



# PHPT610030NPK

NPN/PNP high power double bipolar transistor

10 September 2020

Product data sheet

## 1. General description

NPN/PNP high power double bipolar transistor in a SOT1205 (LFPAK56D) Surface-Mounted Device (SMD) power plastic package.

NPN/NPN complement: PHPT610030NK

PNP/PNP complement: PHPT610030PK

## 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

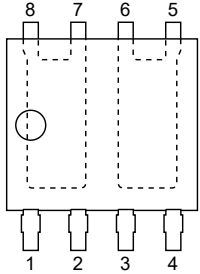
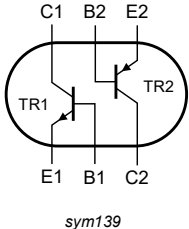
## 4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Per transistor; for the PNP transistor with negative polarity</b>						
$V_{CE0}$	collector-emitter voltage	open base	-	-	100	V
$I_C$	collector current		-	-	3	A
<b>TR1 (NPN)</b>						
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = 3\text{ A}$ ; $I_B = 300\text{ mA}$ ; $t_p \leq 300\ \mu\text{s}$ ; pulsed; $\delta \leq 0.02$ ; $T_{amb} = 25\text{ °C}$	-	75	110	m $\Omega$
<b>TR2 (PNP)</b>						
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = -2\text{ A}$ ; $I_B = -200\text{ mA}$ ; $t_p \leq 300\ \mu\text{s}$ ; pulsed; $\delta \leq 0.02$ ; $T_{amb} = 25\text{ °C}$	-	110	180	m $\Omega$

## 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>sym139</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
PHPT610030NPK	LFPAK56D; Dual LFPAK	plastic, single ended surface mounted package (LFPAK56D); 8 leads	SOT1205

## 7. Marking

Table 4. Marking codes

Type number	Marking code
PHPT610030NPK	1003NPK

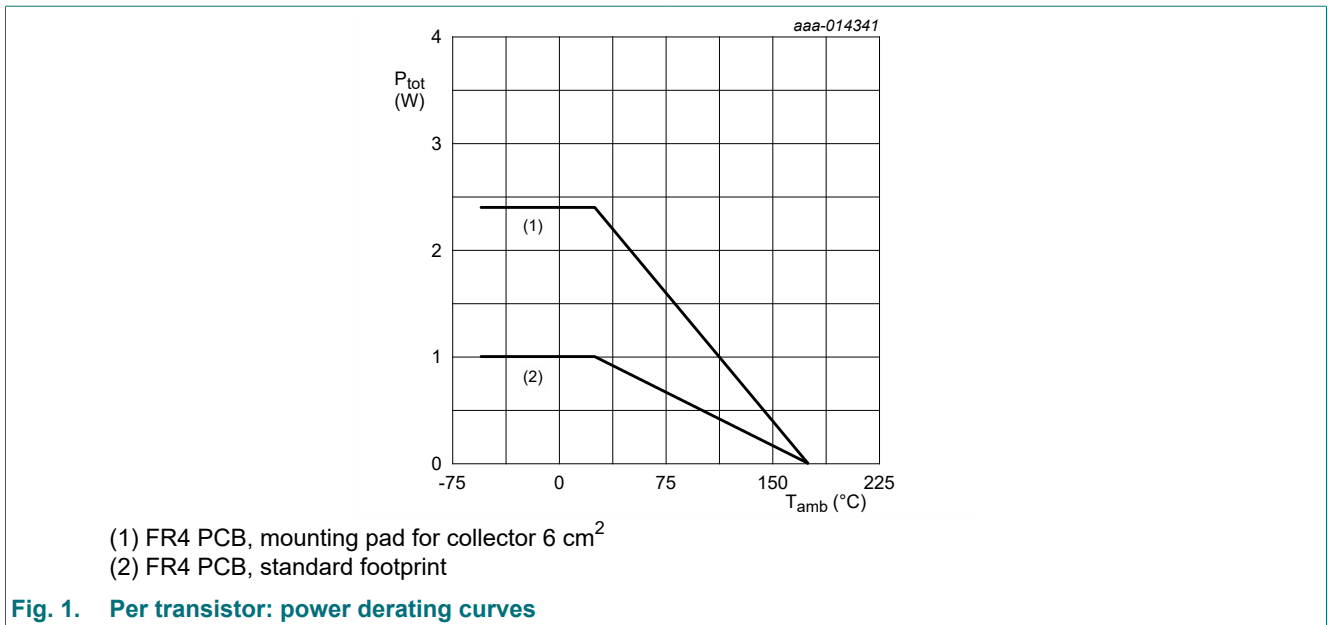
## 8. Limiting values

**Table 5. Limiting values**

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

Symbol	Parameter	Conditions	Min	Max	Unit	
<b>Per transistor; for the PNP transistor with negative polarity</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	
$P_{tot}$	total power dissipation	$T_{amb} \leq 25$ °C	[1]	-	1	W
			[2]	-	2.4	W
			[3]	-	25	W
<b>Per device</b>						
$P_{tot}$	total power dissipation	$T_{amb} \leq 25$ °C	[1]	-	1.25	W
			[2]	-	3	W
			[4]	-	5	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 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.



## 9. Thermal characteristics

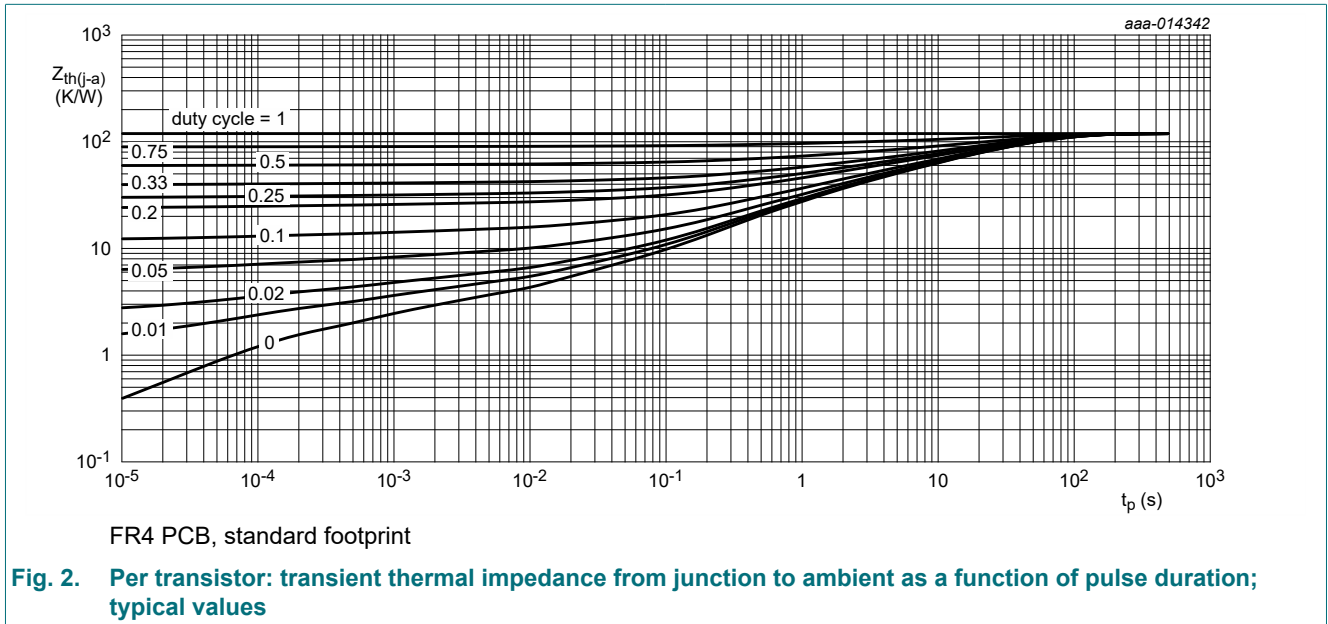
Table 6. Thermal characteristics

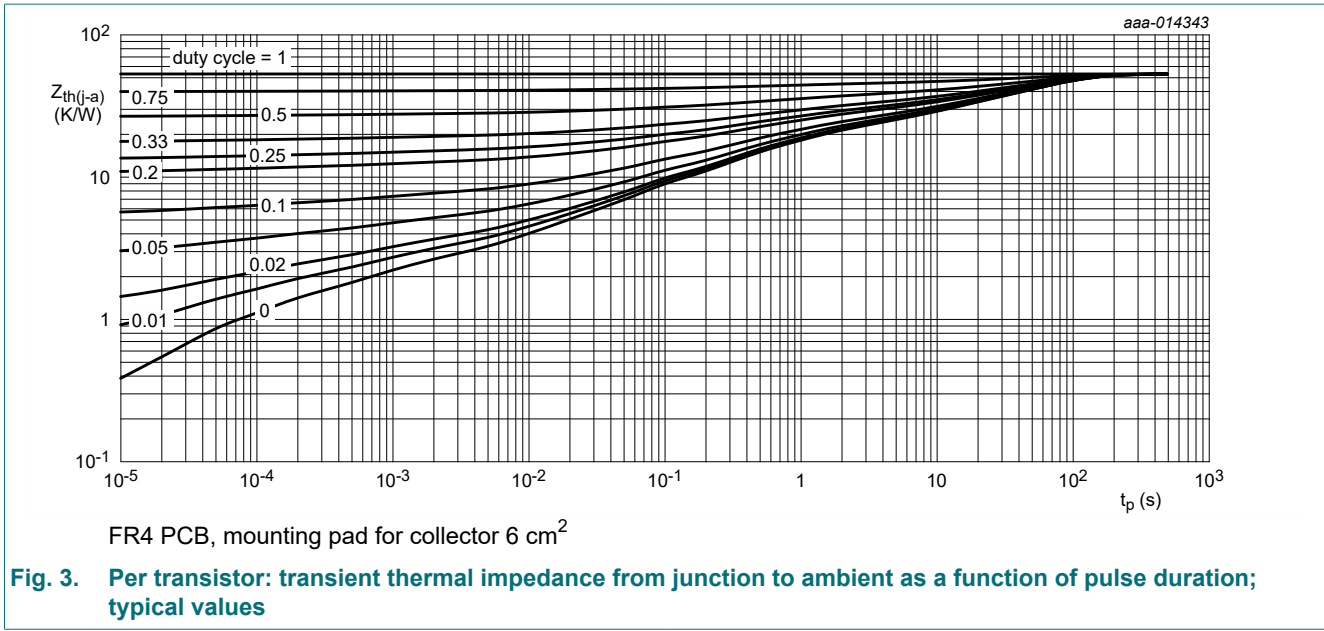
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
<b>Per transistor</b>							
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	150	K/W
			[2]	-	-	62.5	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	-	6	K/W
<b>Per device</b>							
$R_{th(j-a)}$	thermal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

[3] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint.



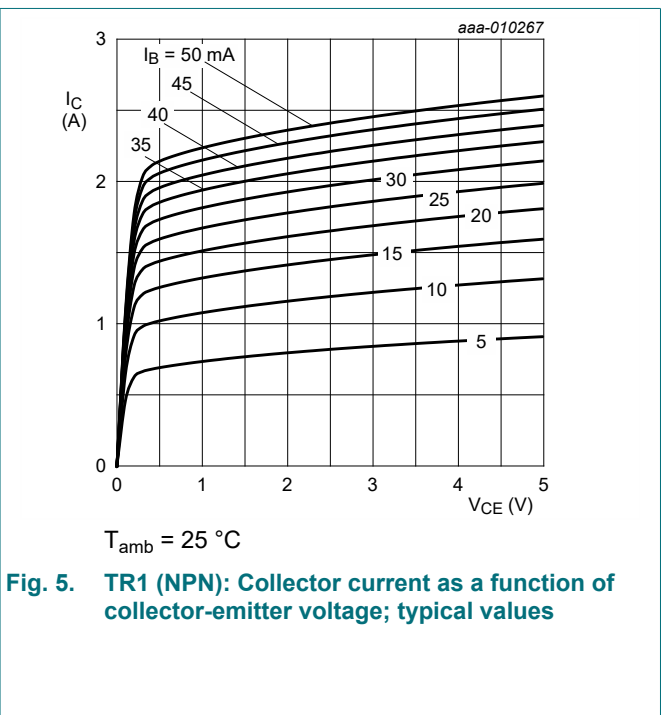
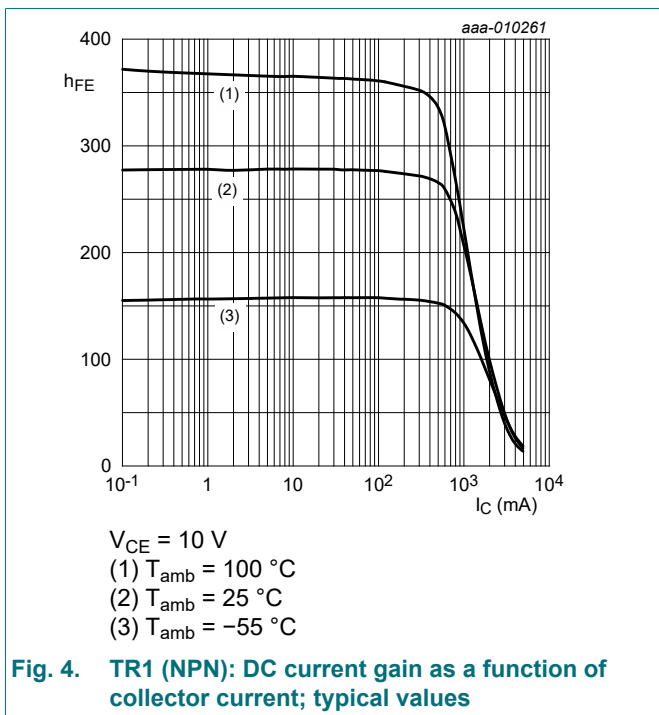


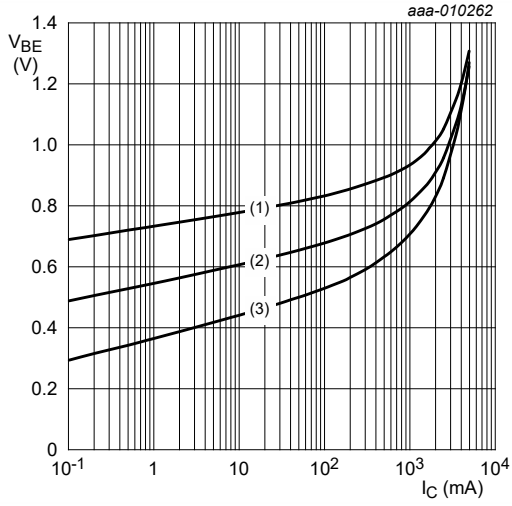
## 10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>TR1 (NPN)</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	$V_{CE} = 80\text{ V}; V_{BE} = 0\text{ V}$	-	-	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	$V_{CE} = 10\text{ V}; I_C = 500\text{ mA}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	150	250	-	
		$V_{CE} = 10\text{ V}; I_C = 1\text{ A}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	80	250	-	
		$V_{CE} = 10\text{ V}; I_C = 2\text{ A}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	20	100	-	
		$V_{CE} = 10\text{ V}; I_C = 3\text{ A}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	10	40	-	
$V_{CEsat}$	collector-emitter saturation voltage	$I_C = 1\text{ A}; I_B = 50\text{ mA}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	90	150	mV
		$I_C = 3\text{ A}; I_B = 0.3\text{ A}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	225	330	mV
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = 3\text{ A}; I_B = 300\text{ mA}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	75	110	$\text{m}\Omega$
$V_{BEsat}$	base-emitter saturation voltage	$I_C = 1\text{ A}; I_B = 50\text{ mA}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	0.86	1	V
		$I_C = 2\text{ A}; I_B = 200\text{ mA}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	1	1.2	V
$V_{BEon}$	base-emitter turn-on voltage	$V_{CE} = 2\text{ V}; I_C = 100\text{ mA}; t_p \leq 300\text{ }\mu\text{s};$ 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
<b>TR2 (PNP)</b>						
$I_{CBO}$	collector-base cut-off current	$V_{CB} = -80\text{ V}; I_E = 0\text{ A}$	-	-	-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	$V_{CE} = -80\text{ V}; V_{BE} = 0\text{ V}$	-	-	-100	nA
$I_{EBO}$	emitter-base cut-off current	$V_{EB} = -7\text{ V}; I_C = 0\text{ A}$	-	-	-100	nA

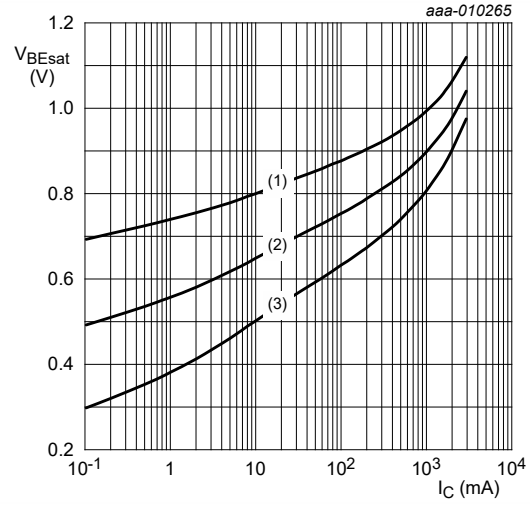
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$h_{FE}$	DC current gain	$V_{CE} = -10\text{ V}; I_C = -500\text{ mA}; T_{amb} = 25\text{ }^\circ\text{C}$	150	200	-	
		$V_{CE} = -10\text{ V}; I_C = -1\text{ A}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	80	210	-	
		$V_{CE} = -10\text{ V}; I_C = -2\text{ A}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	20	100	-	
		$V_{CE} = -10\text{ V}; I_C = -3\text{ A}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	10	40	-	
$V_{CEsat}$	collector-emitter saturation voltage	$I_C = -500\text{ mA}; I_B = -50\text{ mA}; T_{amb} = 25\text{ }^\circ\text{C}$	-	-70	-110	mV
		$I_C = -2\text{ A}; I_B = -0.2\text{ A}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	-220	-360	mV
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = -2\text{ A}; I_B = -200\text{ mA}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	110	180	m $\Omega$
$V_{BEsat}$	base-emitter saturation voltage	$I_C = -1\text{ A}; I_B = -50\text{ mA}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	-0.91	-1	V
		$I_C = -2\text{ A}; I_B = -200\text{ mA}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	-1.02	-1.2	V
$V_{BEon}$	base-emitter turn-on voltage	$V_{CE} = -2\text{ V}; I_C = -100\text{ mA}; t_p \leq 300\text{ }\mu\text{s};$ pulsed; $\delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	-0.68	-0.9	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		-	180	-	ns
$t_{on}$	turn-on time		-	200	-	ns
$t_s$	storage time		-	350	-	ns
$t_f$	fall time		-	220	-	ns
$t_{off}$	turn-off time		-	570	-	ns
$f_T$	transition frequency		$V_{CE} = -10\text{ V}; I_C = -100\text{ mA}; f = 100\text{ MHz};$ $T_{amb} = 25\text{ }^\circ\text{C}$	-	125	-
$C_c$	collector capacitance	$V_{CB} = -10\text{ V}; I_E = 0\text{ A}; i_e = 0\text{ A};$ $f = 1\text{ MHz}; T_{amb} = 25\text{ }^\circ\text{C}$	-	30	-	pF





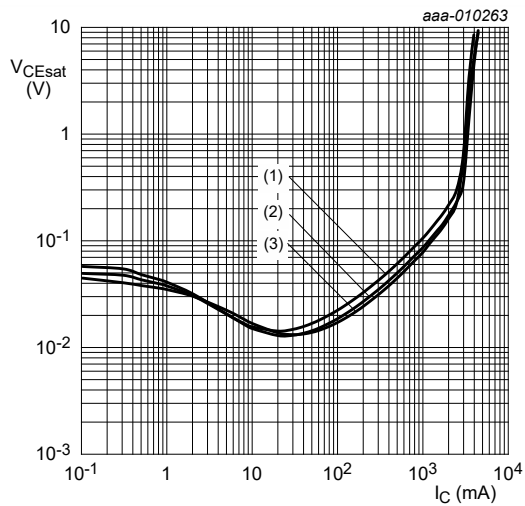
$V_{CE} = 2\text{ V}$   
 (1)  $T_{amb} = -55\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = 100\text{ °C}$

**Fig. 6. TR1 (NPN): Base-emitter voltage as a function of collector current; typical values**



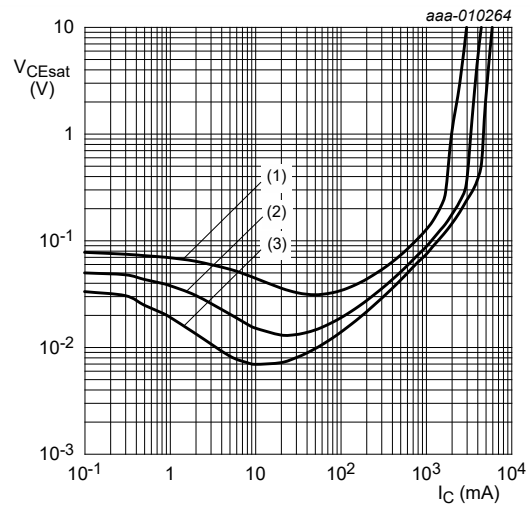
$I_C/I_B = 20$   
 (1)  $T_{amb} = -55\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = 100\text{ °C}$

**Fig. 7. TR1 (NPN): 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)  $T_{amb} = -55\text{ °C}$

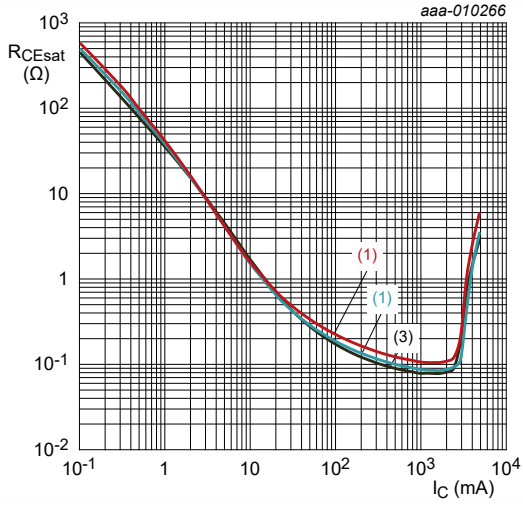
**Fig. 8. TR1 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values**



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

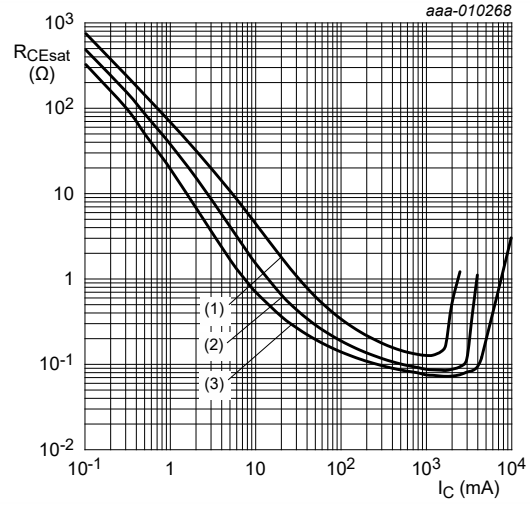
**Fig. 9. TR1 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values**





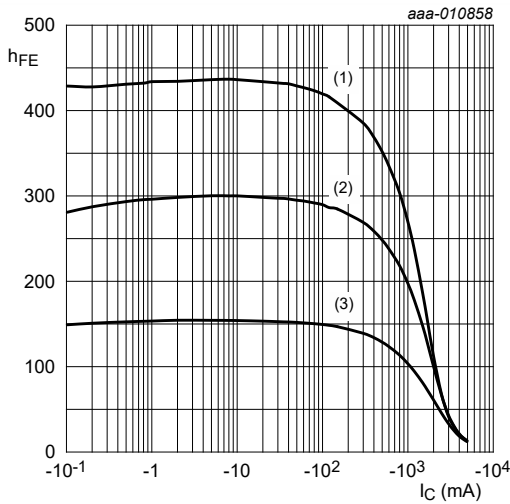
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -55\text{ °C}$

Fig. 10. TR1 (NPN): Collector-emitter saturation resistance as a function of collector current; typical values



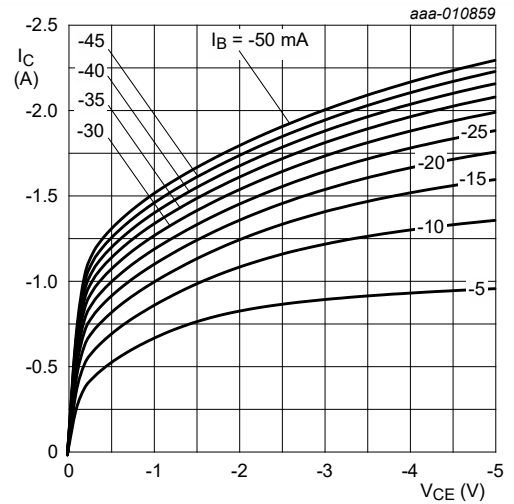
$T_{amb} = 25\text{ °C}$   
 (1)  $I_C/I_B = 50$   
 (2)  $I_C/I_B = 20$   
 (3)  $I_C/I_B = 10$

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



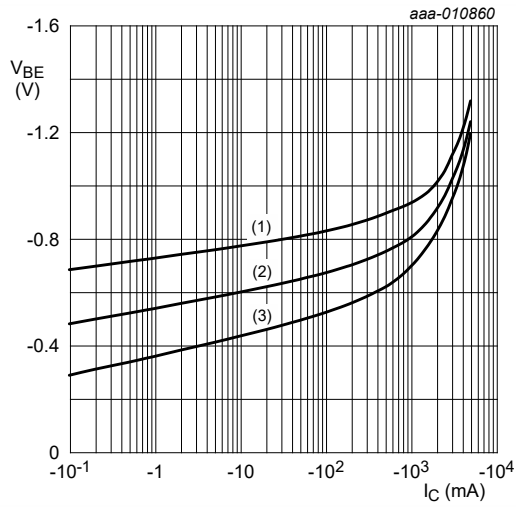
$V_{CE} = -10\text{ V}$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -55\text{ °C}$

Fig. 12. TR2 (PNP): DC current gain as a function of collector current; typical values



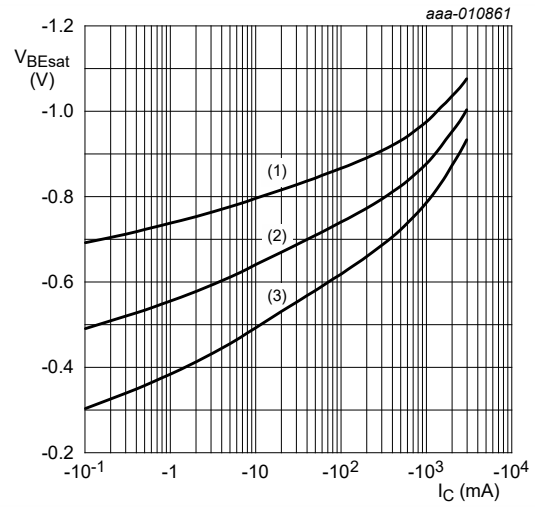
$T_{amb} = 25\text{ °C}$

Fig. 13. TR2 (PNP): Collector current as a function of collector-emitter voltage; typical values



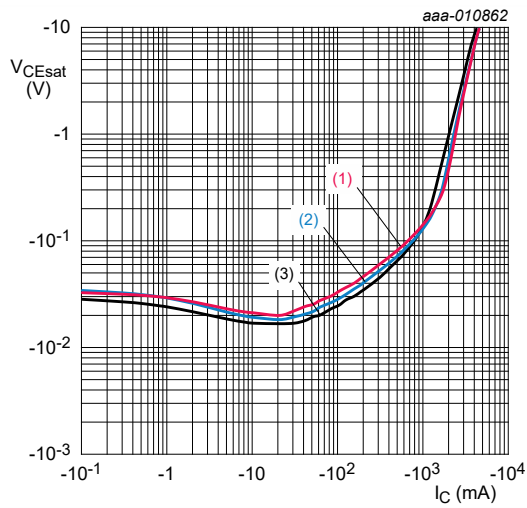
$V_{CE} = -2 \text{ V}$   
 (1)  $T_{amb} = -55 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

**Fig. 14. TR2 (PNP): Base-emitter voltage as a function of collector current; typical values**



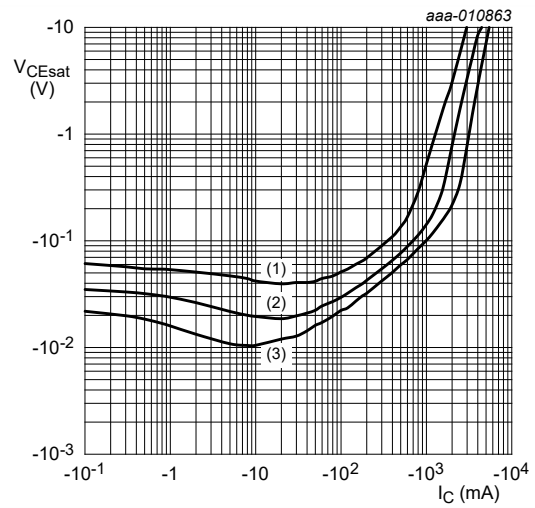
$I_C/I_B = 20$   
 (1)  $T_{amb} = -55 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

**Fig. 15. TR2 (PNP): Base-emitter saturation voltage as a function of collector current; typical values**



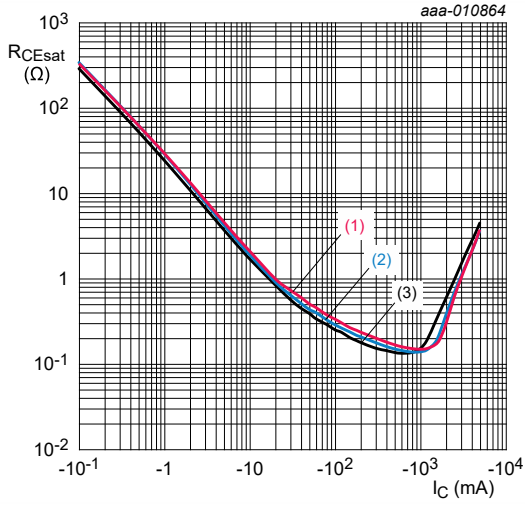
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = -55 \text{ }^\circ\text{C}$

**Fig. 16. TR2 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values**



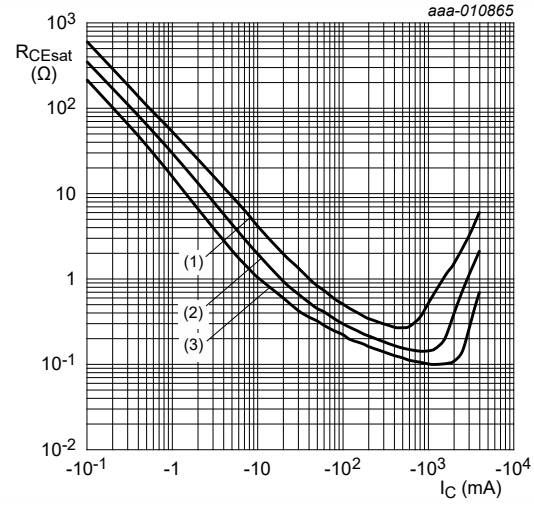
$T_{amb} = 25 \text{ }^\circ\text{C}$   
 (1)  $I_C/I_B = 50$   
 (2)  $I_C/I_B = 20$   
 (3)  $I_C/I_B = 10$

**Fig. 17. TR2 (PNP): 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. 18. TR2 (PNP): 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. 19. TR2 (PNP): Collector-emitter saturation resistance as a function of collector current; typical values**

11. Test information

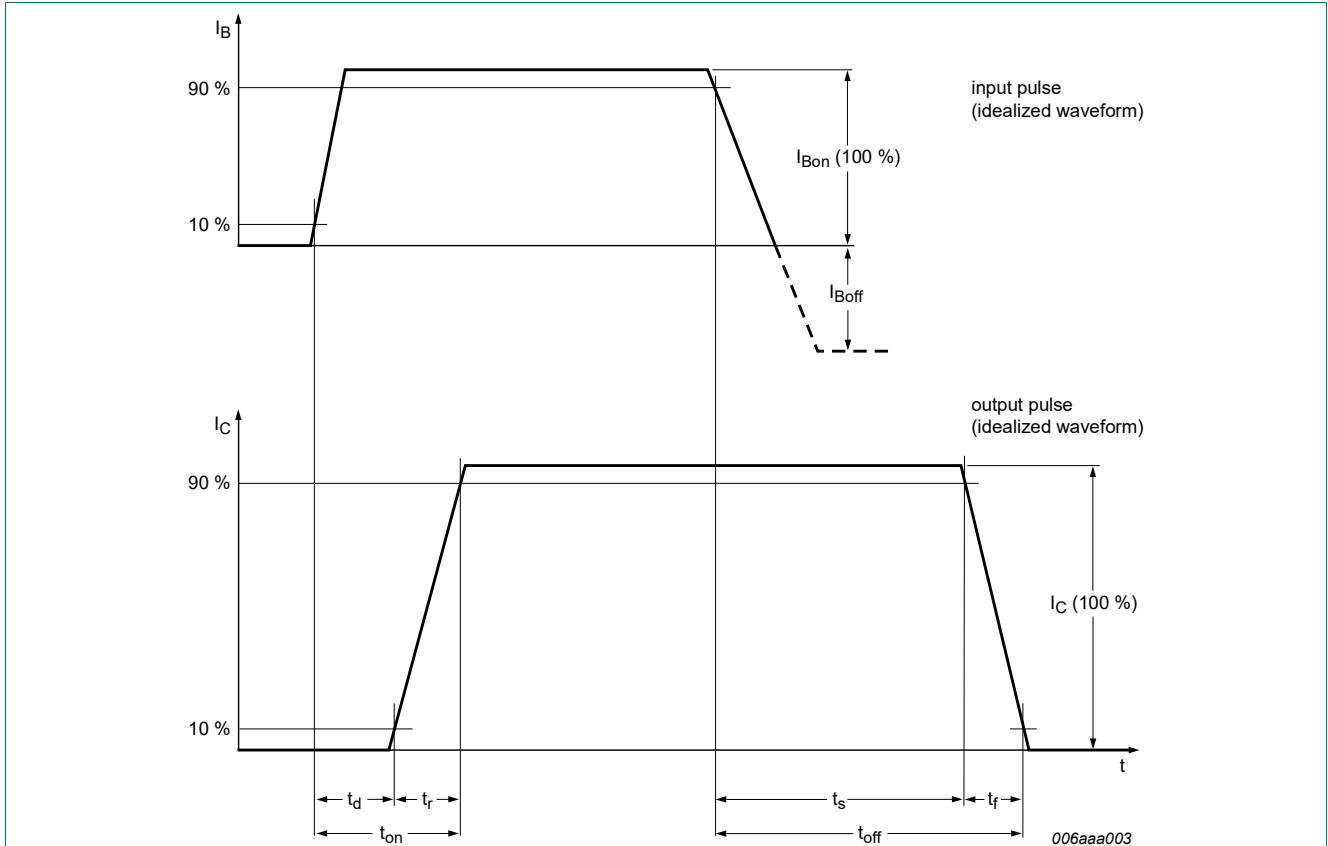


Fig. 20. TR1 (NPN): BISS transistor switching time definition

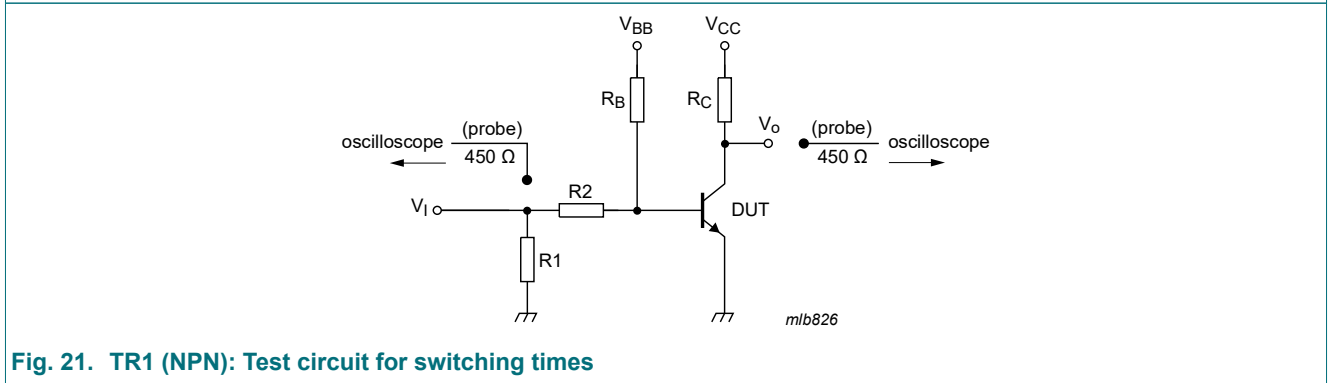


Fig. 21. TR1 (NPN): Test circuit for switching times

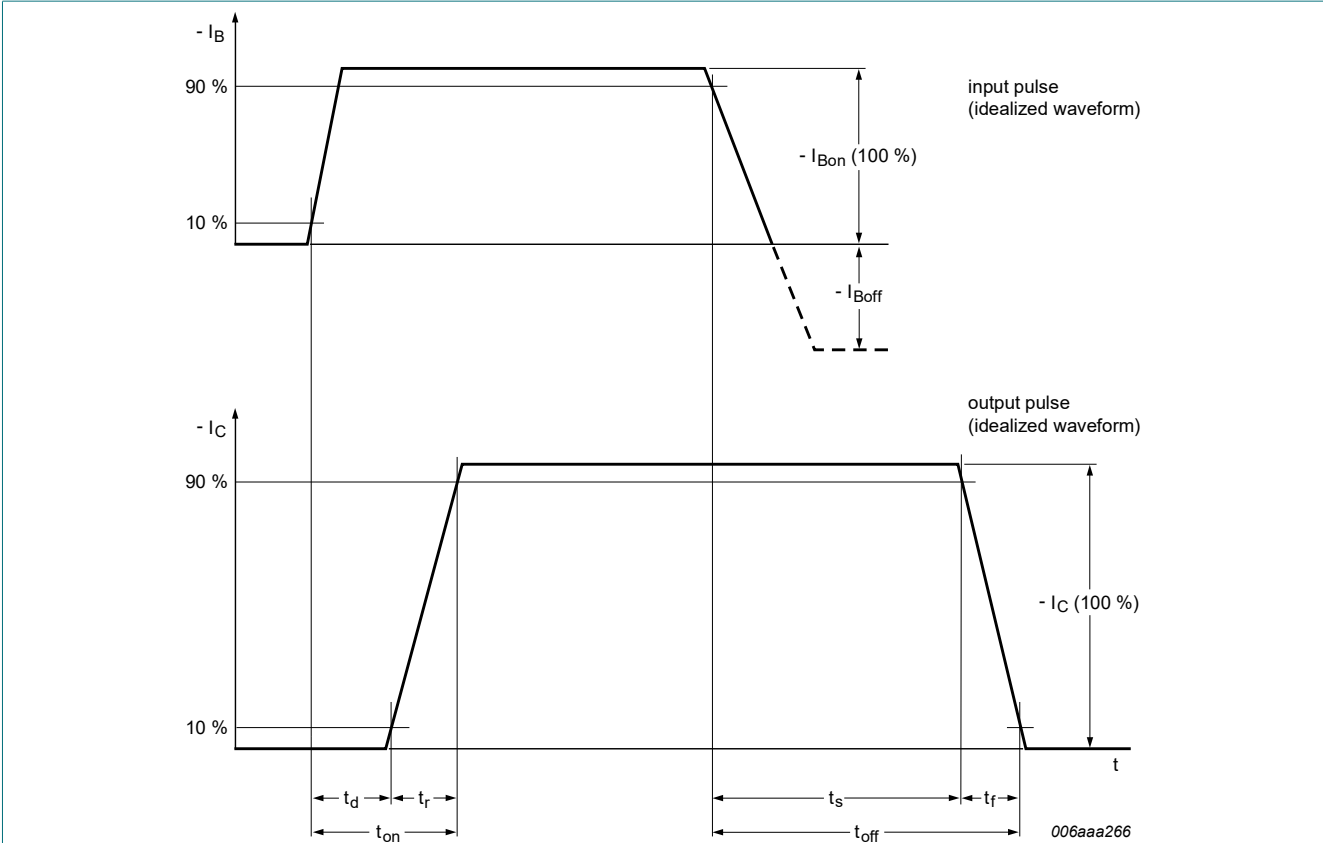


Fig. 22. TR2 (PNP): BISS transistor switching time definition

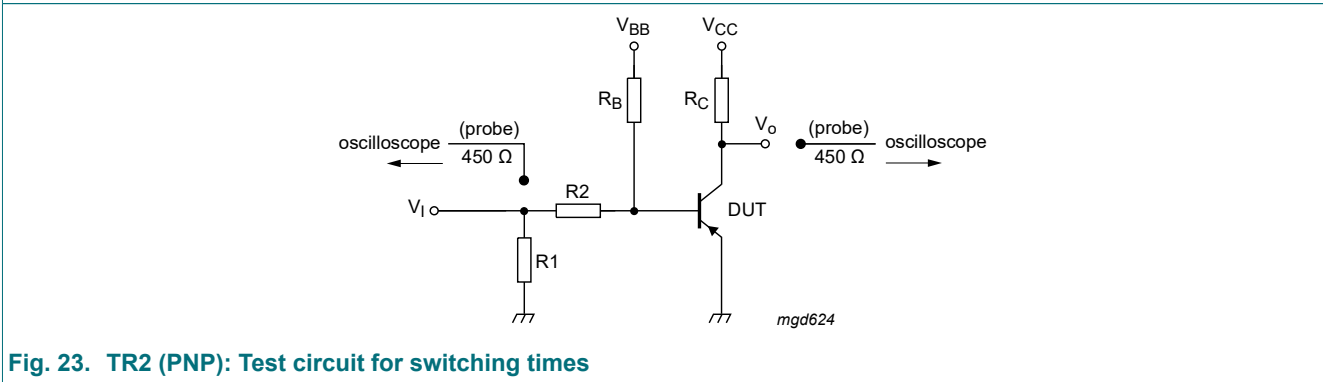


Fig. 23. TR2 (PNP): Test circuit for switching times

**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

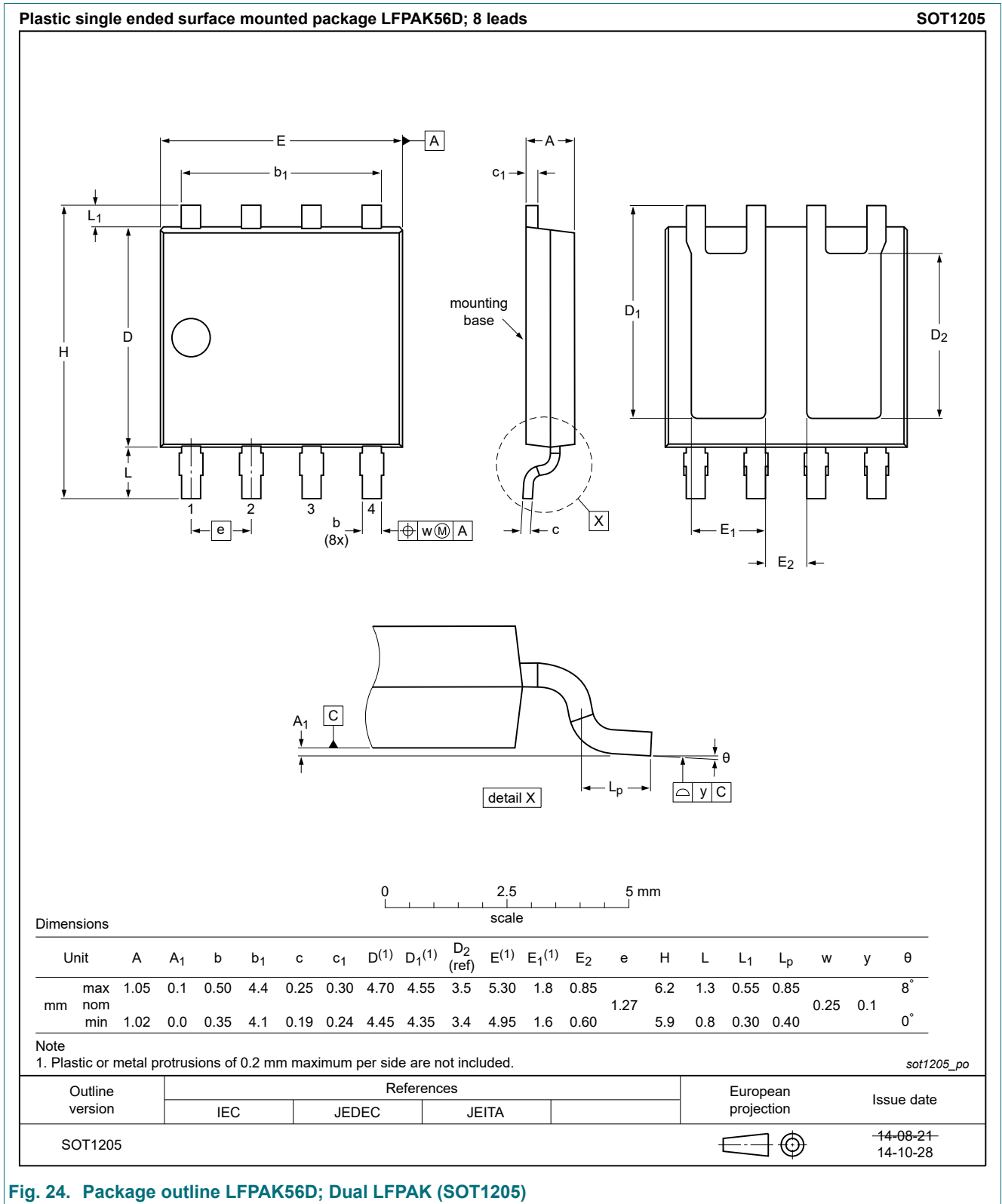


Fig. 24. Package outline LFAK56D; Dual LFAK (SOT1205)

### 13. Soldering

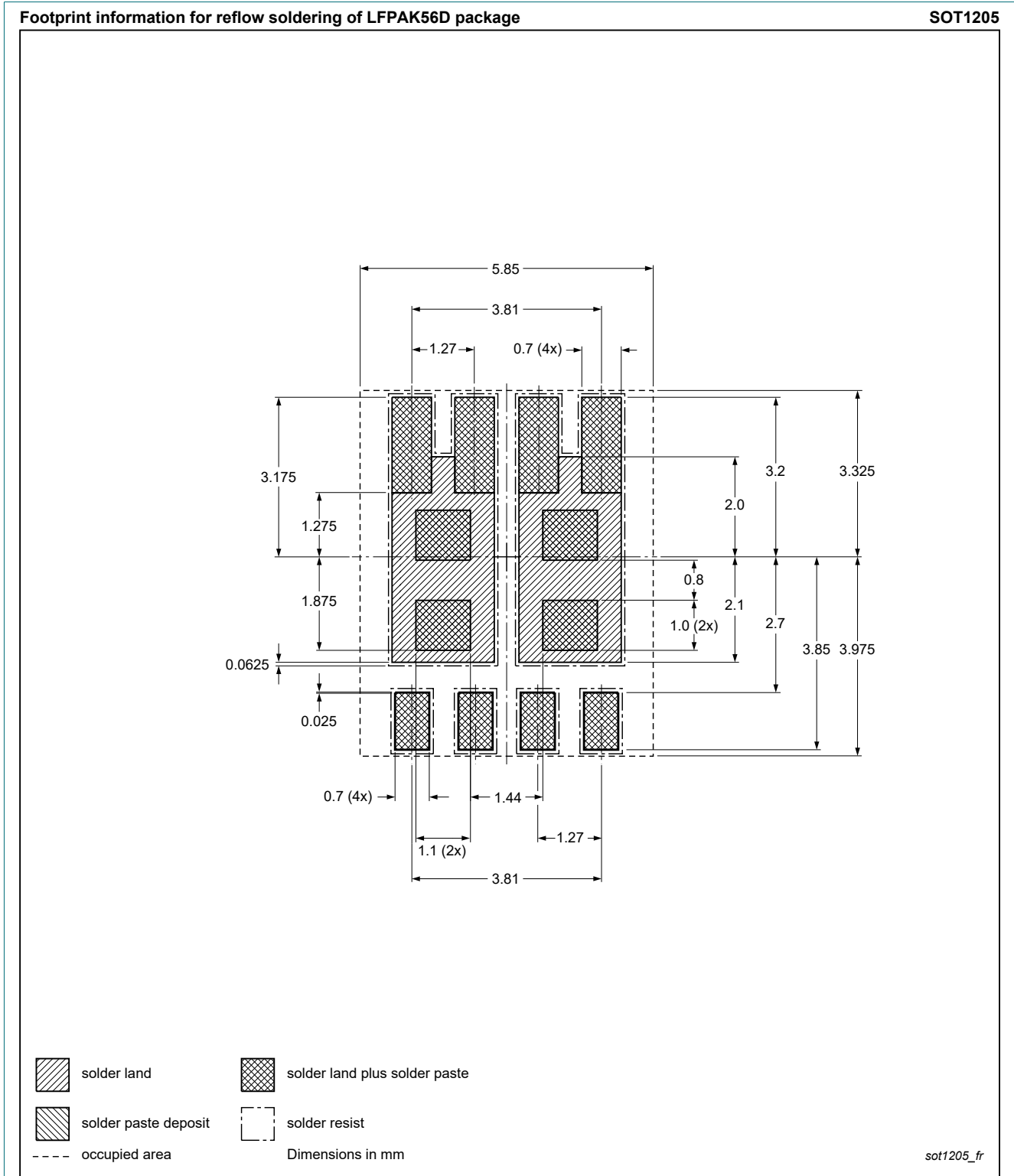


Fig. 25. Reflow soldering footprint for LFPAK56D; Dual LFPAK (SOT1205)

## 14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PHPT610030NPK v.2	20200910	Product data sheet	-	PHPT610030NPK v.1
Modifications:	• Characteristics: Figures 6, 7, 8 and 10 corrected			
PHPT610030NPK 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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