temperature
Junction temperature
Lead soldering temperature

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>V_{R}</td>
<td>max.</td>
<td>3 V</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td>I_{F}</td>
<td>max.</td>
<td>50 mA</td>
</tr>
<tr>
<td>Forward current (peak value)</td>
<td>I_{FM}</td>
<td>max.</td>
<td>1000 mA</td>
</tr>
<tr>
<td>Power dissipation up to T_{amb} = 37.5 °C</td>
<td>P_{tot}</td>
<td>max.</td>
<td>100 mW</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>T_{stg}</td>
<td>-55 to +100 °C</td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{j}</td>
<td>max.</td>
<td>100 °C</td>
</tr>
<tr>
<td>Lead soldering temperature</td>
<td>T_{sld}</td>
<td>max.</td>
<td>260 °C</td>
</tr>
</tbody>
</table>

THERMAL RESISTANCE

From junction to ambient

\[ R_{thj-a} = 0.625 \text{ °C/mW} \]

From junction to ambient (device mounted on a printed-circuit board *)

\[ R_{thj-a} = 0.5 \text{ °C/mW} \]

CHARACTERISTICS

T_{j} = 25 °C unless otherwise specified

Forward voltage
\[ I_{F} = 20 \text{ mA} \]
\[ V_{F} \text{ typ.} < 1.7 \text{ V} \]
Reverse current
\[ V_{R} = 3 \text{ V} \]
\[ I_{R} \text{ < } 100 \text{ μA} \]
Diode capacitance
\[ V_{R} = 0; f = 1 \text{ MHz} \]
\[ C_{d} \text{ typ. } 60 \text{ pF} \]
Luminous intensity (on-axis)
\[ I_{F} = 20 \text{ mA}; T_{amb} = 25 \text{ °C} \]
\[ \lambda_{pk} \text{ typ. } 650 \text{ nm} \]
Wavelength at peak emission
\[ \alpha_{50\%} \text{ typ. } 100^\circ \]

* With copper island rings of 0.8 mm and 1.3 mm diameters on both sides of 1.6 mm glass-epoxy printed-circuit board; thickness of copper 35 μm.

March 1978
Fig. 5. $Z_{th \, j \cdot a}$ ($^\circ$C/mW)

Fig. 6 $T_j = 25 \, ^\circ$C.

Fig. 7 $T_j = 25 \, ^\circ$C; $t_p = 10 \, \mu$s; $T = 1 \, ms$. 

March 1978
GaAsP red light emitting diodes

Fig. 8 $T_J = 25^\circ C$.

Fig. 9 $I_F = 20\, mA$.

Fig. 10 Typical values; $T_J = 25^\circ C$; $t_{av} = T$.

Fig. 11 $T_J = 25^\circ C$; $t_p = 1\, \mu s$; $\delta = 0$. 

March 1978
Fig. 12.

Fig. 13.
GaAs LIGHT EMITTING DIODES


<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
</tr>
<tr>
<td>Total power dissipation up to ( T_{amb} = 25 \degree C )</td>
</tr>
<tr>
<td>Radiant intensity (on-axis) at ( I_F = 50 ) mA CQY49B</td>
</tr>
<tr>
<td>Radiant intensity (on-axis) at ( I_F = 50 ) mA CQY49C</td>
</tr>
<tr>
<td>Wavelength at peak emission</td>
</tr>
<tr>
<td>Thermal resistance from junction to ambient</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

CQY49B : TO-18 except for window

CQY49C : TO-18 except for lens
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage
Continuous reverse voltage

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Symbol</th>
<th>min.</th>
<th>max.</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$</td>
<td></td>
<td>max.</td>
<td>2 V</td>
</tr>
</tbody>
</table>

Current
Forward current (d.c.)
Forward current (peak value)

<table>
<thead>
<tr>
<th>Current</th>
<th>Symbol</th>
<th>min.</th>
<th>max.</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward current (d.c.)</td>
<td>$I_F$</td>
<td></td>
<td>max.</td>
<td>100 mA</td>
</tr>
<tr>
<td>Forward current (peak value)</td>
<td>$I_{FM}$</td>
<td></td>
<td>max.</td>
<td>1 A</td>
</tr>
<tr>
<td>$t_p \leq 10 \mu s; \delta &lt; 0.01$</td>
<td>$I_{FM}$</td>
<td></td>
<td>max.</td>
<td>1 A</td>
</tr>
</tbody>
</table>

Power dissipation
Total power dissipation up to $T_{amb} = 25 \, ^\circ C$

<table>
<thead>
<tr>
<th>Power dissipation</th>
<th>Symbol</th>
<th>min.</th>
<th>max.</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$</td>
<td></td>
<td>max.</td>
<td>150 mW</td>
</tr>
</tbody>
</table>

Temperature
Storage temperature
Operating junction temperature
Lead soldering temperature

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Symbol</th>
<th>min.</th>
<th>max.</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td></td>
<td>-40 to +100</td>
<td>0°C</td>
</tr>
<tr>
<td>Operating junction temperature</td>
<td>$T_j$</td>
<td></td>
<td>max.</td>
<td>125 oC</td>
</tr>
<tr>
<td>Lead soldering temperature</td>
<td>$T_{sld}$</td>
<td>max.</td>
<td>260 oC</td>
<td></td>
</tr>
<tr>
<td>$&gt; 1,5 , mm$ from the body; $t_{sld} &lt; 10 , s$</td>
<td>$T_{sld}$</td>
<td>max.</td>
<td>260 oC</td>
<td></td>
</tr>
</tbody>
</table>

THERMAL RESISTANCE
From junction to ambient in free air
From junction to case

<table>
<thead>
<tr>
<th>THERMAL RESISTANCE</th>
<th>Symbol</th>
<th>min.</th>
<th>max.</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to ambient in free air</td>
<td>$R_{th \ j-a}$</td>
<td>=</td>
<td>0.665</td>
<td>0°C/mW</td>
</tr>
<tr>
<td>From junction to case</td>
<td>$R_{th \ j-c}$</td>
<td>=</td>
<td>0.3</td>
<td>0°C/mW</td>
</tr>
<tr>
<td>CHARACTERS</td>
<td>( T_J = 25 , ^\circ C ) unless otherwise specified</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage at ( I_P = 50 , mA )</td>
<td>( V_F )</td>
<td>typ.</td>
<td>1.3</td>
<td>V</td>
</tr>
<tr>
<td>Reverse current at ( V_R = 2 , V )</td>
<td>( I_R )</td>
<td>&lt;</td>
<td>200</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>Diode capacitance</td>
<td>( V_R = 0; f = 1 , MHz )</td>
<td>( C_d )</td>
<td>typ.</td>
<td>85</td>
</tr>
<tr>
<td>Radiant intensity (on-axis) at ( I_P = 50 , mA )</td>
<td>( I_e )</td>
<td>typ.</td>
<td>3.3</td>
<td>3 ( \text{mW/str} )</td>
</tr>
<tr>
<td>Wavelength at peak emission</td>
<td>( \lambda_{pk} )</td>
<td>typ.</td>
<td>6920</td>
<td>( \text{nm} )</td>
</tr>
<tr>
<td>Bandwidth at half height</td>
<td>( B_{50%} )</td>
<td>typ.</td>
<td>50</td>
<td>( \text{nm} )</td>
</tr>
<tr>
<td>Beamwidth between half-intensity directions</td>
<td>( \alpha_{50%} )</td>
<td>typ.</td>
<td>800</td>
<td>50°</td>
</tr>
<tr>
<td>Angle between optical and mechanical axis</td>
<td>typ.</td>
<td>--</td>
<td>60°</td>
<td></td>
</tr>
</tbody>
</table>

**Switching times**

\( I_{Fon} = 50 \, mA; \, t_p = 2 \, \mu s; \, f = 45 \, \text{kHz} \)

- Light rise time
  - \( t_r \) | typ. | 800 | ns |
- Light fall time
  - \( t_f \) | typ. | 350 | ns |
GaAs LIGHT EMITTING DIODES

Gallium arsenide light emitting diodes which emit near-infrared light when forward biased. Ceramic-metal envelope with glass lens like BPX71, suitable for matrix layout on printed circuit boards. In conjunction with BPX71 also suitable for punched card reading.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25 , ^\circ C$ mounted on printed circuit board</td>
</tr>
<tr>
<td>Total radiant power at $I_F = 20 , mA$</td>
</tr>
<tr>
<td>Radiant intensity (on-axis) at $I_F = 20 , mA$</td>
</tr>
<tr>
<td>Wavelength at peak emission</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

DO-31 except for length

[Diagram of the diode dimensions]
**RATINGS**  Limiting values in accordance with the Absolute Maximum System (IEC 134)

**Voltage**
- Continuous reverse voltage: $V_R \text{ max.} = 2 \text{ V}$

**Current**
- Forward current (d.c.): $I_F \text{ max.} = 100 \text{ mA}$
- Forward current (peak value): $I_{FM} \text{ max.} = 500 \text{ mA}$

**Temperature**
- Storage temperature: $T_{\text{stg}} = -65 \text{ to } +150 \text{ °C}$
- Operating junction temperature: $T_j \text{ max.} = 125 \text{ °C}$

**Power dissipation**
- Total power dissipation up to $T_{\text{amb}} = 25 \text{ °C}$: $P_{\text{tot}} \text{ max.} = 150 \text{ mW}$

**THERMAL RESISTANCE**
- From junction to ambient, device mounted on p.c. board: $R_{\text{th j-a.}} = 0.66 \text{ °C/mW}$

---

1) With copper islands of 6 x 2 mm on both sides of 1.6 mm glass-epoxy printed circuit board; thickness of copper 35 μm.
**CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CQY50</th>
<th>CQY52</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forward voltage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_F = 50 \text{ mA}$</td>
<td>$V_F \text{ typ.}$</td>
<td>1,3</td>
</tr>
<tr>
<td>$I_F = 500 \text{ mA} ;; ; t_p = 10 \mu s ;; ; \delta = 0,01$</td>
<td>$V_F \text{ typ.}$</td>
<td>2,3</td>
</tr>
<tr>
<td><strong>Reverse current</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_R = 2 \text{ V}$</td>
<td>$I_R &lt; 100$</td>
<td>100</td>
</tr>
<tr>
<td><strong>Diode capacitance</strong></td>
<td>$C_d \text{ typ.}$</td>
<td>45</td>
</tr>
<tr>
<td>$V_R = 0 ;; ; f = 1 \text{ MHz}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total radiant power</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_F = 20 \text{ mA}$</td>
<td>$\phi_e &gt; 160$</td>
<td>400</td>
</tr>
<tr>
<td>$I_F = 50 \text{ mA}$</td>
<td>$\phi_e \text{ typ.}$</td>
<td>700</td>
</tr>
<tr>
<td><strong>Radiant intensity (on-axis)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_F = 20 \text{ mA}$</td>
<td>$I_e &gt; 180$</td>
<td>450</td>
</tr>
<tr>
<td><strong>Wavelength at peak emission</strong></td>
<td>$\lambda_{pk} \text{ typ.}$</td>
<td>930</td>
</tr>
<tr>
<td><strong>Bandwidth at half height</strong></td>
<td>$B_{50%} \text{ typ.}$</td>
<td>40</td>
</tr>
<tr>
<td><strong>Beamwidth between half-intensity directions</strong></td>
<td>$\alpha_{50%} \text{ typ.}$</td>
<td>35°</td>
</tr>
<tr>
<td><strong>Switching times</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{Fon} = 20 \text{ mA} ;; ; t_p = 2 \mu s ;; ; f = 45 \text{ kHz}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light rise time</td>
<td>$t_r \text{ typ.}$</td>
<td>600</td>
</tr>
<tr>
<td>Light fall time</td>
<td>$t_f \text{ typ.}$</td>
<td>350</td>
</tr>
</tbody>
</table>

$T_{amb} = 25^\circ \text{C}$ unless otherwise specified
$V_{CE} = 5V$
$I_F = 50 \text{ mA}$
$T_{amb} = 25 \degree C$

BPX71 with $I_C = 10 \text{ mA}$
at $V_{CE} = 5 \text{ V}$ and
$E = 20 \text{ mW/cm}^2$

BPX71 with $I_C = 5 \text{ mA}$
at $V_{CE} = 5 \text{ V}$ and
$E = 20 \text{ mW/cm}^2$
GaAsP RED LIGHT EMITTING DIODE

Gallium arsenide phosphide light emitting diode which emits visible red light when forward biased. The envelope is of light-diffusing red plastic, and has been designed for high-density arrays.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CQY54</th>
<th>CQY54-1</th>
<th>CQY54-II</th>
<th>CQY54-III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 37,5 , \text{°C}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luminous intensity (on-axis)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_F = 20 , \text{mA}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_R$ max.</td>
<td>3 , \text{V}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_F$ max.</td>
<td>50 , \text{mA}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_{tot}$ max.</td>
<td>100 , \text{mW}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_V &gt; 0,3 , \text{mcd}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_V &gt; 0,7 , \text{mcd}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_V 1 , \text{to} 2,2 , \text{mcd}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_V &gt; 1,6 , \text{mcd}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\lambda_{pk}$ typ.</td>
<td>650 , \text{nm}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\alpha_{50%}$ typ.</td>
<td>80\degree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wavelength at peak emission</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beamwidth between half-intensity directions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOD-53C.

Dimensions in mm

June 1978
RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Continuous reverse voltage
Forward current (d.c.)
Forward current (peak value) \[ t_p = 1 \mu s; f = 300 \text{ Hz} \]
Storage temperature
Junction temperature
Total power dissipation up to \( T_{\text{amb}} = 37,5 \degree \text{C} \)

THERMAL RESISTANCE

From junction to ambient,
in free air
mounted on a p.c. board

\[
R_{\text{thj-a}} = 0.625 \degree \text{C/mW} \\
R_{\text{thj-a}} = 0.500 \degree \text{C/mW}
\]
GaAsP red light emitting diode

CHARACTERISTICS

T<sub>j</sub> = 25 °C

Forward voltage

I<sub>F</sub> = 20 mA

- Negative temperature coefficient of V<sub>F</sub>
  I<sub>F</sub> = 20 mA

Reverse current

V<sub>R</sub> = 3 V

Luminous intensity (on-axis)

I<sub>F</sub> = 20 mA

Diode capacitance

V<sub>R</sub> = 0; F = 1 MHz

Wavelength at peak emission

Bandwidth at half height

Beamwidth between half-intensity directions

---

**Fig. 2.**
GaAsP red light emitting diode

$I_F$ (mA) vs $V_F$ (V)

- $T_j = 25^\circ C$

$I_{FM}$ (mA) vs $V_{FM}$ (V)

- $T_j = 25^\circ C$
- $t_p = 10 \mu s$
- $T = 1 \text{ ms}$

$I_v$ (mcd) vs $I_F$ (mA)

- $T_j = 25^\circ C$
- (pulses)

$I_v$ (mcd) vs $I_{F(\text{av})}$ (mA)

- $T_j = 25^\circ C$
- (d.c.)

Typical values:

- $T_{amb} = 25^\circ C$

$I_v$ (mcd) vs $I_F$ (mA)

- $T_j = 25^\circ C$
- (pulses)

$I_v$ (mcd) vs $I_{F(\text{av})}$ (mA)

- $T_j = 25^\circ C$
- Typ. values

- $G = 0.05$
- $0.1$
- $0.2$
- $1$
$I_{V_m} (\text{mcd})$ vs $I_{F_M} (\text{mA})$

$T_j = 25^\circ C$
$\tau_p = 1 \mu s$

$I_V (%)$ vs $T_j (\text{C})$
$T_j = 200^\circ C$

$I_f = 20 mA$

$0^\circ C$ to $90^\circ C$ graph

June 1978
GaAs LIGHT EMITTING DIODE

Diffused planar gallium arsenide light emitting diode intended for optical coupling and encoding. It emits radiation in the near infrared when forward biased. Red epoxy resin envelope with lens. Combination with phototransistor BPW22 is recommended.

### QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$</td>
<td>max. 2 V</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td>$I_F$</td>
<td>max. 50 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25 , ^\circ C$</td>
<td>$P_{tot}$</td>
<td>max. 75 mW</td>
</tr>
<tr>
<td>Radiant output power at $I_F = 20 , mA$</td>
<td>$\phi_e$</td>
<td>typ. 500 $\mu W$</td>
</tr>
<tr>
<td>Radiant intensity (on-axis) at $I_F = 20 , mA$</td>
<td>$I_e$</td>
<td>$&gt; 400 , \mu W/\text{sr}$</td>
</tr>
<tr>
<td>Wavelength at peak emission</td>
<td>$\lambda_{pk}$</td>
<td>typ. 875 nm</td>
</tr>
<tr>
<td>Thermal resistance from junction to ambient</td>
<td>$R_{th , j-a}$</td>
<td>= 1 $^{\circ}C/\text{mW}$</td>
</tr>
</tbody>
</table>

### MECHANICAL DATA

**SOD-53D**

Dimensions in mm

March 1978
**RATINGS** Limiting values in accordance with the Absolute Maximum System (IEC 134)

**Voltage**
- Continuous reverse voltage
  \[ V_R \text{ max.} \quad 2 \text{ V} \]

**Current**
- Forward current (d.c.)
  \[ I_F \text{ max.} \quad 50 \text{ mA} \]
- Forward current (peak value)
  \[ I_{F\text{M}} \text{ max.} \quad 200 \text{ mA} \]

**Temperature**
- Storage temperature
  \[ T_{stg} \text{ -55 to } +100 \text{ °C} \]
- Junction temperature
  \[ T_j \text{ max.} \quad 100 \text{ °C} \]
- Lead soldering temperature
  \[ T_{sld} \text{ max.} \quad 230 \text{ °C} \]

**Power dissipation**
- Total power dissipation up to \( T_{amb} = 25 \text{ °C} \),
  device mounted on printed-circuit board
  \[ P_{tot} \text{ max.} \quad 75 \text{ mW} \]

**THERMAL RESISTANCE**
- From junction to ambient,
  device mounted on printed-circuit board
  \[ R_{th \text{ j-a}} = 1 \text{ °C/mW} \]
CHARACTERISTICS

Forward voltage

\[ V_F \text{ typ.} \leq 1.2 \text{ V} \leq 1.5 \text{ V} \]

Reverse current

\[ I_R < 100 \mu A \]

Diode capacitance

\[ C_d \text{ typ.} = 80 \text{ pF} \]

Total radiant power

\[ \phi_e \text{ typ.} = 500 \mu W \]

Radiant intensity (on-axis)

\[ I_e \text{ typ.} = 800 \mu W/\text{sr} \]

Wavelength at peak emission

\[ \lambda_{pk} \text{ typ.} = 875 \text{ nm} \]

Bandwidth at half height

\[ B_{50\%} \text{ typ.} = 50 \text{ nm} \]

Beamwidth between half-intensity directions

\[ \alpha_{50\%} \text{ typ.} = 10^\circ \]

Switching times

\[ I_{Fon} = 50 \text{ mA}; \; t_p = 100 \text{ ns}; \; f = 100 \text{ kHz} \]

Light rise time

\[ t_r \text{ typ.} = 20 \text{ ns} \]

Light fall time

\[ t_f \text{ typ.} = 20 \text{ ns} \]
Typ. Values

$V_F$ (V)

- $I_F = 30 \text{ mA}$
- $I_F = 20 \text{ mA}$
- $I_F = 10 \text{ mA}$
- $I_F = 5 \text{ mA}$

$(-1.55 \text{ mV/°C})$

$50 \mu A$

$I_e$ ($\mu W/sr$)

$T_j = 25 \text{ °C}$

$I_F$ (mA)

$I_F = 20 \text{ mA}$ and $50 \text{ mA}$

$I_e$ (%)

$I_{FM}$ (mA)

$T_j (°C)$
GaAsP RED LIGHT EMITTING DIODE

Gallium arsenide phosphide light emitting diode which emits visible red light when forward biased. The envelope is of non-diffusing red plastic. It is intended for low-current drive (5 mA) applications.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max. 3 V</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td>$I_F$ max. 10 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 60 , ^\circ C$</td>
<td>$P_{tot}$ max. 20 mW</td>
</tr>
<tr>
<td>Luminous intensity (on-axis)</td>
<td>$I_V &gt; 0.3 , mcd$</td>
</tr>
<tr>
<td>Wavelength at peak emission</td>
<td>$\lambda_{pk}$ typ. 650 nm</td>
</tr>
<tr>
<td>Beamwidth between half-intensity directions</td>
<td>$\alpha_{50%}$ typ. 50$^\circ$</td>
</tr>
<tr>
<td>Thermal resistance from junction to ambient in free air</td>
<td>$R_{th j-a} = 2 , ^\circ C/mW$</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

SOD-53C

Dimensions in mm

March 1978
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage
Continuous reverse voltage $V_R$ max. 3 V

Current
Forward current (d.c.) $I_F$ max. 10 mA
Forward current (peak value) $I_{FM}$ max. 100 mA

Power dissipation
Total power dissipation up to $T_{amb}$ = 60 $^\circ$C $P_{tot}$ max. 20 mW

Temperatures
Storage temperature $T_{stg}$ -55 to +100 $^\circ$C
Junction temperature $T_j$ max. 100 $^\circ$C
Lead soldering temperature $T_{sld}$ max. 230 $^\circ$C

THERMAL RESISTANCE
From junction to ambient in free air $R_{th j-a}$ = 2 $^\circ$C/mW

CHARACTERISTICS
Forward voltage $I_F$ = 5 mA $V_F$ typ. 1.7 V

Reverse current $V_R$ = 3 V $I_R$ < 100 $\mu$A

Diode capacitance $V_R$ = 0; $f$ = 1 MHz $C_d$ typ. 30 pF

Luminous intensity (on-axis) $I_F$ = 5 mA $I_v$ > 0.3 mcd typ. 0.5 mcd

Wavelength at peak emission $\lambda_{pk}$ typ. 650 nm

Bandwidth at half height $B_{50\%}$ typ. 20 nm

Beamwidth between half-intensity directions $\alpha_{50\%}$ typ. 50$^\circ$
**GaAs LIGHT EMITTING DIODE**

Epitaxial gallium arsenide light emitting diode intended for remote-control applications. It emits radiation in the near infrared when forward biased. Clear epoxy encapsulation.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max. 5 V</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td>$I_F$ max. 130 mA</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max. 100 °C</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25$ °C</td>
<td>$P_{tot}$ max. 215 mW</td>
</tr>
<tr>
<td>Radiant intensity (on-axis) at $I_F = 100$ mA</td>
<td>$I_e &gt; 7$ mW/sr</td>
</tr>
<tr>
<td>Wavelength at peak emission</td>
<td>$\lambda_{pk}$ typ. 930 nm</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

SOD-63

Dimensions in mm

![Diagram of GaAs LIGHT EMITTING DIODE](image-url)
### RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

#### Voltage

**Continuous reverse voltage**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_R$</td>
<td>max.</td>
<td>5 V</td>
</tr>
</tbody>
</table>

#### Current

**Forward current (d. c.)**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_F$</td>
<td>max.</td>
<td>130 mA</td>
</tr>
</tbody>
</table>

**Forward current (peak value)**

$t_p \leq 50 \mu s; \delta = 0.05$

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{FM}$</td>
<td>max.</td>
<td>1000 mA</td>
</tr>
</tbody>
</table>

**Non-repetitive peak forward current ($t_p \leq 10 \mu s$)**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{FSM}$</td>
<td>max.</td>
<td>2500 mA</td>
</tr>
</tbody>
</table>

#### Power dissipation

**Total power dissipation up to $T_{amb} = 25^\circ C$**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{tot}$</td>
<td>max.</td>
<td>215 mW</td>
</tr>
</tbody>
</table>

#### Temperatures

**Storage temperature**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{stg}$</td>
<td></td>
<td>-55 to +100 °C</td>
</tr>
</tbody>
</table>

**Junction temperature**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_j$</td>
<td>max.</td>
<td>100 °C</td>
</tr>
</tbody>
</table>

**Lead soldering temperature**

up to the seating plane; $t_{sld} < 10$ s

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{sld}$</td>
<td>max.</td>
<td>260 °C</td>
</tr>
</tbody>
</table>

#### THERMAL RESISTANCE

From junction to ambient

mounted on a printed-circuit board

$R_{th j-a} = 0.35 \, °C/mW$
**CHARACTERISTICS**  

$T_j = 25 \, ^\circ C$ unless otherwise specified

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward voltage</td>
<td></td>
</tr>
<tr>
<td>$I_F = 100 , mA$</td>
<td>$V_F$ typ. $1.4 , V$</td>
</tr>
<tr>
<td>$I_{FM} = 1500 , mA$; $t_p = 20 , \mu s$; $\delta = 0.033$</td>
<td>$V_{FM}$ typ. $2.4 , V$</td>
</tr>
<tr>
<td>Reverse current</td>
<td></td>
</tr>
<tr>
<td>$V_R = 5 , V$</td>
<td>$I_R$ $&lt; 100 , \mu A$</td>
</tr>
<tr>
<td>Diode capacitance</td>
<td></td>
</tr>
<tr>
<td>$V_R = 0$; $f = 1 , MHz$</td>
<td>$C_d$ typ. $40 , pF$</td>
</tr>
<tr>
<td>Total radiant power</td>
<td></td>
</tr>
<tr>
<td>$I_F = 100 , mA$</td>
<td>$\phi_e$ typ. $5 , mW$</td>
</tr>
<tr>
<td>Decrease of radiant power with temperature</td>
<td>$\frac{\Delta \phi_e}{\Delta T_j}$ typ. $1 , %/^\circ C$</td>
</tr>
<tr>
<td>Radiant intensity (on-axis)</td>
<td></td>
</tr>
<tr>
<td>$I_F = 100 , mA$</td>
<td>$I_e$ typ. $7 , mW/sr$</td>
</tr>
<tr>
<td>Wavelength at peak emission</td>
<td></td>
</tr>
<tr>
<td>$I_F = 100 , mA$</td>
<td>$\lambda_{pk}$ typ. $930 , nm$</td>
</tr>
<tr>
<td>Bandwidth at half height</td>
<td></td>
</tr>
<tr>
<td>$I_F = 100 , mA$</td>
<td>$\beta_{50%}$ typ. $50 , nm$</td>
</tr>
<tr>
<td>Beamwidth between half-intensity directions</td>
<td>$\alpha_{50%}$ typ. $30^\circ$</td>
</tr>
</tbody>
</table>
GaP GREEN LIGHT EMITTING DIODE

Gallium phosphide light emitting diode which emits green light when forward biased. Green, light-diffusing plastic envelope.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max. 3 V</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td>$I_F$ max. 20 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 55 , ^\circ C$</td>
<td>$P_{tot}$ max. 60 mW</td>
</tr>
<tr>
<td>Luminous intensity (on-axis) at $I_F = 10 , mA$</td>
<td>$I_V$ CQY94 max. 0,3 mcd</td>
</tr>
<tr>
<td></td>
<td>CQY94-I $I_V$ typ. 0,7 to 1,6 mcd</td>
</tr>
<tr>
<td></td>
<td>CQY94-II $I_V$ typ. 1,0 to 2,2 mcd</td>
</tr>
<tr>
<td></td>
<td>CQY94-III $I_V$ typ. &gt; 1,6 mcd</td>
</tr>
<tr>
<td>Wavelength at peak emission</td>
<td>$\lambda_{pk}$ typ. 560 nm</td>
</tr>
<tr>
<td>Beamwidth between half-intensity directions</td>
<td>$\alpha_{50%}$ typ. 60°</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOD-63.

Dimensions in mm
CQY94

RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Continuous reverse voltage
\[ V_R \text{ max.} = 3 \text{ V} \]

Forward current (d.c.)
\[ I_F \text{ max.} = 20 \text{ mA} \]

Forward current (peak value)
\[ I_{FM} \text{ max.} = 60 \text{ mA} \]
\[ I_{FM} \text{ max.} = 1000 \text{ mA} \]

Total power dissipation up to \( T_{amb} = 55 \text{ °C} \)
\[ P_{tot} \text{ max.} = 60 \text{ mW} \]

Storage temperature
\[ T_{stg} \text{ max.} = 100 \text{ °C} \]

Junction temperature
\[ T_j = -55 \text{ to } +100 \text{ °C} \]

Lead soldering temperature
\[ T_{slld} \text{ max.} = 230 \text{ °C} \]

THERMAL RESISTANCE

From junction to ambient
\[ R_{th j-a} = 0,75 \text{ °C/mW} \]
\[ R_{th j-a} = 0,5 \text{ °C/mW} \]

in free air

mounted on a printed-circuit board

CHARACTERISTICS

\( T_j = 25 \text{ °C} \) unless otherwise specified

Forward voltage
\[ I_F = 10 \text{ mA} \]
\[ V_F \text{ typ.} = 2,1 \text{ V} \]
\[ V_F < 3 \text{ V} \]

Reverse current
\[ V_R = 3 \text{ V} \]
\[ I_R < 100 \text{ μA} \]

Diode capacitance
\[ V_R = 0; f = 1 \text{ MHz} \]
\[ C_d \text{ typ.} = 35 \text{ pF} \]

Diode luminous intensity (on-axis)
\[ I_F = 10 \text{ mA} \]
\[ CQY94 \]
\[ I_v > 0,3 \text{ mcd} \]
\[ CQY94-I \]
\[ I_v = 0,7 \text{ to } 1,6 \text{ mcd} \]
\[ CQY94-II \]
\[ I_v = 1,0 \text{ to } 2,2 \text{ mcd} \]
\[ CQY94-III \]
\[ I_v > 1,6 \text{ mcd} \]

Wavelength at peak emission
\[ \lambda_{pk} \text{ typ.} = 560 \text{ nm} \]

Bandwidth at half height
\[ B_{50\%} \text{ typ.} = 30 \text{ nm} \]

Beamwidth between half-intensity directions
\[ \alpha_{50\%} \text{ typ.} = 60^\circ \]
GaP GREEN LIGHT EMITTING DIODE

Gallium phosphide light emitting diode which emits green light when forward biased. Green, light-diffusing plastic envelope.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max. 3 V</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td>$I_F$ max. 20 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 55^\circ C$</td>
<td>$P_{tot}$ max. 60 mW</td>
</tr>
<tr>
<td>Luminous intensity (on-axis) at $I_F = 10$ mA</td>
<td>$I_V$ &gt; 0.3 mcd</td>
</tr>
<tr>
<td></td>
<td>$I_V$ 0.7 to 1.6 mcd</td>
</tr>
<tr>
<td></td>
<td>$I_V$ 1.0 to 2.2 mcd</td>
</tr>
<tr>
<td></td>
<td>$I_V$ &gt; 1.6 mcd</td>
</tr>
<tr>
<td>Wavelength at peak emission</td>
<td>$\lambda_{pk}$ typ. 560 nm</td>
</tr>
<tr>
<td>Beamwidth between half-intensity directions</td>
<td>$\alpha_{50%}$ typ. 60°</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOD-53C.
RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Continuous reverse voltage
\[ V_R = 3 \, \text{V} \]

Forward current (d.c.)
\[ I_F = 20 \, \text{mA} \]

Forward current (peak value)
\[ I_{FM} = 60 \, \text{mA} \]
\[ I_{FM} = 1000 \, \text{mA} \]

Total power dissipation up to \( T_{amb} = 55 \, ^\circ\text{C} \)
\[ P_{tot} = 60 \, \text{mW} \]

Storage temperature
\[ T_{stg} = \text{from } -55 \text{ to } +100 \, ^\circ\text{C} \]

Junction temperature
\[ T_j = 100 \, ^\circ\text{C} \]

Lead soldering temperature
\[ T_{slid} = 230 \, ^\circ\text{C} \]

THERMAL RESISTANCE

From junction to ambient
\[ R_{th\,j-a} = 0.75 \, ^\circ\text{C/mW} \]
\[ R_{th\,j-a} = 0.5 \, ^\circ\text{C/mW} \]

CHARACTERISTICS

\( T_j = 25 \, ^\circ\text{C} \) unless otherwise specified

Forward voltage
\[ I_F = 10 \, \text{mA} \]
\[ V_F = 2.1 \, \text{V} \]

Reverse current
\[ I_R < 100 \, \mu\text{A} \]

Diode capacitance
\[ V_R = 3 \, \text{V} \]
\[ C_d = 35 \, \text{pF} \]

Luminous intensity (on-axis)
\[ I_F = 10 \, \text{mA} \]
\[ \text{CQY95} \quad I_v > 0.3 \, \text{mcd} \]
\[ \text{CQY95-I} \quad I_v \quad 0.7 \text{ to } 1.6 \, \text{mcd} \]
\[ \text{CQY95-II} \quad I_v \quad 1.0 \text{ to } 2.2 \, \text{mcd} \]
\[ \text{CQY95-III} \quad I_v \quad > 1.6 \, \text{mcd} \]

Wavelength at peak emission
\[ \lambda_{pk} = 560 \, \text{nm} \]

Bandwidth at half height
\[ B_{50\%} = 30 \, \text{nm} \]

Beamwidth between half-intensity directions
\[ \alpha_{50\%} = 60^\circ \]
GaP green light emitting diode

$I_F$ (mA)

$V_F$ (V)

Typ.

$T_J = 25 \, ^\circ\text{C}$

$I_{F\text{M}}$ (mA)

$V_{FM}$ (V)

Typ.

$T_J = 25 \, ^\circ\text{C}$

Typ. values

$T_J$ (°C)

$I_F$ = 20 mA

$I_F$ = 10 mA

$I_F$ = 5 mA

$I_{V\text{AV}}$ (µcd)

Typ.

$T_J = 25 \, ^\circ\text{C}$

$I_{F\text{AV}}$ (mA)

Typ. values

$T_J = 25 \, ^\circ\text{C}$

June 1978
GaAsP YELLOW LIGHT EMITTING DIODE

Gallium arsenide phosphide light emitting diode which emits yellow light when forward biased. Yellow, light-diffusing plastic envelope.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage V_R max.</td>
<td>3 V</td>
</tr>
<tr>
<td>Forward current (d.c.) I_F max.</td>
<td>20 mA</td>
</tr>
<tr>
<td>Total power dissipation up to T_amb = 55 °C</td>
<td></td>
</tr>
<tr>
<td>Luminous intensity (on-axis) at I_F = 10 mA</td>
<td></td>
</tr>
<tr>
<td>COY96</td>
<td>I_V &gt; 0,5 mcd</td>
</tr>
<tr>
<td>COY96-I</td>
<td>0,7 to 1,6 mcd</td>
</tr>
<tr>
<td>COY96-II</td>
<td>1,0 to 2,2 mcd</td>
</tr>
<tr>
<td>COY96-III</td>
<td>&gt; 1,6 mcd</td>
</tr>
<tr>
<td>Luminous intensity at I_F = 10 mA</td>
<td></td>
</tr>
<tr>
<td>Wavelength at peak emission ( \lambda_{pk} )</td>
<td>typ. 590 nm</td>
</tr>
<tr>
<td>Beamwidth between half-intensity directions</td>
<td>typ. 60°</td>
</tr>
<tr>
<td>a_50%</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOD-63.

Dimensions in mm

June 1978
CQY96

RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)
Continuous reverse voltage \( V_R \) max. 3 V
Forward current (d.c.) \( I_F \) max. 20 mA
Forward current (peak value)
\( \tau_p < 1 \text{ ms}; f < 300 \text{ Hz} \)
\( \tau_p < 1 \mu \text{s}; f < 300 \text{ Hz} \)
Total power dissipation up to \( T_{\text{amb}} = 55 \text{ °C} \)
Storage temperature
Junction temperature
Lead soldering temperature
> 1,5 mm from the seating plane; \( t_{\text{sld}} < 7 \text{ s} \)

THERMAL RESISTANCE
From junction to ambient in free air \( R_{\text{th j-a}} = 0,75 \text{ °C/mW} \)
mounted on a printed board \( R_{\text{th j-a}} = 0,5 \text{ °C/mW} \)

CHARACTERISTICS
\( T_j = 25 \text{ °C} \) unless otherwise specified
Forward voltage
\( I_F = 10 \text{ mA} \)
\( V_F \) typ. 2,1 V < 3 V
Reverse current
\( V_R = 3 \text{ V} \)
\( I_R \) < 100 \( \mu \text{A} \)
Diode capacitance
\( V_R = 0; f = 1 \text{ MHz} \)
\( C_d \) typ. 35 pF
Luminous intensity (on-axis)
\( I_F = 10 \text{ mA} \)
\( I_v \) typ. CQY96 0,5 mcd
CQY96-I 0,7 to 1,6 mcd
CQY96-II 1,0 to 2,2 mcd
CQY96-III > 1,6 mcd
Wavelength at peak emission
\( \lambda_{pk} \) typ. 590 nm
Bandwidth at half height
\( B_{50\%} \) typ. 38 nm
Beamwidth between half-intensity directions
\( \alpha_{50\%} \) typ. 60°
GaAsP yellow light emitting diode

1. **Typical Values**

   - $I_F = 20$ mA
   - $10$ mA
   - $5$ mA

2. **Typical Values**

   - $V_F = 2.3$ V
   - $2.2$ V
   - $2.1$ V
   - $2$ V
   - $1.9$ V

3. **Typical Values**

   - $I_{F(MV)}$ (mA)
   - $V_{F(MV)}$ (V)

4. **Typical Values**

   - $I_{F(AV)}$ (μcd)
   - $I_{F(AV)}$ (mA)

5. **Typical Values**

   - $T_j = 25^\circ C$
   - $t_{p} = 50 \mu s$
   - $T = 5 \text{ ms}$

---

June 1978
GaAsP YELLOW LIGHT EMITTING DIODE

Gallium arsenide phosphide light emitting diode which emits yellow light when forward biased. Yellow, light-diffusing plastic envelope.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max. 3 V</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td>$I_F$ max. 20 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 55 , ^\circ C$</td>
<td>$P_{tot}$ max. 60 mW</td>
</tr>
<tr>
<td>Luminous intensity (on-axis) at $I_F = 10$ mA</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>CQY97</strong></td>
</tr>
<tr>
<td></td>
<td>$I_V$ $&gt; 0.3$ mcd</td>
</tr>
<tr>
<td></td>
<td><strong>CQY97-I</strong></td>
</tr>
<tr>
<td></td>
<td>$I_V$ 0.7 to 1.6 mcd</td>
</tr>
<tr>
<td></td>
<td><strong>CQY97-II</strong></td>
</tr>
<tr>
<td></td>
<td>$I_V$ 1.0 to 2.2 mcd</td>
</tr>
<tr>
<td></td>
<td><strong>CQY97-III</strong></td>
</tr>
<tr>
<td></td>
<td>$I_V$ $&gt; 1.6$ mcd</td>
</tr>
<tr>
<td>Wavelength at peak emission</td>
<td>$\lambda_{pk}$ typ. 590 nm</td>
</tr>
<tr>
<td>Beamwidth between half-intensity directions</td>
<td>$\alpha_{50%}$ typ. 60$^\circ$</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig. 1 SOD-53C. Dimensions in mm

![Diagram of the diode with dimensions and symbols]
**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>( V_R )</td>
<td>max. 3 V</td>
<td></td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td>( I_F )</td>
<td>max. 20 mA</td>
<td></td>
</tr>
<tr>
<td>Forward current (peak value)</td>
<td>( I_{FM} )</td>
<td>max. 60 mA</td>
<td>max. 1000 mA</td>
</tr>
<tr>
<td>( t_D &lt; 1 ) ms; ( f &lt; 300 ) Hz</td>
<td>( I_{FM} )</td>
<td>max. 60 mA</td>
<td></td>
</tr>
<tr>
<td>( t_p &lt; 1 ) µs; ( f &lt; 300 ) Hz</td>
<td>( P_{tot} )</td>
<td>max. 60 mW</td>
<td></td>
</tr>
<tr>
<td>Total power dissipation up to ( T_{amb} = 55 ) °C</td>
<td>( T_{stg} )</td>
<td>-55 to +100 °C</td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>( T_j )</td>
<td>max. 100 °C</td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>( T_{sld} )</td>
<td>max. 230 °C</td>
<td></td>
</tr>
<tr>
<td>Lead soldering temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 3 mm from the seating plane; ( t_{sld} &lt; 7 ) s</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**THERMAL RESISTANCE**

From junction to ambient
- in free air
- mounted on a printed board

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( R_{th \ j-a} )</td>
<td>0,75 °C/mW</td>
</tr>
<tr>
<td></td>
<td>( R_{th \ j-a} )</td>
<td>0,5 °C/mW</td>
</tr>
</tbody>
</table>

**CHARACTERISTICS**

\( T_j = 25 \) °C unless otherwise specified

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward voltage</td>
<td>( V_F )</td>
</tr>
<tr>
<td></td>
<td>( I_F = 10 ) mA</td>
</tr>
<tr>
<td>Reverse current</td>
<td>( I_R )</td>
</tr>
<tr>
<td></td>
<td>( V_R = 3 ) V</td>
</tr>
<tr>
<td>Diode capacitance</td>
<td>( C_d )</td>
</tr>
<tr>
<td></td>
<td>( V_R = 0; f = 1 ) MHz</td>
</tr>
<tr>
<td>Luminous intensity (on-axis)</td>
<td>( I_F = 10 ) mA</td>
</tr>
<tr>
<td>CDY97</td>
<td>( I_Y )</td>
</tr>
<tr>
<td>CDY97-I</td>
<td>( I_Y )</td>
</tr>
<tr>
<td>CDY97-II</td>
<td>( I_Y )</td>
</tr>
<tr>
<td>CDY97-III</td>
<td>( I_Y )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength at peak emission</td>
<td>( \lambda_{pk} )</td>
</tr>
<tr>
<td>Bandwidth at half height</td>
<td>( B_{50%} )</td>
</tr>
<tr>
<td>Beamwidth between half-intensity directions</td>
<td>( \alpha_{50%} )</td>
</tr>
</tbody>
</table>
GaAsP yellow light emitting diode

**Graph 1:**
- **Label:** $T_j = 25 \, ^\circ\text{C}$
- **X-axis:** $V_F (\text{V})$
- **Y-axis:** $I_F (\text{mA})$
- **Typical values:** $I_F = 20 \, \text{mA}$

**Graph 2:**
- **Label:** $T_j = 25 \, ^\circ\text{C}$
- **X-axis:** $V_{FM} (\text{V})$
- **Y-axis:** $I_{FM} (\text{mA})$
- **Typical values:**
  - $V_{FM} = 2.1 \, \text{V}$
  - $I_{FM} = 20 \, \text{mA}$

**Graph 3:**
- **Label:** typ. values
- **X-axis:** $T_j (\text{\degree C})$
- **Y-axis:** $I_v(\text{AV}) (\mu\text{cd})$
- **Typical values:**
  - $I_v(\text{AV}) = 5 \, \mu\text{cd}$
  - $T_j = 25 \, ^\circ\text{C}$

**Graph 4:**
- **Label:** typ. values
- **X-axis:** $I_F(\text{AV}) (\text{mA})$
- **Y-axis:** $I_v(\text{AV}) (\mu\text{cd})$
- **Typical values:**
  - $I_v(\text{AV}) = 5 \, \mu\text{cd}$
  - $I_F(\text{AV}) = 10 \, \text{mA}$
  - $T_j = 25 \, ^\circ\text{C}$
PHOTOCOUPLECTERS

Optically coupled isolators consisting of an infrared emitting GaAs diode and a silicon n-p-n phototransistor. Plastic envelopes. Suitable for TTL integrated circuits. The CNY22 is the 5 pin version with an accessible transistor base; the CNY42 is the 4 pin version without accessible base.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diode</strong></td>
</tr>
<tr>
<td>Reverse voltage</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
</tr>
<tr>
<td>Forward current (peak value)</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 65^\circ C$</td>
</tr>
<tr>
<td><strong>Transistor</strong></td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
</tr>
<tr>
<td>Collector cut-off current (dark)</td>
</tr>
<tr>
<td>$V_{CE} = 10 \text{ V}; \text{diode}: I_F = 0$</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25^\circ C$</td>
</tr>
<tr>
<td><strong>Photocoupler</strong></td>
</tr>
<tr>
<td>Output/input d.c. current transfer ratio</td>
</tr>
<tr>
<td>$I_F = 8 \text{ mA}; V_{CE} = 5 \text{ V}; (I_B = 0)$</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
</tr>
<tr>
<td>$I_F = 8 \text{ mA}; I_C = 2 \text{ mA}; (I_B = 0)$</td>
</tr>
<tr>
<td>Isolation voltage, r.m.s. value</td>
</tr>
</tbody>
</table>

MECHANICAL DATA See page 2.
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Diode
Reverse voltage
Forward current (d. c.)
Forward current (peak value)
Total power dissipation up to $T_{\text{amb}} = 65\,^\circ\text{C}$
Junction temperature

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse voltage</td>
<td>$V_R$</td>
<td>2 V</td>
</tr>
<tr>
<td>Forward current (d. c.)</td>
<td>$I_F$</td>
<td>30 mA</td>
</tr>
<tr>
<td>Forward current (peak value)</td>
<td>$I_{FM}$</td>
<td>200 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{\text{amb}} = 65,^\circ\text{C}$</td>
<td>$P_{\text{tot}}$</td>
<td>50 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$</td>
<td>125 °C</td>
</tr>
</tbody>
</table>

Transistor
Collector-emitter voltage (open base)
Collector-base voltage (open emitter) (CNY22)
Emitter-collector voltage (open base)
Collector current (d. c.)
Total power dissipation up to $T_{\text{amb}} = 25\,^\circ\text{C}$
Junction temperature

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$V_{CEO}$</td>
<td>50 V</td>
</tr>
<tr>
<td>Collector-base voltage (open emitter) (CNY22)</td>
<td>$V_{CBO}$</td>
<td>50 V</td>
</tr>
<tr>
<td>Emitter-collector voltage (open base)</td>
<td>$V_{ECO}$</td>
<td>6 V</td>
</tr>
<tr>
<td>Collector current (d. c.)</td>
<td>$I_C$</td>
<td>30 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{\text{amb}} = 25,^\circ\text{C}$</td>
<td>$P_{\text{tot}}$</td>
<td>200 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$</td>
<td>125 °C</td>
</tr>
</tbody>
</table>

Photocoupler
Storage temperature

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{\text{stg}}$</td>
<td>-55 to +125 °C</td>
</tr>
</tbody>
</table>

THERMAL RESISTANCE
From junction to ambient in free air
-diode
-transistor

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal resistance (diode)</td>
<td>$R_{\text{th j-a}}$</td>
<td>1.2 °C/mW</td>
</tr>
<tr>
<td>Thermal resistance (transistor)</td>
<td>$R_{\text{th j-a}}$</td>
<td>0.5 °C/mW</td>
</tr>
</tbody>
</table>

September 1974
CHARACTERISTICS

Diode
Forward voltage, $I_F = 8 \text{ mA}$
Reverse current, $V_R = 2 \text{ V}$

Transistor ($I_B = 0$)
Collector cut-off current (dark)
$V_{CE} = 10 \text{ V}$; diode: $I_F = 0$

Photocoupler ($I_B = 0$) 1)
Output/input d.c. current transfer ratio
$I_F = 8 \text{ mA}$; $V_{CE} = 5 \text{ V}$
Collector-emitter saturation voltage
$I_F = 8 \text{ mA}$; $I_C = 2 \text{ mA}$; $T_{amb} = 25 \degree \text{C}$
Isolation voltage, r.m.s. value
Capacitance between input and output
$V_I = 0$; $V = 0$; $f = 1 \text{ MHz}$
Insulation resistance between input and output
$V_{IO} = 1000 \text{ V}$
Turn-on time (circuit below)
$I_{CM} = 2 \text{ mA}$; $V_{CC} = 5 \text{ V}$; $R_L = 100 \Omega$
Turn-off time (circuit below)
$I_{CM} = 2 \text{ mA}$; $V_{CC} = 5 \text{ V}$; $R_L = 100 \Omega$

Data on $V_I$:
$t_r = t_f = 20 \text{ ns}$
$t_P = 30 \mu s$
$f = 500 \text{ Hz}$

$T_j = 25 \degree \text{C}$ unless otherwise specified

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_F$</td>
<td>1, 2 V</td>
<td>typ.</td>
</tr>
<tr>
<td>$I_R$</td>
<td>$&lt; 1, 6 \mu \text{A}$</td>
<td></td>
</tr>
<tr>
<td>$I_{CEO}$</td>
<td>$&lt; 100 \text{nA}$</td>
<td>typ. 5 nA</td>
</tr>
<tr>
<td>$I_{C/I_F}$</td>
<td>$&gt; 0, 25$</td>
<td>typ. 0, 5</td>
</tr>
<tr>
<td>$V_{CEsat}$</td>
<td>$&lt; 0, 17 \text{ V}$</td>
<td></td>
</tr>
<tr>
<td>$V_{IO(RMS)}$</td>
<td>$&gt; 2800$</td>
<td>V</td>
</tr>
<tr>
<td>$C_{io}$</td>
<td>$1 \text{ pF}$</td>
<td></td>
</tr>
<tr>
<td>$r_{IO}$</td>
<td>$&gt; 1010 \Omega$</td>
<td>typ. $1012 \Omega$</td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>5 \mu s</td>
<td>typ.</td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>5 \mu s</td>
<td></td>
</tr>
</tbody>
</table>

1) Where the phototransistor receives light from the diode the O (for open base) has been omitted from the symbols.
2) Measured with pulses: $t_P = 100 \mu s$; $T = 1 \text{ ms}$.
3) Aging of the light-emitting diode decreases the transfer ratio at a rate proportional to current and operating time. In circuits that operate for long periods, therefore, the duty factor of the couplers should be kept as low as possible. This can often be done with the aid of an inverter.
4) Tested with a 50 Hz a.c. voltage for 1 minute between shorted input leads and shorted output leads.

---

CNY22
CNY42

October 1973
$T_j = 25^\circ C$ ($I_B = 0$)
Pulses $t_p = 100 \mu s$

Typ. values

$I_F = 20 \ mA$

$V_{CE} = 0.4 \ V$ ($I_B = 0$)
$T_{amb} = 25^\circ C$

Continuous current

$V_{CE} = 5 \ V$ ($I_B = 0$)
$T_j = 25^\circ C$
Pulses $t_p = 100 \mu s$

Typ.
$I_{C25} =$ typ. value at $T_{amb} = 25 \, ^\circ C$

for $V_{CE} = 0.4 \, V$ and $5 \, V$

$I_F = 8 \, mA$ ($I_B = 0$)

$V_{CER}$ at $T_{amb} = T_{CER}$

$I_F = 8 \, mA$

$I_C = 2 \, mA$ ($I_B = 0$)

Typical values
PHOTOCOUPLERS

Optically coupled isolators consisting of an infrared emitting GaAs diode and a silicon n-p-n phototransistor. Plastic envelopes. Suitable for TTL integrated circuits. The CNY23 is the 5 pin version with an accessible transistor base; the CNY43 is the 4 pin version without accessible base.

### QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Diode</th>
<th>Reverse voltage</th>
<th>$V_R$</th>
<th>max.</th>
<th>2 V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Forward current (d.c.)</td>
<td>$I_F$</td>
<td>max.</td>
<td>30 mA</td>
</tr>
<tr>
<td></td>
<td>Forward current (peak value)</td>
<td>$I_{FM}$</td>
<td>max.</td>
<td>200 mA</td>
</tr>
<tr>
<td></td>
<td>Total power dissipation up to $T_{amb} = 65 , ^\circ C$</td>
<td>$P_{tot}$</td>
<td>max.</td>
<td>50 mW</td>
</tr>
</tbody>
</table>

| Transistor | Collector-emitter voltage (open base) | $V_{CEO}$ | max. | 30 V |
|            | Collector cut-off current (dark) | $I_{CEO}$ | < | 100 nA |
|            | $V_{CE} = 10 \, V$; diode: $I_F = 0$ | $P_{tot}$ | max. | 200 mW |
|            | Total power dissipation up to $T_{amb} = 25 \, ^\circ C$ | |

| Photocoupler | Output/input d.c. current transfer ratio | $I_C / I_F$ | > | 0.5 |
|             | $I_F = 8 \, mA$; $V_{CE} = 5 \, V$; ($I_B = 0$) | |
|             | Collector-emitter saturation voltage | $V_{CEsat}$ | < | 0.4 V |
|             | $I_F = 8 \, mA$; $I_C = 4 \, mA$; ($I_B = 0$) | |
|             | Isolation voltage, r.m.s. value | $V_{IO(RMS)}$ | > | 2000 V |

**MECHANICAL DATA**  See page 2.
MECHANICAL DATA

CNY23

Dimensions in mm

CNY43
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

Diode
- Reverse voltage
- Forward current (d.c.)
- Forward current (peak value)
- Total power dissipation up to $T_{amb} = 65 \, ^\circ C$
- Junction temperature

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse voltage</td>
<td>$V_R$</td>
<td>2 V</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td>$I_F$</td>
<td>30 mA</td>
</tr>
<tr>
<td>Forward current (peak value)</td>
<td>$I_{FM}$</td>
<td>200 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 65 , ^\circ C$</td>
<td>$P_{tot}$</td>
<td>50 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$</td>
<td>125 , ^\circ C</td>
</tr>
</tbody>
</table>

Transistor
- Collector-emitter voltage (open base)
- Collector-base voltage (open emitter) (CNY23)
- Emitter-collector voltage (open base)
- Collector current (d.c.)
- Total power dissipation up to $T_{amb} = 25 \, ^\circ C$
- Junction temperature

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$V_{CEO}$</td>
<td>30 V</td>
</tr>
<tr>
<td>Collector-base voltage (open emitter) (CNY23)</td>
<td>$V_{CBO}$</td>
<td>40 V</td>
</tr>
<tr>
<td>Emitter-collector voltage (open base)</td>
<td>$V_{ECO}$</td>
<td>6 V</td>
</tr>
<tr>
<td>Collector current (d.c.)</td>
<td>$I_C$</td>
<td>30 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25 , ^\circ C$</td>
<td>$P_{tot}$</td>
<td>200 mW</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$</td>
<td>125 , ^\circ C</td>
</tr>
</tbody>
</table>

Photocoupler
- Storage temperature

THERMAL RESISTANCE
- From junction to ambient in free air
  - diode
  - transistor

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal resistance from junction to ambient in free air</td>
<td>$R_{th , j-a}$</td>
<td>1.2 , ^\circ C/mW</td>
</tr>
<tr>
<td></td>
<td>$R_{th , j-a}$</td>
<td>0.5 , ^\circ C/mW</td>
</tr>
</tbody>
</table>

September 1974
CHARACTERISTICS

Diode
Forward voltage, $I_F = 8 \text{ mA}$
Reverse current, $V_R = 2 \text{ V}$

Transistor ($I_B = 0$)
Collector cut-off current (dark)
$V_{CE} = 10 \text{ V}; \text{diode: } I_F = 0$

Photocoupler ($I_B = 0$) 1)
Output/input d.c. current transfer ratio
$I_F = 8 \text{ mA}; \ V_{CE} = 5 \text{ V}$
Collector-emitter saturation voltage
$I_F = 8 \text{ mA}; \ IC = 4 \text{ mA}; \ T_{amb} = 25 \text{ °C}$
Isolation voltage, r.m.s. value
Capacitance between input and output
$I_F = 0; \ V = 0; \ f = 1 \text{ MHz}$
Insulation resistance between input and output
$V_{IO} = 1000 \text{ V}$

Turn-on time (circuit below)
$I_{CM} = 4 \text{ mA}; \ V_{CC} = 5 \text{ V}; \ R_L = 100 \Omega$

Turn-off time (circuit below)
$I_{CM} = 4 \text{ mA}; \ V_{CC} = 5 \text{ V}; \ R_L = 100 \Omega$

Data on $V_T$
$t_p = t_f = 20 \text{ ns}$
$t_p = 30 \mu\text{s}$
$f = 500 \text{ Hz}$

1) Where the phototransistor receives light from the diode the O (for open base) has been omitted from the symbols.
2) Measured with pulses: $t_p = 100 \mu\text{s}; \ T = 1 \text{ ms}$.
3) Aging of the light-emitting diode decreases the transfer ratio at a rate proportional to current and operating time. In circuits that operate for long periods, therefore, the duty factor of the couplers should be kept as low as possible. This can often be done with the aid of an inverter.
4) Tested with a 50 Hz a.c. voltage for 1 minute between shorted input leads and shorted output leads.

$T_j = 25 \text{ °C}$ unless otherwise specified

$V_F \ \text{typ.} \ 1,2 \ \text{V}$
$V_R \ < \ 1,6 \ \text{V}$
$I_R \ < \ 100 \ \mu\text{A}$
$I_{CEO} \ < \ 100 \ \text{nA}$
$I_{CM} \ > \ 0,5 \ \text{mA}$
$I_C/I_F \ \text{typ.} \ 1 \ 2) 3)$
$V_{CESat} \ < \ 0,4 \ \text{V}$
$V_{IO(RMS)} \ > \ 2000 \ \text{V}$
$C_{io} \ \text{typ.} \ 1 \ \text{pF}$
$r_{IO} \ > \ 10^{10} \ \Omega$
$t_{on} \ \text{typ.} \ 5 \ \mu\text{s}$
$t_{off} \ \text{typ.} \ 5 \ \mu\text{s}$
$I_{CEO}$

$V_{CE} = 10 \text{ V}$

$I_F = 0$

$max$

(typ)
Ie (mA)

VCE (V)

Tj = 25 °C (Ib = 0)
pulses tp = 100 μs
T = 1 ms

Ic (mA)

IF (mA)

VCE = 0.4 V (Ib = 0)
Tamb = 25 °C
continuous current

typ

VCE = 5 V (Ib = 0)
Tj = 25 °C
pulses tp = 100 μs
T = 1 ms

typ
I_C(\text{T}) / I_C25 (%)

I_C25 = typ. value at T_{amb} = 25 \degree C
for V_{CE} = 0.4 V and 5 V
I_F = 8 mA (I_B = 0)

V_{CE\text{sat}} (mV)

I_F = 8 mA
I_C = 4 mA
(I_B = 0)
PHOTOCOUPLE

Optically coupled isolater consisting of an infra-red emitting GaAs diode and a silicon n-p-n phototransistor. TO-12 envelope. Suitable for TTL integrated circuits.

### QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diode</strong></td>
<td>Continuous reverse voltage</td>
<td>$V_R$ max.</td>
</tr>
<tr>
<td></td>
<td>Forward current (d.c.)</td>
<td>$I_F$ max.</td>
</tr>
<tr>
<td></td>
<td>Forward current (peak value)</td>
<td>$I_{FM}$ max.</td>
</tr>
<tr>
<td></td>
<td>Total power dissipation up to $T_{amb} = 100, ^\circ C$</td>
<td>$P_{tot}$ max.</td>
</tr>
<tr>
<td><strong>Transistor</strong></td>
<td>Collector-emitter voltage (open base)</td>
<td>$V_{CEO}$ max.</td>
</tr>
<tr>
<td></td>
<td>Collector cut-off current (dark)</td>
<td>$I_{CEO}$</td>
</tr>
<tr>
<td></td>
<td>$V_{CE} = 15, V$; diode: $I_F = 0$</td>
<td>$I_C/I_F$ &gt;</td>
</tr>
<tr>
<td></td>
<td>Total power dissipation up to $T_{amb} = 25, ^\circ C$</td>
<td>$P_{tot}$ max.</td>
</tr>
<tr>
<td><strong>Photocoupler</strong></td>
<td>Output/input d.c. current transfer ratio</td>
<td>$I_C/I_F$</td>
</tr>
<tr>
<td></td>
<td>$I_F = 10, mA$; $V_{CE} = 10, V$</td>
<td>$I_{CEsat}$ &lt;</td>
</tr>
<tr>
<td></td>
<td>Collector-emitter saturation voltage</td>
<td>$V_{CEsat}$ &gt;</td>
</tr>
<tr>
<td></td>
<td>$I_F = 10, mA$; $I_C = 3, mA$</td>
<td>$V_{IO(RMS)}$</td>
</tr>
<tr>
<td></td>
<td>Isolation voltage, r.m.s. value</td>
<td>Dimensions in mm</td>
</tr>
</tbody>
</table>

### MECHANICAL DATA

**TO-12**

- **Dimensions in mm**

Cathode (2) connected to case

Max. lead diameter is guaranteed only for 12.7 mm.

September 1974
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Diode
Continuous reverse voltage
Forward current (d.c.)
Forward current (peak value)
Total power dissipation up to $T_{amb} = 100 \, ^\circ C$
Junction temperature

Transistor
Collector-emitter voltage (open base)
Emitter-collector voltage (open base)
Collector current (d.c.)
Collector current (peak value)
Total power dissipation up to $T_{amb} = 25 \, ^\circ C$
Junction temperature

Photocoupler
Storage temperature
Solder temperature ($t < 10 \, s$)

THERMAL RESISTANCE
From junction to ambient in free air
- diode
- transistor
From junction to case, diode
CHARACTERISTICS

**Diode**

Forward voltage, \( I_F = 10 \text{ mA} \)

\[ V_F \text{ typ. } 1 \text{ to } 1.5 \text{ V} \]

\[ V_F \text{ typ. } 1.2 \text{ V} \]

\[ V_F \text{ typ. } 1.3 \text{ V} \]

\[ V_F \text{ typ. } 1.6 \text{ V} \]

\[ V_F \text{ typ. } 1.5 \text{ V} \]

Reverse current, \( V_R = 3 \text{ V} \)

\[ I_R < 20 \mu\text{A} \]

Diode capacitance, \( f = 1 \text{ MHz}; V = 0 \)

\[ C_d \text{ typ. } 50 \text{ pF} \]

**Transistor**

Collector cut-off current (dark) at \( I_F = 0 \)

\[ V_C = 5 \text{ V} \]

\[ V_C = 15 \text{ V} \]

\[ V_C = 15 \text{ V}; T_j = 85 \text{ °C} \]

\[ I_{CEO} \text{ typ. } 3 \text{ nA} \]

\[ I_{CEO} \text{ typ. } 10 \text{ nA} \]

\[ I_{CEO} \text{ typ. } 100 \text{ nA} \]

**Photocoupler**

Output/input d.c. current transfer ratio

\[ I_F = 10 \text{ mA}; V_C = 10 \text{ V} \]

\[ t_p = 80 \mu\text{s}; T = 10 \text{ ms} \]

\[ I_C/I_F > 0.3 \]

\[ I_C/I_F > 0.6 \]  

Collector-emitter saturation voltage

\[ I_F = 10 \text{ mA}; I_C = 3 \text{ mA}; T_{amb} = 25 \text{ °C} \]

\[ V_{CESat} < 0.4 \text{ V} \]

\[ V_{CESat} < 0.4 \text{ V} \]

Forward voltage

for \( I_C = 10 \mu\text{A}; V_C = 10 \text{ V} \)

\[ V_F > 0.9 \text{ V} \]

\[ V_F > 1.0 \text{ V} \]

Isolation voltage, r.m.s. value

\[ V_{IO(RMS)} > 1000 \text{ V} \]

\[ r_{IO} > 10^{10} \text{ } \Omega \]

\[ r_{IO} > 10^{11} \text{ } \Omega \]

---

1) Where the phototransistor receives light from the diode, the O (for open base) has been omitted from the symbols.

2) Aging of the light-emitting diode reduces the transfer ratio at a rate proportional to current and operating time. In circuits that operate for long periods, therefore, the duty factor of the couplers should be kept as low as possible. This can often be done with the aid of an inverter.

3) Tested with a 50 Hz a.c. voltage for 1 minute between shorted input leads and shorted output leads.
CHARACTERISTICS (continued)

Rise time of output voltage (circuit below)
$I_{CM} = 2 \text{ mA}; V_{CC} = 10 \text{ V}$

Fall time of output voltage (circuit below)
$I_{CM} = 2 \text{ mA}; V_{CC} = 10 \text{ V}$

$T_j = 25 ^\circ\text{C unless otherwise specified}$

$t_r$ typ. $2 \mu\text{s}$ 1) 

$t_f$ typ. $2 \mu\text{s}$ 1)

Data on $V_I$:
$t_r = t_f = 20 \text{ ns}$ 1)

$t_p = 30 \mu\text{s}$

$f = 500 \text{ Hz}$

---

1) Between the 10% and 90% of the edges.
$I_C = 10 \text{ mA}$
$T_J = 25 \degree \text{C}$
pulses $t_p = 80 \mu\text{s}$
$T = 10 \text{ ms}$

$I_C(T)$

$I_C = \text{typ. value}$

$V_{CE} = 10 \text{ V}$

$T_{amb} = 25 \degree \text{C}$

$I_F = 10 \text{ mA}$

$RL = 1000 \Omega$

$500$

$100$

$V_{ac}$

$0$

$25$

$50$

$75$

$100$

$10^3$

$10^4$

$10^5$

$10^6$

$f (\text{Hz})$

$470 \Omega$

$10 \mu\text{F}$

$2k\Omega$

$V_{ac}$

April 1973
Circuit see graph \( V_{ac} = f(f) \)

\( T_{amb} = 25 \, ^\circ C \)

Typical values

\( R_L = 1000 \, \Omega \)

\( \text{Typo values} \)

\( R_L = 1000 \, \Omega \)

\( t_d = f(I_{FM}) \)

\( T_{amb} = 25 \, ^\circ C \)
PHOTOCOUPLER

Optically coupled isolator consisting of an infrared emitting GaAs diode and a silicon n-p-n phototransistor. TO-12 envelope. Suitable for TTL integrated circuits. Only difference between CNY44 and CNY46 is in the pin connections.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diode</strong></td>
<td></td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max. 3 V</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td>$I_F$ max. 30 mA</td>
</tr>
<tr>
<td>Forward current (peak value)</td>
<td>$I_{FM}$ max. 200 mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 100 , ^\circ C$</td>
<td>$P_{tot}$ max. 50 mW</td>
</tr>
</tbody>
</table>

**Transistor**

| Collector-emitter voltage (open base) | $V_{CEO}$ max. 50 V |
| Collector cut-off current (dark) $V_{CE} = 15 \, V$; diode: $I_F = 0$ | $I_{CEO}$ < 100 nA |
| Total power dissipation up to $T_{amb} = 25 \, ^\circ C$ | $P_{tot}$ max. 80 mW |

**Photocoupler**

| Output/input d.c. current transfer ratio $I_F = 10 \, mA$; $V_{CE} = 10 \, V$ | $I_C/I_F$ > 0,3 |
| Collector-emitter saturation voltage $I_F = 10 \, mA$; $I_C = 3 \, mA$ | $V_{CEsat}$ < 0,4 V |
| Isolation voltage, r.m.s. value | $V_{IO(RMS)}$ > 1000 V |

**MECHANICAL DATA**

Dimensions in mm

TO-12

Cathode (4) connected to case. Max. lead diameter is guaranteed only for 12,7 mm.

ALL OTHER DATA IDENTICAL TO CNY44

April 1976
PHOTOCOUPLERS

Optically coupled isolators consisting of an infra-red emitting GaAs diode and a silicon n-p-n phototransistor. Plastic 6 lead dual in-line envelopes. Suitable for TTL integrated circuits.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
<th>CNY47</th>
<th>CNY47A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diode</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max.</td>
<td>3</td>
<td>V</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
<td>$I_F$ max.</td>
<td>30</td>
<td>mA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25^\circ C$</td>
<td>$P_{tot}$ max.</td>
<td>100</td>
<td>mW</td>
</tr>
<tr>
<td><strong>Transistor</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>$V_{CEO}$ max.</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>Collector cut-off current (dark) $V_{CE} = 10 , V$; diode: $I_F = 0$</td>
<td>$I_{CEO}$</td>
<td>&lt; 100</td>
<td>nA</td>
</tr>
<tr>
<td>Total power dissipation up to $T_{amb} = 25^\circ C$</td>
<td>$P_{tot}$ max.</td>
<td>150</td>
<td>mW</td>
</tr>
<tr>
<td><strong>Photocoupler</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output/input d.c. current transfer ratio $I_F = 10 , mA$; $I_B = 0$; $V_{CE} = 0,4 , V$</td>
<td>$I_C/I_F$</td>
<td>&gt; 0,2</td>
<td>0,4</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage $I_F = 10 , mA$; $I_B = 0$; $I_C = 2 , mA$</td>
<td>$V_{CESat}$</td>
<td>&lt; 0,4</td>
<td>V</td>
</tr>
<tr>
<td>$I_F = 10 , mA$; $I_B = 0$; $I_C = 4 , mA$</td>
<td>$V_{CESat}$</td>
<td>&lt; 0,4</td>
<td>V</td>
</tr>
<tr>
<td>Isolation voltage, r.m.s. value</td>
<td>$V_{IO(RMS)}$</td>
<td>&gt; 2000</td>
<td>2000 V</td>
</tr>
</tbody>
</table>

MECHANICAL DATA  See page 2.
MECHANICAL DATA

Dimensions in mm

3 = n.c.

August 1974
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Diode
Continuous reverse voltage
\[ V_R \text{ max.} = 3 \text{ V} \]
Forward current (d.c.)
\[ I_F \text{ max.} = 30 \text{ mA} \]
Forward current (peak value)
\[ I_{FM} \text{ max.} = 200 \text{ mA} \]
Total power dissipation up to \( T_{amb} = 25 \text{ °C} \)
\[ P_{tot} \text{ max.} = 100 \text{ mW} \]
Operating junction temperature
\[ T_j \text{ max.} = 100 \text{ °C} \]

Transistor
Collector-emitter voltage (open base)
\[ V_{CEO} \text{ max.} = 30 \text{ V} \]
Collector-base voltage (open emitter)
\[ V_{CBO} \text{ max.} = 50 \text{ V} \]
Emitter-base voltage (open collector)
\[ V_{EBO} \text{ max.} = 4 \text{ V} \]
Collector current (d.c.)
\[ I_C \text{ max.} = 30 \text{ mA} \]
Total power dissipation up to \( T_{amb} = 25 \text{ °C} \)
\[ P_{tot} \text{ max.} = 150 \text{ mW} \]
Operating junction temperature
\[ T_j \text{ max.} = 100 \text{ °C} \]

Photocoupler
Storage temperature
\[ T_{stg} -55 \text{ to } +150 \text{ °C} \]

THERMAL RESISTANCE
From junction to ambient in free air
- diode
\[ R_{th j-a} = 0,75 \text{ °C/mW} \]
- transistor
\[ R_{th j-a} = 0,5 \text{ °C/mW} \]
From junction to ambient,
device mounted on a p.c. board ¹)
- diode
\[ R_{th j-a} = 0,6 \text{ °C/mW} \]
- transistor
\[ R_{th j-a} = 0,4 \text{ °C/mW} \]

¹) With copper islands of 1,5 mm diameter around each terminal, on one side of 1,6 mm glass-epoxy printed circuit board; thickness of copper 35 \( \mu \text{m} \); pins fully inserted (i.e. to seating plane, see drawing).
**CHARACTERISTICS**

**Diode** $T_j = 25 \, ^\circ C$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward voltage, $I_F = 10 , mA$</td>
<td>$V_F$</td>
<td>$&lt; 1,2$</td>
</tr>
<tr>
<td>Reverse current, $V_R = 3 , V$</td>
<td>$I_R$</td>
<td>$&lt; 100$</td>
</tr>
</tbody>
</table>

**Transistor** (diode: $I_F = 0$) $T_j = 25 \, ^\circ C$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector cut-off current (dark)</td>
<td>$V_{CE}$</td>
<td>$&lt; 1.5$</td>
</tr>
<tr>
<td></td>
<td>$I_{CEO}$</td>
<td>$&lt; 100$</td>
</tr>
<tr>
<td></td>
<td>$I_{CBO}$</td>
<td>$&lt; 20$</td>
</tr>
</tbody>
</table>

**Photocoupler** ($I_B = 0, \, T_{amb} = 25 \, ^\circ C$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output/input d.c. current transfer ratio</td>
<td>$I_C/I_F$</td>
<td>$&gt; 0.2$, $0.4$</td>
</tr>
<tr>
<td></td>
<td>$I_{CEO}$</td>
<td>$&lt; 5$</td>
</tr>
<tr>
<td></td>
<td>$I_{CBO}$</td>
<td>$&lt; 100$</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>$V_{CEsat}$</td>
<td>$&lt; 0.2$, $0.4$</td>
</tr>
<tr>
<td></td>
<td>$V_{CEsat}$</td>
<td>$&lt; 0.2$, $0.4$</td>
</tr>
<tr>
<td>Isolation voltage, r.m.s. value</td>
<td>$V_{IO(RMS)}$</td>
<td>$&gt; 2000$</td>
</tr>
<tr>
<td>Capacitance between input and output</td>
<td>$C_{io}$</td>
<td>$&lt; 1$</td>
</tr>
</tbody>
</table>

1) Where the phototransistor receives light from the diode, the O (for open terminal) has been omitted from the symbols.

2) Aging of the light-emitting diode reduces the transfer ratio at a rate proportional to current and operating time. In circuits that operate for long periods, therefore, the duty factor of the couplers should be kept as low as possible. This can often be done with the aid of an inverter.

3) Tested with a 50 Hz a.c. voltage for 1 minute between shorted input leads and shorted output leads.
CHARACTERISTICS (continued)

Insulation resistance between input and output

\[ V_{IO} = 500 \text{ V} \]

Switching times (circuit below)

\[ I_{Con} = 2 \text{ mA}; V_{CC} = 5 \text{ V}; R_L = 100 \Omega \]

Turn-on time

Turn-off time

\[ I_{Con} = 4 \text{ mA}; V_{CC} = 5 \text{ V}; R_L = 100 \Omega \]

Turn-on time

Turn-off time

\[
\begin{array}{|c|c|c|}
\hline
& \text{CNY47} & \text{CNY47A} \\
\hline
\tau_{IO} & 10^{11} & 10^{12} \\
\text{typ.} & 10^{12} & \Omega \\
\hline
\tau_{on} & 3 & \mu\text{s} \\
\text{typ.} & & \\
\tau_{off} & 3 & \mu\text{s} \\
\text{typ.} & & \\
\hline
\end{array}
\]

---

\[
\begin{array}{|c|c|}
\hline
\text{CNY47} & \text{CNY47A} \\
\hline
720428 & 7267238.1 \\
\hline
\end{array}
\]
CNY47
CNY47A

**Typical Values**

- **T\textsubscript{amb} = 25°C**
- **A\textsubscript{VF} = -2 mV/°C**

**Graphs:**
- Power dissipation vs. temperature
- Current vs. voltage

**Note:**
- Free in air
- Transistor and diode characteristics

**Additional Information:**
- Aug 1974
Ic (mA)

VCE (V)

If = 10 mA
8 mA
6 mA
4 mA
2 mA

If = 0 mA

VCE sat (V)

If

Ic (mA)

Ic (mA)

VCE sat (V)

If

If

CNY47

CNY47

If

If

If

If

CNY47A

CNY47

August 1974
CNY47
CNY47A

$V_{CE\text{sat}}$ (V) vs. $I_c$ (mA)

- $I_F = 2$ mA, $4$ mA, $6$ mA, $8$ mA, $10$ mA, $15$ mA, $20$ mA, $25$ mA, $30$ mA
- Typ. Values:
  - $I_B = 0$
  - $T_{amb} = 25^\circ C$
  - Pulses: $t_p = 50 \mu s$
  - $T = 500 \mu s$

Typ. Values:
- $V_{CE} = 10$ V
- $10$ V
- $1$ V
- $0.4$ V

Typ. Values:
- $I_c = 30$ mA
- $25$ mA
- $20$ mA
- $15$ mA
- $10$ mA
- $5$ mA

August 1974
CNY47
CNY47A

Typical values:

- $I_F = 10 \text{ mA}$
- $V_{CC} = 10 \text{ V}$
- $T_{amb} = 25^\circ \text{C}$

Graphs showing:

- $V_{\text{in}}$ vs. $f$ (kHz)
- $t$ vs. $I_C$ (mA)

Electrical schematic:

- $i_F$ vs. $V_{\text{CC}}$

- $i_C$ vs. $t_{on}$, $t_{off}$, $t_f$, $t_r$

- $R_L = 1 \text{ k}\Omega$

August 1974
typical values
$I_B = 0$
$T_{amb} = 25^\circ C$

$I_F = 2 \text{ mA}$

$I_F = 4 \text{ mA}$

$I_F = 6 \text{ mA}$

$I_F = 8 \text{ mA}$

$I_F = 10 \text{ mA}$

$I_F = 15 \text{ mA}$

$I_F = 20 \text{ mA}$

$I_F = 25 \text{ mA}$

$I_F = 30 \text{ mA}$
CNY47
CNY47A

Typical values
I_B = 0
T_amb = 25°C
pulses: t_p = 50 µs
T = 500 µs

V_CE = 10 V
5 V
1 V
0.4 V

I_C (mA)

10^2
10^1
10
1

I_F (mA)

10^2
10^1
10
1

V_CE (V)

60
40
20
0

CNY47A

10 mA
5 mA

CNY47A

25 mA
20 mA
15 mA
10 mA
5 mA

CNY47
CNY47A

Typical values

- $I_F = 10 \text{ mA}$
- $V_{CC} = 10 \text{ V}$
- $T_{amb} = 25\degree \text{ C}$

Graphs showing

- $V_\sim$ vs. $f$ (kHz)
- $I_e$ vs. $I_C$ (mA)

Typo values

- $I_F = 10 \text{ mA}$
- $V_{CC} = 10 \text{ V}$
- $T_{amb} = 25\degree \text{ C}$

August 1974
PHOTOCOUPLER

Optically coupled isolator consisting of an infrared emitting GaAs diode and a silicon n-p-n Darlington phototransistor. Plastic 6 lead dual-in line envelope. Suitable for TTL integrated circuits.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diode</strong></td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
</tr>
<tr>
<td>Forward current (d.c.)</td>
</tr>
<tr>
<td>Total power dissipation up to T_amb = 25 °C</td>
</tr>
<tr>
<td><strong>Transistor</strong></td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
</tr>
<tr>
<td>Collector cut-off current (dark)</td>
</tr>
<tr>
<td>V_CE = 10 V; diode: I_F = 0</td>
</tr>
<tr>
<td>Total power dissipation up to T_amb = 25 °C</td>
</tr>
<tr>
<td><strong>Photocoupler</strong></td>
</tr>
<tr>
<td>Output/input d.c. current transfer ratio</td>
</tr>
<tr>
<td>I_F = 10 mA; I_B = 0; V_CE = 1 V</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
</tr>
<tr>
<td>I_F = 5 mA; I_B = 0; I_C = 10 mA</td>
</tr>
<tr>
<td>I_F = 10 mA; I_B = 0; I_C = 60 mA</td>
</tr>
<tr>
<td>Isolation voltage, r.m.s. value</td>
</tr>
</tbody>
</table>

MECHANICAL DATA  See page 2.
MECHANICAL DATA

Dimensions in mm

SOT-90

A) Centre lines of all leads are within ±0,127 mm of the nominal positions shown: in the worst case, the spacing between adjacent leads may deviate from nominal by ±0,254 mm.

B) Tolerances of note A within this distance.

© Locational truth

M Maximum Material Condition

May 1975
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

**Diode**
- Continuous reverse voltage
  \[ V_R \text{ max.} \, 3 \, \text{V} \]
- Forward current (d.c.)
  \[ I_F \text{ max.} \, 60 \, \text{mA} \]
- Forward current (peak value)
  \[ I_{FM} \text{ max.} \, 3 \, \text{A} \]
- Total power dissipation up to \( T_{\text{amb}} = 25 \, \text{°C} \)
  \[ P_{\text{tot}} \text{ max.} \, 100 \, \text{mW} \]
- Junction temperature
  \[ T_j \text{ max.} \, 100 \, \text{°C} \]

**Transistor**
- Collector-emitter voltage (open base)
  \[ V_{CEO} \text{ max.} \, 30 \, \text{V} \]
- Collector-base voltage (open emitter)
  \[ V_{CBO} \text{ max.} \, 30 \, \text{V} \]
- Emitter-base voltage (open collector)
  \[ V_{EBO} \text{ max.} \, 6 \, \text{V} \]
- Collector current (d.c.)
  \[ I_C \text{ max.} \, 100 \, \text{mA} \]
- Collector current (peak value)
  \[ I_{CM} \text{ max.} \, 150 \, \text{mA} \]
- Total power dissipation up to \( T_{\text{amb}} = 25 \, \text{°C} \)
  \[ P_{\text{tot}} \text{ max.} \, 150 \, \text{mW} \]
- Junction temperature
  \[ T_j \text{ max.} \, 100 \, \text{°C} \]

**Photocoupler**
- Storage temperature
  \[ T_{\text{stg}} \text{ -55 to +100} \, \text{°C} \]

**THERMAL RESISTANCE**
- From junction to ambient in free air
  \[ R_{\text{th j-a}} \, 0,75 \, \text{°C/mW} \]
  \[ R_{\text{th j-a}} \, 0,5 \, \text{°C/mW} \]
- From junction to ambient
  \[ R_{\text{th j-a}} \, 0,6 \, \text{°C/mW} \]
  \[ R_{\text{th j-a}} \, 0,4 \, \text{°C/mW} \]

May 1975
CHARACTERISTICS

Diode Tj = 25 °C

Forward voltage, IF = 10 mA

\[ V_F \text{ typ. } < 1.2 \text{ V} \]

Reverse current, VR = 3 V

\[ I_R < 10 \mu A \]

Diode capacitance, VR = 0; f = 1 MHz

\[ C_d \text{ typ. } 80 \text{ pF} \]

Transistor (diode: IF = 0) Tj = 25 °C

Collector cut-off current (dark)

\[ V_{CE} = 10 \text{ V} \]

\[ I_{CEO} < 100 \text{ nA} \]

Photocoupler (Ip = 0, Tamb = 25 °C

unless otherwise specified)

Output/input d.c. current transfer ratio

\[ I_F = 10 \text{ mA}; V_{CE} = 1 \text{ V} \]

\[ I_C/I_F > 6 \]

Collector-emitter saturation voltage

\[ I_F = 5 \text{ mA}; I_C = 10 \text{ mA} \]

\[ V_{CEsat} < 0.8 \text{ V} \]

\[ I_F = 10 \text{ mA}; I_C = 60 \text{ mA} \]

\[ V_{CEsat} < 1 \text{ V} \]

Isolation voltage, r.m.s. value

\[ V_{IO(RMS)} > 1500 \text{ V} \]

Capacitance between input and output

\[ I_F = 0; V = 0; f = 1 \text{ MHz} \]

\[ C_{io} \text{ typ. } 1 \text{ pF} \]

---

1) Where the phototransistor receives light from the diode, the 0 (for open terminal) has been omitted from the symbols.

2) Aging of the light-emitting diode reduces the transfer ratio at a rate proportional to current and operating time. In circuits that operate for long periods, therefore, the duty factor of the couplers should be kept as low as possible. This can often be done with the aid of an inverter.

3) Tested with a 50 Hz a.c. voltage for 1 minute between shorted input leads and shorted output leads.
CHARACTERISTICS (continued)

Insulation resistance between input and output

\[ V_{IO} = 1500 \text{ V} \]

Switching times (circuit below)

\[ I_{Con} = 10 \text{ mA}; \quad V_{CC} = 10 \text{ V}; \quad R_E = 100 \Omega \]

- Turn-on time
- Turn-off time

\[ T_{amb} = 25 \degree C, \text{ unless otherwise specified} \]

\[ R_{IO} \quad \text{typ.} \quad 10^{11} \Omega \]

\[ t_{on} \quad \text{typ.} \quad 68 \mu s \]

\[ t_{off} \quad \text{typ.} \quad 37 \mu s \]
CNY48

$\begin{align*}
I_{CE0} (\text{nA}) & \\ 10^3 & \rightarrow \\ 10^2 & \rightarrow \\ 10 & \rightarrow \\ 1 & \quad \rightarrow \\
V_{CE} (\text{V}) & \\ 10^2 & \rightarrow \\ 10 & \rightarrow \\ 1 & \quad \rightarrow \\
10 & \rightarrow \\ 10^2 & \rightarrow \\ 10^3 & \rightarrow \\
\end{align*}$

$\begin{align*}
I_{CBO} (\text{nA}) & \\ 10 & \rightarrow \\ 10^{-1} & \rightarrow \\ 10^{-2} & \rightarrow \\
T_j (\degree \text{C}) & \\ 75 & \rightarrow \\ 50 & \rightarrow \\ 25 & \rightarrow \\
100 & \rightarrow \\ 75 & \rightarrow \\ 50 & \rightarrow \\ 25 & \rightarrow \\
\end{align*}$

$\begin{align*}
I_C (\text{mA}) & \\ 10^3 & \rightarrow \\ 10^2 & \rightarrow \\ 10 & \rightarrow \\ 1 & \quad \rightarrow \\
I_F (\text{mA}) & \\ 10^2 & \rightarrow \\ 10 & \rightarrow \\ 1 & \quad \rightarrow \\
0 & \rightarrow \\ 0.8 & \rightarrow \\ 1 & \rightarrow \\ 5 & \rightarrow \\
\end{align*}$

$\begin{align*}
I_C (\text{mA}) & \\ 100 & \rightarrow \\ 75 & \rightarrow \\ 50 & \rightarrow \\ 25 & \rightarrow \\
T_{amb} (\degree \text{C}) & \\ 100 & \rightarrow \\ 50 & \rightarrow \\ 0 & \rightarrow \\ -50 & \rightarrow \\
\end{align*}$

May 1975
typ. values
$V_{CE} = 5\, V$
$T_{amb} = 25\, ^{\circ}C$
typ. values
$I_B = 0$
$T_{amb} = 25 \, ^\circ C$

$V_{CE_{sat}} (V)$

$I_F = 5 \, mA$
$10 \, mA$
$20 \, mA$
$30 \, mA$
$60 \, mA$

$I_C$ (mA)

$T_{amb}$ ($^\circ C$)

$V_{CE_{sat}} (V)$

$10^3$

$C_C$ (pF)

$10^2$

$10$

$V_{CB}$ (V)

$10^2$
INFRARED SENSITIVE DEVICES
PHOTOCONDUCTIVE CELL

Indium antimonide photoconductive element mounted on a copper heatsink, recommended for operation at a temperature of 20 °C.
Sensitive to infra-red radiation extending to 7.5 µm and intended for use with modulated or pulsed radiation.

RATINGS (Limiting values) 1)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bias current at $T_{\text{amb}} = 20$ °C</td>
<td>1 max. 100 mA</td>
</tr>
<tr>
<td>$T_{\text{amb}}$ max.</td>
<td>70 °C</td>
</tr>
<tr>
<td>$T_{\text{stg}}$</td>
<td>-50 to +70 °C</td>
</tr>
</tbody>
</table>

CHARACTERISTICS

- Peak spectral response
- Spectral response range
- Cell resistance
- Time constant
- Sensitive area

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak spectral response</td>
<td>$\lambda = 6.0$ to $6.3$ µm</td>
</tr>
<tr>
<td>Spectral response range</td>
<td>from visible to 7.5 µm</td>
</tr>
<tr>
<td>Cell resistance</td>
<td>$r_1 = 30$ to $120 \ \Omega$</td>
</tr>
<tr>
<td>Time constant</td>
<td>0.1 µs</td>
</tr>
<tr>
<td>Sensitive area</td>
<td>$6.0 \times 0.5 \ \text{mm}^2$</td>
</tr>
</tbody>
</table>

Sensitivity (6.0 µm radiation)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>* $D^*$</td>
</tr>
<tr>
<td></td>
<td>(500 °K, 800 Hz, 1 Hz)</td>
</tr>
</tbody>
</table>

Noise equivalent power (N.E.P.)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(6.0 µm, 800 Hz, 1 Hz)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(500 °K, 800 Hz, 1 Hz)</td>
</tr>
</tbody>
</table>

MECHANICAL DATA (see page 2)

1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.
MECHANICAL DATA

Dimensions in mm

NOTES

1. Measuring conditions.

The detector is attached to a heatsink which is maintained at a temperature of 20 °C and a bias current of 50 mA is applied. A parallel beam of monochromatic radiation of wavelength 4.4 µm, which would produce a steady irradiance of 68 µW/cm² at the sensitive element, is chopped at 800 Hz, giving an actual r.m.s. power at the element which amounts to

\[
\frac{68}{2.2} = 31 \mu W/cm^2
\]

Measurements of the detector output are made with an amplifier tuned to 800 Hz and with a bandwidth of 50 Hz, and are referred to open circuit conditions i.e. correction is made for the shunting effects of the bias supply impedance and the amplifier input impedance. Under these test conditions, the ORP10 will exhibit a minimum signal-to-noise ratio of 45 and typical of 105. The sensitivities quoted at the wavelength of peak response and under black body conditions are calculated from these measurements, assuming the detector to have a typical response curve.

2. $D^*$ and N.E.P.

These are figures of merit for the materials of detectors.

$D^*$ is defined in the expression:

\[
D^* = \frac{V_s}{V_n} \times \sqrt{A(\Delta f)}
\]

where:

- $V_s$ = signal voltage across detector terminals
- $V_n$ = noise voltage across detector terminals
- $A$ = detector area
- $(\Delta f)$ = bandwidth of measuring amplifier
- $W$ = radiation power incident on detector sensitive element in watts.
NOTES (continued)

The figures in brackets which follow D* refer to the measuring conditions e.g.
D* (5.3 μm, 800 Hz, 1 Hz) denotes monochromatic radiation incident on the de-
tector of wavelength 5.3 μm, chopping frequency 800 Hz, bandwidth 1 Hz.

The Noise Equivalent Power (N.E.P.) is related to D* by the expression:

\[ \text{N.E.P.} = \frac{\sqrt{A}}{D^*} \]

3. Variation of performance with bias current.

Both signal and noise vary with bias current. Typical curves are shown on page 5. 
At high currents the noise increases more rapidly than the signal, and therefore
the signal-to-noise ratio has a peak value at some optimum current, which will
vary slightly from cell to cell. A typical value is 50 mA. In addition the ohmic
heating caused by bias currents above 60 mA causes the temperature of the element
to become significantly greater than the substrate so that the signal de-
creases as described in note 4.

4. Variation of performance with element temperature.

As with all semiconductor photocells, the performance depends on the tempera-
ture of the sensitive element. In the case of the ORP10 this is influenced by the
ambient temperature and ohmic heating caused by the d.c. bias current. To mini-
mise fluctuations, the element is mounted on a copper base from which it is in-
sulated by a layer of aluminium oxide, and can readily be attached to a large
heatsink.

A typical variation of performance with temperature is given on page 5. The
curve on page 5 shows the decrease in signal caused by the high current raising
the temperature of the element.

On cooling, indium antimonide exhibits improved sensitivity and increased resis-
tance. Below 15 °C this is impractical with the ORP10 unless special precautions
are taken to prevent condensation and icing on the exposed element.

5. Warning.

The sensitive surface is unprotected and should not be touched. It is stable in
normal atmospheres but should not be exposed to high concentrations of the va-
pours of organic solvents. Care should be taken to avoid strain when attaching
cells to heatsinks.
Recommended circuit for use with radiation chopped at 800 Hz.

CIRCUIT NOTES
The transformer should be adequately screened to prevent stray pick-up. The resistor R should be wire wound to minimise noise. It must be substantially larger than the cell resistance and its actual value will depend upon the supply voltage and the cell currents required. The 560 pF capacitor tunes the secondary to 800 Hz.

---

**Relative response versus \( \lambda \)**

<table>
<thead>
<tr>
<th>( \lambda (\mu m) )</th>
<th>0</th>
<th>5</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>( N (%) )</td>
<td>1000</td>
<td>100</td>
<td>10</td>
</tr>
</tbody>
</table>

**Chopping frequency 800Hz**

<table>
<thead>
<tr>
<th>( \lambda (\mu m) )</th>
<th>0</th>
<th>5</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>( D* )</td>
<td>( 10^9 )</td>
<td>( 10^8 )</td>
<td>( 10^7 )</td>
</tr>
</tbody>
</table>
normalised curves for resistance and open circuit signal at 6.0μm

resistance

signal

T (°C)

0 10 20 30 40 50 60 70

0 0.5 1 1.5 2

7208506

ORP10
PHOTOCONDUCTIVE CELL

Indium antimonide photoconductive element mounted in a glass dewar vessel and cooled by liquid nitrogen or liquid air. Sensitive to infrared radiation extending to 5.6\(\mu\)m and intended for use with modulated or pulsed radiation.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak spectral response</td>
</tr>
<tr>
<td>Operating temperature</td>
</tr>
<tr>
<td>Responsivity (5.3 (\mu)m, 800 Hz)</td>
</tr>
<tr>
<td>(D^*) (5.3 (\mu)m, 800 Hz, 1 Hz)</td>
</tr>
<tr>
<td>Time constant</td>
</tr>
<tr>
<td>Sensitive area</td>
</tr>
</tbody>
</table>

MECHANICAL DATA see page 2
MECHANICAL DATA

Dimensions in mm

- Metal encapsulation
- Glass dewar vessel
- Sapphire window
- Surface aluminised mirror
- Incident radiation
- Sensitive area
- Cell lead
- Leads
- Terminals

Dimensions in mm:
- Cell lead
- Dewar opening
- Mirror attachment
- Mirror

December 1970
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC134)

Bias current at $T_{amb} = 77$ K

$I_{max.} = 30$ mA

Temperatures

Storage temperature

$T_{stg} = -55$ to $+55$ °C

CHARACTERISTICS (see note 1 on page 4)

Peak spectral response

$\lambda_m = 5.3$ µm

Spectral response range

from visible to $5.6$ µm

Cell resistance

$r_i = 20$ to $60$ kΩ

Time constant

typ. $5$ µs

Boil-off time of bulk liquid nitrogen

> $90$ min

typ. $120$ min

Performance

1. Black body source measurement

colour temperature : $500$ K

chopping frequency : $800$ Hz

bandwidth : $1$ Hz

Responsivity

$\rightarrow > 4$ mV/µW

typ. $7$ mV/µW

$D^*$

$\rightarrow > 5 \times 10^9$ cm√Hz/W

typ. $7.5 \times 10^9$ cm√Hz/W

N.E.P.

typ. $16$ pW

$< < 35$ pW

2. Monochromatic source measurement

radiation : $5.3$ µm

chopping frequency : $800$ Hz

bandwidth : $1$ Hz

Responsivity

$D^*$

typ. $35$ mV/µW

typ. $55 \times 10^9$ cm√Hz/W

N.E.P.

typ. $3.2$ pW
NOTES

1. Test conditions

The detector is cooled to 77K by filling the dewar vessel with liquid nitrogen, or by use of a liquid transfer system. An optimum bias of 250 to 500μA is applied. The sensitive element is situated at a distance of 264mm from a black body source limited by an aperture of 3mm diameter.

The radiation path is interrupted at 800Hz by a chopper blade at ambient temperature. Under these conditions the r.m.s. power at the element (chopping factor 2.2) is 4.5μW/cm².

Measurements of the detector output are made with an amplifier tuned to 800Hz with a bandwidth of 50Hz, and referred to open-circuit conditions, i.e., correction is made for the shunting effects of the bias supply impedance and the amplifier impedance.

2. $D^*$ and N.E.P.

These are figures of merit for the materials of detectors.

The detectivity $D^*$ is defined in the expression:

$$D^* = \frac{V_s}{\sqrt{\frac{V_n}{A(\Delta f)}}}$$

where:

$V_s$ = signal voltage across detector terminals

$V_n$ = noise voltage across detector terminals

$A$ = detector area

$(\Delta f)$ = bandwidth of measuring amplifier

$W$ = radiation power incident on detector sensitive element in r.m.s. watts.

The Noise Equivalent Power (N.E.P.) is related to $D^*$ by the expression:

$$\text{N.E.P.} = \frac{\sqrt{A}}{D^*}$$

3. Time constant

Detector time constant figures are based on the response to a step function in the incident radiation. Quoted times indicate the interval between the moment the radiation is cut off and the output falling to 63% of its peak value.

4. Variation of performance with bias current

Both signal and noise vary with current in this type of cell. At high currents the noise increases more rapidly than the signal, and therefore the signal-to-noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell.
5. **Warnings**

a. The resistance of the cell at room temperature is three orders of magnitude less than at the operating temperature (77K). Care should therefore be taken to ensure that the device is not allowed to reach room temperature while still biased, if any form of low impedance biasing is employed.

b. If provision is made for cells to be plugged into the bias current and amplifier, steps must be taken to limit the current available from the amplifier input capacitor. This current can be excessive at the instant of plugging in the cell.

A zener diode can be used to limit the voltage developed across the input capacitor as shown in the diagram.

c. The dewar vessel must always be completely dry before being refilled with liquid nitrogen. In humid conditions, water vapour may condense at the top of the dewar. Should this occur, the remaining liquid nitrogen should be allowed to boil off, the ice should be removed carefully and precautions taken to avoid a recurrence. In very humid conditions the window should be purged with a clean dry gas.

6. **Low frequency noise**

This will be minimised by use of non-absorbent cotton wool placed in the bottom of the dewar. The recommended quantity is 40mg.
The first graph shows the relative response (%) of a device as a function of wavelength (\(\lambda\) in \(\mu\text{m}\)) ranging from 0 to 7.5. The y-axis ranges from 1 to 100.

The second graph illustrates the responsivity (\(\text{mV/\mu W}\)) as a function of current (I in mA) with a log-log scale. The x-axis ranges from \(10^{-2}\) to 10, and the y-axis ranges from 1 to 1000.

Additional notes include:
- Colour temperature: 500K
- Chopping frequency: 800 Hz

Date: December 1970
PHOTOCONDUCTIVE CELL

Lead sulphide, chemically deposited, photoconductive cell recommended for room temperature operation.
It is encapsulated in a hermetically sealed TO-5 envelope with an end viewing window. It has a germanium filter to cut off radiation below 1.5 \( \mu \text{m} \) and therefore it may be exposed continuously to visible radiation.

### QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>( \lambda_m )</th>
<th>typ.</th>
<th>( \lambda )</th>
<th>1.5 to 3.0</th>
<th>( \mu \text{m} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak spectral response</td>
<td></td>
<td></td>
<td>Spectral response range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsivity (2.0 ( \mu \text{m} ), 800 Hz)</td>
<td>( &gt; 200 )</td>
<td>mA/W</td>
<td>( &gt; 2.0 )</td>
<td>mA/W</td>
<td></td>
</tr>
<tr>
<td>Responsivity (500K, 800 Hz)</td>
<td>( &gt; 1.0 \times 10^8 )</td>
<td>cm( \sqrt{\text{Hz/W}} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time constant</td>
<td>typ.</td>
<td>250</td>
<td>( \mu \text{s} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitive area</td>
<td></td>
<td></td>
<td>1.0 ( \times 1.0 )</td>
<td>mm(^2)</td>
<td></td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig. 1 TO-5 (except for window).

Dimensions in mm

(1) Connected to case
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

Power dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{\text{max.}}$</td>
<td>20 mW</td>
</tr>
</tbody>
</table>

Temperatures

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{\text{stg}}$</td>
<td>-20 to +50 °C</td>
</tr>
<tr>
<td>$T_{\text{amb max.}}$</td>
<td>50 °C</td>
</tr>
</tbody>
</table>

CHARACTERISTICS at $T_{\text{amb}} = 20$ °C (see notes on pages 3 and 4)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak spectral response</td>
<td></td>
</tr>
<tr>
<td>$\lambda_m$ typ.</td>
<td>1.9 μm</td>
</tr>
<tr>
<td>Spectral response range</td>
<td></td>
</tr>
<tr>
<td>$\lambda$ range</td>
<td>1.5 to 3.0 μm</td>
</tr>
<tr>
<td>Cell resistance</td>
<td></td>
</tr>
<tr>
<td>$r_t$ typ.</td>
<td></td>
</tr>
<tr>
<td>typ.</td>
<td>200 kΩ</td>
</tr>
<tr>
<td>&lt;</td>
<td>600 kΩ</td>
</tr>
<tr>
<td>Time constant</td>
<td></td>
</tr>
<tr>
<td>typ.</td>
<td>250 μs</td>
</tr>
<tr>
<td>&lt;</td>
<td>400 μs</td>
</tr>
</tbody>
</table>

Performance

1. Black body source measurement
   - Colour temperature : 500 K
   - Chopping frequency : 800 Hz
   - Bandwidth : 1 Hz
   - Responsivity
     - $D^* > 2.0$ mA/W
     - N. E. P.
     - $< 1.0 \times 10^8$ cm$\sqrt{\text{Hz/W}}$

2. Monochromatic source measurement
   - Radiation : 2.0 μm
   - Chopping frequency : 800 Hz
   - Bandwidth : 1 Hz
   - Responsivity
     - $D^* > 2.0 \times 10^{10}$ cm$\sqrt{\text{Hz/W}}$
     - N. E. P.
     - $< 10$ pW
NOTES

1. Test conditions

The cell is operated at a temperature of 20 °C. The sensitive element is situated at a distance of 264 mm from a black body source limited by an aperture of 3 mm diameter.

The radiation path is interrupted at 800 Hz by a chopper blade at ambient temperature. Under these conditions the r.m.s. power at the element (chopping factor 2,2) is 4,5 µW/cm².

A bias voltage of 24 V is applied to the cell. Measurements of the detector output are made using a low value resistive load, followed by a current pre-amplifier, as shown below. The output is fed into an amplifier tuned to 800 Hz with a bandwidth of 50 Hz.

2. $D^*$ and N.E.P.

These are figures of merit for the materials of detectors.

The detectivity $D^*$ is defined in the expression:

$$D^* = \frac{V_S}{V_n} \frac{\sqrt{A(\Delta f)}}{W}$$

where:

- $V_S$ = signal voltage across detector terminals
- $V_n$ = noise voltage across detector terminals
- $A$ = detector area
- $(\Delta f)$ = bandwidth of measuring amplifier
- $W$ = radiation power incident on detector sensitive element in r.m.s. watts.

The Noise Equivalent Power (N.E.P.) is related to $D^*$ by the expression:

$$N.E.P. = \frac{\sqrt{A}}{D^*}$$
NOTES (continued)

3. Time constant
Detector time constant figures are based on the response to a step function in the incident radiation. Quoted times indicate the interval between the moment the radiation is cut off and the output falling to 63% of its peak value.

4. a. Variation of performance with bias
Both signal and noise vary with bias in this type of cell. At bias levels at which the cell dissipation is less than 2.5 mW the maximum level of $D^*$ is maintained. At higher levels the noise increases more rapidly than the signal so that although the responsivity increases, $D^*$ falls. The maximum responsivity typically occurs at a dissipation level of 10 mW, beyond which heating occurs with a consequent reduction in responsivity.

b. Variation of performance with temperature/life
Resistance, responsivity and $D^*$ are dependent on the previous temperature/life history of the cell. The quoted values are the minimum which may be expected after storage or operation up to 35°C. These values may decrease by 50% after storage or operation at temperatures up to the absolute maximum temperature of 50°C.

5. Recommended operating conditions
In order to minimise the effects of parameter variations with temperature and life it is recommended that a constant voltage bias is used. A suitable circuit is shown on page 3. With this mode of operation the signal is the short-circuit current, which is related to the open-circuit cell voltage by the expression:

$$V_{oc} = I_{sc} \times r_f$$
PYROELECTRIC INFRARED DETECTORS

This is an infrared sensitive device, combined with a pre-amplifier which is stabilized to overcome d.c. drift due to thermal changes. It is hermetically sealed with a choice of window in a low-profile TO-5 can.

### QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>RPY86</th>
<th>RPY87</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectral response</td>
<td>6.5 to 14</td>
<td>1.0 to 15</td>
</tr>
<tr>
<td>Responsivity</td>
<td>(10 µm, 10)</td>
<td>(6 µm, 10)</td>
</tr>
<tr>
<td></td>
<td>typ. 640</td>
<td>500</td>
</tr>
<tr>
<td>Noise Equivalent Power (N. E. P.),</td>
<td>(10 µm, 10, 1)</td>
<td>(6 µm, 10, 1)</td>
</tr>
<tr>
<td></td>
<td>typ. 1.3 x 10^-9</td>
<td>1.7 x 10^-9</td>
</tr>
<tr>
<td>Element dimensions</td>
<td>2 x 1</td>
<td>mm</td>
</tr>
<tr>
<td>Field of view (to centre of element)</td>
<td>145</td>
<td>degrees</td>
</tr>
<tr>
<td>Operating voltage</td>
<td>9</td>
<td>V</td>
</tr>
<tr>
<td>Operating frequency</td>
<td>0.01 to 1000</td>
<td>Hz</td>
</tr>
</tbody>
</table>

### MECHANICAL DATA

**SOT-49D**

Dimensions in mm

1. When making soldered connections to the leads, a thermal shunt must be used.
2. It is essential that any mains operated soldering iron used should be both screened and earthed. Failure to observe these precautions could lead to the introduction of line voltage and possible damage to the device.
### RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC134)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating voltage at 100 °C max.</td>
<td>30 V</td>
</tr>
<tr>
<td>Temperature, operating max.</td>
<td>+100 °C</td>
</tr>
<tr>
<td>min.</td>
<td>-20 °C</td>
</tr>
<tr>
<td>Temperature, storage max.</td>
<td>+100 °C</td>
</tr>
<tr>
<td>min.</td>
<td>-20 °C</td>
</tr>
</tbody>
</table>

### CHARACTERISTICS

(at 25 ± 3 °C and with recommended test circuit)

#### RPY86

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.E.P. (500 K, 10, 1) min.</td>
<td>$2.0 \times 10^{-9}$ WHz$^{-1/2}$</td>
</tr>
<tr>
<td>N.E.P. (10 µm, 10, 1) typ.</td>
<td>$1.3 \times 10^{-9}$ WHz$^{-1/2}$</td>
</tr>
<tr>
<td>Responsivity (500 K, 10) min.</td>
<td>430 VW·1</td>
</tr>
<tr>
<td>Responsivity (10 µm, 10) typ.</td>
<td>640 VW·1</td>
</tr>
<tr>
<td>Spectral response min.</td>
<td>$6.5 \pm 0.5$ µm</td>
</tr>
<tr>
<td>Field of view (from centre of element)</td>
<td>135 145 155 degrees</td>
</tr>
<tr>
<td>Operating voltage 2)</td>
<td>8 9 10 V</td>
</tr>
</tbody>
</table>

#### RPY87

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.E.P. (500 K, 10, 1) or (6 µm, 10, 1)</td>
<td>$1.7 \times 10^{-9}$ WHz$^{-1/2}$</td>
</tr>
<tr>
<td>Responsivity (500 K, 10) or (6 µm, 10)</td>
<td>500 VW·1</td>
</tr>
<tr>
<td>Spectral response min.</td>
<td>$1.0 &gt;15$ µm</td>
</tr>
<tr>
<td>Field of view (from centre of element)</td>
<td>135 145 155 degrees</td>
</tr>
<tr>
<td>Operating voltage 2)</td>
<td>8 9 10 V</td>
</tr>
</tbody>
</table>

1) These characteristics apply throughout the spectral response range.

2) The detector will operate outside the quoted range but may have a degraded performance.

3) For performance as a function of frequency, see pages 6 and 8.
OPERATING NOTES

1. The detector is supplied with a black plastic cap to protect the window. This cap must be removed before operation.

2. The case potential must not be allowed to become positive with respect to the other two terminals.

3. The shape of the electrical output waveform is the integral of the incident radiation waveform.

4. It is inadvisable to operate the detector at mains related frequencies.

5. To avoid the possibility of optical microphony, the detector must be firmly mounted.

6. Use recommended circuit for low noise operation.

7. An increase in temperature of the element will produce a negative going signal at the output.

DEFINITIONS

1. N.E.P. (Noise Equivalent Power), Whz⁻¹⁄₂
   This is the r.m.s. value of the incident, chopped, radiant power necessary to produce an r.m.s. signal to r.m.s. noise ratio of unity. The r.m.s. noise refers to the value calculated for unit square root bandwidth Whz⁻¹⁄₂.

2. Responsivity VW-1
   This is the ratio of the r.m.s. signal in volts to the r.m.s. value of the incident, chopped, radiant power.
APPLICATION INFORMATION

1. Optional additional stage for extra gain.

\[ \text{Gain} \times \text{R1 (kΩ)} \quad \text{R2 (MΩ)} \]

<table>
<thead>
<tr>
<th>Gain</th>
<th>R1</th>
<th>R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>560</td>
<td>5.6</td>
</tr>
<tr>
<td>20</td>
<td>220</td>
<td>2.2</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
<td>1.0</td>
</tr>
</tbody>
</table>

2. The pyroelectric element may be considered as a capacitor whose charge state changes with temperature. It also behaves as a normal capacitor, i.e. its voltage changes with charge. Thus a change of temperature results in a change of charge. It can be seen that, for a given change in amplitude of incident radiation, the resulting change in temperature will decrease as the chopping frequency increases. Thus the voltage change will also decrease with frequency. In addition, there is a 90° phase lag between the thermal and electrical signals. The voltage signal therefore becomes the integral of the radiation signal.
3. Temperature slew

The FET used with a pyroelectric detector requires a gate leakage resistor to earth in parallel with the element. This stabilizes its working point. The pyroelectric voltage appearing across this resistor is proportional to the rate of change of temperature.

To ensure a low level of noise current from this resistor, its value should be of the order of $3 \times 10^{10} \, \Omega$. When the temperature slew rate is $1^\circ C/\text{minute}$, the pyroelectric voltage produced is 1 Volt. In a system which is designed to sense microvolts, this is almost certain to cause overload and any a.c. signal superimposed on this d.c. shift will be lost.

Our detectors incorporate a bleed system which acts progressively on the d.c. shift caused by temperature slew. The law is logarithmic.

Thus a slew rate of $0.1^\circ C/\text{minute}$ may produce an offset across the sensing element of 200 millivolts, $1^\circ C/\text{minute}$ 280 millivolts and $10^\circ C/\text{minute}$ 360 millivolts.
Pyroelectric infrared detectors

Responsivity $R$ v temperature

Noise $N(\Delta f)^{1/2}$ v temperature

Noise equivalent power $N.E.P.$ v temperature

June 1978
Responsivity
\( (\text{VW}^{-1}) \)

\begin{align*}
\text{Frequency (Hz)}
\end{align*}

\begin{align*}
10^{-5} & \quad 1 \quad 10 \quad 100 \quad 1000 \quad 10000
\end{align*}

Noise equivalent power v frequency

\begin{align*}
\text{Frequency (Hz)}
\end{align*}

\begin{align*}
10^{-7} & \quad 1 \quad 10 \quad 100 \quad 1000
\end{align*}
Pyroelectric infrared detectors

**RPY87 Responsivity vs Temperature**

- Responsivity (V/W°)
- Temperature (°C)

**RPY87 Noise vs Temperature**

- $N(\Delta t)^{1/2}$ (VHz$^{1/2}$)
- Temperature (°C)

**RPY87 Noise Equivalent Power vs Temperature**

- N.E.P. (WHz$^{1/2}$)
- Temperature (°C)
PYROELECTRIC INFRARED DETECTORS

This is an infrared sensitive device, combined with a pre-amplifier which is stabilized to overcome d.c. drift due to thermal changes. It is hermetically sealed with a choice of window in a low-profile TO-5 can.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
<th>RPY88</th>
<th>RPY89</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectral response</td>
<td>6.5 to 14</td>
<td>1.0 to 15</td>
</tr>
<tr>
<td>Responsivity, typ.</td>
<td>(10 ( \mu \text{m}, 10 )</td>
<td>(6 ( \mu \text{m}, 10 )</td>
</tr>
<tr>
<td>Noise Equivalent Power (N.E.P.) typ.</td>
<td>(10 ( \mu \text{m}, 10, 1 )</td>
<td>(6 ( \mu \text{m}, 10, 1 )</td>
</tr>
<tr>
<td>Element dimensions</td>
<td>2 \times 2</td>
<td>mm</td>
</tr>
<tr>
<td>Field of view (to centre of element) typ.</td>
<td>145</td>
<td>degrees</td>
</tr>
<tr>
<td>Operating voltage</td>
<td>9</td>
<td>V</td>
</tr>
<tr>
<td>Operating frequency</td>
<td>0.01 to 1000</td>
<td>Hz</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

SOT-49D

Soldering

1. When making soldered connections to the leads, a thermal shunt must be used.
2. It is essential that any mains operated soldering iron used should be both screened and earthed. Failure to observe these precautions could lead to the introduction of line voltage and possible damage to the device.

June 1978
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC134)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating voltage at 100 °C</td>
<td>V</td>
<td>-20</td>
<td>+100</td>
<td>+100</td>
</tr>
<tr>
<td>Temperature, operating</td>
<td>°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min.</td>
<td>-20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max.</td>
<td>+100</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature, storage</td>
<td>°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min.</td>
<td>-20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max.</td>
<td>+100</td>
<td>30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CHARACTERISTICS  (at 25 ± 3 °C and with recommended test circuit)

<table>
<thead>
<tr>
<th>RPY88</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N.E.P. (500 K, 10, 1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min.</td>
<td></td>
<td>3.0 × 10⁻⁹</td>
<td>3 × 10⁻⁹</td>
</tr>
<tr>
<td>Typ.</td>
<td></td>
<td>3.0 × 10⁻⁹</td>
<td>3 × 10⁻⁹</td>
</tr>
<tr>
<td>Max.</td>
<td></td>
<td>3.0 × 10⁻⁹</td>
<td>3 × 10⁻⁹</td>
</tr>
<tr>
<td>N.E.P. (10 μm, 10, 1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min.</td>
<td>2.0 × 10⁻⁹</td>
<td>3 × 10⁻⁹</td>
<td></td>
</tr>
<tr>
<td>Typ.</td>
<td>2.0 × 10⁻⁹</td>
<td>3 × 10⁻⁹</td>
<td></td>
</tr>
<tr>
<td>Max.</td>
<td>2.0 × 10⁻⁹</td>
<td>3 × 10⁻⁹</td>
<td></td>
</tr>
<tr>
<td>Responsivity (500 K, 10)</td>
<td>V/m²</td>
<td>215</td>
<td></td>
</tr>
<tr>
<td>Responsivity (10 μm, 10)</td>
<td>V/m²</td>
<td>320</td>
<td></td>
</tr>
<tr>
<td>Spectral response</td>
<td></td>
<td>6.5 ± 0.5</td>
<td>&gt;14</td>
</tr>
<tr>
<td>Field of view (from centre of element)</td>
<td></td>
<td>135</td>
<td>145</td>
</tr>
<tr>
<td>Operating voltage ²)</td>
<td></td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RPY89</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N.E.P. (500 K, 10, 1) or (6 μm, 10, 1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min.</td>
<td></td>
<td>2.5 × 10⁻⁹</td>
<td>3 × 10⁻⁹</td>
</tr>
<tr>
<td>Typ.</td>
<td></td>
<td>2.5 × 10⁻⁹</td>
<td>3 × 10⁻⁹</td>
</tr>
<tr>
<td>Max.</td>
<td></td>
<td>2.5 × 10⁻⁹</td>
<td>3 × 10⁻⁹</td>
</tr>
<tr>
<td>Responsivity (500 K, 10) or (6 μm, 10)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min.</td>
<td></td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>Typ.</td>
<td></td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>Max.</td>
<td></td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>Spectral response</td>
<td></td>
<td>1.0</td>
<td>&gt;15</td>
</tr>
<tr>
<td>Field of view (from centre of element)</td>
<td></td>
<td>135</td>
<td>145</td>
</tr>
<tr>
<td>Operating voltage ²)</td>
<td></td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

¹) These characteristics apply throughout the spectral response range.
²) The detector will operate outside the quoted range but may have a degraded performance.
³) For performance as a function of frequency, see pages 6 and 8.
Pyroelectric infrared detectors

Test circuit

OPERATING NOTES
1. The detector is supplied with a black plastic cap to protect the window. This cap must be removed before operation.
2. The case potential must not be allowed to become positive with respect to the other two terminals.
3. The shape of the electrical output waveform is the integral of the incident radiation waveform.
4. It is inadvisable to operate the detector at mains related frequencies.
5. To avoid the possibility of optical microphony, the detector must be firmly mounted.
6. Use recommended circuit for low noise operation.
7. An increase in temperature of the element will produce a negative going signal at the output.

DEFINITIONS
1. N.E.P. (Noise Equivalent Power), $\text{WHz}^{-\frac{1}{2}}$
   This is the r.m.s. value of the incident, chopped, radiant power necessary to produce an r.m.s. signal to r.m.s. noise ratio of unity. The r.m.s. noise refers to the value calculated for unit square root bandwidth $\text{VHz}^{-\frac{1}{2}}$
2. Responsivity $\text{VW}^{-1}$
   This is the ratio of the r.m.s. signal in volts to the r.m.s. value of the incident, chopped, radiant power.
APPLICATION INFORMATION

1. Optional additional stage for extra gain.

The following table gives recommended component values for various gains.

<table>
<thead>
<tr>
<th>Gain</th>
<th>R1</th>
<th>R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>×</td>
<td>kΩ</td>
<td>MΩ</td>
</tr>
<tr>
<td>50</td>
<td>560</td>
<td>5.6</td>
</tr>
<tr>
<td>20</td>
<td>220</td>
<td>2.2</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
<td>1.0</td>
</tr>
</tbody>
</table>

2. The pyroelectric element may be considered as a capacitor whose charge state changes with temperature. It also behaves as a normal capacitor, i.e. its voltage changes with charge. Thus a change of temperature results in a change of charge. It can be seen that, for a given change in amplitude of incident radiation, the resulting change in temperature will decrease as the chopping frequency increases. Thus the voltage change will also decrease with frequency. In addition, there is a 90° phase lag between the thermal and electrical signals. The voltage signal therefore becomes the integral of the radiation signal.

![Diagram of radiation and voltage signals]

*this capacitor must be a low leakage type e.g. our 344 series
3. Temperature slew

The FET used with a pyroelectric detector requires a gate leakage resistor to earth in parallel with the element. This stabilizes its working point. The pyroelectric voltage appearing across this resistor is proportional to the rate of change of temperature.

To ensure a low level of noise current from this resistor, its value should be of the order of $3 \times 10^{10} \, \Omega$. When the temperature slew rate is $1^\circ C/\text{minute}$, the pyroelectric voltage produced is 1 Volt. In a system which is designed to sense microvolts, this is almost certain to cause overload and any a.c. signal superimposed on this d.c. shift will be lost.

Our detectors incorporate a bleed system which acts progressively on the d.c. shift caused by temperature slew. The law is logarithmic.

Thus a slew rate of $0.1^\circ C/\text{minute}$ may produce an offset across the sensing element of 200 millivolts, $1^\circ C/\text{minute}$ 280 millivolts and $10^\circ C/\text{minute}$ 360 millivolts.
Pyroelectric infrared detectors

RPY88 Responsivity vs Temperature

RPY88 Noise vs Temperature

RPY88 Noise Equivalent Power vs Temperature

June 1978
Noise v frequency

N(Ef)/V2
(VHz^1/2)

10^-5

10^-6

10^-7

10^-8

10^-9

Frequency (Hz)

1 10 100 1000

Noise equivalent power v frequency

N.E.P.
(WHz^1/2)

10^-7

10^-8

10^-9

Frequency (Hz)

1 10 100 1000

Responsivity (VW^-1)

Responsivity v frequency

Frequency (Hz)

1 10 100 1000 10,000
Pyroelectric infrared detectors

RPY88 RPY89

Responsivity
(VW⁻¹)

Temperature (°C)

Noise
(N(Δf)¹/₂
(VHz⁻¹/₂)

Temperature (°C)

Noise equivalent power
(N.E.P.
(WHz⁻¹/₂)

Temperature (°C)
PHOTOCONDUCTIVE CELL

Evaporated lead sulphide photoconductive cell with sensitive element mounted in a glass dewar, encapsulated in an envelope for room temperature operation. Also available without envelope for cooled operation. The cells are intended for use with pulsed or modulated radiation.

### QUICK REFERENCE DATA

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peak spectral response</strong></td>
<td>$\lambda_m$</td>
</tr>
<tr>
<td><strong>Spectral response range</strong></td>
<td>$\lambda$</td>
</tr>
<tr>
<td><strong>Internal resistance</strong></td>
<td>$r_i$</td>
</tr>
<tr>
<td><strong>Responsivity (radiation 2.0 $\mu$m)</strong></td>
<td>typ.</td>
</tr>
<tr>
<td><strong>$D^*$ (2.0 $\mu$m, 800 Hz, 1 Hz)</strong></td>
<td>typ.</td>
</tr>
<tr>
<td><strong>Time constant</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Sensitive area</strong></td>
<td></td>
</tr>
</tbody>
</table>

### MECHANICAL DATA

Fig. 1.

**Cooled version**

Code No. 9332 401 30

Dimensions in mm

**Encapsulated version**

Code No. 9330 200 30

March 1978
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage (bidirectional) \( V \) max. 250 V
Current (bidirectional) \( I \) max. 0.5 mA

Temperatures
Storage temperature encapsulated version \( T_{stg} \) -55 to +60 °C
cooled version \( T_{stg} \) -80 to +60 °C
Operating ambient temperature \( T_{amb} \) max. 60 °C

CHARACTERISTICS at \( T_{amb} = 20 \) °C (see note 1 on page 3)

Peak spectral response \( \lambda_m \) 2.2 \( \mu m \)
Spectral response range \( \lambda \) typ. 1.5 M\( \Omega \)
Internal resistance \( R_i \) 1.0 to 4.0 M\( \Omega \)
Time constant typ. 100 \( \mu s \)
Noise voltage typ. 8.5 \( \mu V \)

Performance

1. Black body source
colour temperature: 500 K
chopping frequency: 800 Hz
bandwidth: 1 Hz
Responsivity typ. 1.3 mV/\( \mu W \)
\( D^* \) typ. 6.5 x 10^8 cm\( \sqrt{Hz/W} \)
N.E.P. typ. 0.92 nW

2. Monochromatic source
radiation: 2.0 \( \mu m \)
chopping frequency: 800 Hz
bandwidth: 1 Hz
Responsivity typ. 80 mV/\( \mu W \)
\( D^* \) typ. 4 x 10^10 cm\( \sqrt{Hz/W} \)
N.E.P. typ. 15 pW
NOTES

1. Test conditions

The characteristics are measured with the cell biased from a 200 V d.c. supply in series with a 1.0 MΩ load resistor. No correction is made for the loading effect of the 1.0 MΩ resistor, i.e. open circuit characteristics are not given.

The sensitive element is situated at a distance of 264 mm a black body source limited by an aperture of 3 mm. The radiation path is interrupted at 800 Hz by a chopper blade at ambient temperature. Under these conditions the r.m.s. power at the element (chopping factor 2.2) is 4.5 μW/cm².

Measurements of the detector output are made with an amplifier tuned to 800 Hz with a bandwidth of 50 Hz.

2. D* and N. E. P.

These are figures of merit for the materials of detectors.

The detectivity D* is defined in the expression:

$$D^* = \frac{V_s}{V_n} \sqrt{A(\Delta f)}$$

where:

- $V_s$ = signal voltage across detector terminals
- $V_n$ = noise voltage across detector terminals
- $A$ = detector area
- $(\Delta f)$ = bandwidth of measuring amplifier
- $W$ = radiation power incident on detector sensitive element in r.m.s. watts.

The Noise Equivalent Power (N. E. P.) is related to $D^*$ by the expression:

$$N. E. P. = \frac{\sqrt{A}}{D^*}$$

3. Time constant

Detector time constant figures are based on the response to a step function in the incident radiation. Quoted times indicate the interval between the moment the radiation is cut off and the output falling to 63% of its peak value.

4. Variation of performance with bias current.

Both signal and noise vary with current in this type of cell. At high currents the noise increases more rapidly than the signal, and therefore the signal-to-noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell.
NOTES (continued)

5. **Effect of ambient radiation**

Care should be taken to avoid the incidence on the cell of appreciable radiation in the visible range. Such radiation will cause a decrease in the cell resistance and signal as long as the cell is kept cool. Normal daylight can cause this effect if seen for more than a few minutes. Precautions should be taken to prevent visible light reaching the sensitive element via the liquid nitrogen compartment.

6. **Warning**

Care should be taken to ensure that the device is not allowed to reach room temperature while still biased.
The dewar vessel must always be completely dry before being refilled with liquid nitrogen. In very humid conditions, water vapour may condense at the top of the dewar vessel. Should this occur, the remaining liquid nitrogen should be allowed to boil off, the ice should be removed and precautions taken to avoid a recurrence.
relative internal resistance
\( \lambda = 2 \mu m \)
\( f_{\text{chop}} = 800 \text{Hz} \)
\( B = 1 \text{Hz} \)
\( V_S = 200 \text{V} \)
\( R_L = 1 \text{M} \Omega \)

\[ \eta \text{ at } T_{\text{amb}} \]

\[ \frac{\eta}{\eta \text{ at } 20^\circ C} \]

\( T_{\text{amb}} (^\circ C) \)

\( 100 \)

\( 0 \)

\( 10^{-1} \)

\[ \text{typ} \]

relative values

\( \lambda = 2 \mu m \)

\( f_{\text{chop}} = 800 \text{Hz} \)

\( B = 1 \text{Hz} \)

\( T_{\text{amb}} = 20^\circ C \)

responsivity

\( F \)

\( \eta \)

\( V_S \)

\( 1.5 \text{ M} \Omega \)

\( 1 \text{M} \Omega \)

\[ \text{typ} \]

\[ \text{typ} \]

\[ \text{typ} \]

\[ \text{typ} \]

November 1970
relative response

$10^2$

$10^1$

$10^0$

$10^{-1}$

$10^{-2}$

$10^{-3}$

colour temperature (K)

$200$ $400$ $600$ $800$

$f_{chop} = 800\text{Hz}$

$B = 1\text{Hz}$

$T_{amb} = 20^\circ\text{C}$

typ
cooled version

typical values
$I = 25\mu A$
$f_{\text{chop}} = 800\text{Hz}$
$B = 1\text{Hz}$

$D^* = \frac{\text{cm}^2\sqrt{\text{Hz}}}{\text{W}}$

$T_{\text{amb}} = -76^\circ\text{C}, -40^\circ\text{C}, 0^\circ\text{C}, +20^\circ\text{C}$
PHOTOCONDUCTIVE DEVICES
# LIST OF SYMBOLS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>Cell voltage</td>
</tr>
<tr>
<td>I</td>
<td>Cell current</td>
</tr>
<tr>
<td>I_l</td>
<td>Illumination current</td>
</tr>
<tr>
<td>I_{l0}</td>
<td>Initial illumination current</td>
</tr>
<tr>
<td>I_{le}</td>
<td>Equilibrium illumination current</td>
</tr>
<tr>
<td>I_d</td>
<td>Dark current</td>
</tr>
<tr>
<td>I_{do}</td>
<td>Initial dark current</td>
</tr>
<tr>
<td>I_{de}</td>
<td>Equilibrium dark current</td>
</tr>
<tr>
<td>r_l</td>
<td>Illumination resistance</td>
</tr>
<tr>
<td>r_{lo}</td>
<td>Initial illumination resistance</td>
</tr>
<tr>
<td>r_{le}</td>
<td>Equilibrium illumination resistance</td>
</tr>
<tr>
<td>r_d</td>
<td>Dark resistance</td>
</tr>
<tr>
<td>r_{do}</td>
<td>Initial dark resistance</td>
</tr>
<tr>
<td>r_{de}</td>
<td>Equilibrium dark resistance</td>
</tr>
<tr>
<td>t_{ri}</td>
<td>Current rise time</td>
</tr>
<tr>
<td>t_{fl}</td>
<td>Current decay time</td>
</tr>
<tr>
<td>t_p</td>
<td>Pulse duration</td>
</tr>
<tr>
<td>t_{av}</td>
<td>Averaging time</td>
</tr>
<tr>
<td>p_{rr}</td>
<td>Pulse repetition rate</td>
</tr>
<tr>
<td>N</td>
<td>Illumination sensitivity</td>
</tr>
<tr>
<td>\gamma</td>
<td>Illumination response</td>
</tr>
<tr>
<td>\alpha</td>
<td>Voltage response</td>
</tr>
<tr>
<td>T_{amb}</td>
<td>Ambient temperature</td>
</tr>
<tr>
<td>R_{th}</td>
<td>Thermal resistance</td>
</tr>
<tr>
<td>T_{tablet}</td>
<td>Temperature of CdS tablet</td>
</tr>
<tr>
<td>T_{c} (T_K)</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Dissipation</td>
</tr>
<tr>
<td>E</td>
<td>Illumination</td>
</tr>
<tr>
<td>D_{0}</td>
<td>Initial drift</td>
</tr>
<tr>
<td>M</td>
<td>Peak value (subscript)</td>
</tr>
</tbody>
</table>
GENERAL OPERATIONAL RECOMMENDATIONS
PHOTOCONDUCTIVE DEVICES

1. GENERAL
1.1 These application directions are valid for all types of photoconductive cells, unless otherwise stated on the individual technical data sheets.
1.2 A photoconductive device is a light-sensitive device whose resistance varies with the illumination on the device.
1.3 Where the term illumination is used in the following sections it shall be taken to mean the radiant energy which is normally used to excite the device.
1.4 Also in the following sections, history is taken to mean the duration of the specified conditions plus a sufficient description of previous conditions.

2. OPERATING CHARACTERISTICS
2.1 The data given on the individual technical data sheets are based on the devices being uniformly illuminated.
2.2 The illumination resistance is the ratio of the voltage across the device to the current through the device when illumination is applied to the device.
2.2.1 For a particular set of conditions the equilibrium illumination resistance is the illumination resistance after such a time under these conditions that the rate of change of the illumination resistance is less than 1% per 5 minutes.
2.2.2 For a particular set of conditions the initial illumination resistance is the first virtually constant value of the illumination resistance after a period of storage or other operating conditions.
The initial-illumination resistance usually occurs after a few seconds under the specified conditions.
2.3 The illumination current is the current which passes when a voltage and illumination are applied to the device.
2.3.1 For a particular set of conditions the equilibrium illumination current is the illumination current after such a time under these conditions that the rate of change of the illumination current is less than 1% per 5 minutes.
2.3.2 For a particular set of conditions the initial illumination current is the first virtually constant value of the illumination current after a period of storage or other operating conditions. The initial illumination current usually occurs after a few seconds under the specified conditions.

2.4 The dark resistance is the resistance of the device in the absence of illumination.

2.4.1 For a particular set of conditions the equilibrium dark resistance is the dark resistance after such a time under these conditions that the rate of change of the dark resistance is less than 2% per 5 minutes.

2.4.2 For a particular set of conditions the initial dark resistance is the dark resistance after a specified time under these conditions following a specified history.

2.5 The dark current is the current which passes when a voltage is applied to the device in the absence of illumination.

2.5.1 For a particular set of conditions the equilibrium dark current is the dark current after such a time under these conditions that the rate of change of the dark current is less than 2% per 5 minutes.

2.5.2 For a particular set of conditions the initial dark current is the dark current after a specified time under these conditions immediately following a specified history.
2.6.1 For a particular set of conditions and history the current rise time is the time taken for the current through the device to rise to 90% of its initial illumination current measured from the instant of starting the illumination.

2.6.2 For a particular set of conditions and history the current decay time is the time taken for the current through the device to fall to 10% of its value at the instant of stopping the illumination, measured from that instant.

2.7 The illumination sensitivity is the quotient of illumination current by the incident illumination.

2.8 The illumination resistance (current) temperature response is the relationship between the illumination resistance (current) and the ambient temperature of the device under constant illumination and voltage conditions.

2.9 For a particular set of conditions the initial drift is the difference between the equilibrium and initial illumination current, expressed as a percentage of the initial illumination current.

2.10 The illumination response is the relationship between the initial illumination resistance and the illumination, defined as $\frac{\Delta \log I_{10}}{\Delta \log E}$.
3. THERMAL DATA

3.1 Ambient temperature. The ambient temperature of a device is the temperature of the surrounding air of that device in its practical situation, which means that other elements in the same space or apparatus must have their normal maximum dissipation and that the same apparatus envelope must be used. This ambient temperature can normally be measured by using a mercury thermometer the mercury container of which has been blackened, placed at a distance of 5 mm from the envelope in the horizontal plane through the centre of the effective area of the CdS tablet. It shall be exposed to substantially the same radiant energy as that incident on the CdS tablet.

3.2 The thermal resistance of a device is defined as the temperature difference between the hottest point of the device and the dissipating medium, divided by the power dissipated in the device.

4. OPERATIONAL NOTES

4.1 When a photoconductive device is subjected to a change of operating conditions there may be a transient change of current in excess of that due to the difference between the equilibrium illumination currents. This transient change is called overshoot.

4.2 Direct sunlight irradiation should be avoided.

5. MOUNTING

5.1 If no restrictions are made on the individual published data sheets, the device may be mounted in any position.

5.2 Most of the photoconductive devices may be soldered directly into the circuit, which is indicated on the individual published data sheets. However, the heat conducted to the seal of the device should be kept to a minimum by the use of a thermal shunt. If not otherwise indicated, the device may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 seconds up to a point 5 mm from the seals.
6. STORAGE
It is recommended that the devices be stored in the dark. At any rate direct sunlight irradiation should be avoided.

7. LIMITING VALUES
The limiting values of photoconductive devices are given in the absolute maximum rating system.

8. OUTLINE DIMENSIONS
The outline dimensions are given in mm.

9. MECHANICAL ROBUSTNESS
The conditions for shock and vibration given on the individual data sheets are intended only to give an indication of the mechanical quality of the device. It is not advisable to subject the device to such conditions.

Type D response curve
PHOTOCONDUCTIVE DEVICES

Current rise curves for cells with type D response curve

Current decay curves for cells with type D response curve
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Top sensitive cadmium sulphide photoconductive cell in hermetically sealed metal envelope with glass window intended for use in general control circuits such as twilight switches and flame failure circuits. The cell is shock and vibration resistant.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power dissipation at $T_{\text{amb}} = 25^\circ\text{C}$</td>
</tr>
<tr>
<td>Cell voltage, d.c. and repetitive peak</td>
</tr>
<tr>
<td>Cell resistance at 50 lx, 2700 K colour temperature</td>
</tr>
<tr>
<td>Spectral response, current rise and decay curves</td>
</tr>
<tr>
<td>Outline dimensions</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

![Dimensions Diagram](image-url)
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Top and side sensitive cadmium sulphide photoconductive cell in hermetically sealed all-glass envelope intended for on-off applications such as flame failure circuits. The cell is shock and vibration resistant.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power dissipation at $T_{amb} = 25 , ^\circ C$</td>
<td>$P_{\text{max.}} = 0.4 , \text{W}$</td>
</tr>
<tr>
<td>Cell voltage, d.c. and repetitive peak</td>
<td>$V_{\text{max.}} = 200 , \text{V}$</td>
</tr>
<tr>
<td>Cell resistance at 50 lx, 2700 K colour temperature</td>
<td>$r_{10} , \text{typ.} = 1200 , \Omega$</td>
</tr>
<tr>
<td>Spectral response, current rise and decay curves</td>
<td>type D</td>
</tr>
<tr>
<td>Outline dimensions</td>
<td>max. $15.9 , \text{dia.} \times 44 , \text{mm}$</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Dimensions in mm

Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of $240 \, ^\circ C$ for maximum 10 s up to a point 5 mm from the seals.

1) Not tinned.

2) Centre of sensitive area.
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

Top sensitive cadmium sulphide photoconductive cells in hermetically sealed all-glass envelope intended for on-off applications such as flame failure circuits, and for automatic brightness and contrast control in television receivers. The cells are shock and vibration resistant.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power dissipation at $T_{\text{amb}} = 25 \degree \text{C}$</td>
</tr>
<tr>
<td>Cell voltage, d.c. and repetitive peak</td>
</tr>
<tr>
<td>Cell resistance at 50 lx, 2700 K colour temperature, ORP60</td>
</tr>
<tr>
<td>ORP66</td>
</tr>
<tr>
<td>Spectral response, current rise and decay curves</td>
</tr>
<tr>
<td>Outline dimensions</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for maximum 10 s up to a point 5 mm from the seals.

1) Not tinned.
2) Sensitive surface.
3) Blue dot on ORP66.
ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at $T_{\text{amb}} = 25 \, ^{\circ}\text{C}$, illumination with colour temperature of 2700 K and at delivery

<table>
<thead>
<tr>
<th></th>
<th>ORP60</th>
<th>ORP66</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial dark resistance</td>
<td>$r_{\text{do}} &gt;$</td>
<td>200</td>
</tr>
<tr>
<td>measured at 300 V d.c.</td>
<td></td>
<td>MΩ</td>
</tr>
<tr>
<td>applied via</td>
<td></td>
<td>1 MΩ</td>
</tr>
<tr>
<td>1 MΩ, 20 s after</td>
<td></td>
<td></td>
</tr>
<tr>
<td>switching off the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>illumination</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Initial illumination resistance

<table>
<thead>
<tr>
<th></th>
<th>$r_{\text{io}}$</th>
<th>$r_{\text{le}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>measured at 30 V d.c.</td>
<td>typ. 60 $\Omega$</td>
<td>typ. 75 $\Omega$</td>
</tr>
<tr>
<td>illumination = 50 lx,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>after 16 hrs in darkness</td>
<td>$&lt; 37.5 \Omega$</td>
<td>$&lt; 37.5 \Omega$</td>
</tr>
</tbody>
</table>

Equilibrium illumination resistance

<table>
<thead>
<tr>
<th></th>
<th>$r_{\text{le}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>measured at 30 V d.c.</td>
<td>typ. 75 $\Omega$</td>
</tr>
<tr>
<td>illumination = 50 lx,</td>
<td></td>
</tr>
<tr>
<td>after 15 min under the</td>
<td></td>
</tr>
<tr>
<td>measuring conditions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$&lt; 190 \Omega$</td>
</tr>
</tbody>
</table>

Negative temperature response of illumination resistance

<table>
<thead>
<tr>
<th></th>
<th>typ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage response $r$ at</td>
<td>0,2</td>
</tr>
<tr>
<td>0.5 V d.c.</td>
<td>%/°C</td>
</tr>
<tr>
<td>$r$ at 30 V d.c.</td>
<td>0,5</td>
</tr>
<tr>
<td></td>
<td>%/°C</td>
</tr>
</tbody>
</table>

1) The spread of the dark resistance is large and values higher than 1000 MΩ are possible for the initial dark resistance.

2) After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage d.c. and repetitive peak
\[ V \text{ max. } 350 \text{ V} \]

Cell voltage, pulse, \( t_p \leq 5 \text{ ms}, \) \( P_{rr} \leq \text{ once per minute} \)
\[ V_M \text{ max. } 500 \text{ V} \]

Power dissipation \((t_{av} = 2 \text{ s})\) see graph \( P_{max} \)

Power dissipation, pulse
\[ P_M \text{ max. } 5 \times P_{max} \]

Illumination
\[ E \text{ max. } 50000 \text{ lx} \]

Temperature CdS tablet, operating
\[ T_{tablet} \text{ max. } 85 \text{ °C} \]

Ambient temperature, storage and operation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage ( T_{stg} ) max.</td>
<td>50 °C</td>
</tr>
<tr>
<td>Operating ( T_{amb} ) max.</td>
<td>70 °C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating ( T_{amb} ) max.</td>
<td>70 °C</td>
</tr>
<tr>
<td>Storage ( T_{stg} ) max.</td>
<td>50 °C</td>
</tr>
</tbody>
</table>

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in illumination resistance of the cells during life under rated load from \(-50\%\) to \(+100\%\) (typ. \(+50\%) do not impair the circuit performance. Direct irradiation by sunlight should be avoided.

MECHANICAL ROBUSTNESS

An indication for the ruggedness of the device is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95\% of the devices pass these tests without perceptible damage.

Shock
\[ 25 \text{ g}_{peak}, \text{ 10 000 shocks in one of the three positions of the cell.} \]

Vibration
\[ 2.5 \text{ g}_{peak}, \text{ 50 Hz, during 32 hours in each of the three positions of the cell.} \]

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.

December 1972
$P_{\text{max}}$ (mW) vs. $T_{\text{amb}}$ (°C)

$T_{\text{av}} = 2\text{s}$ free in air

$T_C = 2700\text{ K}$
$V_{\text{dc}} = 30\text{ V}$ after 16 h in darkness

December 1972
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

Side sensitive cadmium sulphide photoconductive cells in hermetically sealed all-glass envelope intended for on-off applications such as flame failure circuits, and for automatic brightness and contrast control in television receivers. The cells are shock and vibration resistant.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th></th>
<th>ORP61</th>
<th>ORP62</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power dissipation at (T_{\text{amb}} = 25 , ^\circ \text{C})</td>
<td>(P) max.</td>
<td>70</td>
</tr>
<tr>
<td>Cell voltage, d.c. and repetitive peak</td>
<td>(V) max.</td>
<td>350</td>
</tr>
<tr>
<td>Cell resistance at 50 lx, 2700 K colour temperature</td>
<td>(r_{10}) typ.</td>
<td>60</td>
</tr>
<tr>
<td>Spectral response, current rise and decay curves</td>
<td>type D</td>
<td></td>
</tr>
<tr>
<td>Outline dimensions</td>
<td>max. 6 dia. x 15.5 mm</td>
<td></td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Dimensions in mm

![Diagram of the cells with dimensions labeled]

**Soldering**

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of 240 \(^\circ\)C for maximum 10 s up to a point 5 mm from the seals.

1) Not tinned
2) Centre of sensitive area
3) ORP61 brown dot; ORP62 red dot.

December 1972
ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at $T_{amb} = 25^\circ C$, illumination with colour temperature of 2700 K and at delivery.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>ORP61</th>
<th>ORP62</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial dark resistance</td>
<td>$r_{do}$</td>
<td>&gt; 200</td>
</tr>
<tr>
<td>measured at 300 V d.c. applied via 1 M$\Omega$, 20 s after switching off the illumination</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial illumination resistance</td>
<td>$r_{io}$</td>
<td>&gt; 37,5</td>
</tr>
<tr>
<td>measured at 30 V d.c., illumination = 50 lx, after 16 hrs in darkness 2)</td>
<td>typ.</td>
<td>60</td>
</tr>
<tr>
<td>Equilibrium illumination resistance</td>
<td>$r_{ie}$</td>
<td>&gt; 37,5</td>
</tr>
<tr>
<td>measured at 30 V d.c., illumination = 50 lx, after 15 min under the measuring conditions</td>
<td>typ.</td>
<td>75</td>
</tr>
<tr>
<td>Negative temperature response of illumination resistance</td>
<td>typ.</td>
<td>&lt; 0,5</td>
</tr>
<tr>
<td>Voltage response</td>
<td>$\alpha$</td>
<td>typ.</td>
</tr>
</tbody>
</table>

1) The spread of the dark resistance is large and values higher than 1000 M$\Omega$ are possible for the initial dark resistance.

2) After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.
### RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell voltage, d.c. and repetitive peak</td>
<td>$V_{\text{max}}$</td>
<td>V</td>
<td>350 V</td>
</tr>
<tr>
<td>Cell voltage, pulse, $t_p \leq 5$ ms, $P_{\text{TR}} \leq$ once per minute - ORP61</td>
<td>$V_M$</td>
<td>V</td>
<td>500 V</td>
</tr>
<tr>
<td></td>
<td>$V_M$</td>
<td>V</td>
<td>1000 V</td>
</tr>
<tr>
<td>Power dissipation ($t_{\text{av}} = 2$ s) see graph $P_{\text{max}}$</td>
<td>$P_{\text{M}}$</td>
<td>max. $5 \times P_{\text{max}}$</td>
<td></td>
</tr>
<tr>
<td>Power dissipation, pulse</td>
<td>$E$</td>
<td>max.</td>
<td>50 000 lx</td>
</tr>
<tr>
<td>Temperature CdS tablet, operating</td>
<td>$T_{\text{tablet}}$</td>
<td>max.</td>
<td>85 °C</td>
</tr>
<tr>
<td>Ambient temperature, storage and operation storage</td>
<td>$T_{\text{amb}}$</td>
<td>min.</td>
<td>-40 °C</td>
</tr>
<tr>
<td></td>
<td>$T_{\text{stg}}$</td>
<td>max.</td>
<td>50 °C</td>
</tr>
<tr>
<td></td>
<td>$T_{\text{amb}}$</td>
<td>max.</td>
<td>70 °C</td>
</tr>
</tbody>
</table>

### DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that under rated load, during life, changes in illumination resistance - for ORP61 from $-50\%$ to $+100\%$ (typ. $+50\%$) and for ORP62 from $-30\%$ to $+70\%$ (typ. $+40\%$) - do not impair the circuit performance.

Direct irradiation by sunlight should be avoided.

### MECHANICAL ROBUSTNESS

An indication for the ruggedness of the device is the following:

Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

#### Shock

25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

#### Vibration

2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

---

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.
P_{max} (mW)

T_{amb} (°C)

T_{C} = 2700 K
V_{dc} = 30 V
after 16 h in darkness
typ. values

December '1972
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

See data ORP60
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

Top and side sensitive cadmium sulphide photoconductive cells in hermetically sealed all-glass envelope intended for on-off applications such as flame failure circuits, and for automatic brightness and contrast control in television receivers. The cells are shock and vibration resistant.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power dissipation at $T_{\text{amb}} = 25 , ^\circ\text{C}$</td>
<td>$P_{\text{max}} = 100 , \text{mW}$</td>
</tr>
<tr>
<td>Cell voltage, d.c. and repetitive peak</td>
<td>$V_{\text{max}} = 350 , \text{V}$</td>
</tr>
<tr>
<td>Cell resistance at 50 lx,</td>
<td>$r_{10} = 64 , \text{k}\Omega$</td>
</tr>
<tr>
<td>2700 K colour temperature, ORP68</td>
<td>$r_{10} = 30 , \text{k}\Omega$</td>
</tr>
<tr>
<td>ORP69</td>
<td></td>
</tr>
<tr>
<td>Spectral response, current rise and</td>
<td>type D</td>
</tr>
<tr>
<td>decay curves</td>
<td></td>
</tr>
<tr>
<td>Outline dimensions</td>
<td>$\text{max.} = 6 \text{ dia. x 15.5 mm}$</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Dimensions in mm

Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of $240 \, ^\circ\text{C}$ for maximum 10 s up to a point 5 mm from the seals.

1) Not tinned.
2) Centre of sensitive area.
3) ORP68: gray dot; ORP69: white dot.
The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and the time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

**Basic characteristics at** $T_{\text{amb}} = 25\, ^\circ\text{C}$, illumination with colour temperature of $2700\, \text{K}$ and at delivery.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>ORP68</th>
<th>ORP69</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial dark resistance</td>
<td>$r_{do} &gt; 150$ MΩ</td>
<td>$100$ MΩ</td>
</tr>
<tr>
<td>Initial illumination resistance</td>
<td>$r_{i0}$ typ. $46$ kΩ</td>
<td>$30$ kΩ</td>
</tr>
<tr>
<td>Equilibrium illumination resistance</td>
<td>$r_{le}$ typ. $60$ kΩ</td>
<td>$46$ kΩ</td>
</tr>
<tr>
<td>Voltage response $r$ at $0.5, \text{V d.c.}$</td>
<td>typ. $1.4$ %/°C</td>
<td></td>
</tr>
<tr>
<td>Voltage response $r$ at $30, \text{V d.c.}$</td>
<td>typ. $0.5$ %/°C</td>
<td></td>
</tr>
</tbody>
</table>

1) The spread of the dark resistance is large and values higher than $1000\, \text{MΩ}$ are possible for the initial dark resistance.
2) After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.
3) Measured at top sensitivity.
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell voltage, d.c. and repetitive peak</td>
<td>V</td>
<td>350</td>
</tr>
<tr>
<td>Cell voltage, pulse, $t_p \leq 5$ ms, $p_{rr} \leq$ once per minute - ORP68</td>
<td>V&lt;sub&gt;M&lt;/sub&gt;</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>V&lt;sub&gt;M&lt;/sub&gt;</td>
<td>700</td>
</tr>
<tr>
<td>Power dissipation ($t_{av} = 2$ s) see graph $P_{max}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power dissipation, pulse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illumination</td>
<td>V&lt;sub&gt;M&lt;/sub&gt;</td>
<td>5 x $P_{max}$</td>
</tr>
<tr>
<td>Temperature of CdS tablet, operating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_{tablet}$</td>
<td>°C</td>
<td>+85</td>
</tr>
<tr>
<td>Ambient temperature, storage and operating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_{amb}$</td>
<td>°C</td>
<td>-40</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>°C</td>
<td>+50</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>°C</td>
<td>+70</td>
</tr>
</tbody>
</table>

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be so designed that changes in illumination resistance of the cells during life under rated load from $-30\%$ to $+70\%$ (typ. $+40\%$) do not impair the circuit performance. Direct irradiation by sunlight should be avoided.

MECHANICAL ROBUSTNESS

An indication of the ruggedness of the device is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock
25 $g_{peak}$: 10 000 shocks in one of the three positions of the cell

Vibration
2.5 $g_{peak}$: 50 Hz, during 32 hours in each of the three positions of the cell.

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.
$P_{\text{max}} (\text{mW})$

- $t_{av} = 2 \text{s}$
- free in air

$T_{\text{amb}} (^{\circ} \text{C})$

$T_c = 2700 \text{ K}$
$V_{dc} = 30 \text{ V}$
after 16h in darkness

typ. values

ORP68

ORP69

December 1972
CADMIUM SULPHIDE PHOTOCONDUCTIVE DEVICE

Cadmium sulphide photoconductive device with side sensitivity in plastic encapsulation. The device consists of two cells connected in series and is intended for general applications.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power dissipation at $T_{amb} \leq 25 , ^\circ C$</td>
<td>$P$ 100 mW</td>
</tr>
<tr>
<td>Voltage, d.c. and repetitive peak</td>
<td>$V_{max.}$ 50 V</td>
</tr>
<tr>
<td>Resistance at 50 lux, $T_C = 2700 , ^\circ K$</td>
<td>$r_{10}$ 600 $\Omega$</td>
</tr>
<tr>
<td>Wavelengths at 50% sensitivity</td>
<td>$\lambda$ 500 and 675 nm</td>
</tr>
<tr>
<td>Outline dimensions</td>
<td>max. $5.3 \times 5.3 \times 1.4 , mm$</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Soldering

The device may be soldered direct into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt.

It may be dip-soldered at a solder temperature of 270 $^\circ C$ for a maximum of 2 s up to a point 6 mm from the envelope.

October 1972
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell voltage, d.c. and repetitive peak</td>
<td>$V_{MM}$</td>
<td>max.</td>
<td>50 V</td>
</tr>
<tr>
<td>Cell voltage, $P_{rr}$ ≤ once per minute, $t_p ≤ 5$ ms</td>
<td>$V_M$</td>
<td>max.</td>
<td>100 V</td>
</tr>
<tr>
<td>Power dissipation, $t_{av} = 0.5$ s, $T_{amb} ≤ 25$ °C</td>
<td>$P$</td>
<td>max.</td>
<td>100 mW</td>
</tr>
<tr>
<td>Cell current, d.c. and repetitive peak</td>
<td>$I$</td>
<td>max.</td>
<td>25 mA</td>
</tr>
<tr>
<td>Ambient temperature, storage and operating storage</td>
<td>$T_{amb}$</td>
<td>min.</td>
<td>−40 °C</td>
</tr>
<tr>
<td></td>
<td>$T_{stg}$</td>
<td>max.</td>
<td>+50 °C</td>
</tr>
<tr>
<td>Temperature of CdS tablet</td>
<td>$T_{tablet}$</td>
<td>max.</td>
<td>+70 °C</td>
</tr>
</tbody>
</table>

THERMAL RESISTANCE

Thermal resistance from CdS tablet to ambient

$R_{th \text{ t-a}} = 0,45 \, ^\circ\text{C/mW}$

CHARACTERISTICS

Initial dark resistance,
measured with 50 V d.c. applied via
1 MΩ, 20 s after switching off the illumination

$\theta_{do} > 200 \, \text{kΩ}$

Initial illumination resistance
measured at 1 V d.c., illumination
50 lx, $T_c = 2700$ K

$r_{lo}$ typ. 0,6 kΩ

Initial drift
$D_o$ typ. 0 %

$F_{4700} = \frac{r_1 \text{ at } 4700 \, \text{K}}{r_1 \text{ at } 2856 \, \text{K}}$ at constant illumination
and using a Davis-Gibson filter
typ. 1,2

OPERATING NOTES

1. The device consists of two photoconductive cells connected in series. The resistance
   of the device is mainly governed by the resistance of that cell receiving the lower
   luminous flux.
   If it is required for any application that the device is partly shaded, the shadow line
   should be perpendicular to the axis of the device.

2. For optimum heat dissipation use the shortest permissible lead length.
after 16 hrs in darkness

\[ V = 1 \text{ V} \]

\[ T_c = 2700 \text{ K} \]
CADMIUM SULPHIDE PHOTOCONDUCTIVE DEVICE

Cadmium sulphide photoconductive cell with side sensitivity in a plastic encapsulation. The device consists of two cells in series and is intended for use in cameras, exposure meters, light control equipment and for general industrial use.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power dissipation</td>
</tr>
<tr>
<td>Cell voltage, d.c. and repetitive peak</td>
</tr>
<tr>
<td>Cell resistance at 10 lux, 2700 °K</td>
</tr>
<tr>
<td>Outline dimensions</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Dimensions in mm

Soldering

The device may be soldered direct into the circuit but heat conducted to the seals should be kept at a minimum by the use of a thermal shunt. Dip soldering at a solder temperature of 270 °C may be employed for a maximum of 2 s up to a point 6 mm from the seals.
# ELECTRICAL DATA

**Basic characteristics at** $T_{\text{amb}} = 25 \, ^\circ\text{C}$, illumination with 2700 K c.t.

**Pre-conditioning 1 h illumination with 300 lx (fluorescent light)**

<table>
<thead>
<tr>
<th></th>
<th>symbol</th>
<th>min.</th>
<th>typical</th>
<th>max.</th>
<th>unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial dark resistance</td>
<td>$r_{do}$</td>
<td>0.6</td>
<td></td>
<td></td>
<td>MΩ</td>
</tr>
<tr>
<td>measured with 50 V d.c. applied via 1 MΩ, 20 s after stopping the illumination of 10 lx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial illumination resistance</td>
<td>$r_{10}$</td>
<td>2.4</td>
<td>6.0</td>
<td></td>
<td>kΩ</td>
</tr>
<tr>
<td>measured at $V = 1$ V d.c., illumination 10 lx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illumination response $1)$</td>
<td>$\gamma_{0.1-10}$</td>
<td>0.94</td>
<td>1.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>measured at 1 V d.c. between 0.1 lx and 10 lx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative temperature response of illumination resistance</td>
<td>$r_{1}/\Delta T$</td>
<td>0.5</td>
<td></td>
<td></td>
<td>%/°C</td>
</tr>
<tr>
<td>between $-10 , ^\circ\text{C}$ and $+40 , ^\circ\text{C}$ at 1 lx, $V = 1$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-conditioning factor $2)$</td>
<td></td>
<td>0.9</td>
<td>1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actinism</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illumination at 2700 K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illumination at 4700 K (referred to the same cell current)</td>
<td>0.9</td>
<td>1.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) $\gamma = \frac{\log r_1 - \log r_2}{\log E_2 - \log E_1}$ where $E_1 = 0.1$ lx and $E_2 = 10$ lx

2) Pre-conditioning factor = \[ \frac{\text{Cell current at 1 lx, after 3 days in darkness}}{\text{Cell current at 1 lx, after 1 h pre-conditioning at 300 lx (fluorescent light)}} \]

measured when a stable current is reached
LIMITING VALUES (Absolute max. rating system)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell voltage, d.c. and repetitive peak</td>
<td>V max. 50 V</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>P max. 50 mW</td>
</tr>
<tr>
<td>Cell current, d.c. and repetitive peak</td>
<td>I max. 20 mA</td>
</tr>
<tr>
<td>Operating ambient temperature</td>
<td>Tamb -40 to +70 °C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>Tstg -40 to +70 °C</td>
</tr>
</tbody>
</table>

OPERATING NOTE

The device consists of two photoconductive cells connected in series. The resistance of the device is mainly governed by the resistance of that cell receiving the lowest luminous flux. If it is essential for the application that the device is partly shaded off, the shadow line should be perpendicular to the axis A-A of the device.
The graph shows the initial illumination resistance at $T_k=2700\text{ K}$ measured at $1V_{d.c.}$. The resistance, $r_0$, varies with the intensity of illumination, $E$ (lx), on a logarithmic scale.
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Side sensitive cadmium sulphide photoconductive cell protected by a lacquer coating.
The device withstands the steady state damp heat test of IEC Publication 68-2-3 (test Ca: severity 56 days).

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power dissipation at $T_{\text{amb}} = 25 , ^\circ\text{C}$</td>
</tr>
<tr>
<td>Cell voltage, d.c. and repetitive peak</td>
</tr>
<tr>
<td>Cell resistance at 50 lx, 2700 K colour temperature</td>
</tr>
<tr>
<td>Spectral response, current rise and decay curves</td>
</tr>
<tr>
<td>Outline dimensions</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Soldering
The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of 240 $^\circ$C for maximum 10 s up to a point 5 mm from the stress relief band.

Mounting
The cell is not insulated electrically and should be mounted accordingly.

Notice
If the cell is to be encapsulated, request manufacturer's instructions.

1) Stress relief band.

November 1972
ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at $T_{\text{amb}} = 25 \, ^\circ\text{C}$, illumination with colour temperature of 2700 K and at delivery

Initial dark resistance
measured with 100 V d. c. applied via 1 $\text{M}\Omega$, 20 s after switching off the illumination

$$r_{do} > 6 \, \text{M}\Omega \, ^1)$$

Equilibrium dark resistance
measured with 100 V d. c. applied via 1 $\text{M}\Omega$, 30 minutes after switching off the illumination

$$r_{de} > 50 \, \text{M}\Omega \, ^1)$$

Initial illumination resistance
measured at 10 V d. c., illumination = 50 lx, after 16 hrs in darkness $^2)$

$$r_{io} \text{ typ.} \quad 560 \text{ to } 2800 \, \Omega$$

Equilibrium illumination resistance
measured at 10 V d. c., illumination = 50 lx, after 15 min under the measuring conditions

$$r_{ie} \text{ typ.} \quad 560 \text{ to } 3800 \, \Omega$$

Negative temperature response of illumination resistance

$$< 0,5 \, \%/\text{^\circ\text{C}} \text{ typ.} \quad 0,2 \, \%/\text{^\circ\text{C}}$$

Voltage response

$$\frac{r \text{ at } 0,5 \text{ V d. c.}}{r \text{ at } 10 \text{ V d. c.}} \quad \alpha \quad \text{typ.} \quad 1,05$$

$^1)$ The spread of the dark resistance is large and values higher than 100 M$\Omega$ and 1000 M$\Omega$ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

$^2)$ After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.
**RATINGS** Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell voltage, d.c. and repetitive peak</td>
<td>V max. 100 V</td>
</tr>
<tr>
<td>Cell voltage, pulse, $t_p \leq 5$ ms, $p_{RR} \leq$ once per minute</td>
<td>$V_M$ max. 250 V</td>
</tr>
<tr>
<td>Power dissipation ($t_{av} = 2$ s) see graph $P_{max}$</td>
<td>$P_M$ max. $5xP_{max}$</td>
</tr>
<tr>
<td>Power dissipation, pulse</td>
<td>$P_M$ max. $5xP_{max}$</td>
</tr>
<tr>
<td>Cell current, d.c. and repetitive peak</td>
<td>I max. 100 mA</td>
</tr>
<tr>
<td>Illumination</td>
<td>E max. 50 000 lx</td>
</tr>
<tr>
<td>Temperature Cds tablet, operating</td>
<td>$T_{tablet}$ max. $+85$ °C</td>
</tr>
<tr>
<td>Ambient temperature, storage and operation</td>
<td>$T_{Amb}$ min. $-40$ °C</td>
</tr>
<tr>
<td>storage</td>
<td>$T_{stg}$ max. $-50$ °C</td>
</tr>
<tr>
<td>operating</td>
<td>$T_{Amb}$ max. $+70$ °C</td>
</tr>
</tbody>
</table>

**DESIGN CONSIDERATIONS**

Apparatus with Cds cells should be designed so that changes in illumination resistance of the cells during life under rated load from $-30\%$ to $+70\%$ (typ. $+40\%$) do not impair the circuit performance. Direct sunlight irradiation should be avoided.

**CLIMATIC DATA**

The device withstands the damp heat test Ca (steady state) of IEC Publication 68-2-3; severity 56 days, under no-load conditions or under continuous load conditions such that the tablet temperature is $\geq 5$ °C above ambient temperature.

**MECHANICAL ROBUSTNESS**

**Tensile test**

The device withstands the tensile test of IEC Publication 68-2-21, Test Ua; loading weight 500 g.

**Pull test**

The device withstands the following test: The leads are bent outwards over an angle of $90^\circ$ at 2 mm from the stress relief band; a pulling force of 500 g is then applied at the end of the leads.

---

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.
$T_C = 2700 \text{ K}$

$V_{dc} = 10 \text{ V}$

after 16 h in darkness

$T_{amb} (\text{ C})$
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Side sensitive cadmium sulphide photoconductive cell protected by a lacquer coating. The device withstands the steady state damp heat test of IEC publication 68-2-3 (test Ca: severity 56 days).

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power dissipation at $T_{\text{amb}} = 25, ^\circ\text{C}$</td>
<td>$P_{\text{max.}} = 0.75, \text{W}$</td>
</tr>
<tr>
<td>Cell voltage, d.c. and repetitive peak</td>
<td>$V_{\text{max.}} = 400, \text{V}$</td>
</tr>
<tr>
<td>Cell resistance at 50 lx, 2700 K colour temperature</td>
<td>$r_{10 \text{ typ.}} = 1150, \Omega$</td>
</tr>
<tr>
<td>Spectral response, current rise and decay curves</td>
<td>type D</td>
</tr>
<tr>
<td>Outline dimensions</td>
<td>max. $29.5 \times 12.6 \times 1.5, \text{mm}$</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Dimensions in mm

Soldering
The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of 240 $\, ^\circ\text{C}$ for maximum 10 s up to a point 5 mm from the stress relief band.

Mounting
The cell is not insulated electrically and should be mounted accordingly.

Notice
If the cell is to be encapsulated, request manufacturer's instructions.

1) Stress relief band.

November 1972
ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at $T_{\text{amb}} = 25 \, ^{\circ}C$, illumination with colour temperature of $2700 \, K$ and at delivery

Initial dark resistance measured with 400 V d.c. applied via 1 MΩ, 20 s after switching off the illumination

$\quad r_{\text{do}} > 9 \, \text{MΩ}$

Equilibrium dark resistance measured with 400 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination

$\quad r_{\text{de}} > 200 \, \text{MΩ}$

Initial illumination resistance measured at 10 V d.c., illumination = 50 lx, after 16 hrs in darkness $^2$)

$\quad r_{\text{lo}} \, \text{typ.} \, 1150 \, \Omega$

Equilibrium illumination resistance measured at 10 V d.c., illumination = 50 lx, after 15 min under the measuring conditions

$\quad r_{\text{le}} \, \text{typ.} \, 1450 \, \Omega$

Negative temperature response of illumination resistance

$\quad \text{typ.} \, 0.2 \, \%/\circ\text{C}$

Voltage response $\frac{r \, \text{at} \, 0.5 \, \text{V d.c.}}{r \, \text{at} \, 10 \, \text{V d.c.}}$

$\quad \alpha \, \text{typ.} \, 1.05$

1) The spread of the dark resistance is large and values higher than 100 MΩ and 1000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.
**RATINGS** Limiting values in accordance with the Absolute Maximum System (IEC 134)

- **Cell voltage, d.c. and repetitive peak**
  - $V_{\text{max.}} = 400 \text{ V}$

- **Cell voltage, pulse, $t_p \leq 5 \text{ ms}$, $P_{\text{rr}} \leq \text{once per minute}**
  - $V_{\text{M}}_{\text{max.}} = 1000 \text{ V}$

- **Power dissipation ($t_{\text{av}} = 2 \text{ s}$) see graph $P_{\text{max.}}$**
  - $P_{\text{M}}_{\text{max.}} = 5 \times P_{\text{max.}}$

- **Power dissipation, pulse**
  - $P_{\text{M}}_{\text{max.}} = 5 \times P_{\text{max.}}$

- **Cell current, d.c. and repetitive peak**
  - $I_{\text{max.}} = 500 \text{ mA}$

- **Illumination**
  - $E_{\text{max.}} = 50,000 \text{ lx}$

- **Temperature Cds tablet, operating**
  - $T_{\text{tablet}}_{\text{max.}} = +85 \degree \text{C}$

- **Ambient temperature, storage and operating**
  - $T_{\text{amb}}_{\text{min.}} = -40 \degree \text{C}$
  - $T_{\text{stg}}_{\text{max.}} = +50 \degree \text{C}^{1)}$
  - $T_{\text{amb}}_{\text{max.}} = +70 \degree \text{C}$

**DESIGN CONSIDERATIONS**

Apparatus with Cds cells should be designed so that changes in illumination resistance of the cells during life under rated load from $-30\%$ to $+70\%$ (typ. $+40\%$) do not impair the circuit performance. Direct sunlight irradiation should be avoided.

**CLIMATIC DATA**

The device withstands the damp heat test Ca (steady state) of IEC Publication 68-2-3: severity 56 days, under no-load conditions or under continuous load conditions such that the tablet temperature is $\geq 5 \degree \text{C}$ above ambient temperature.

**MECHANICAL ROBUSTNESS**

**Tensile test**

The device withstands the tensile test of IEC Publication 68-2-21, Test Ua: loading weight 500 g.

**Pull test**

The device withstands the following test: The leads are bent outwards over an angle of $90^\circ$ at 2 mm from the stress relief band; a pulling force of 500 g is then applied at the end of the leads.

---

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.

November 1972
$P_{\text{max}}$ (mW)

$t_{\text{av}} = 2$ s
free in air

$T_{\text{amb}}$ (°C)

$T_c = 2700$ K
$V_{dc} = 10$ V
after 16 h in darkness
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Side sensitive cadmium sulphide photoconductive cell protected by a lacquer coating. The device withstands the steady state damp heat test of IEC publication 68-2-3 (test Ca: severity 56 days).

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power dissipation at $T_{amb} = 25 \degree C$</td>
</tr>
<tr>
<td>Cell voltage, d.c. and repetitive peak</td>
</tr>
<tr>
<td>Cell resistance at 50 lx, 2700 K colour temperature</td>
</tr>
<tr>
<td>Spectral response, current rise and decay curves</td>
</tr>
<tr>
<td>Outline dimensions</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of 240 °C for maximum 10 s up to a point 5 mm from the stress relief band.

Mounting

The cell is not insulated electrically and should be mounted accordingly.

Notice

If the cell is to be encapsulated, request manufacturer's instructions.

1) Stress relief band.
ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at $T_{amb} = 25 \, ^oC$, illumination with colour temperature of $2700 \, K$

and at delivery

Initial dark resistance measured with $200 \, V \, d.c.$ applied via $1 \, M\Omega$, 20 s after switching off the illumination

$$r_{do} > 9 \, M\Omega \, ^1)$$

Equilibrium dark resistance measured with $200 \, V \, d.c.$ applied via $1 \, M\Omega$, 30 minutes after switching off the illumination

$$r_{de} > 100 \, M\Omega \, ^1)$$

Initial illumination resistance measured at $10 \, V \, d.c.$, illumination $= 50 \, lx$, after 16 hrs in darkness $^2)$

$$r_{lo} \quad \text{typ.} \quad 1150 \, \Omega$$

Equilibrium illumination resistance measured at $10 \, V \, d.c.$, illumination $= 50 \, lx$, after 15 min under the measuring conditions

$$r_{le} \quad \text{typ.} \quad 1450 \, \Omega$$

Negative temperature response of illumination resistance

$$< \quad 0.5 \%/^oC$$

$$\text{typ.} \quad 0.2 \%/^oC$$

Voltage response $\frac{r \, \text{at} \, 0.5 \, V \, d.c.}{r \, \text{at} \, 10 \, V \, d.c.}$

$$\alpha \quad \text{typ.} \quad 1.05$$

1) The spread of the dark resistance is large and values higher than $100 \, M\Omega$ and $1000 \, M\Omega$ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage, d.c. and repetitive peak  \( V \)  max.  200  \( V \)

Cell voltage, pulse,  \( t_p \leq 5 \text{ ms} \),  \( p_{rr} \leq \text{once per minute} \)  \( V_M \)  max.  500  \( V \)

Power dissipation (\( t_{av} = 2 \text{ s} \)) see graph  \( P_{max} \)

Power dissipation, pulse  \( P_M \)  max.  5 \( x \)  \( P_{max} \)

Cell current, d.c. and repetitive peak  \( I \)  max.  250  \( \text{mA} \)

Illumination  \( E \)  max.  50000  \( \text{lx} \)

Temperature CdS tablet, operating  \( T_{tablet} \)  max.  +85  \( ^\circ C \)

Ambient temperature, storage and operation  \( T_{stg} \)  max.  +50  \( ^\circ C \)  1)

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in illumination resistance of the cells during life under rated load from \(-30\% \) to \(+70\% \) (typ. \(+40\% \)) do not impair the circuit performance. Direct sunlight irradiation should be avoided.

CLIMATIC DATA

The device withstands the damp heat test Ca (steady state) of IEC Publication 68-2-3: severity 56 days, under no-load conditions or under continuous load conditions such that the tablet temperature is \( \geq 5 \text{ }^\circ C \) above ambient temperature.

MECHANICAL ROBUSTNESS

Tensile test

The device withstands the tensile test of IEC Publication 68-2-21, Test Ua: loading weight 500 g.

Pull test

The device withstands the following test: The leads are bent outwards over an angle of 90\( ^\circ \) at 2 mm from the stress relief band; a pulling force of 500 g is then applied at the end of the leads.

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.
$P_{\text{max}}$ (mW)

$t_{av} = 2 \text{ s}

\text{free in air}

T_{\text{amb}} (^{\circ}\text{C})

$V_{dc} = 10 \text{ V after 16 h in darkness}$

$T_c = 2700 \text{ K}$

$E (\text{lx})$
GENERAL

PHOTOSENSITIVE DIODES AND TRANSISTORS

LIGHT EMITTING DIODES

PHOTOCOUPERS

INFRARED SENSITIVE DEVICES

PHOTOCONDUCTIVE DEVICES
This information is furnished for guidance, and with no guarantees as to its accuracy or completeness. Its publication conveys no licence under any patent or other right does the publisher assume liability for any consequence of its use; specifications and availability of goods mentioned in it are subject to change without notice; it is not reproduced in any way, in whole or in part, without the written consent of the publisher.