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Kind regards,

Team Nexperia



# PHPT610030NPK

NPN/PNP high power double bipolar transistor

14 October 2014

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>						
$V_{CEO}$	collector-emitter voltage	open base	-	-	100	V
$I_C$	collector current		-	-	3	A
<b>TR1 (NPN)</b>						
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = 3\text{ A}$ ; $I_B = 300\text{ mA}$ ; pulsed; $t_p \leq 300\text{ }\mu\text{s}$ ; $\delta \leq 0.02$ ; $T_{amb} = 25\text{ }^\circ\text{C}$	-	75	110	m $\Omega$



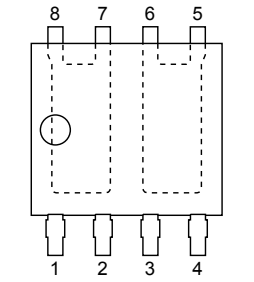
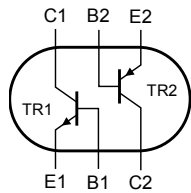
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Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>TR2 (PNP)</b>						
R <sub>CEsat</sub>	collector-emitter saturation resistance	I <sub>C</sub> = -2 A; I <sub>B</sub> = -200 mA; pulsed; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	-	110	180	mΩ

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	E1	emitter TR1	 <p>LFPAK56D (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	Plastic single ended surface mounted package (LFPAK56D); 8 leads	SOT1205

## 7. Marking

Table 4. Marking codes

Type number	Marking code
PHPT610030NPK	1003NPK



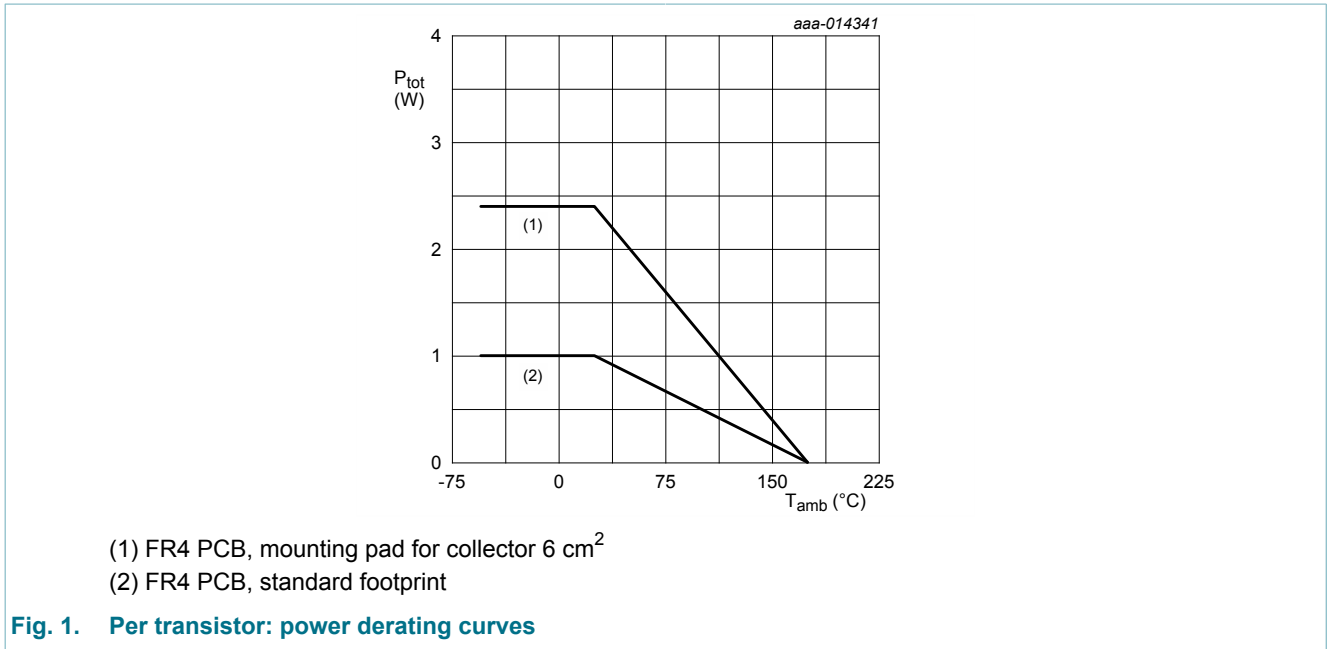
## 8. Limiting values

**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 <sub>CBO</sub>	collector-base voltage	open emitter		-	100	V
V <sub>CEO</sub>	collector-emitter voltage	open base		-	100	V
V <sub>EBO</sub>	emitter-base voltage	open collector		-	7	V
I <sub>C</sub>	collector current			-	3	A
I <sub>CM</sub>	peak collector current	single pulse; t <sub>p</sub> ≤ 1 ms		-	8	A
I <sub>B</sub>	base current			-	0.5	A
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> ≤ 25 °C	[1]	-	1	W
		T <sub>amb</sub> ≤ 25 °C	[2]	-	2.4	W
			[3]	-	25	W
<b>Per device</b>						
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> ≤ 25 °C	[1]	-	1.25	W
			[2]	-	3	W
			[4]	-	5	W
T <sub>j</sub>	junction temperature			-	175	°C
T <sub>amb</sub>	ambient temperature			-55	175	°C
T <sub>stg</sub>	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.

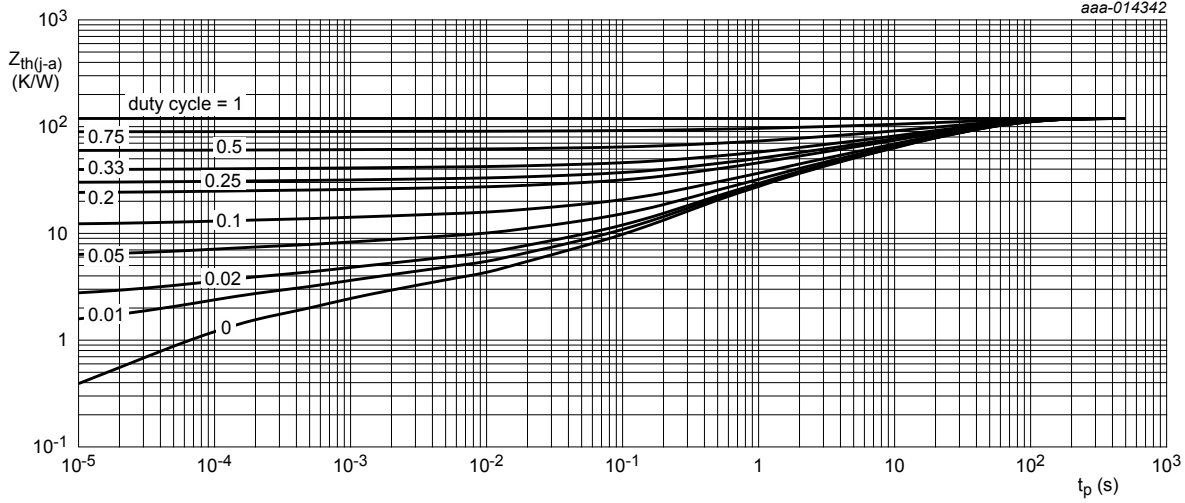


## 9. Thermal characteristics

Table 6. Thermal characteristics

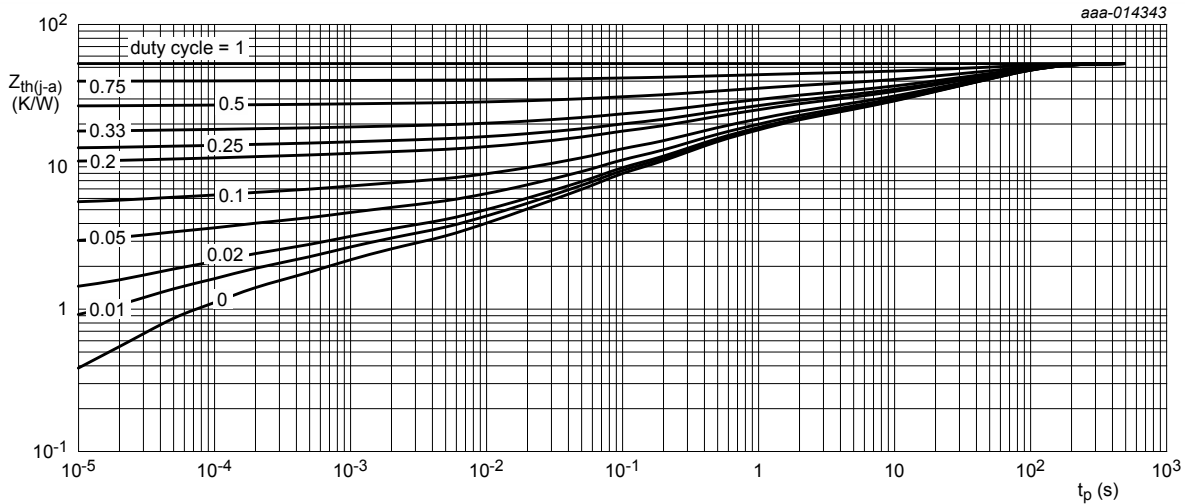
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
<b>Per transistor</b>							
R <sub>th(j-a)</sub>	thermal resistance from junction to ambient	in free air	[1]	-	-	150	K/W
			[2]	-	-	62.5	K/W
R <sub>th(j-sp)</sub>	thermal resistance from junction to solder point			-	-	6	K/W
<b>Per device</b>							
R <sub>th(j-a)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

**Fig. 2. Per transistor: transient thermal impedance from junction to ambient as a function of pulse duration; typical values**



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

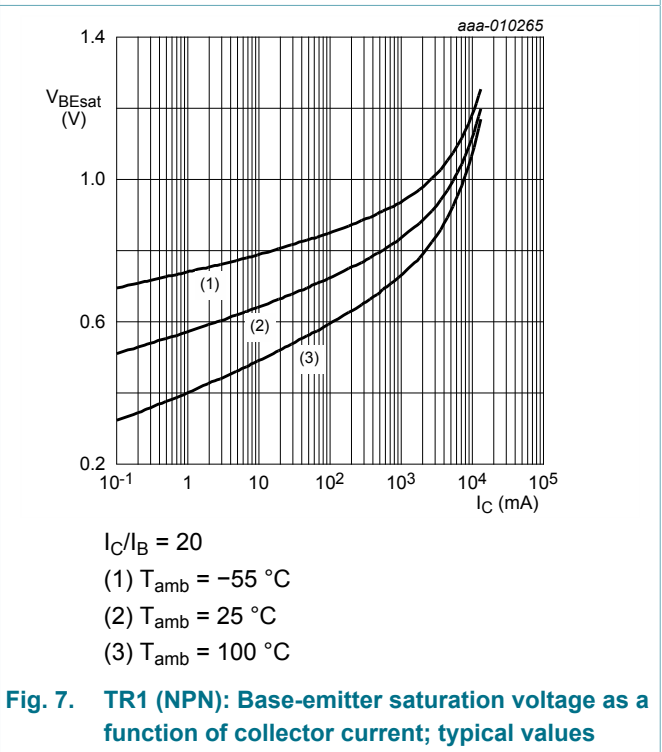
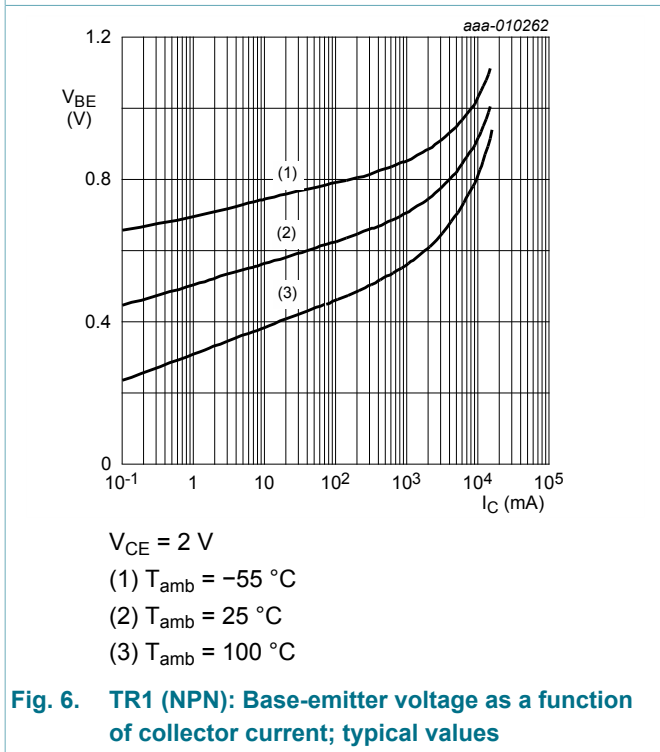
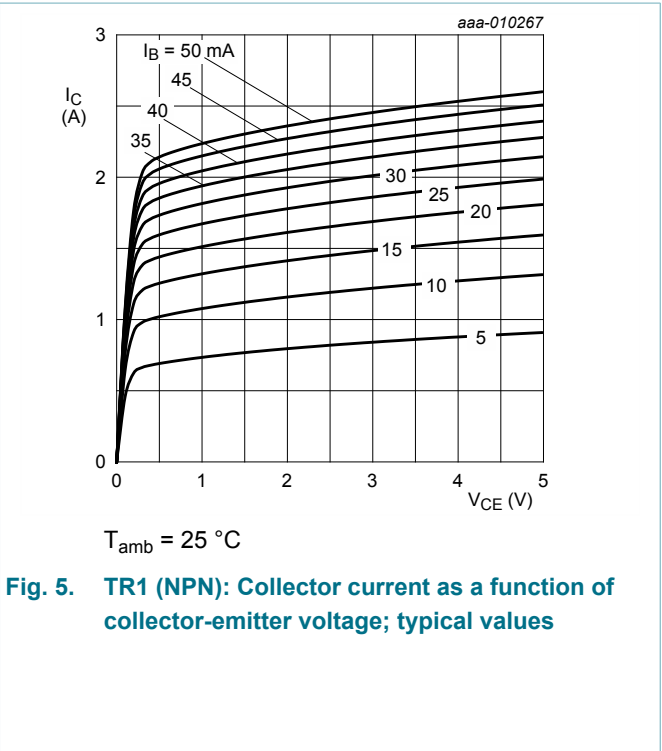
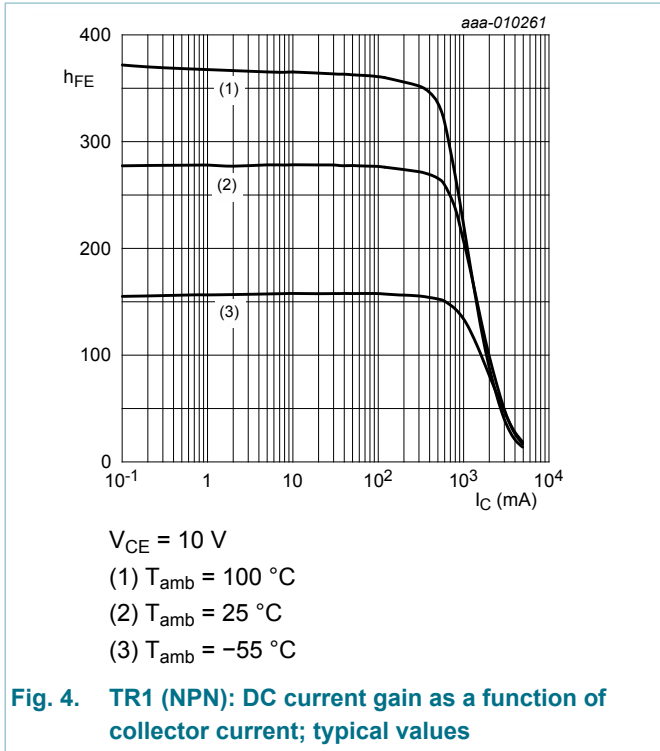
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>TR1 (NPN)</b>						
I <sub>CBO</sub>	collector-base cut-off current	V <sub>CB</sub> = 80 V; I <sub>E</sub> = 0 A; T <sub>amb</sub> = 25 °C	-	-	100	nA
		V <sub>CB</sub> = 80 V; I <sub>E</sub> = 0 A; T <sub>j</sub> = 150 °C	-	-	50	µA
I <sub>CES</sub>	collector-emitter cut-off current	V <sub>CE</sub> = 80 V; V <sub>BE</sub> = 0 V	-	-	100	nA
I <sub>EBO</sub>	emitter-base cut-off current	V <sub>EB</sub> = 7 V; I <sub>C</sub> = 0 A; T <sub>amb</sub> = 25 °C	-	-	100	nA
h <sub>FE</sub>	DC current gain	V <sub>CE</sub> = 10 V; I <sub>C</sub> = 500 mA; pulsed; t <sub>p</sub> ≤ 300 µs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	150	250	-	
		V <sub>CE</sub> = 10 V; I <sub>C</sub> = 1 A; pulsed; t <sub>p</sub> ≤ 300 µs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	80	250	-	
		V <sub>CE</sub> = 10 V; I <sub>C</sub> = 2 A; pulsed; t <sub>p</sub> ≤ 300 µs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	20	100	-	
		V <sub>CE</sub> = 10 V; I <sub>C</sub> = 3 A; pulsed; t <sub>p</sub> ≤ 300 µs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	10	40	-	
V <sub>CEsat</sub>	collector-emitter saturation voltage	I <sub>C</sub> = 1 A; I <sub>B</sub> = 50 mA; pulsed; t <sub>p</sub> ≤ 300 µs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	-	90	150	mV
		I <sub>C</sub> = 3 A; I <sub>B</sub> = 0.3 A; pulsed; t <sub>p</sub> ≤ 300 µs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	-	225	330	mV
R <sub>CEsat</sub>	collector-emitter saturation resistance	I <sub>C</sub> = 3 A; I <sub>B</sub> = 300 mA; pulsed; t <sub>p</sub> ≤ 300 µs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	-	75	110	mΩ
V <sub>BEsat</sub>	base-emitter saturation voltage	I <sub>C</sub> = 1 A; I <sub>B</sub> = 50 mA; pulsed; t <sub>p</sub> ≤ 300 µs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	-	0.86	1	V
		I <sub>C</sub> = 2 A; I <sub>B</sub> = 200 mA; pulsed; t <sub>p</sub> ≤ 300 µs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	-	1	1.2	V
V <sub>BEon</sub>	base-emitter turn-on voltage	V <sub>CE</sub> = 2 V; I <sub>C</sub> = 100 mA; pulsed; t <sub>p</sub> ≤ 300 µs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	-	0.67	0.85	V
t <sub>d</sub>	delay time	V <sub>CC</sub> = 12.5 V; I <sub>C</sub> = 1 A; I <sub>Bon</sub> = 50 mA; I <sub>Boff</sub> = -50 mA; T <sub>amb</sub> = 25 °C	-	20	-	ns
t <sub>r</sub>	rise time		-	300	-	ns
t <sub>on</sub>	turn-on time		-	320	-	ns
t <sub>s</sub>	storage time		-	830	-	ns
t <sub>f</sub>	fall time		-	470	-	ns
t <sub>off</sub>	turn-off time		-	1300	-	ns
f <sub>T</sub>	transition frequency		V <sub>CE</sub> = 10 V; I <sub>C</sub> = 100 mA; f = 100 MHz; T <sub>amb</sub> = 25 °C	-	140	-

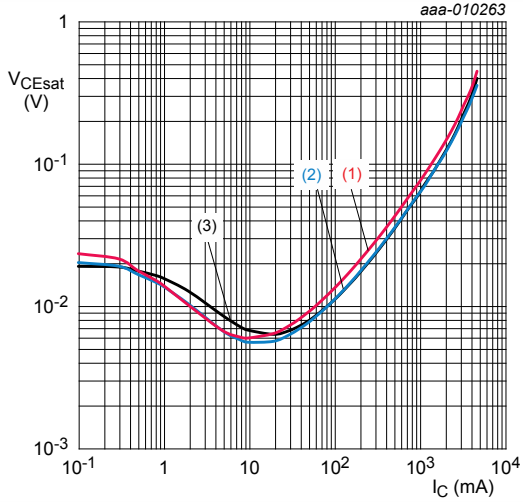


NPN/PNP high power double bipolar transistor

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$C_c$	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
$h_{FE}$	DC current gain	$V_{CE} = -10\text{ V}; I_C = -500\text{ mA};$ $T_{amb} = 25\text{ }^\circ\text{C}$	150	200	-	
		$V_{CE} = -10\text{ V}; I_C = -1\text{ A};$ pulsed; $t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	80	210	-	
		$V_{CE} = -10\text{ V}; I_C = -2\text{ A};$ pulsed; $t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	20	100	-	
		$V_{CE} = -10\text{ V}; I_C = -3\text{ A};$ 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	$I_C = -500\text{ mA}; I_B = -50\text{ mA};$ $T_{amb} = 25\text{ }^\circ\text{C}$	-	-70	-110	mV
		$I_C = -2\text{ A}; I_B = -0.2\text{ A};$ pulsed; $t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	-220	-360	mV
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = -2\text{ A}; I_B = -200\text{ mA};$ pulsed; $t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	110	180	$\text{m}\Omega$
$V_{BEsat}$	base-emitter saturation voltage	$I_C = -1\text{ A}; I_B = -50\text{ mA};$ pulsed; $t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	-0.91	-1	V
		$I_C = -2\text{ A}; I_B = -200\text{ mA};$ pulsed; $t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	-1.02	-1.2	V
$V_{BEon}$	base-emitter turn-on voltage	$V_{CE} = -2\text{ V}; I_C = -100\text{ mA};$ pulsed; $t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$	-	-0.68	-0.9	V
$t_d$	delay time	$V_{CC} = -12.5\text{ V}; I_C = -1\text{ A}; I_{Bon} = -50\text{ mA};$ $I_{Boff} = 50\text{ mA}; T_{amb} = 25\text{ }^\circ\text{C}$	-	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	-

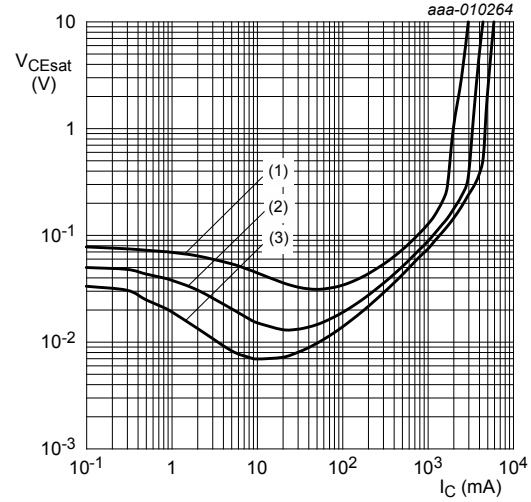
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$C_c$	collector capacitance	$V_{CB} = -10\text{ V}$ ; $I_E = 0\text{ A}$ ; $i_e = 0\text{ A}$ ; $f = 1\text{ MHz}$ ; $T_{amb} = 25\text{ }^\circ\text{C}$	-	30	-	pF





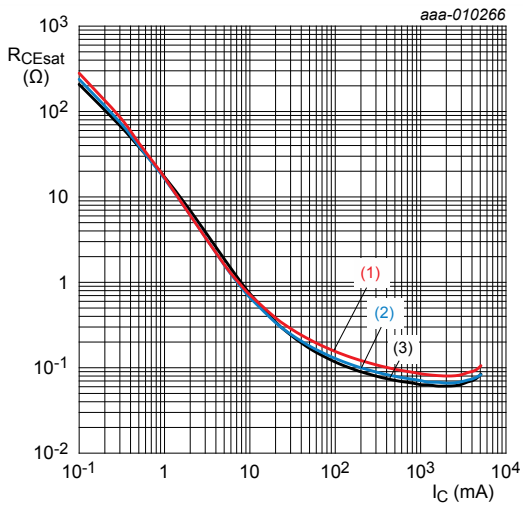
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (3)  $T_{amb} = -55\text{ }^\circ\text{C}$

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



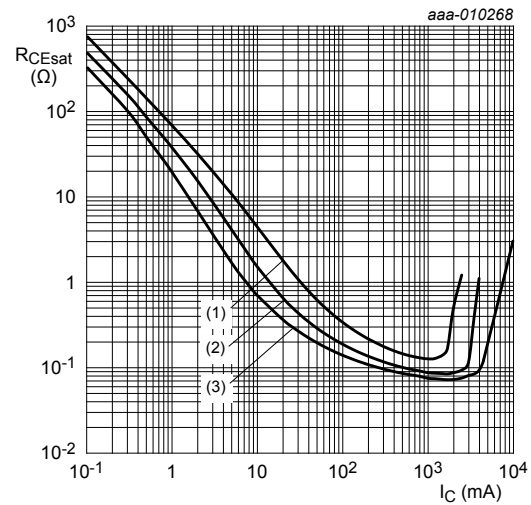
$T_{amb} = 25\text{ }^\circ\text{C}$   
 (1)  $I_C/I_B = 50$   
 (2)  $I_C/I_B = 20$   
 (3)  $I_C/I_B = 10$

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



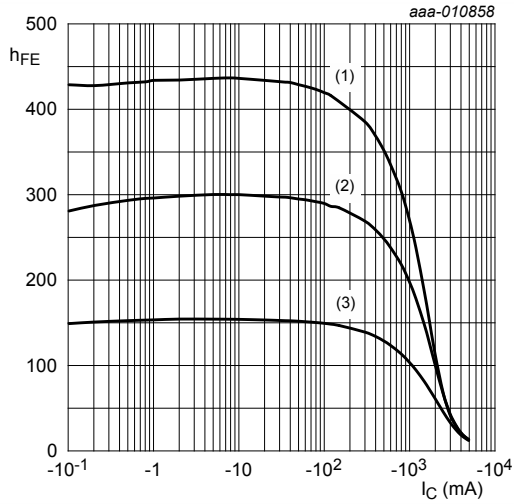
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (3)  $T_{amb} = -55\text{ }^\circ\text{C}$

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



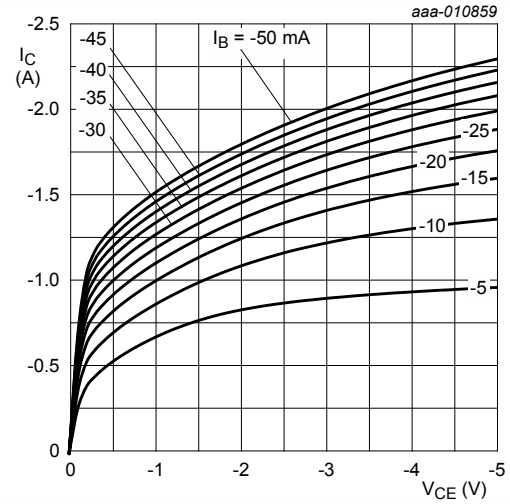
$T_{amb} = 25\text{ }^\circ\text{C}$   
 (1)  $I_C/I_B = 50$   
 (2)  $I_C/I_B = 20$   
 (3)  $I_C/I_B = 10$

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



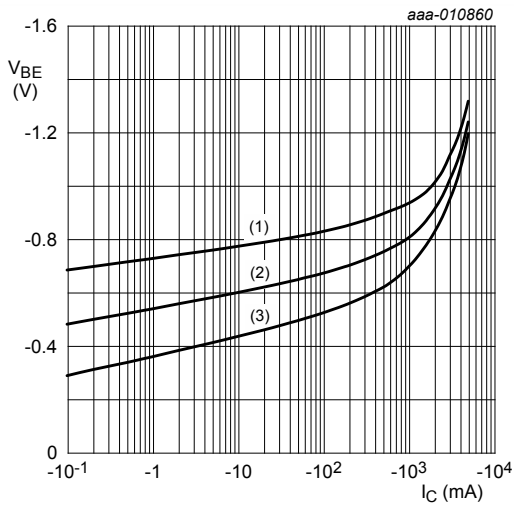
$V_{CE} = -10\text{ V}$   
 (1)  $T_{amb} = 100\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (3)  $T_{amb} = -55\text{ }^\circ\text{C}$

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



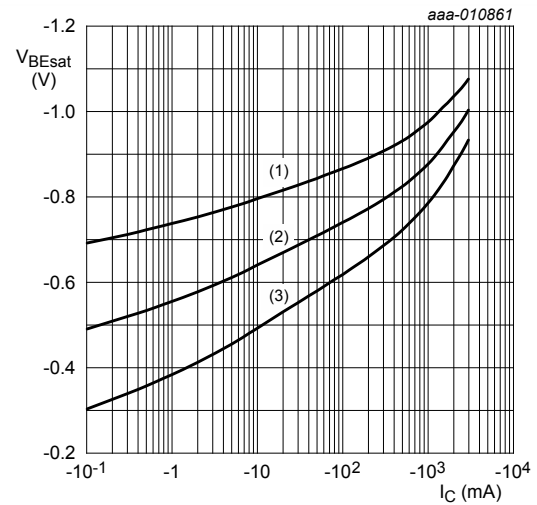
$T_{amb} = 25\text{ }^\circ\text{C}$

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



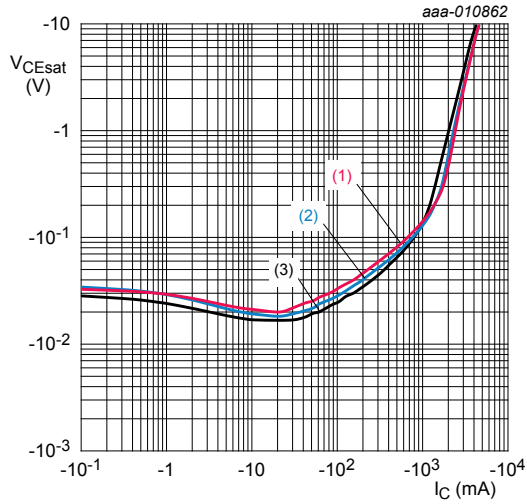
$V_{CE} = -2\text{ V}$   
 (1)  $T_{amb} = -55\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100\text{ }^\circ\text{C}$

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



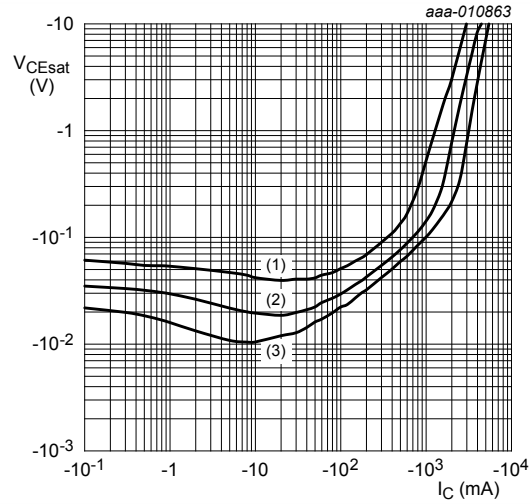
$I_C/I_B = 20$   
 (1)  $T_{amb} = -55\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100\text{ }^\circ\text{C}$

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



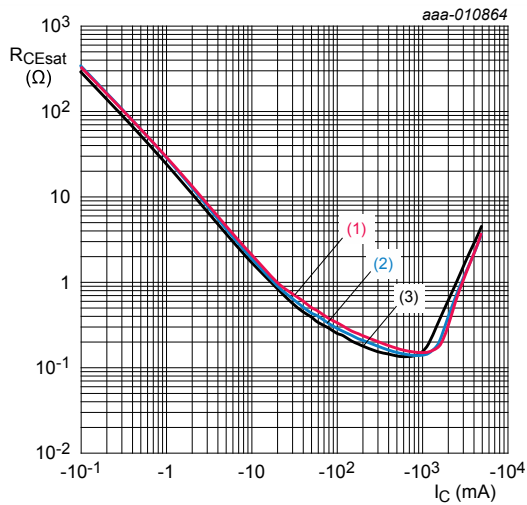
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -55\text{ °C}$

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



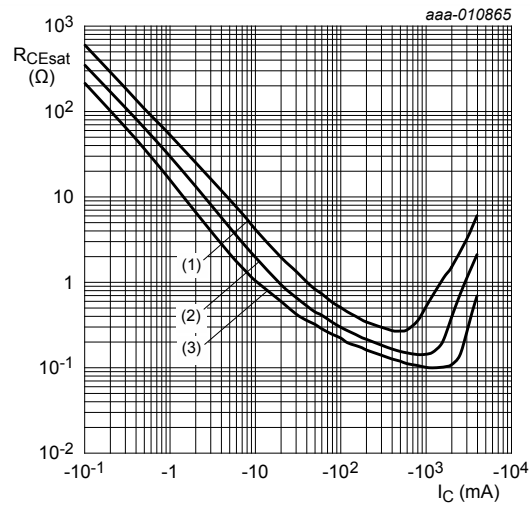
$T_{amb} = 25\text{ °C}$   
 (1)  $I_C/I_B = 50$   
 (2)  $I_C/I_B = 20$   
 (3)  $I_C/I_B = 10$

**Fig. 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

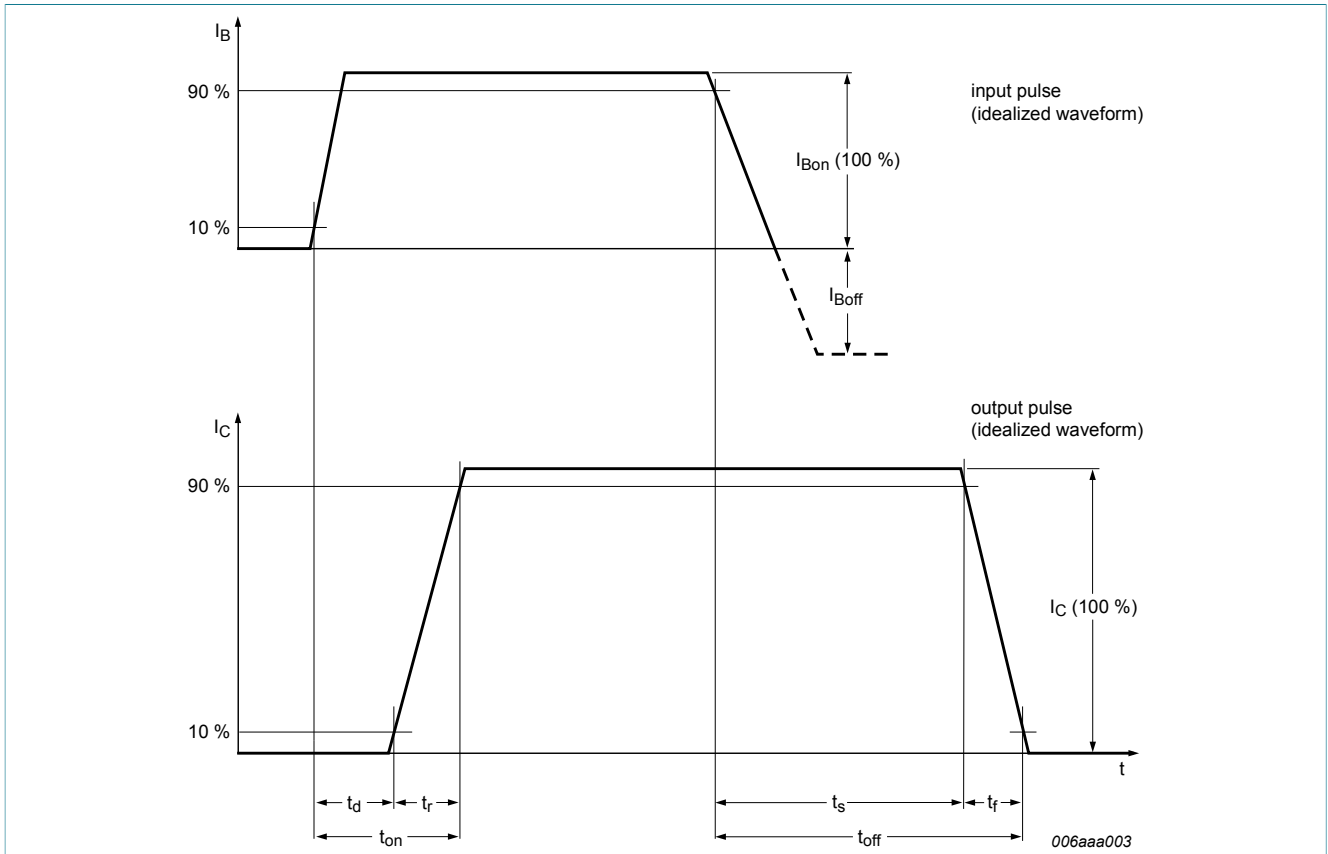


Fig. 20. TR1 (NPN): BISS transistor switching time definition

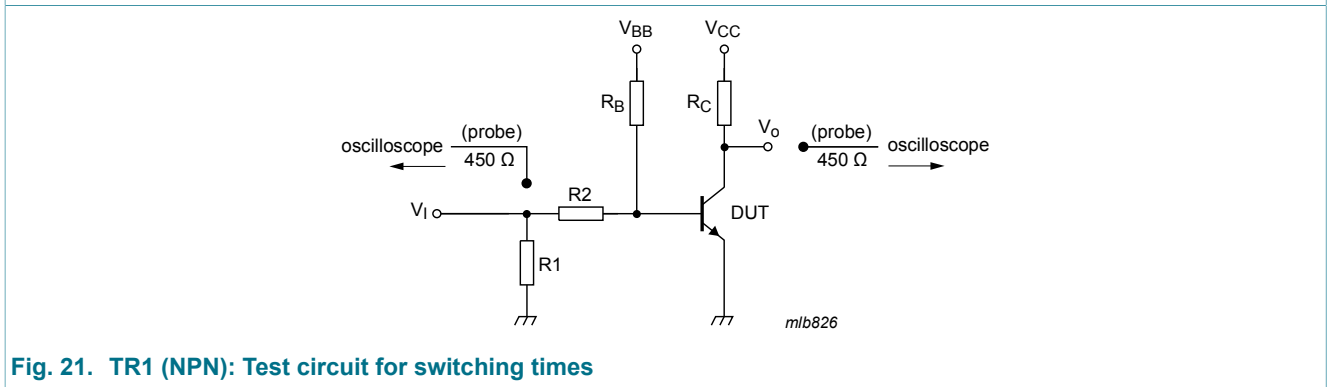


Fig. 21. TR1 (NPN): Test circuit for switching times



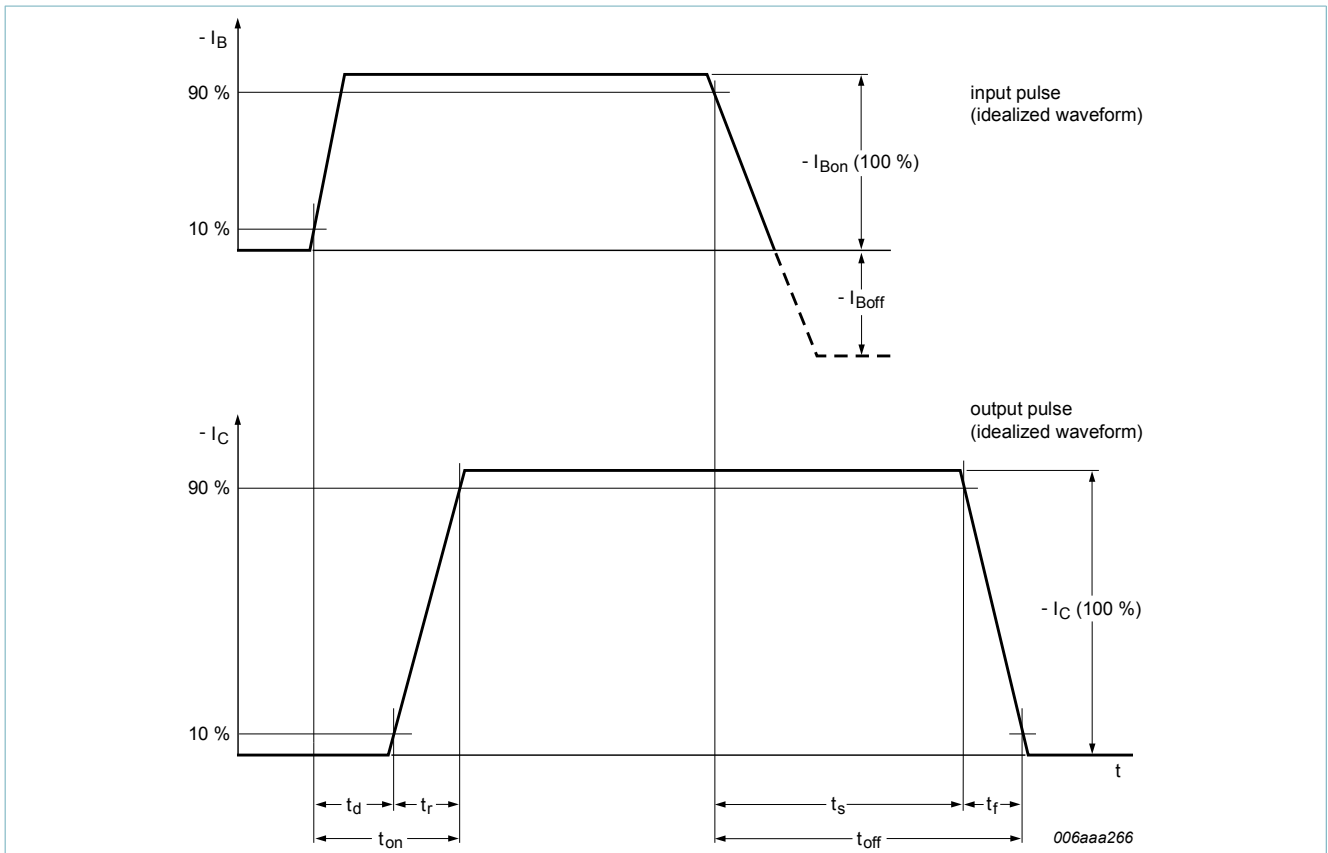


Fig. 22. TR2 (PNP): BISS transistor switching time definition

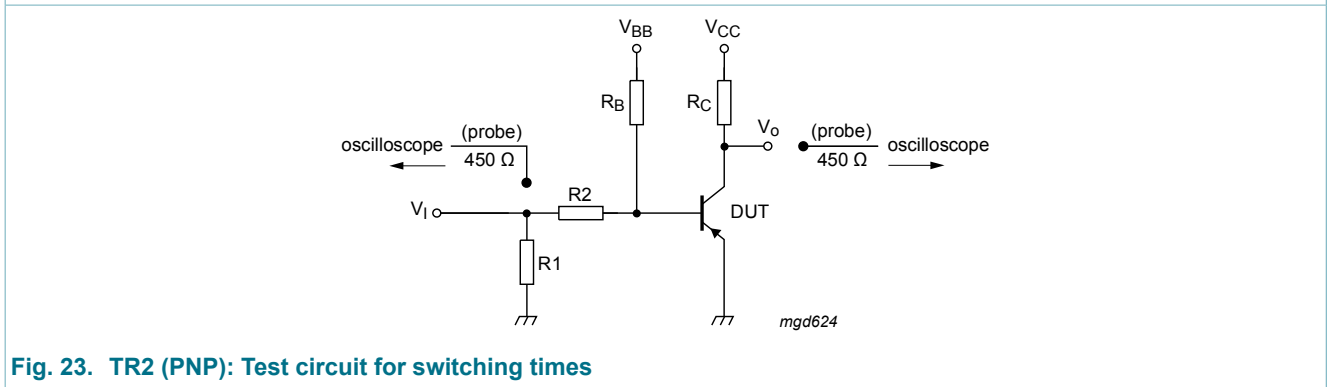


Fig. 23. TR2 (PNP): Test circuit for switching times

### 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

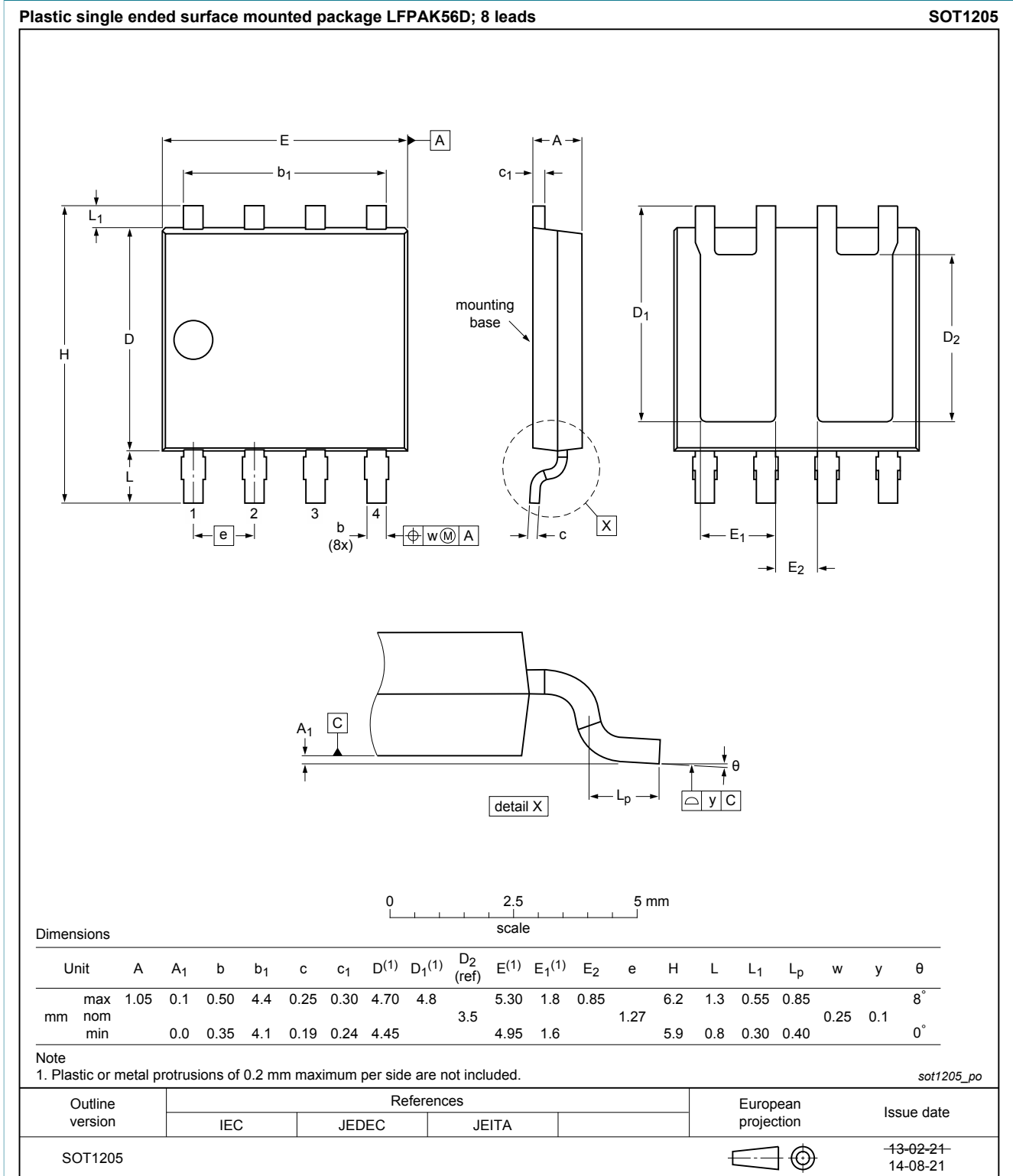


Fig. 24. Package outline LFPAK56D (SOT1205)

### 13. Soldering

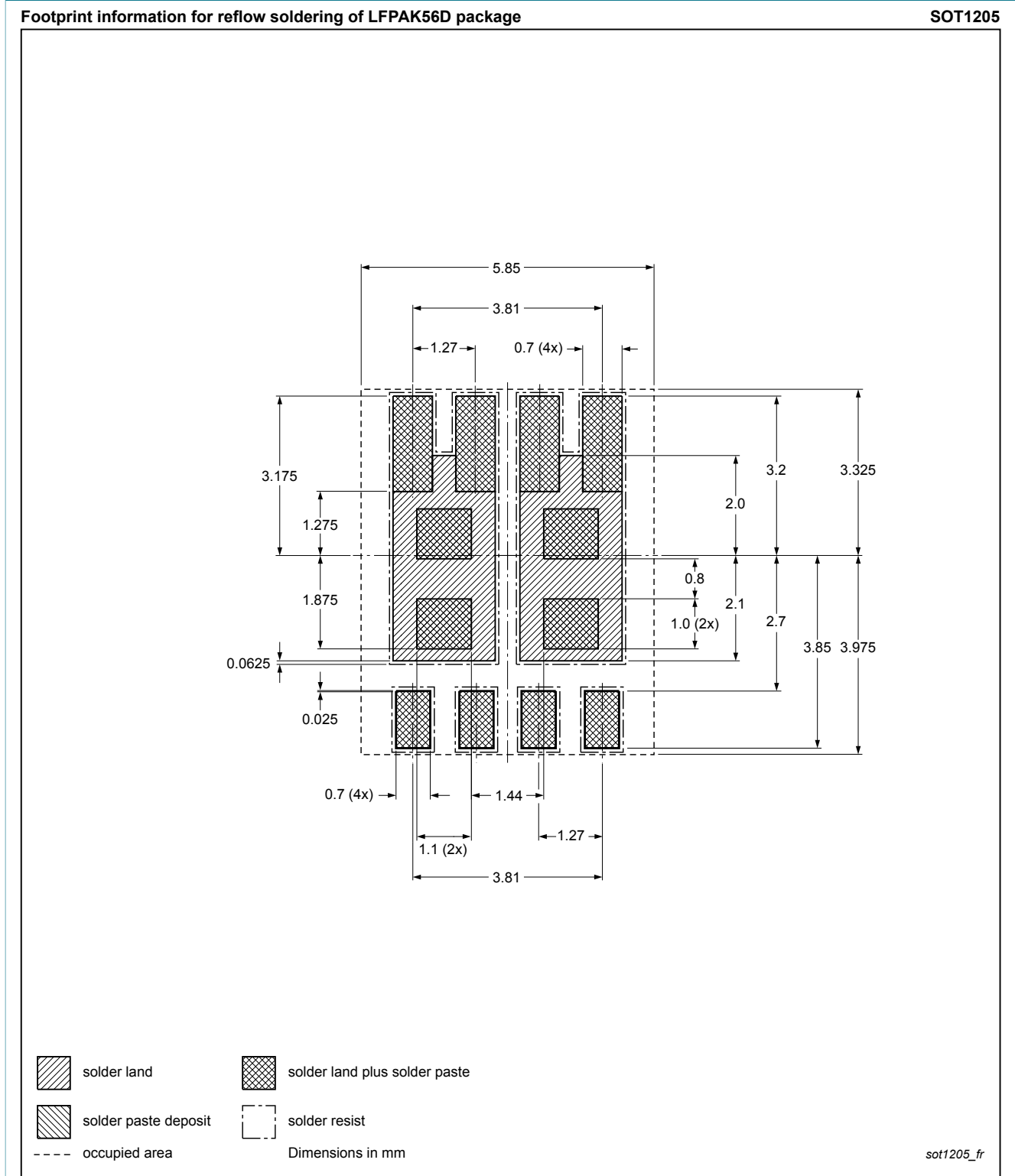


Fig. 25. Reflow soldering footprint for LFPAK56D (SOT1205)

## 14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PHPT610030NPK v.1	20141014	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.

- [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".
- [3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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