# TIL187-1 THRU TIL187-4
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# AC-INPUT OPTOCOUPLERS/OPTOISOLATORS

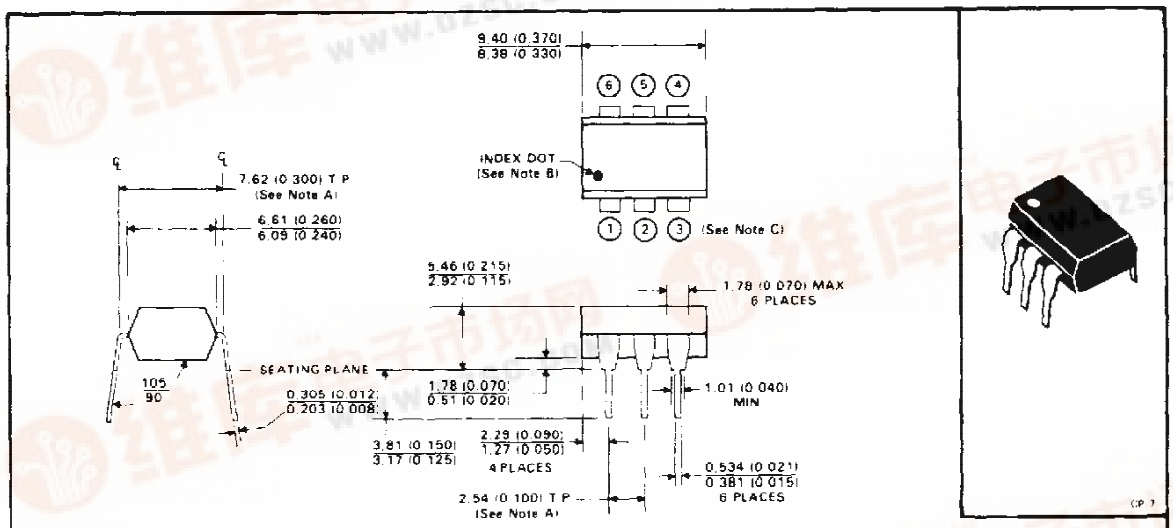
SOOS012A D2980, JANUARY 1987—REVISED JULY 1989

- AC Signal Input
- Gallium Arsenide Dual-Diode Infrared Source Optically Coupled to a Silicon N-P-N Darlington Phototransistor
- Plastic Dual-In-Line Package
- High-Voltage Electrical Isolation, 3.535 kV Peak (2.5 kV rms)
- High Current Transfer Ratio, 500% Minimum at $I_F$ = 10 mA, Up to 1500% Minimum at $I_F$ = 2 mA with Four Categories
- High $V_{(BR)CEO}$, 55 V Min
- UL Recognized — File #E65085
- No Base Lead Connection on TIL188 for High-EMI Environment

## description

The TIL187 and TIL188 Optocouplers are designed for use in AC applications that require very high current transfer ratio and high voltage isolation between input and output. These optocouplers consist of two GaAs light-emitting diodes connected in a reverse-parallel configuration and a silicon n-p-n Darlington phototransistor. The TIL187 has the base connected for applications where a base signal or base resistor is required. The TIL188 is designed with no base connected for applications where high base-noise immunity is desired. Users can select from four different current gains (TIL187-1 through TIL187-4 and TIL188-1 through TIL188-4).

## mechanical data

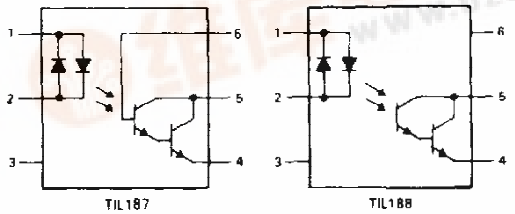



NOTES. A. Leads are within 0.13 mm (0.005 inch) radius of true position (T.P.) with maximum material condition and unit installed.

B. Pin 1 identified by index dot.

C. Terminal connections:

| | | |
|---|---|---|
| 1. Input | } | Infrared-emitting diode |
| 2. Input | | |
| 3. No internal connection | | |
| 4. Emitter | } | Phototransistor |
| 5. Collector | | |
| 6. TIL187: Base<br>TIL188: No internal connection | | |

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ALL LINEAR DIMENSIONS ARE IN MILLIMETERS AND PARENTHETICALLY IN INCHES



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**absolute maximum ratings at 25°C free-air temperature (unless otherwise noted)**

| | |
|---|---|
| Input-to-output voltage | ±3.535 kV peak or dc (±2.5 kV rms) |
| Collector-base voltage (TIL187) | 100 V |
| Collector-emitter voltage (see Note 1) | 55 V |
| Emitter-collector voltage | 7 V |
| Emitter-base voltage (TIL187) | 14 V |
| Input diode continuous forward current at (or below) 25°C free-air temperature (see Note 2) | 100 mA |
| Continuous power dissipation at (or below) 25°C free-air temperature: | |
| Infrared-emitting diode (see Note 3) | 150 mW |
| Phototransistor (see Note 3) | 150 mW |
| Total, infrared-emitting diode plus phototransistor (see Note 4) | 250 mW |
| Storage temperature range | −55°C to 150°C |
| Lead temperature 1,6 mm (1/16-inch) from case for 10 seconds | 260°C |

NOTES: 1. This value applies when the base-emitter diode is open circuited.
2. Derate linearly to 100°C free-air temperature at the rate of 1.33 mA/°C.
3. Derate linearly to 100°C free-air temperature at the rate of 2 mW/°C.
4. Derate linearly to 100°C free-air temperature at the rate of 3.33 mW/°C.

## electrical characteristics at 25°C free-air temperature (unless otherwise noted)

| PARAMETER | | | TEST CONDITIONS | TIL187 | | | TIL188 | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{(BR)CBO}$ | Collector-base breakdown voltage | | $I_C$ = 10 μA, $I_E$ = 0, $I_F$ = 0 | 100 | | | | | | V |
| $V_{(BR)CEO}$ | Collector-emitter breakdown voltage | | $I_C$ = 1 mA, $I_B$ = 0, $I_F$ = 0 | 55 | | | 55 | | | V |
| $V_{(BR)EBO}$ | Emitter-base breakdown voltage | | $I_E$ = 10 μA, $I_C$ = 0, $I_F$ = 0 | 14 | | | | | | V |
| $V_{(BR)ECO}$ | Emitter-collector breakdown voltage | | $I_E$ = 10 μA, $I_F$ = 0 | | | | 7 | | | V |
| $I_{C(on)}$ On-state collector current | Photo-transistor operation | TIL187-1, TIL188-1 | $V_{CE}$ = 1 V, $I_F$ = 2 mA, $I_B$ = 0 | 5 | | | 5 | | | mA |
| | | TIL187-2, TIL188-2 | | 10 | | | 10 | | | |
| | | TIL187-3, TIL188-3 | | 20 | | | 20 | | | |
| | | TIL187-4, TIL188-4 | | 30 | | | 30 | | | |
| | | | $V_{CE}$ = 1 V, $I_F$ = 10 mA, $I_B$ = 0 | 50 | | | 50 | | | |
| | Photodiode operation | | $V_{CB}$ = 1 V, $I_F$ = 10 mA, $I_E$ = 0 | | 12 | | | | | μA |
| $I_{C(off)}$ | Off-state collector current | | $V_{CE}$ = 10 V, $I_F$ = 0, $I_B$ = 0 | | | 100 | | | 100 | nA |
| $h_{FE}$ | Transistor static forward current transfer ratio | | $V_{CE}$ = 1 V, $I_C$ = 10 mA, $I_F$ = 0 | | 25000 | | | | | |
| $V_F$† | Input diode static forward voltage | | $I_F$ = 10 mA | 1 | 1.2 | 1.5 | 1 | 1.2 | 1.5 | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | | $I_C$ = 50 mA, $I_F$ = 10 mA, $I_B$ = 0 | | 0.87 | 1 | | 0.87 | 1 | V |
| $r_{IO}$ | Input-to-output internal resistance | | $V_{in-out}$ = ±500 V, See Note 5 | $10^{11}$ | | | $10^{11}$ | | | Ω |
| $C_{io}$ | Input-to-output capacitance | | $V_{in-out}$ = 0, f = 1 mHz, See Note 5 | | 1 | 1.3 | | 1 | 1.3 | pF |
| $\frac{I_{C(on)1}}{I_{C(on)2}}$ | On-state collector current symmetry ratio (see Note 6) | | $V_{CE}$ = 1 V, $I_F$ = 2 mA | 1 | | 3 | 1 | | 3 | |

†These parameters apply for either direction of the input current.

NOTES: 5. These parameters are measured between both input-diode leads shorted together and all the phototransistor leads shorted together.

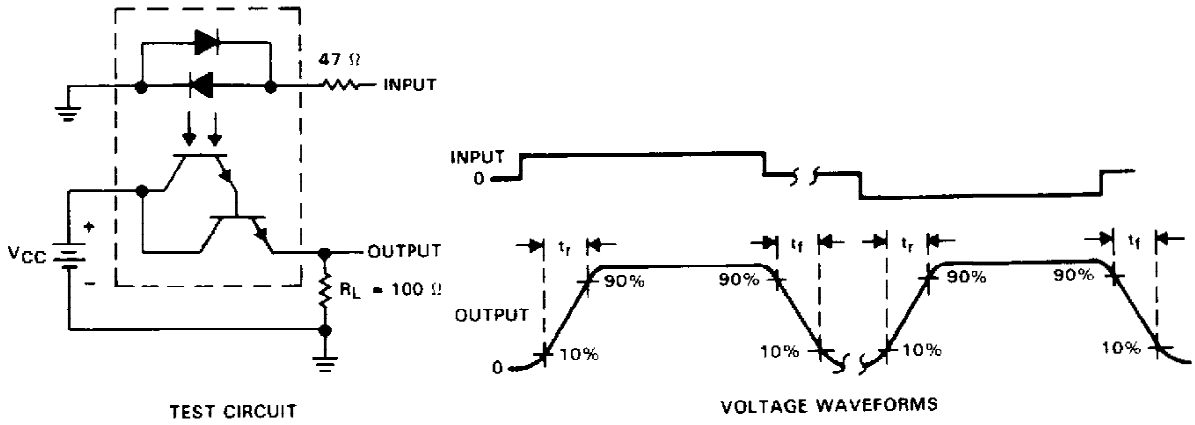
6. The higher of the two $I_{C(on)}$ values generated by the two diodes is taken as $I_{C(on)1}$.

## switching characteristics at 25°C free-air temperature

| PARAMETER | | TEST CONDITIONS | | TIL187 | | | TIL188 | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $t_r$ | Rise time | $V_{CC}$ = 10 V, | $I_{C(on)}$ = 10 mA, | | 100 | | | 100 | | μs |
| $t_f$ | Fall time | $R_L$ = 100 Ω, | see Figure 1 | | 100 | | | 100 | | μs |

## PARAMETER MEASUREMENT INFORMATION

Adjust amplitude of input pulse is for $I_{C(on)}$ = 10 mA




TEST CIRCUIT VOLTAGE WAVEFORMS

NOTES: A. The input waveform is supplied by a generator with the following characteristics: $Z_O$ = 50 Ω, $t_r$ ≤ 15 ns, duty cycle = 1%.
B. The output waveform is monitored on an oscilloscope with the following characteristics: $t_r$ ≤ 12 ns, $R_I$ ≥ 1 MΩ, $C_I$ ≤ 20 pF.

**FIGURE 1. SWITCHING TIMES**

## TYPICAL CHARACTERISTICS

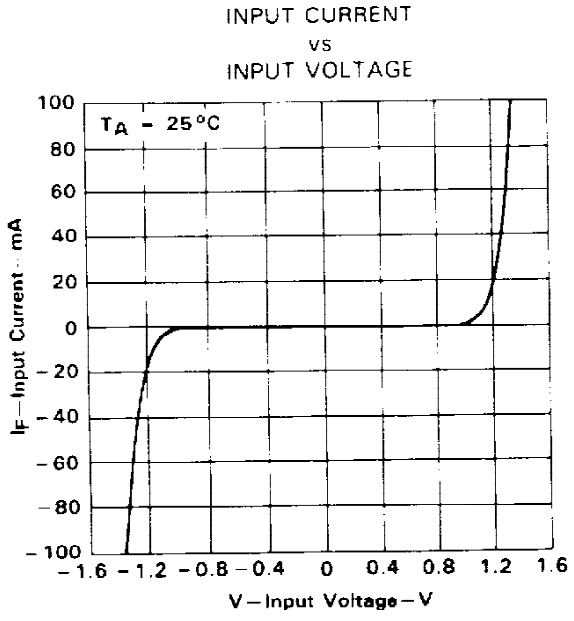



**FIGURE 2**

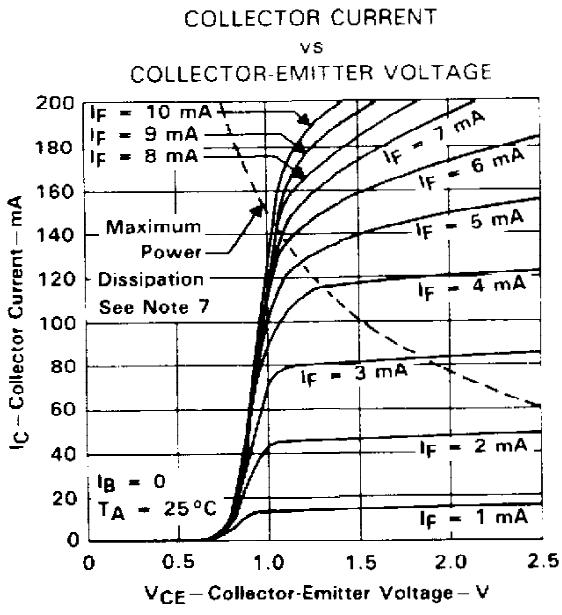



**FIGURE 3**

Note 7: Pulse operation is required for operation beyond limits shown by the dashed line.

COLLECTOR CURRENT
vs
INPUT DIODE FORWARD CURRENT

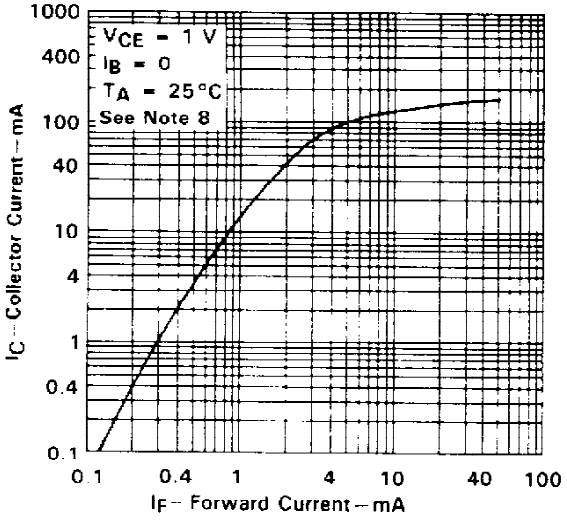



FIGURE 4

NORMALIZED ON STATE COLLECTOR CURRENT
vs
FREE-AIR TEMPERATURE

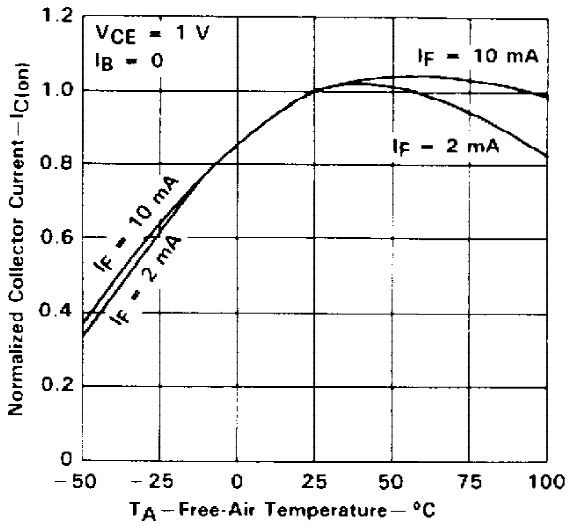



FIGURE 5

TIL187
NORMALIZED TRANSISTOR STATIC
FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

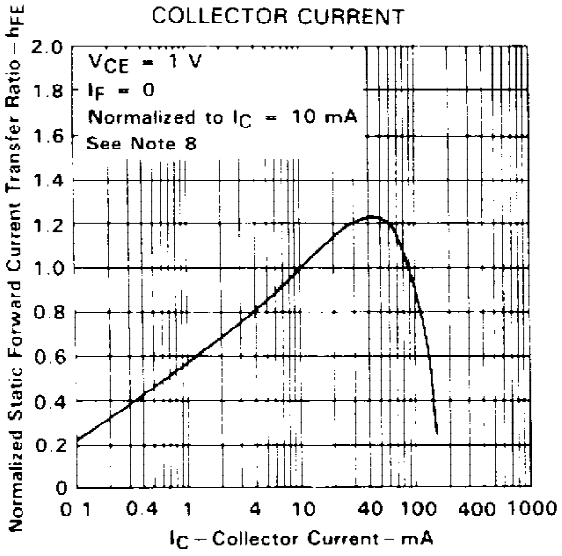



FIGURE 6

TIL187
NORMALIZED TRANSISTOR STATIC
FORWARD CURRENT TRANSFER RATIO
vs
FREE-AIR TEMPERATURE

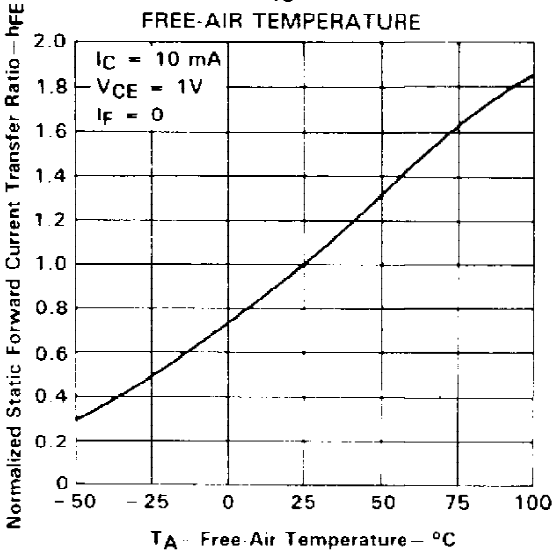



FIGURE 7

NOTE 8: These parameters were measured using pulse techniques $t_w$ = 1 ms, duty cycle ≤ 2%.

TIL187

NORMALIZED ON-STATE COLLECTOR CURRENT
(PHOTODIODE OPERATION)
VS
FREE-AIR TEMPERATURE

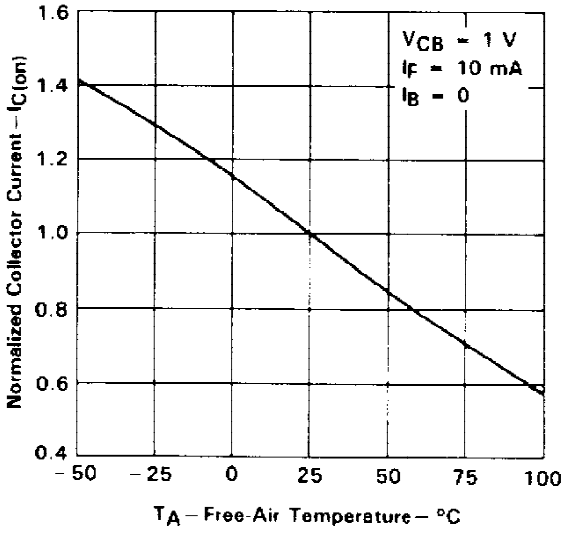



FIGURE 8

NORMALIZED COLLECTOR-EMITTER
BREAKDOWN VOLTAGE
VS
FREE-AIR TEMPERATURE

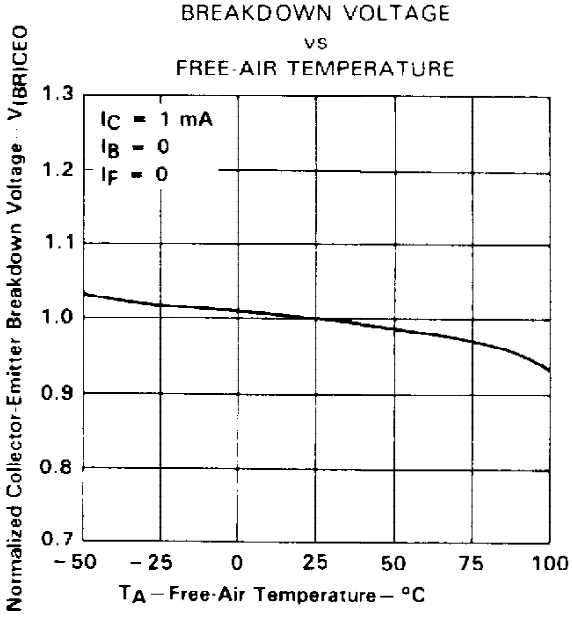



FIGURE 9

OFF-STATE COLLECTOR CURRENT
VS
FREE-AIR TEMPERATURE

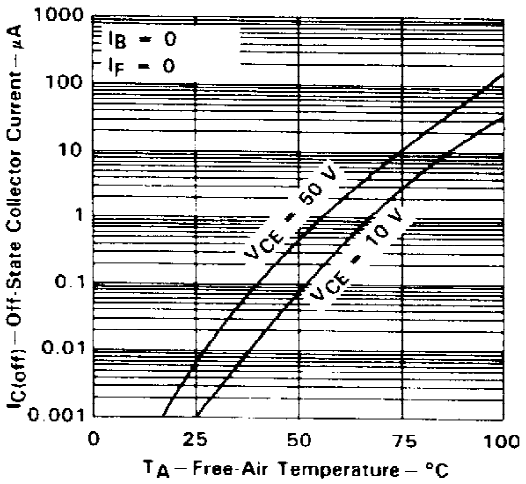



FIGURE 10

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## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| TIL187-1 | OBSOLETE | PDIP | N | 6 | | TBD | Call TI | Call TI |
| TIL187-2 | OBSOLETE | PDIP | N | 6 | | TBD | Call TI | Call TI |
| TIL187-3 | OBSOLETE | PDIP | N | 6 | | TBD | Call TI | Call TI |
| TIL187-4 | OBSOLETE | PDIP | N | 6 | | TBD | Call TI | Call TI |
| TIL188-1 | OBSOLETE | PDIP | P | 6 | | TBD | Call TI | Call TI |
| TIL188-2 | OBSOLETE | PDIP | P | 6 | | TBD | Call TI | Call TI |
| TIL188-3 | OBSOLETE | PDIP | N | 6 | | TBD | Call TI | Call TI |
| TIL188-4 | OBSOLETE | PDIP | N | 6 | | TBD | Call TI | Call TI |

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**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
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**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.
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(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
**TBD:** The Pb-Free/Green conversion plan has not been defined.
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(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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