

## Hi-Rel PNP bipolar transistor 150 V, 0.5 A

Datasheet — production data

### Features

|                             |                 |
|-----------------------------|-----------------|
| $BV_{CEO}$                  | 150 V           |
| $I_C$ (max)                 | 0.5 A           |
| $H_{FE}$ at 10 V - 150 mA   | > 60            |
| Operating temperature range | -65°C to +200°C |

- Hi-Rel PNP bipolar transistor
- Linear gain characteristics
- ESCC qualified
- European preferred part list - EPPL
- 100 krad low dose rate
- Radiation level: lot specific total dose contact marketing for specified level

### Description

The 2N5401HR is a silicon planar epitaxial PNP transistor available in TO-18 and LCC-3 packages. It is specifically designed for aerospace Hi-Rel applications and ESCC qualified according to the 5202-014 specification. In case of conflict between this datasheet and ESCC detailed specification, the latter prevails.

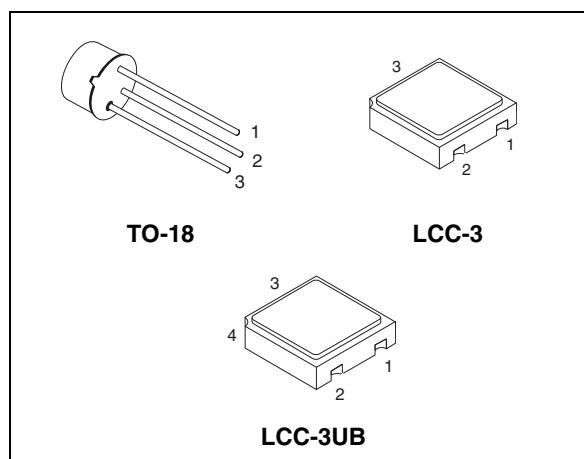


Figure 1. Internal schematic diagram

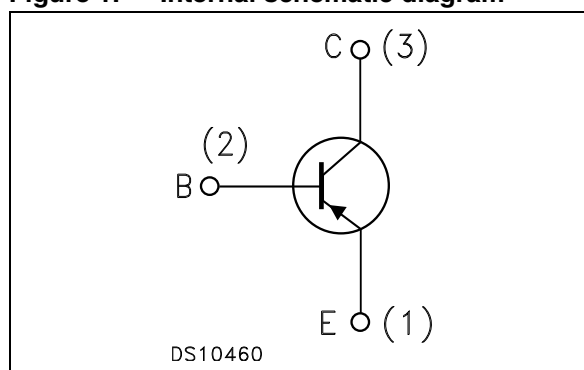


Table 1. Device summary

| Order codes | ESCC part num.    | Quality level | Rad level | Packages | Lead finish                    | Mass (g) | EPPL |
|-------------|-------------------|---------------|-----------|----------|--------------------------------|----------|------|
| 2N5401UB1   | -                 | Eng. Model    |           | LCC-3UB  | Gold                           | 0.06     | -    |
| 2N5401SW    | 5202/014/05       | ESCC Flight   | 100 krad  | LCC-3    | Solder Dip                     | 0.06     | Y    |
| 2N5401UB06  | 5202/014/06       | ESCC Flight   |           | LCC-3UB  | Gold                           | 0.06     | -    |
| 2N5401UB07  | 5202/014/07       | ESCC Flight   |           | LCC-3UB  | Solder Dip                     | 0.06     | -    |
| SOC5401     | -                 | Eng. Model    |           | LCC-3    | Gold                           | 0.06     | -    |
| SOC5401HRB  | 5202/014/04 or 05 | ESCC Flight   |           | LCC-3    | Gold/Solder Dip <sup>(1)</sup> | 0.06     | Y    |
| 2N5401/T1   | -                 | Eng. Model    |           | TO-18    | Gold                           | 0.40     | -    |
| 2N5401HR    | 5202/014/01 or 02 | ESCC Flight   |           | TO-18    | Gold/Solder Dip <sup>(1)</sup> | 0.40     | -    |

1. Depending ESCC part number mentioned on the purchase order.

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol    | Parameter  | Value        | Unit   |
|-----------|--|--------------|--------|
| $V_{CBO}$ | Collector-base voltage ( $I_E = 0$ )                             | -160         | V      |
| $V_{CEO}$ | Collector-emitter voltage ( $I_B = 0$ )                          | -150         | V      |
| $V_{EBO}$ | Emitter-base voltage ( $I_C = 0$ )                               | -5           | V      |
| $I_C$     | Collector current<br>for 2N5401HR<br>for SOC5401HRB              | -0.6<br>-0.5 | A<br>A |
| $P_{TOT}$ | Total dissipation at $T_{amb} \leq 25\text{ °C}$<br>for 2N5401HR | 0.36         | W      |
|           | for SOC5401HRB   | 0.36         | W      |
|           | for SOC5401HRB <sup>(1)</sup>                                    | 0.58         | W      |
|           | Total dissipation at $T_c \leq 25\text{ °C}$<br>for 2N5401HR     | 1.2          | W      |
| $T_{STG}$ | Storage temperature  | -65 to 200   | °C     |
| $T_J$     | Max. operating junction temperature                              | 200          | °C     |

1. When mounted on a 8x10x0.6 mm ceramic substrate.

**Table 3. Thermal data for through-hole package**

| Symbol     | Parameter                               | Value | Unit |
|------------|---|-------|------|
| $R_{thJC}$ | Thermal resistance junction-case max    | 146   | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient max | 486   | °C/W |

**Table 4. Thermal data for SMD package**

| Symbol     | Parameter  | Value | Unit |
|------------|--|-------|------|
| $R_{thJA}$ | Thermal resistance junction-ambient max                | 486   | °C/W |
|            | Thermal resistance junction-ambient <sup>(1)</sup> max | 302   | °C/W |

1. When mounted on a 8x10x0.6 mm ceramic substrate.

## 2 Electrical characteristics

$T_{\text{case}} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

**Table 5. Electrical characteristics**

| Symbol                            | Parameter  | Test conditions   | Min.                 | Typ. | Max.         | Unit                |
|-----------------------------------|--|---|----------------------|------|--------------|---------------------|
| $I_{\text{CBO}}$                  | Collector-base cut-off current ( $I_{\text{E}} = 0$ )      | $V_{\text{CB}} = -120\text{ V}$<br>$V_{\text{CB}} = -120\text{ V}$ $T_{\text{C}} = 150\text{ }^{\circ}\text{C}$   |                      |      | -50<br>-50   | nA<br>$\mu\text{A}$ |
| $I_{\text{EBO}}$                  | Emitter-base cut-off current ( $I_{\text{C}} = 0$ )        | $V_{\text{EB}} = -3\text{ V}$   |                      |      | -50          | nA                  |
| $V_{(\text{BR})\text{CBO}}$       | Collector-base breakdown voltage ( $I_{\text{E}} = 0$ )    | $I_{\text{C}} = -100\text{ }\mu\text{A}$  | -160                 |      |              | V                   |
| $V_{(\text{BR})\text{CEO}}^{(1)}$ | Collector-emitter breakdown voltage ( $I_{\text{B}} = 0$ ) | $I_{\text{C}} = -1\text{ mA}$   | -150                 |      |              | V                   |
| $V_{(\text{BR})\text{EBO}}$       | Emitter-base breakdown voltage ( $I_{\text{C}} = 0$ )      | $I_{\text{E}} = -10\text{ }\mu\text{A}$   | -5                   |      |              | V                   |
| $V_{\text{CE(sat)}}^{(1)}$        | Collector-emitter saturation voltage                       | $I_{\text{C}} = -10\text{ mA}$ $I_{\text{B}} = -1\text{ mA}$<br>$I_{\text{C}} = -50\text{ mA}$ $I_{\text{B}} = -5\text{ mA}$  |                      |      | -0.2<br>-0.5 | V<br>V              |
| $V_{\text{BE(sat)}}^{(1)}$        | Base-emitter saturation voltage                            | $I_{\text{C}} = -10\text{ mA}$ $I_{\text{B}} = -1\text{ mA}$<br>$I_{\text{C}} = -50\text{ mA}$ $I_{\text{B}} = -5\text{ mA}$  |                      |      | -1<br>-1     | V<br>V              |
| $h_{\text{FE}}^{(1)}$             | DC current gain  | $I_{\text{C}} = -1\text{ mA}$ $V_{\text{CE}} = -5\text{ V}$<br>$I_{\text{C}} = -10\text{ mA}$ $V_{\text{CE}} = -5\text{ V}$<br>$I_{\text{C}} = -50\text{ mA}$ $V_{\text{CE}} = -5\text{ V}$<br>$I_{\text{C}} = -10\text{ mA}$ $V_{\text{CE}} = -5\text{ V}$<br>$T_{\text{amb}} = -55\text{ }^{\circ}\text{C}$ | 50<br>60<br>60<br>20 |      | 240          |                     |
| $h_{\text{fe}}$                   | Small signal current gain                                  | $V_{\text{CE}} = -10\text{ V}$ $I_{\text{C}} = -10\text{ mA}$<br>$f = 10\text{ kHz}$  | 5                    |      |              |                     |
| $C_{\text{obo}}$                  | Output capacitance ( $I_{\text{E}} = 0$ )                  | $V_{\text{CB}} = -10\text{ V}$ $f = 1\text{ MHz}$   |                      |      | 6            | pF                  |

1. Pulsed duration = 300  $\mu\text{s}$ , duty cycle  $\leq 2\%$

2.1 Electrical characteristics (curves)

Figure 2.  $h_{FE}$  @  $V_{CE} = 5\text{ V}$

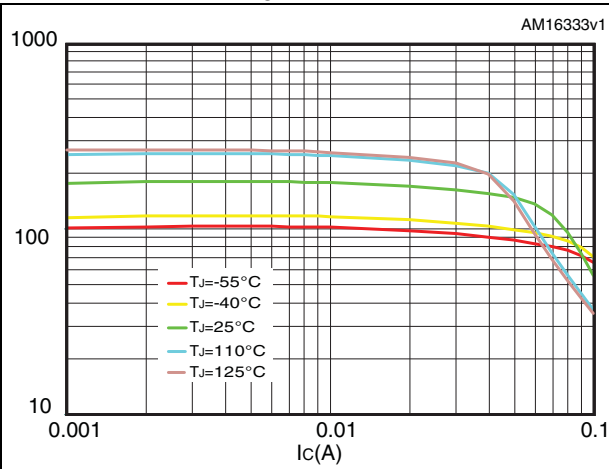


Figure 3.  $V_{CE(sat)}$  @  $h_{FE} = 10$

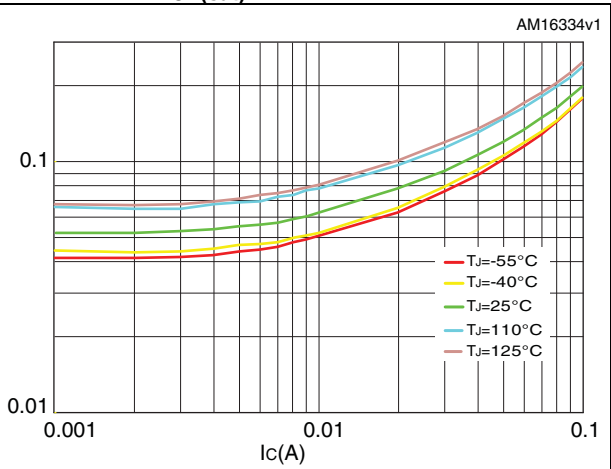
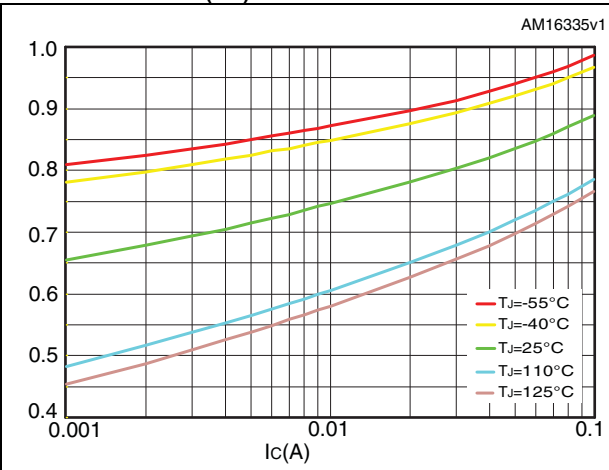


Figure 4.  $V_{BE(sat)}$  @  $h_{FE} = 10$



### 3 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.

**Table 6. LCC-3 mechanical data**

| Dim. | mm.  |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    | 1.16 |      | 1.42 |
| C    | 0.45 | 0.50 | 0.56 |
| D    | 0.60 | 0.76 | 0.91 |
| E    | 0.91 | 1.01 | 1.12 |
| F    | 1.95 | 2.03 | 2.11 |
| G    | 2.92 | 3.05 | 3.17 |
| I    | 2.41 | 2.54 | 2.66 |
| J    | 0.42 | 0.57 | 0.72 |
| K    | 1.37 | 1.52 | 1.67 |
| L    | 0.40 | 0.50 | 0.60 |
| M    | 2.46 | 2.54 | 2.62 |
| N    | 1.80 | 1.90 | 2.00 |
| R    |      | 0.30 |      |

Figure 5. LCC-3 drawings

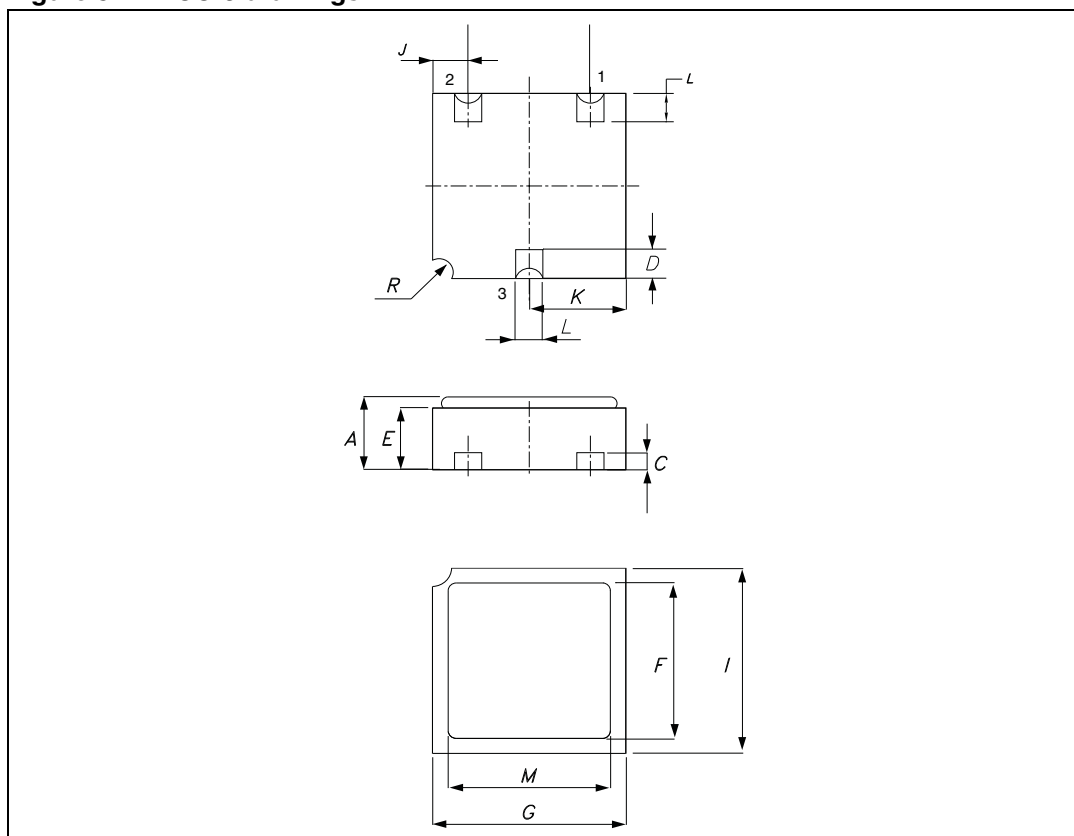


Table 7. LCC-3UB mechanical data

| Dim. | mm.  |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    | 1.16 |      | 1.42 |
| C    | 0.46 | 0.51 | 0.56 |
| D    | 0.56 | 0.76 | 0.96 |
| E    | 0.92 | 1.02 | 1.12 |
| F    | 1.95 | 2.03 | 2.11 |
| G    | 2.92 | 3.05 | 3.18 |
| I    | 2.41 | 2.54 | 2.67 |
| J    | 0.42 | 0.57 | 0.72 |
| K    | 1.37 | 1.52 | 1.67 |
| L    | 0.41 | 0.51 | 0.61 |
| M    | 2.46 | 2.54 | 2.62 |
| N    | 1.81 | 1.91 | 2.01 |
| r    |      | 0.20 |      |
| r1   |      | 0.30 |      |
| r2   |      | 0.56 |      |

Figure 6. LCC-3UB drawings

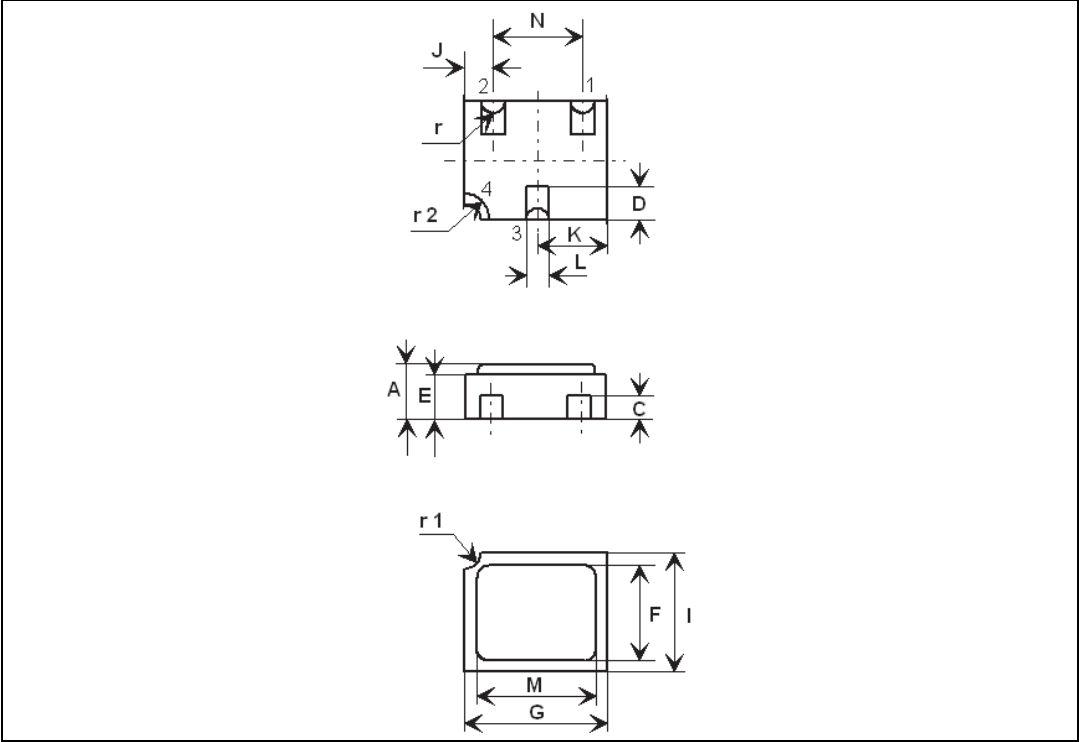
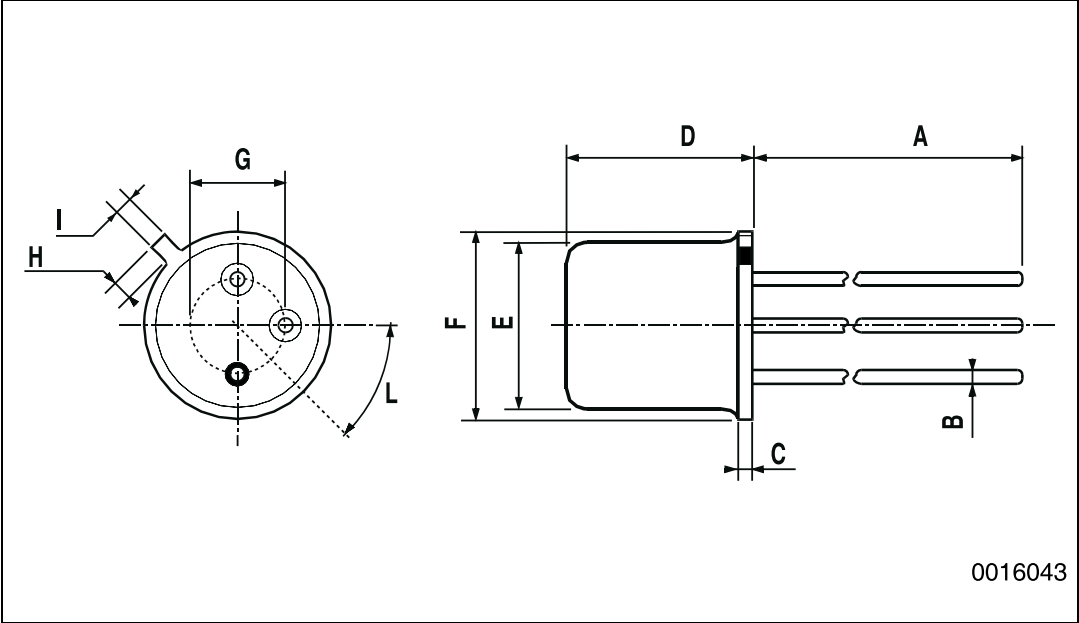


Table 8. TO-18 mechanical data

| Dim. | mm.  |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    |      | 12.7 |      |
| B    |      |      | 0.49 |
| D    |      |      | 5.3  |
| E    |      |      | 4.9  |
| F    |      |      | 5.8  |
| G    | 2.54 |      |      |
| H    |      |      | 1.2  |
| I    |      |      | 1.16 |
| L    | 45°  |      |      |

Figure 7. TO-18 drawings





## 4 Order codes

**Table 9. Order codes**

| Order codes | ESCC part number     | Radiation level | Packages | Lead finish                    | Marking         | EPPL | Packing     |
|-------------|----------------------|-----------------|----------|--------------------------------|-----------------|------|-------------|
| 2N5401UB1   | -                    |                 | LCC-3UB  | Gold                           | 2N5401UB1       | -    | Waffle pack |
| 2N5401SW    | 5202/014/05          | 100 krad        | LCC-3    | Solder Dip                     | 520201407       | Y    | Waffle pack |
| 2N5401UB06  | 5202/014/06          |                 | LCC-3UB  | Gold                           | 520201406       | -    | Waffle pack |
| 2N5401UB07  | 5202/014/07          |                 | LCC-3UB  | Solder Dip                     | 520201407       | -    | Waffle pack |
| SOC5401     | -                    |                 | LCC-3    | Gold                           | SOC5401         | -    | Waffle pack |
| SOC5401HRB  | 5202/014/04<br>or 05 |                 | LCC-3    | Gold/Solder Dip <sup>(1)</sup> | 520201404 or 05 | Y    | Waffle pack |
| 2N5401/T1   | -                    |                 | TO-18    | Gold                           | 2N5401/T1       | -    | Strip pack  |
| 2N5401HR    | 5202/014/01<br>or 02 |                 | TO-18    | Gold/Solder Dip <sup>(1)</sup> | 520201401 or 02 | -    | Strip pack  |

1. Depending ESCC part number mentioned on the purchase order.

Contact ST sales office for information about the specific conditions for:

- Products in die form
- Tape and reel packing

## 5 Revision history

**Table 10. Document revision history**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 04-Jan-2010 | 1        | Initial release   |
| 13-Jul-2010 | 2        | Modified <a href="#">Table 1 on page 1</a> , added <a href="#">Table 9 on page 9</a>  |
| 10-Oct-2012 | 3        | <a href="#">Table 1 on page 1</a> and <a href="#">Section 4: Order codes</a> have been updated.<br><a href="#">Section 3: Package mechanical data</a> has been updated. |
| 12-Nov-2012 | 4        | Added: <a href="#">Section 2.1: Electrical characteristics (curves)</a>   |

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