



PHPT610035NK

NPN/NPN high power double bipolar transistor

10 September 2020

Product data sheet

1. General description

NPN/NPN high power double bipolar transistor in a SOT1205 (LFAK56D) Surface-Mounted Device (SMD) power plastic package. Matched version of PHPT610030NK.

PNP/PNP complement: PHPT610035PK

NPN/PNP complement: PHPT610035NPK

2. Features and benefits

- Current gain matching 5%
- 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

- Current mirror
- Motor control
- Power management
- Backlighting applications
- Relay replacement
- differential amplifiers

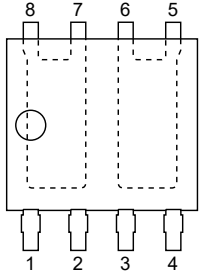
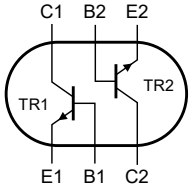
4. Quick reference data

Table 1. Quick reference data

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

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	E1	emitter TR1	 <p>LFPAK56D; Dual LFPAK (SOT1205)</p>	 <p>sym140</p>
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
PHPT610035NK	LFPAK56D; Dual LFPAK	plastic, single ended surface mounted package (LFPAK56D); 8 leads	SOT1205

7. Marking

Table 4. Marking codes

Type number	Marking code
PHPT610035NK	10035NK

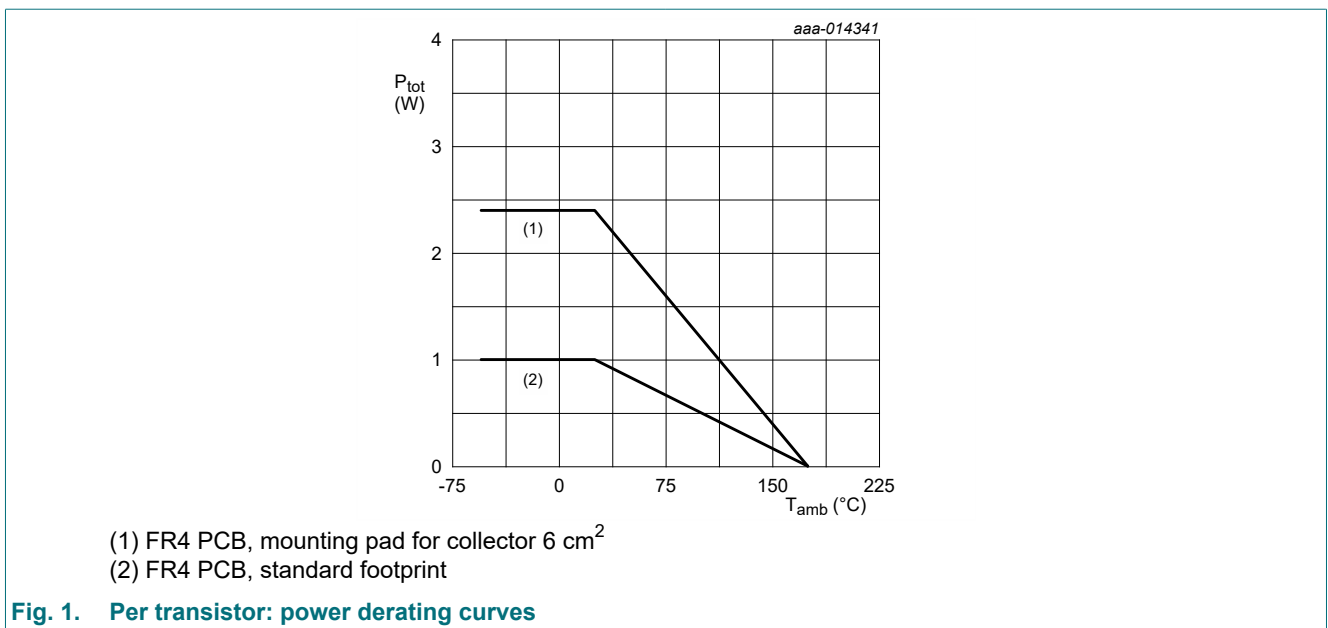
8. Limiting values

Table 5. Limiting values

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

Symbol	Parameter	Conditions		Min	Max	Unit
Per transistor						
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
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	[1]	-	1	W
			[2]	-	2.4	W
			[3]	-	25	W
Per device						
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	[1]	-	1.25	W
			[4]	-	5	W
			[2]	-	3	W
T_j	junction temperature			-	175	°C
T_{amb}	ambient temperature			-55	175	°C
T_{stg}	storage temperature			-65	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 cm².
- [3] Power dissipation from junction to mounting base.
- [4] Device mounted on a ceramic PCB, Al₂O₃, standard footprint.



9. Thermal characteristics

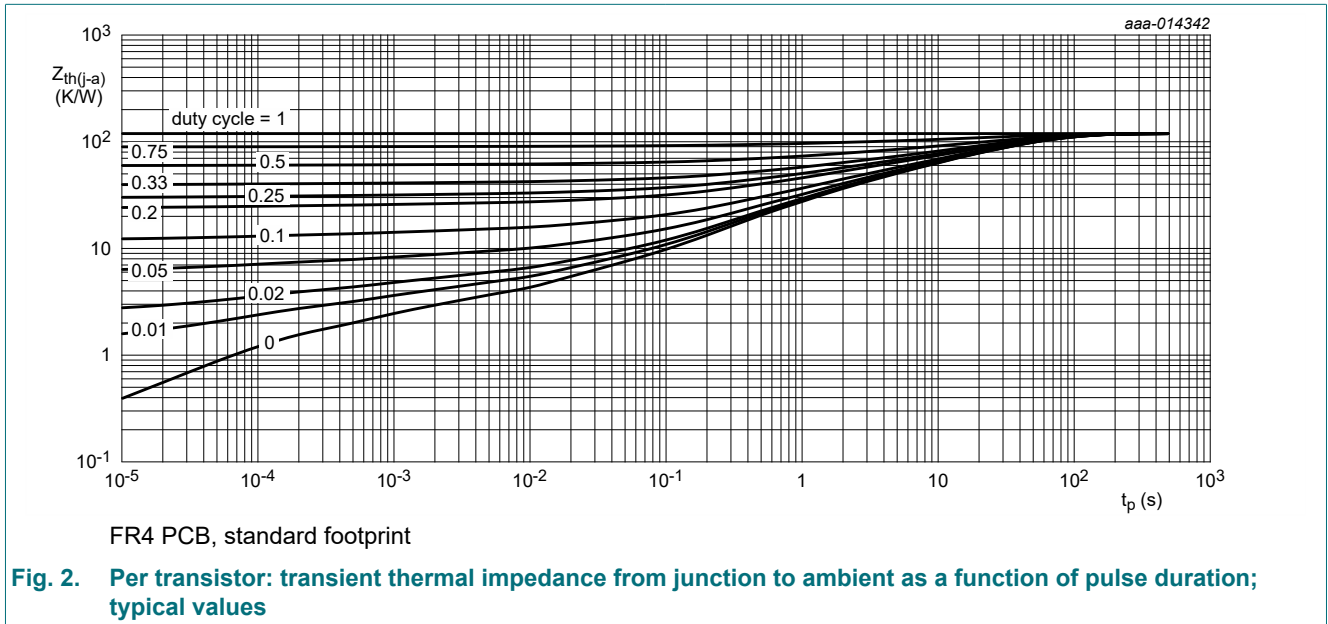
Table 6. Thermal characteristics

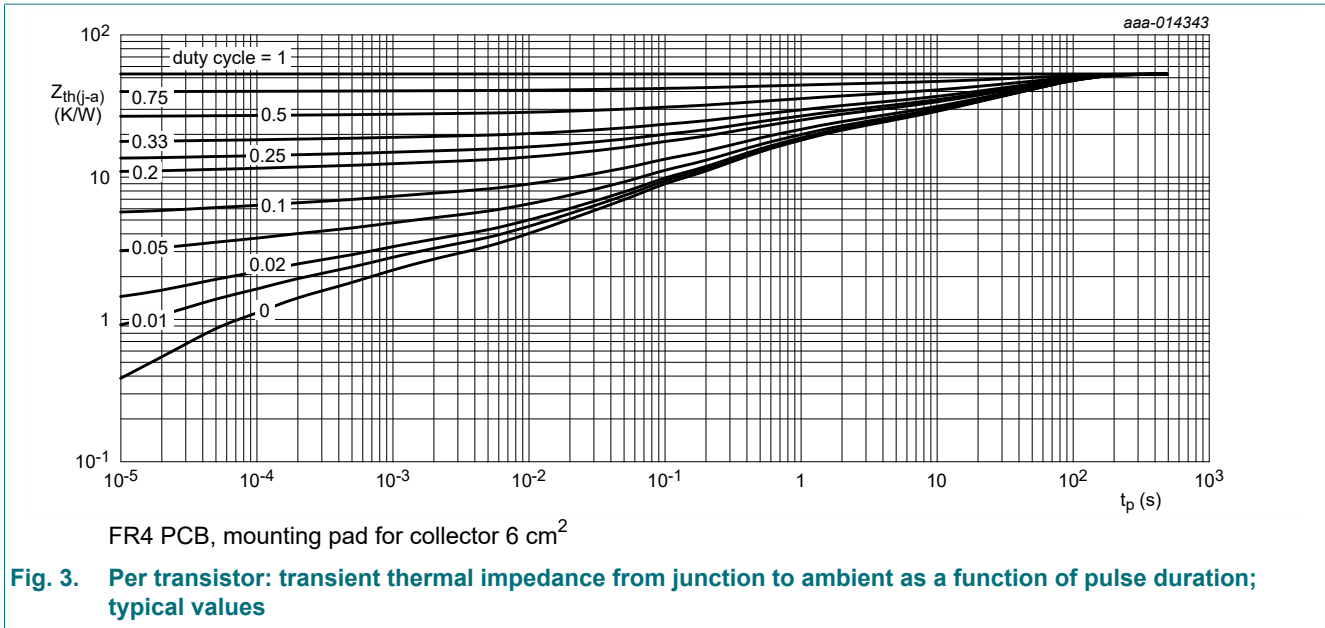
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Per transistor							
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	150	K/W
			[2]	-	-	62.5	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	-	6	K/W
Per device							
$R_{th(j-a)}$	thermal resistance 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 cm².

[3] Device mounted on a ceramic PCB, Al₂O₃, standard footprint.

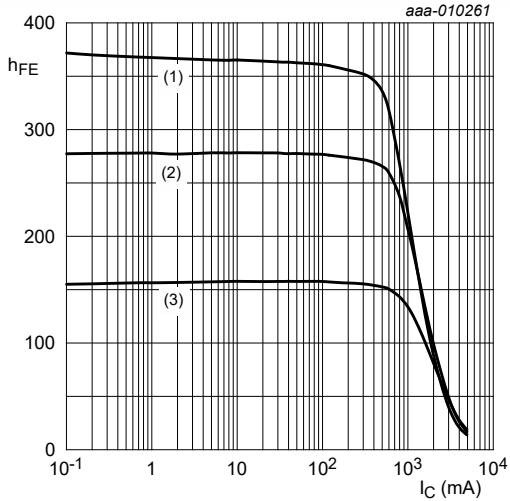




10. Characteristics

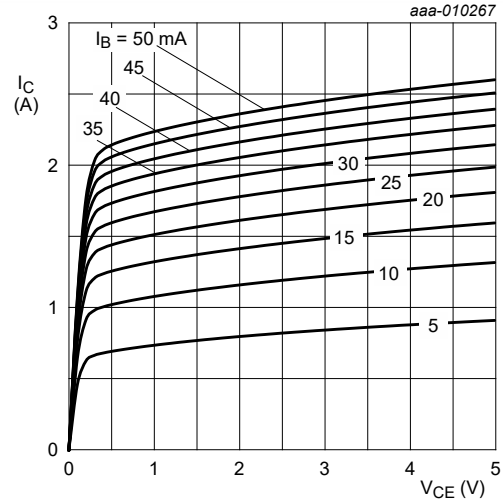
Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
h_{FE1}/h_{FE2}	DC current gain matching	$V_{CE} = 2\text{ V}; I_C = 1\text{ A}$	0.95	1	1.05	
Per transistor						
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	μA
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	$V_{CE} = 2\text{ V}; I_C = 1\text{ A}; t_p \leq 300\text{ }\mu\text{s}; \text{ pulsed}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	80	150	-	
		$V_{CE} = 10\text{ V}; I_C = 500\text{ mA}; t_p \leq 300\text{ }\mu\text{s}; \text{ pulsed}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	150	250	-	
		$V_{CE} = 10\text{ V}; I_C = 1\text{ A}; t_p \leq 300\text{ }\mu\text{s}; \text{ pulsed}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	80	250	-	
		$V_{CE} = 10\text{ V}; I_C = 2\text{ A}; t_p \leq 300\text{ }\mu\text{s}; \text{ pulsed}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	20	100	-	
		$V_{CE} = 10\text{ V}; I_C = 3\text{ A}; t_p \leq 300\text{ }\mu\text{s}; \text{ pulsed}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	10	40	-	
V_{CEsat}	collector-emitter saturation voltage	$I_C = 1\text{ A}; I_B = 50\text{ mA}; t_p \leq 300\text{ }\mu\text{s}; \text{ pulsed}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	90	150	mV
		$I_C = 3\text{ A}; I_B = 300\text{ mA}; t_p \leq 300\text{ }\mu\text{s}; \text{ pulsed}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	225	330	mV
R_{CEsat}	collector-emitter saturation resistance	$I_C = 3\text{ A}; I_B = 300\text{ mA}; t_p \leq 300\text{ }\mu\text{s}; \text{ pulsed}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	75	110	$\text{m}\Omega$
V_{BEsat}	base-emitter saturation voltage	$I_C = 1\text{ A}; I_B = 50\text{ mA}; t_p \leq 300\text{ }\mu\text{s}; \text{ pulsed}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	0.86	1	V
		$I_C = 2\text{ A}; I_B = 200\text{ mA}; t_p \leq 300\text{ }\mu\text{s}; \text{ pulsed}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	1	1.2	V
V_{BEon}	base-emitter turn-on voltage	$V_{CE} = 2\text{ V}; I_C = 0.1\text{ A}; t_p \leq 300\text{ }\mu\text{s}; \text{ pulsed}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	0.67	0.85	V
t_d	delay time	$V_{CC} = 12.5\text{ V}; I_C = 1\text{ A}; I_{B(on)} = 50\text{ mA}; I_{B(off)} = -50\text{ mA}; T_{amb} = 25\text{ }^\circ\text{C}$	-	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	-
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



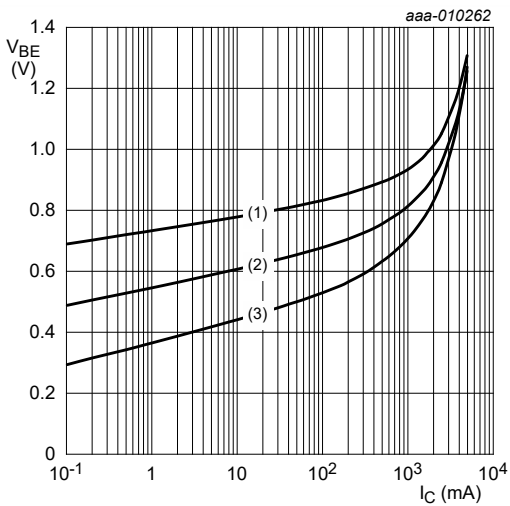
$V_{CE} = 10 \text{ V}$
 (1) $T_{amb} = 100 \text{ }^\circ\text{C}$
 (2) $T_{amb} = 25 \text{ }^\circ\text{C}$
 (3) $T_{amb} = -55 \text{ }^\circ\text{C}$

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



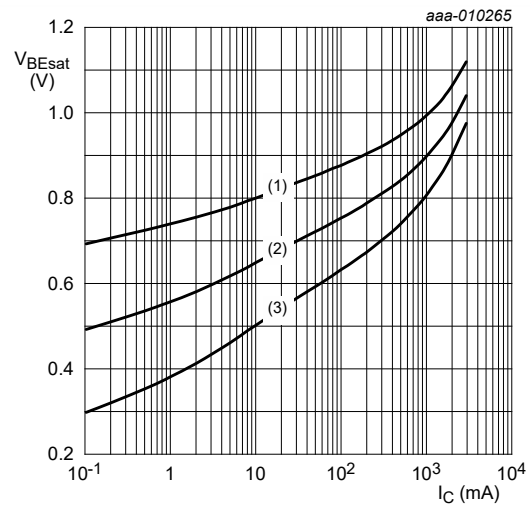
$T_{amb} = 25 \text{ }^\circ\text{C}$

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



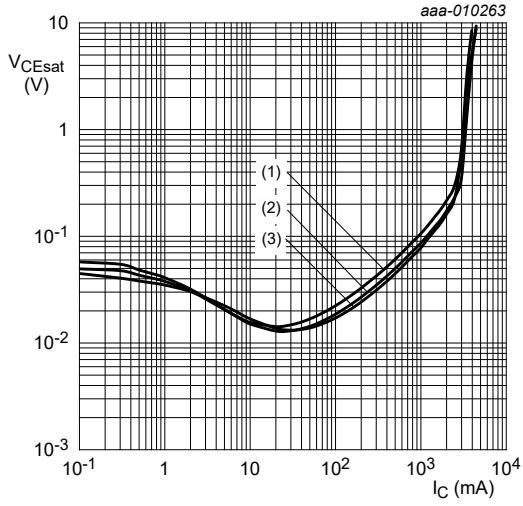
$V_{CE} = 2 \text{ V}$
 (1) $T_{amb} = -55 \text{ }^\circ\text{C}$
 (2) $T_{amb} = 25 \text{ }^\circ\text{C}$
 (3) $T_{amb} = 100 \text{ }^\circ\text{C}$

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



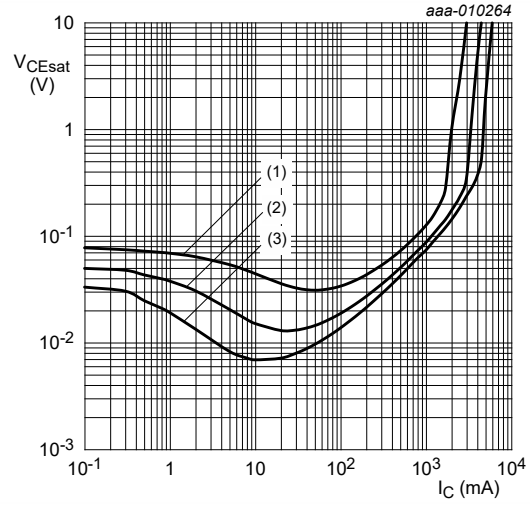
$I_C/I_B = 20$
 (1) $T_{amb} = -55 \text{ }^\circ\text{C}$
 (2) $T_{amb} = 25 \text{ }^\circ\text{C}$
 (3) $T_{amb} = 100 \text{ }^\circ\text{C}$

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



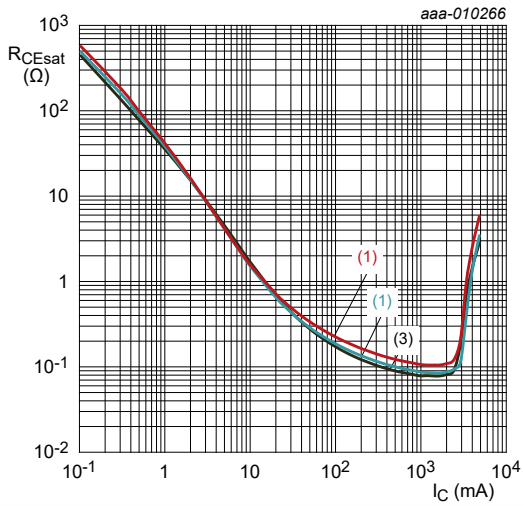
$I_C/I_B = 20$
 (1) $T_{amb} = 100\text{ °C}$
 (2) $T_{amb} = 25\text{ °C}$
 (3) $T_{amb} = -55\text{ °C}$

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



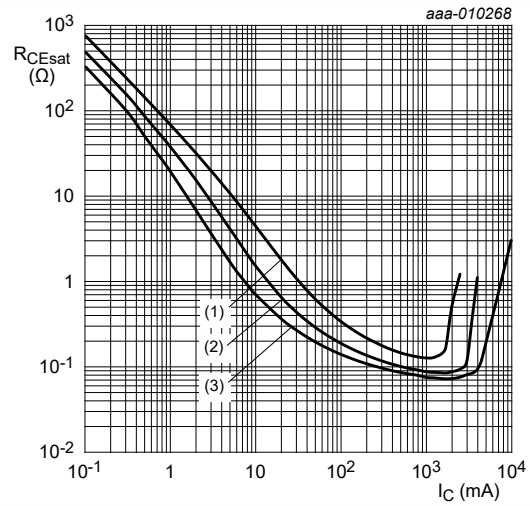
$T_{amb} = 25\text{ °C}$
 (1) $I_C/I_B = 50$
 (2) $I_C/I_B = 20$
 (3) $I_C/I_B = 10$

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



$I_C/I_B = 20$
 (1) $T_{amb} = 100\text{ °C}$
 (2) $T_{amb} = 25\text{ °C}$
 (3) $T_{amb} = -55\text{ °C}$

Fig. 10. Collector-emitter saturation resistance as a function of collector current; typical values



$T_{amb} = 25\text{ °C}$
 (1) $I_C/I_B = 50$
 (2) $I_C/I_B = 20$
 (3) $I_C/I_B = 10$

Fig. 11. TR1 (NPN): Collector-emitter saturation resistance as a function of collector current; typical values

11. Test information

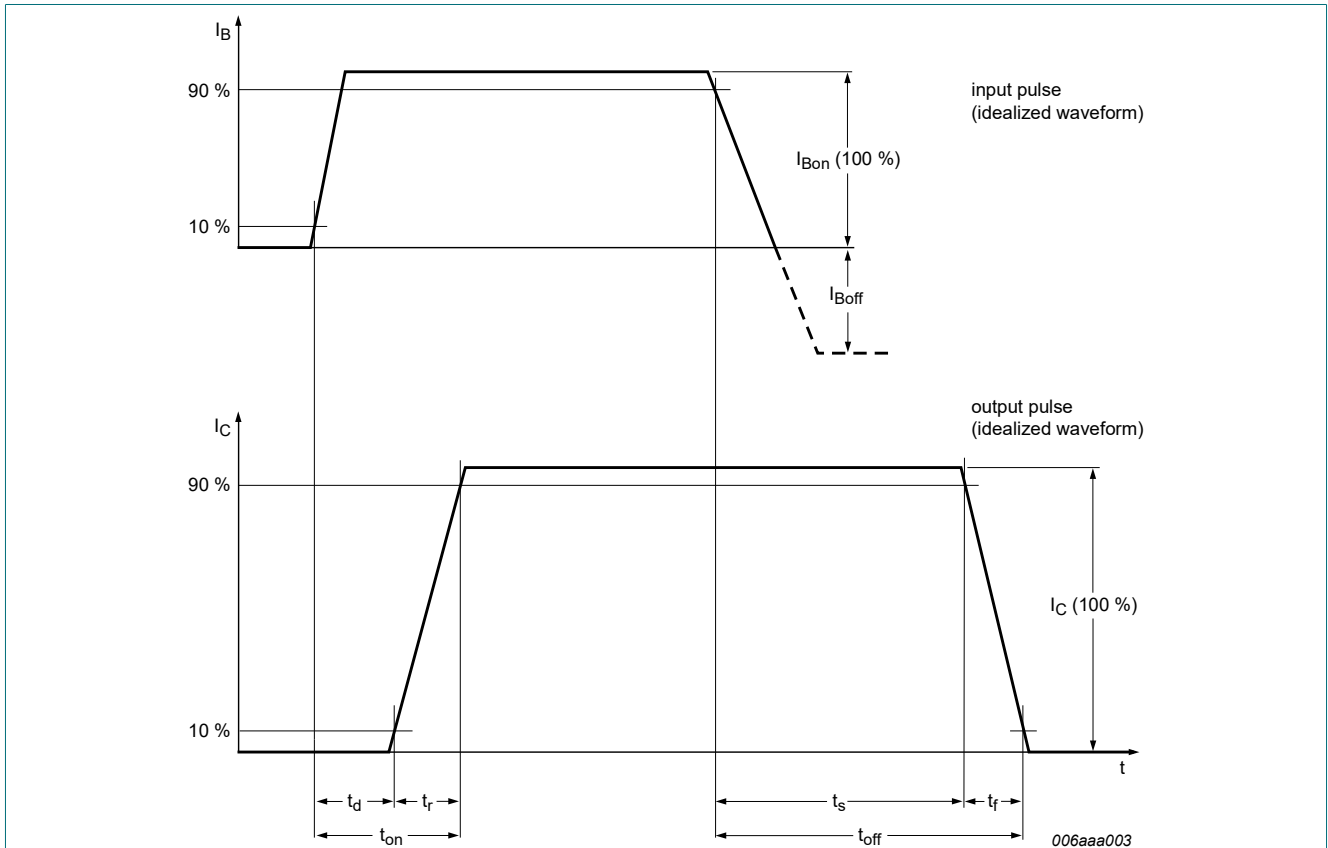


Fig. 12. BISS transistor switching time definition

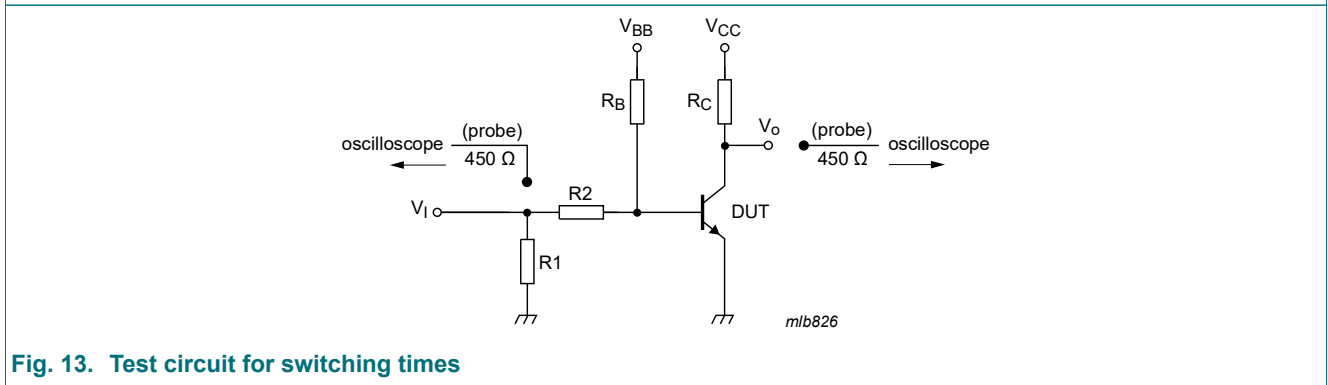


Fig. 13. Test circuit for switching times

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

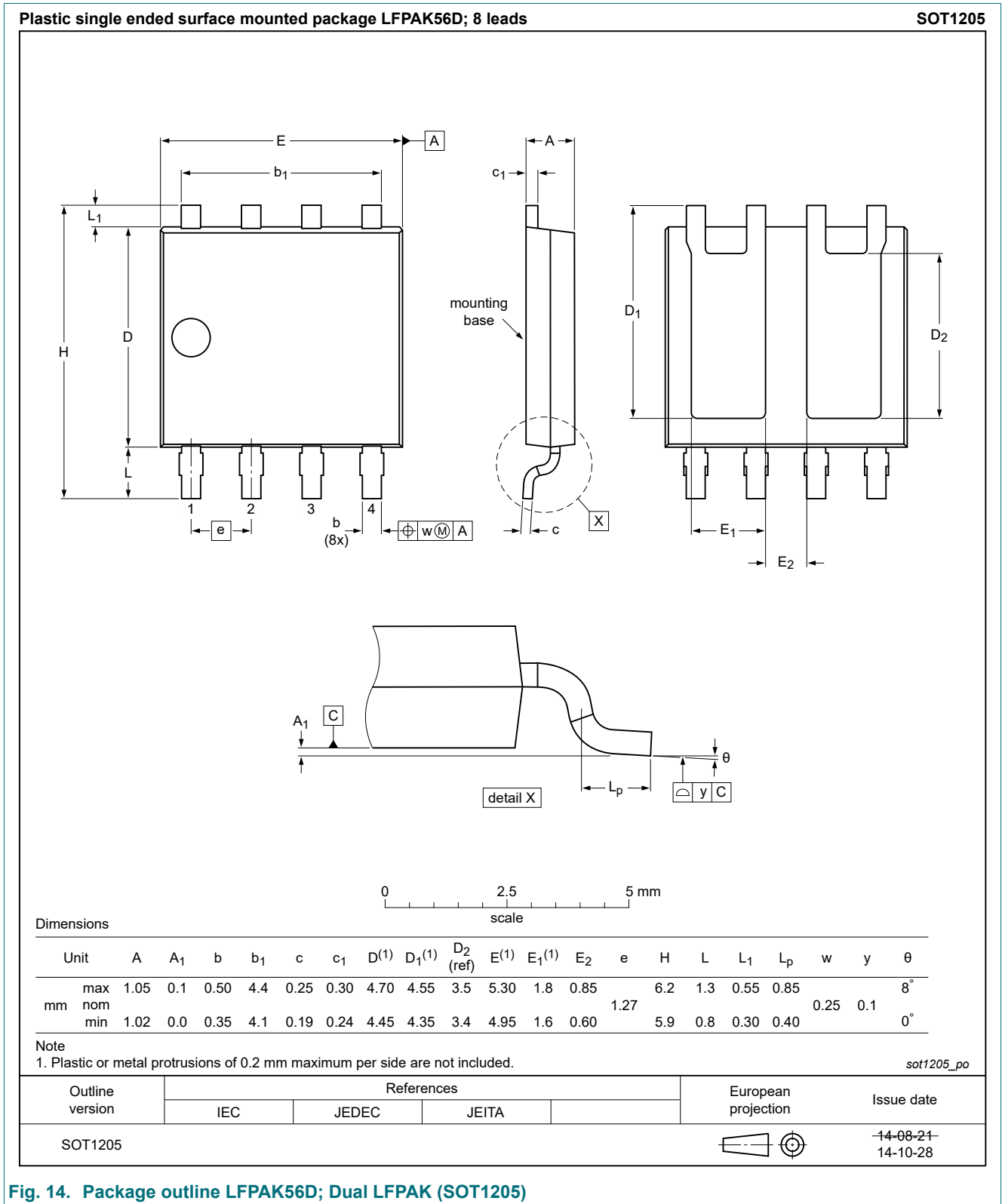


Fig. 14. Package outline LFAK56D; Dual LFAK (SOT1205)

14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PHPT610035NK v.2	20200910	Product data sheet	-	PHPT610035NK v.1
Modifications:	• Characteristics: Figures 6, 7, 8 and 10 corrected			
PHPT610035NK v.1	20141014	Product data sheet	-	-

15. Legal information

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.

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
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