



# PHPT610030NK

NPN/NPN high power double bipolar transistor

20 October 2014

Product data sheet

## 1. General description

NPN/NPN high power double bipolar transistor in a SOT1205 (LFAK56D) Surface-Mounted Device (SMD) power plastic package.

PNP/PNP complement: PHPT610030PK.

NPN/PNP complement: PHPT610030NPK.

## 2. Features and benefits

- High thermal power dissipation capability
- Suitable for high temperature applications up to 175 °C
- Reduced Printed-Circuit Board (PCB) requirements comparing to transistors in DPAK
- High energy efficiency due to less heat generation
- AEC-Q101 qualified

## 3. Applications

- Motor control
- Power management
- Load switch
- Linear mode voltage regulator
- Backlighting applications
- Relay replacement

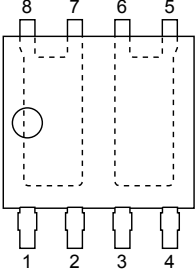
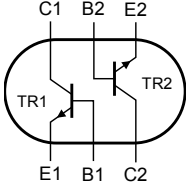
## 4. Quick reference data

Table 1. Quick reference data

| Symbol                | Parameter                               | Conditions                                                                                                                                        | Min | Typ | Max | Unit       |
|-----------------------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|------------|
| <b>Per transistor</b> |                                         |                                                                                                                                                   |     |     |     |            |
| $V_{CEO}$             | collector-emitter voltage               | open base                                                                                                                                         | -   | -   | 100 | V          |
| $I_C$                 | collector current                       |                                                                                                                                                   | -   | -   | 3   | A          |
| <b>Per transistor</b> |                                         |                                                                                                                                                   |     |     |     |            |
| $R_{CEsat}$           | collector-emitter saturation resistance | $I_C = 3\text{ A}$ ; $I_B = 0.3\text{ A}$ ; pulsed; $t_p \leq 300\text{ }\mu\text{s}$ ; $\delta \leq 0.02$ ; $T_{amb} = 25\text{ }^\circ\text{C}$ | -   | 75  | 110 | m $\Omega$ |

## 5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description   | Simplified outline                                                                                     | Graphic symbol                                                                                |
|-----|--------|---------------|--------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| 1   | E1     | emitter TR1   | <br>LFAK56D (SOT1205) | <br>sym140 |
| 2   | B1     | base TR1      |                                                                                                        |                                                                                               |
| 3   | E2     | emitter TR2   |                                                                                                        |                                                                                               |
| 4   | B2     | base TR2      |                                                                                                        |                                                                                               |
| 5   | C2     | collector TR2 |                                                                                                        |                                                                                               |
| 6   | C2     | collector TR2 |                                                                                                        |                                                                                               |
| 7   | C1     | collector TR1 |                                                                                                        |                                                                                               |
| 8   | C1     | collector TR1 |                                                                                                        |                                                                                               |

## 6. Ordering information

Table 3. Ordering information

| Type number  | Package |                                                                 |         |
|--------------|---------|-----------------------------------------------------------------|---------|
|              | Name    | Description                                                     | Version |
| PHPT610030NK | LFAK56D | Plastic single ended surface mounted package (LFAK56D); 8 leads | SOT1205 |

## 7. Marking

Table 4. Marking codes

| Type number  | Marking code |
|--------------|--------------|
| PHPT610030NK | 10030NK      |

## 8. Limiting values

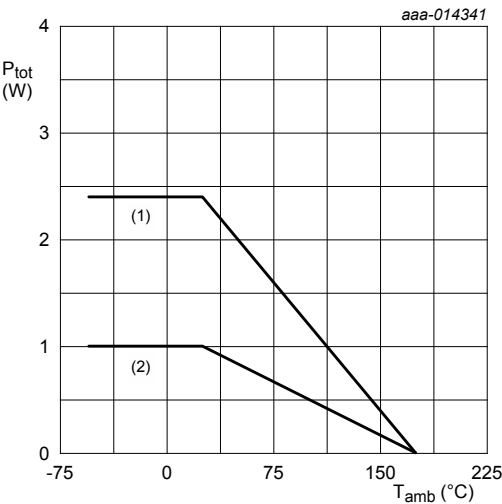
Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol                | Parameter                 | Conditions                    | Min | Max | Unit |
|-----------------------|---------------------------|-------------------------------|-----|-----|------|
| <b>Per transistor</b> |                           |                               |     |     |      |
| $V_{CBO}$             | collector-base voltage    | open emitter                  | -   | 100 | V    |
| $V_{CEO}$             | collector-emitter voltage | open base                     | -   | 100 | V    |
| $V_{EBO}$             | emitter-base voltage      | open collector                | -   | 7   | V    |
| $I_C$                 | collector current         |                               | -   | 3   | A    |
| $I_{CM}$              | peak collector current    | single pulse; $t_p \leq 1$ ms | -   | 8   | A    |
| $I_B$                 | base current              |                               | -   | 0.5 | A    |

| Symbol           | Parameter               | Conditions               |     | Min | Max  | Unit |
|------------------|-------------------------|--------------------------|-----|-----|------|------|
| P <sub>tot</sub> | total power dissipation | T <sub>amb</sub> ≤ 25 °C | [1] | -   | 1    | W    |
|                  |                         |                          | [2] | -   | 2.4  | W    |
|                  |                         |                          | [3] | -   | 25   | W    |
| Per device       |                         |                          |     |     |      |      |
| P <sub>tot</sub> | total power dissipation | T <sub>amb</sub> ≤ 25 °C | [1] | -   | 1.25 | W    |
|                  |                         |                          | [4] | -   | 5    | W    |
|                  |                         |                          | [2] | -   | 3    | W    |
| T <sub>j</sub>   | junction temperature    |                          |     | -   | 175  | °C   |
| T <sub>stg</sub> | storage temperature     |                          |     | -65 | 175  | °C   |
| T <sub>amb</sub> | ambient temperature     |                          |     | -55 | 175  | °C   |

- [1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.
- [2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for collector 6 cm<sup>2</sup>.
- [3] Power dissipation from junction to mounting base.
- [4] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint.



- (1) FR4 PCB, mounting pad for collector 6 cm<sup>2</sup>
- (2) FR4 PCB, standard footprint

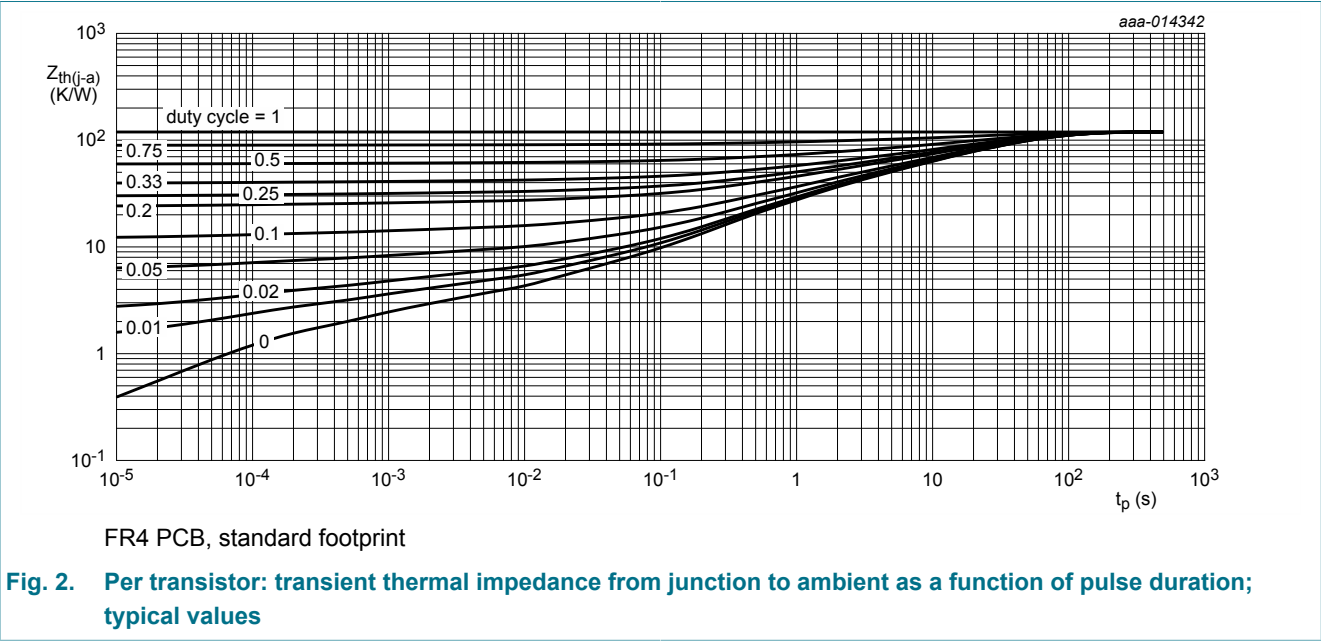
Fig. 1. Per transistor: power derating curves

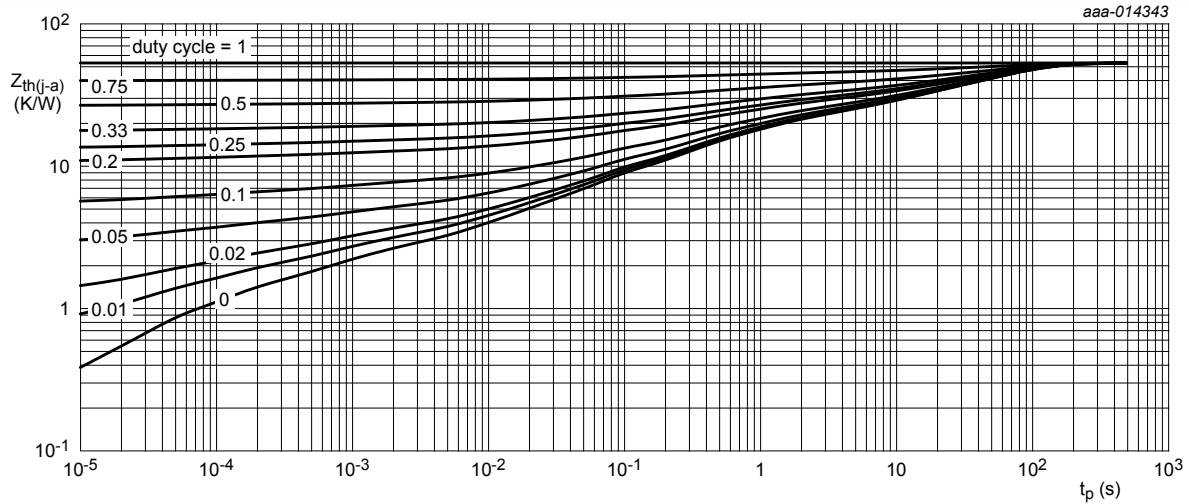
9. Thermal characteristics

Table 6. Thermal characteristics

| Symbol                | Parameter                                        | Conditions  |     | Min | Typ | Max  | Unit |
|-----------------------|--------------------------------------------------|-------------|-----|-----|-----|------|------|
| Per transistor        |                                                  |             |     |     |     |      |      |
| R <sub>th(j-a)</sub>  | thermal resistance from junction to ambient      | in free air | [1] | -   | -   | 150  | K/W  |
|                       |                                                  |             | [2] | -   | -   | 62.5 | K/W  |
| R <sub>th(j-sp)</sub> | thermal resistance from junction to solder point |             |     | -   | -   | 6    | K/W  |
| Per device            |                                                  |             |     |     |     |      |      |
| R <sub>th(j-a)</sub>  | thermal resistance from junction to ambient      | in free air | [1] | -   | -   | 120  | K/W  |
|                       |                                                  |             | [2] | -   | -   | 50   | K/W  |
|                       |                                                  |             | [3] | -   | -   | 30   | K/W  |

- [1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.
- [2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for collector 6 cm<sup>2</sup>.
- [3] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint.





FR4 PCB, mounting pad for collector 6 cm<sup>2</sup>

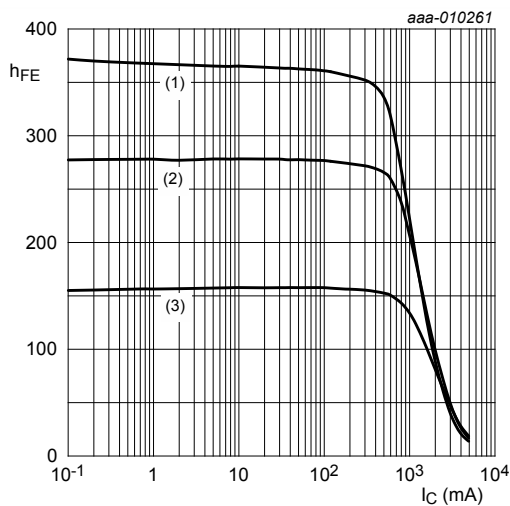
**Fig. 3.** Per transistor: transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 10. Characteristics

**Table 7.** Characteristics

| Symbol                | Parameter                            | Conditions                                                                                                                                               | Min | Typ | Max | Unit          |
|-----------------------|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|---------------|
| <b>Per transistor</b> |                                      |                                                                                                                                                          |     |     |     |               |
| $I_{CBO}$             | collector-base cut-off current       | $V_{CB} = 80 \text{ V}; I_E = 0 \text{ A}; T_{amb} = 25 \text{ }^{\circ}\text{C}$                                                                        | -   | -   | 100 | nA            |
|                       |                                      | $V_{CB} = 80 \text{ V}; I_E = 0 \text{ A}; T_j = 150 \text{ }^{\circ}\text{C}$                                                                           | -   | -   | 50  | $\mu\text{A}$ |
| $I_{CES}$             | collector-emitter cut-off current    | $V_{CE} = 80 \text{ V}; V_{BE} = 0 \text{ V}; T_{amb} = 25 \text{ }^{\circ}\text{C}$                                                                     | -   | -   | 100 | nA            |
| $I_{EBO}$             | emitter-base cut-off current         | $V_{EB} = 7 \text{ V}; I_C = 0 \text{ A}; T_{amb} = 25 \text{ }^{\circ}\text{C}$                                                                         | -   | -   | 100 | nA            |
| $h_{FE}$              | DC current gain                      | $V_{CE} = 10 \text{ V}; I_C = 500 \text{ mA}; \text{pulsed}; t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^{\circ}\text{C}$ | 150 | 250 | -   |               |
|                       |                                      | $V_{CE} = 10 \text{ V}; I_C = 1 \text{ A}; \text{pulsed}; t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^{\circ}\text{C}$    | 80  | 250 | -   |               |
|                       |                                      | $V_{CE} = 10 \text{ V}; I_C = 2 \text{ A}; \text{pulsed}; t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^{\circ}\text{C}$    | 20  | 100 | -   |               |
|                       |                                      | $V_{CE} = 10 \text{ V}; I_C = 3 \text{ A}; \text{pulsed}; t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^{\circ}\text{C}$    | 10  | 40  | -   |               |
| $V_{CEsat}$           | collector-emitter saturation voltage | $I_C = 1 \text{ A}; I_B = 50 \text{ mA}; \text{pulsed}; t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^{\circ}\text{C}$      | -   | 90  | 150 | mV            |
|                       |                                      | $I_C = 3 \text{ A}; I_B = 300 \text{ mA}; \text{pulsed}; t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^{\circ}\text{C}$     | -   | 225 | 330 | mV            |

| Symbol      | Parameter                               | Conditions                                                                                                                                           | Min | Typ  | Max  | Unit             |
|-------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|------|------------------|
| $R_{CEsat}$ | collector-emitter saturation resistance | $I_C = 3\text{ A}$ ; $I_B = 0.3\text{ A}$ ; pulsed; $t_p \leq 300\text{ }\mu\text{s}$ ; $\delta \leq 0.02$ ; $T_{amb} = 25\text{ }^\circ\text{C}$    | -   | 75   | 110  | $\text{m}\Omega$ |
| $V_{BEsat}$ | base-emitter saturation voltage         | $I_C = 1\text{ A}$ ; $I_B = 50\text{ mA}$ ; pulsed; $t_p \leq 300\text{ }\mu\text{s}$ ; $\delta \leq 0.02$ ; $T_{amb} = 25\text{ }^\circ\text{C}$    | -   | 0.86 | 1    | V                |
|             |                                         | $I_C = 2\text{ A}$ ; $I_B = 200\text{ mA}$ ; pulsed; $t_p \leq 300\text{ }\mu\text{s}$ ; $\delta \leq 0.02$ ; $T_{amb} = 25\text{ }^\circ\text{C}$   | -   | 1    | 1.2  | V                |
| $V_{BEon}$  | base-emitter turn-on voltage            | $V_{CE} = 2\text{ V}$ ; $I_C = 0.1\text{ A}$ ; pulsed; $t_p \leq 300\text{ }\mu\text{s}$ ; $\delta \leq 0.02$ ; $T_{amb} = 25\text{ }^\circ\text{C}$ | -   | 0.67 | 0.85 | V                |
| $t_d$       | delay time                              | $V_{CC} = 12.5\text{ V}$ ; $I_C = 1\text{ A}$ ; $I_{Bon} = 50\text{ mA}$ ; $I_{Boff} = -50\text{ mA}$ ; $T_{amb} = 25\text{ }^\circ\text{C}$         | -   | 20   | -    | ns               |
| $t_r$       | rise time                               |                                                                                                                                                      | -   | 300  | -    | ns               |
| $t_{on}$    | turn-on time                            |                                                                                                                                                      | -   | 320  | -    | ns               |
| $t_s$       | storage time                            |                                                                                                                                                      | -   | 830  | -    | ns               |
| $t_f$       | fall time                               |                                                                                                                                                      | -   | 470  | -    | ns               |
| $t_{off}$   | turn-off time                           |                                                                                                                                                      | -   | 1300 | -    | ns               |
| $f_T$       | transition frequency                    | $V_{CE} = 10\text{ V}$ ; $I_C = 100\text{ mA}$ ; $f = 100\text{ MHz}$ ; $T_{amb} = 25\text{ }^\circ\text{C}$                                         | -   | 140  | -    | MHz              |
| $C_C$       | collector capacitance                   | $V_{CB} = 10\text{ V}$ ; $I_E = 0\text{ A}$ ; $i_e = 0\text{ A}$ ; $f = 1\text{ MHz}$ ; $T_{amb} = 25\text{ }^\circ\text{C}$                         | -   | 11   | -    | pF               |



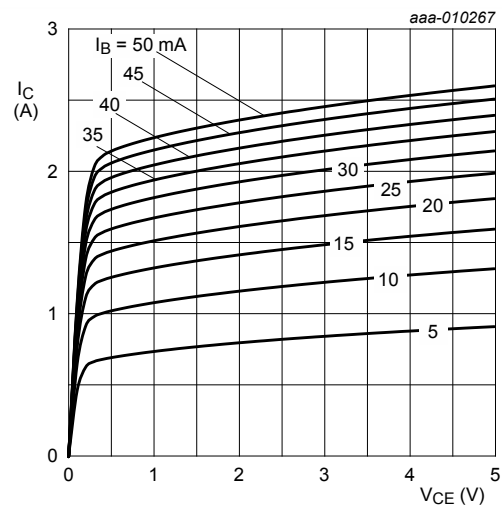
$V_{CE} = 10\text{ V}$

(1)  $T_{amb} = 100\text{ }^\circ\text{C}$

(2)  $T_{amb} = 25\text{ }^\circ\text{C}$

(3)  $T_{amb} = -55\text{ }^\circ\text{C}$

**Fig. 4.** DC current gain as a function of collector current; typical values



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

**Fig. 5.** Collector current as a function of collector-emitter voltage; typical values

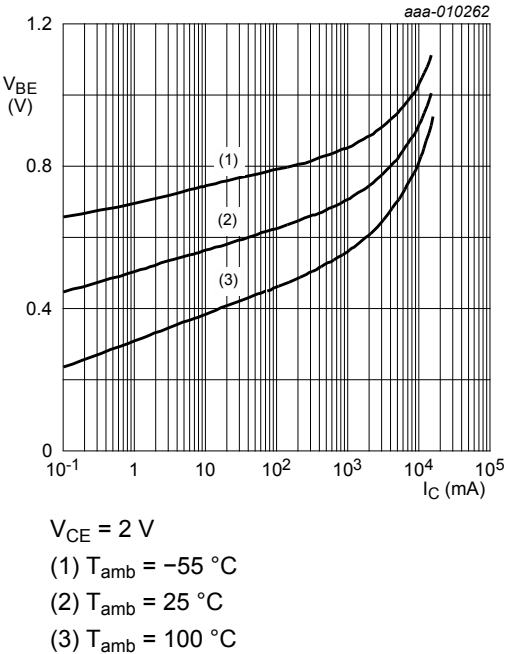


Fig. 6. Base-emitter voltage as a function of collector current; typical values

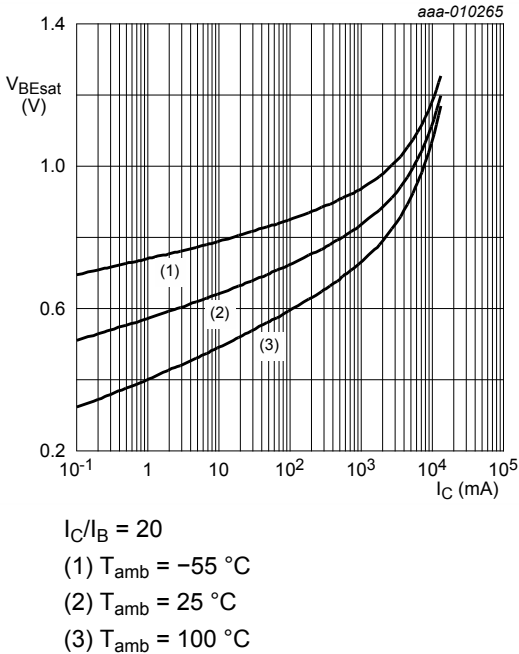


Fig. 7. Base-emitter saturation voltage as a function of collector current; typical values

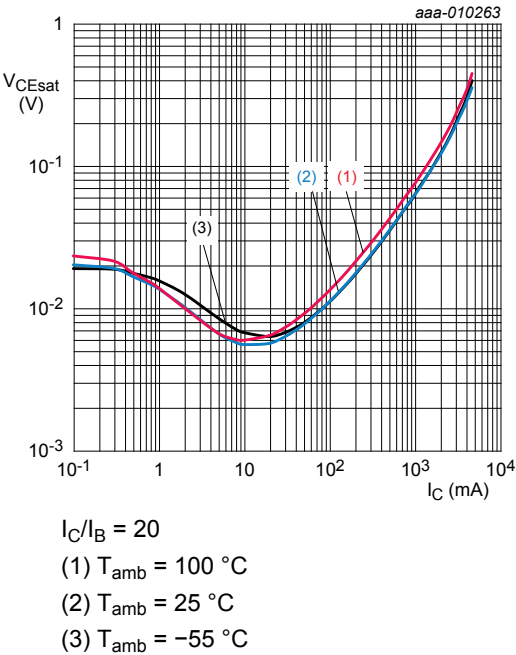


Fig. 8. Collector-emitter saturation voltage as a function of collector current; typical values

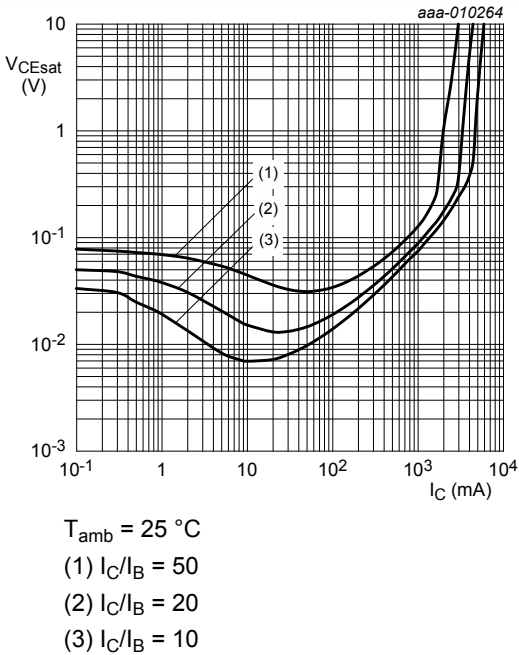
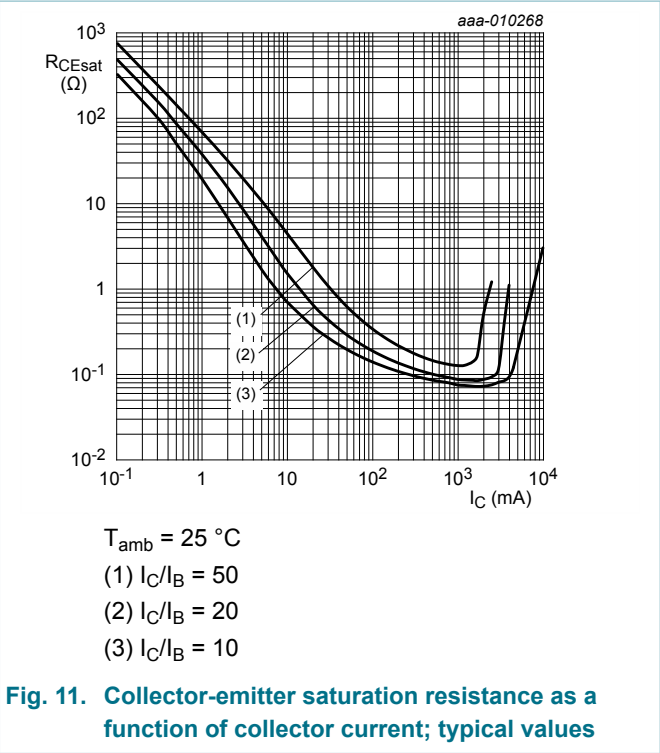
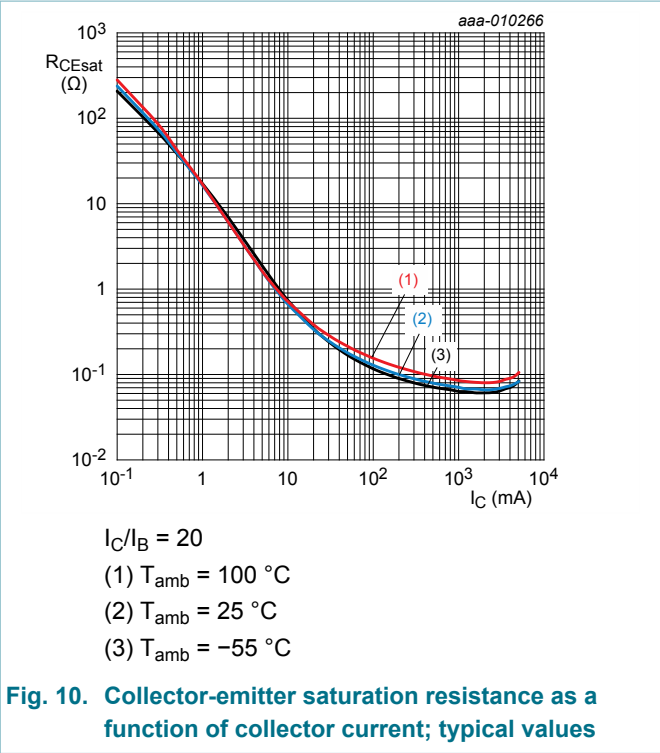
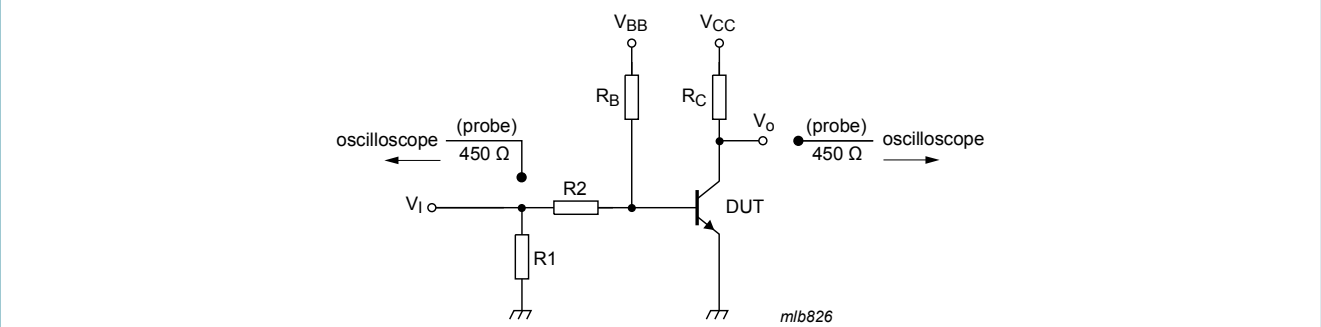
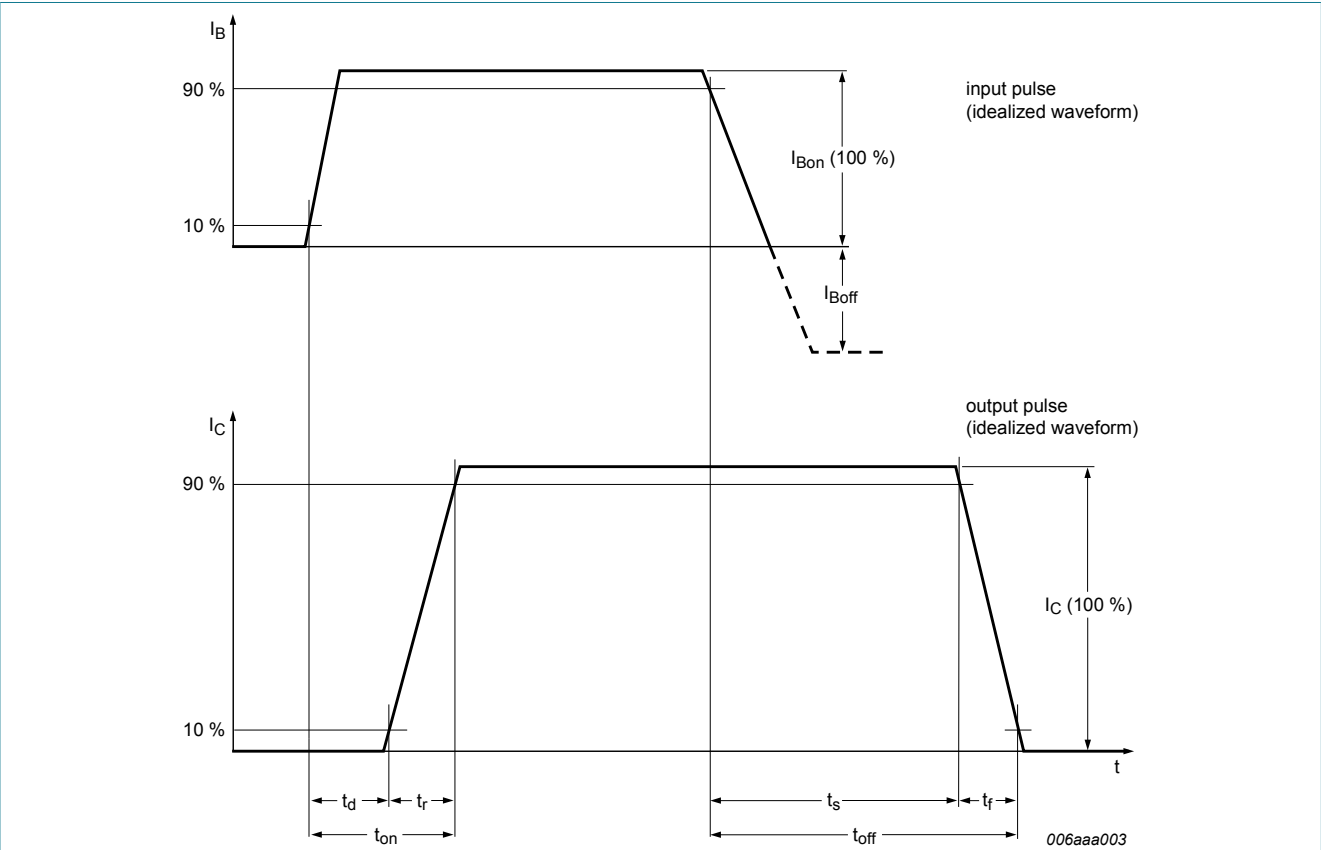


Fig. 9. Collector-emitter saturation voltage as a function of collector current; typical values





11. Test information



11.1 Quality information

This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard Q101 - *Stress test qualification for discrete semiconductors*, and is suitable for use in automotive applications.

12. Package outline

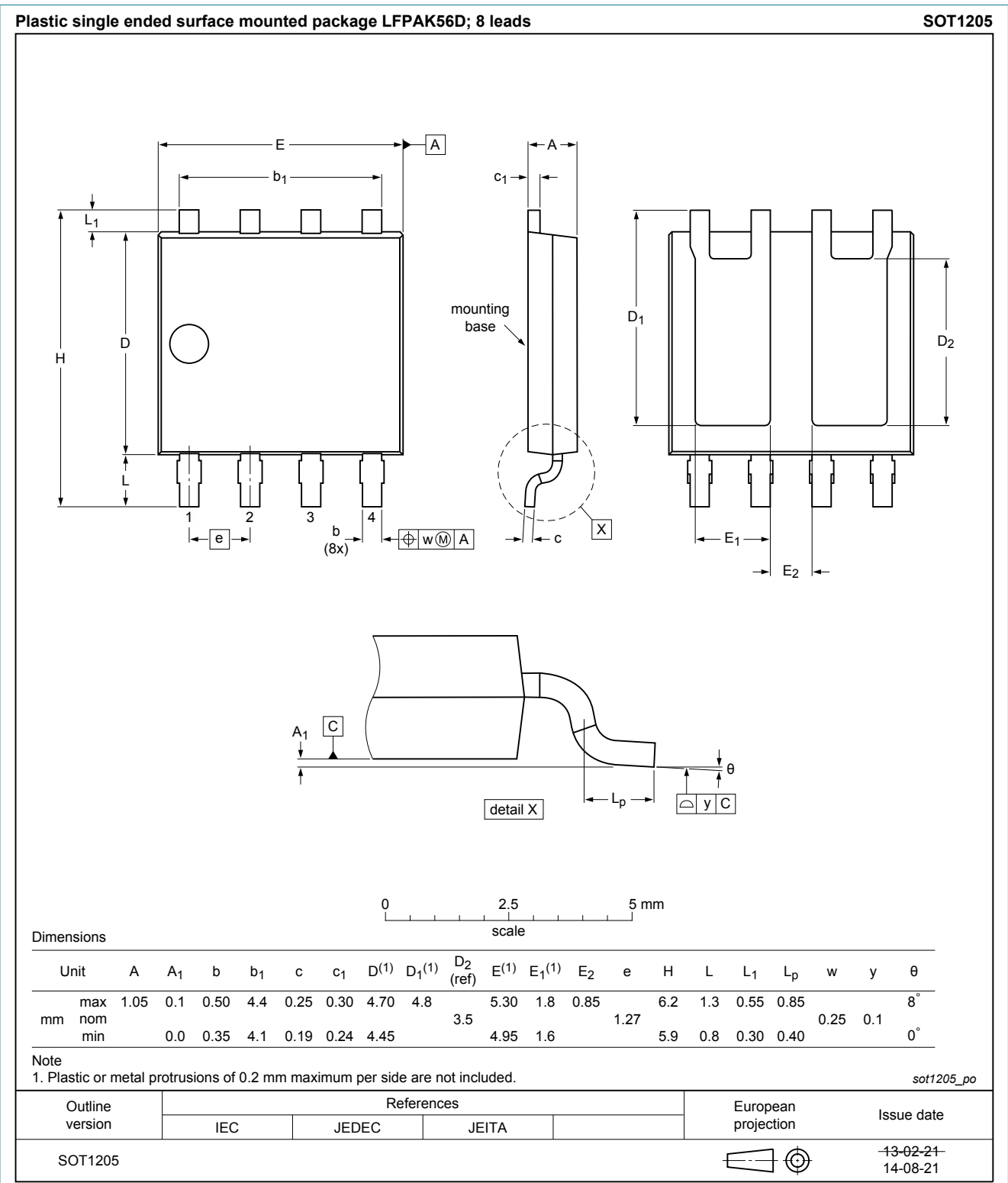
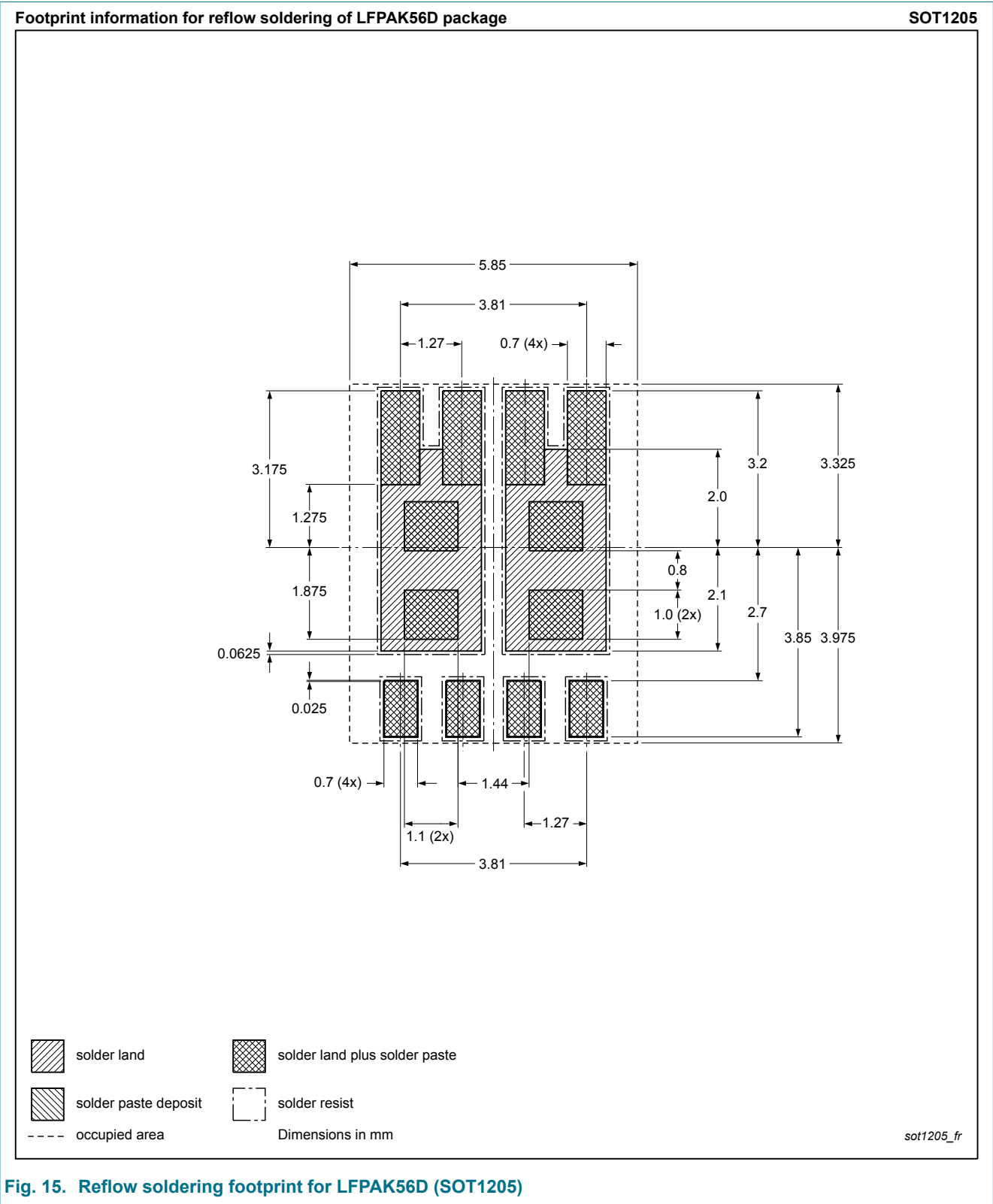


Fig. 14. Package outline LFAK56D (SOT1205)

13. Soldering



14. Revision history

Table 8. Revision history

| Data sheet ID    | Release date | Data sheet status  | Change notice | Supersedes |
|------------------|--------------|--------------------|---------------|------------|
| PHPT610030NK v.1 | 20141020     | Product data sheet | -             | -          |

## 15. Legal information

### 15.1 Data sheet status

| Document status [1][2]         | Product status [3] | Definition                                                                            |
|--------------------------------|--------------------|---------------------------------------------------------------------------------------|
| Objective [short] data sheet   | Development        | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification      | This document contains data from the preliminary specification.                       |
| Product [short] data sheet     | Production         | This document contains the product specification.                                     |

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- [2] The term 'short data sheet' is explained in section "Definitions".
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Date of release: 20 October 2014