



# PHPT60610NY

60 V, 10 A NPN high power bipolar transistor

15 January 2019

Product data sheet

## 1. General description

NPN high power bipolar transistor in a SOT669 (LFAK56) Surface-Mounted Device (SMD) power plastic package.

PNP complement: PHPT60610PY

## 2. Features and benefits

- High thermal power dissipation capability
- 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

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

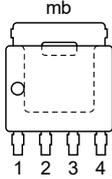
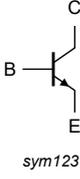
## 4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{CEO}$	collector-emitter voltage	open base	-	-	60	V
$I_C$	collector current		-	-	10	A
$I_{CM}$	peak collector current	single pulse; $t_p \leq 1$ ms	-	-	20	A
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = 10$ A; $I_B = 1$ A; $t_p \leq 300$ $\mu$ s; pulsed; $\delta \leq 0.02$ ; $T_{amb} = 25$ °C	-	25	36	m $\Omega$

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	E	emitter	 <p>LFPAK56; Power-SO8 (SOT669)</p>	
2	E	emitter		
3	E	emitter		
4	B	base		
mb	C	collector		

## 6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
PHPT60610NY	LFPAK56; Power-SO8	Plastic single-ended surface-mounted package (LFPAK56; Power-SO8); 4 leads	SOT669

## 7. Marking

Table 4. Marking codes

Type number	Marking code
PHPT60610NY	0610NAB

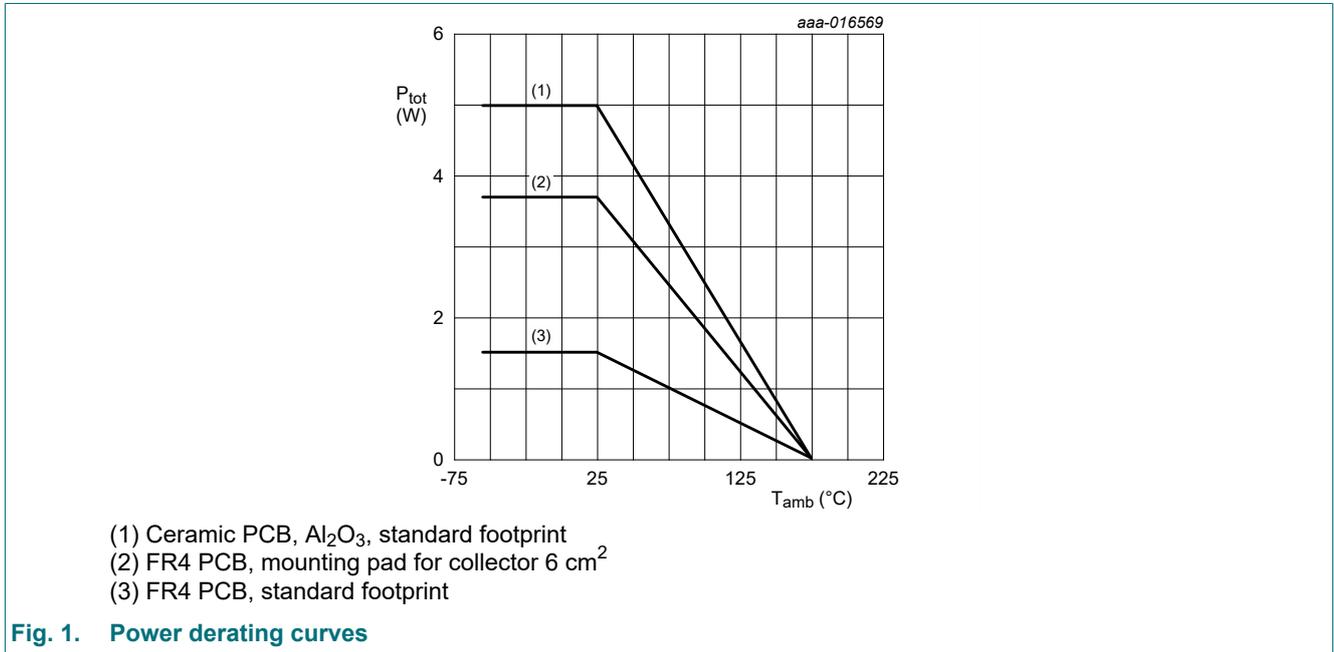
## 8. Limiting values

**Table 5. Limiting values**

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

Symbol	Parameter	Conditions	Min	Max	Unit	
$V_{CBO}$	collector-base voltage	open emitter	-	60	V	
$V_{CEO}$	collector-emitter voltage	open base	-	60	V	
$V_{EBO}$	emitter-base voltage	open collector	-	7	V	
$I_C$	collector current		-	10	A	
$I_{CM}$	peak collector current	single pulse; $t_p \leq 1$ ms	-	20	A	
$I_B$	base current		-	1.5	A	
$I_{BM}$	peak base current	single pulse; $t_p \leq 1$ ms	-	2	A	
$P_{tot}$	total power dissipation	$T_{amb} \leq 25$ °C	[1]	-	1.5	W
			[2]	-	3.7	W
			[3]	-	5	W
			[4]	-	25	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 Printed-Circuit Board (PCB); single-sided copper; tin-plated and standard footprint.
- [2] Device mounted on an FR4 PCB; single-sided copper; tin-plated and 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.
- [4] Power dissipation from junction to mounting base.



**Fig. 1. Power derating curves**

## 9. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	100	K/W
			[2]	-	-	41	K/W
			[3]	-	-	30	K/W
$R_{th(j-mb)}$	thermal resistance from junction to mounting base			-	-	6	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 and mounting pad for collector 6 cm<sup>2</sup>.
- [3] Device mounted on a ceramic Printed-Circuit Board (PCB), Al<sub>2</sub>O<sub>3</sub>, standard footprint.

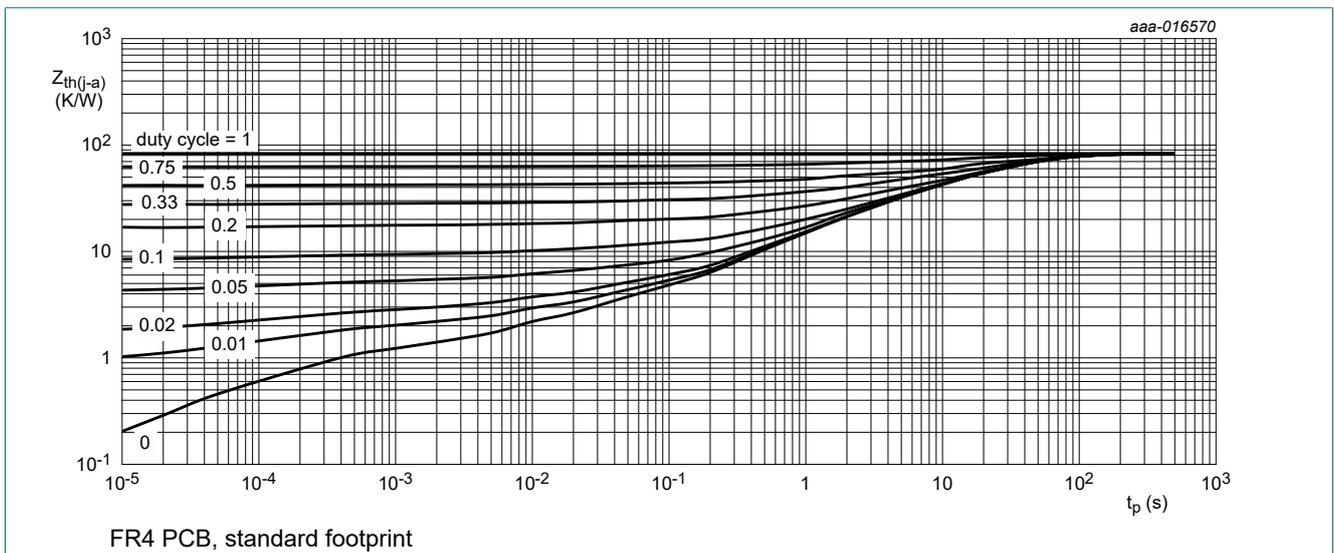


Fig. 2. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

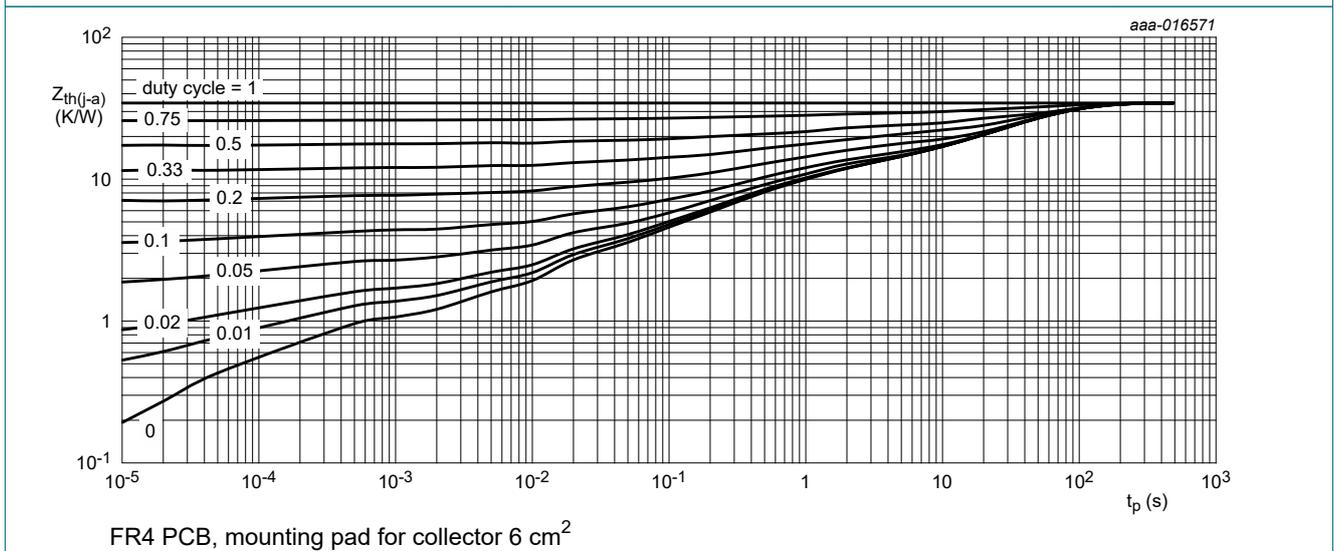
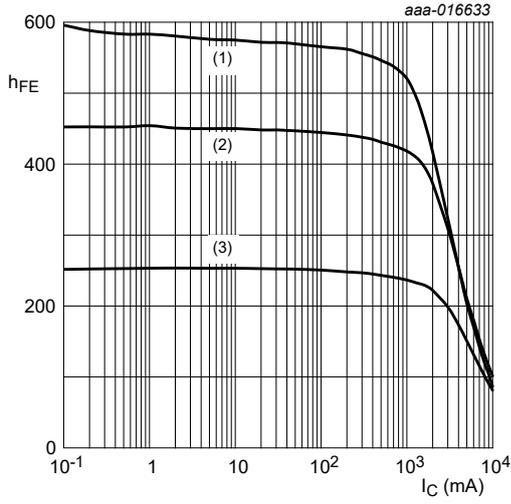


Fig. 3. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 10. Characteristics

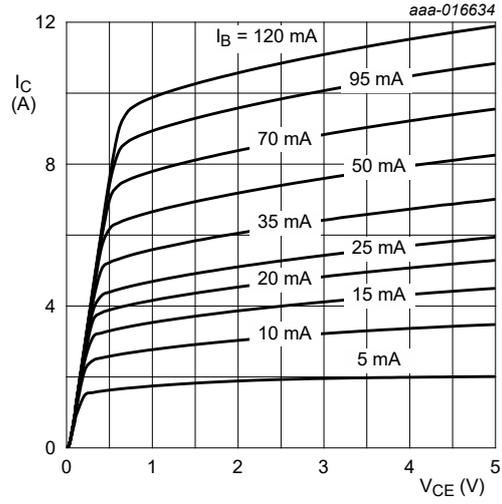
Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{CBO}$	collector-base cut-off current	$V_{CB} = 48 \text{ V}; I_E = 0 \text{ A}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	100	nA
		$V_{CB} = 48 \text{ V}; I_E = 0 \text{ A}; T_J = 150 \text{ }^\circ\text{C}$	-	-	50	$\mu\text{A}$
$I_{CES}$	collector-emitter cut-off current	$V_{CE} = 48 \text{ V}; V_{BE} = 0 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	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	$V_{CE} = 2 \text{ V}; I_C = 500 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	240	410	-	
		$V_{CE} = 2 \text{ V}; I_C = 1 \text{ A}; t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$	210	400	-	
		$V_{CE} = 2 \text{ V}; I_C = 5 \text{ A}; t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$	100	200	-	
		$V_{CE} = 2 \text{ V}; I_C = 10 \text{ A}; t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}; \text{pulsed}$	50	100	-	
$V_{CEsat}$	collector-emitter saturation voltage	$I_C = 1 \text{ A}; I_B = 50 \text{ mA}; t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}; \text{pulsed}$	-	30	40	mV
		$I_C = 5 \text{ A}; I_B = 500 \text{ mA}; t_p \leq 300 \text{ } \mu\text{s}; \text{pulsed}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$	-	115	160	mV
		$I_C = 10 \text{ A}; I_B = 1 \text{ A}; t_p \leq 300 \text{ } \mu\text{s}; \text{pulsed}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$	-	250	360	mV
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = 10 \text{ A}; I_B = 1 \text{ A}; t_p \leq 300 \text{ } \mu\text{s}; \text{pulsed}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$	-	25	36	m $\Omega$
$V_{BEsat}$	base-emitter saturation voltage	$I_C = 1 \text{ A}; I_B = 50 \text{ mA}; t_p \leq 300 \text{ } \mu\text{s}; \text{pulsed}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	0.95	V
		$I_C = 5 \text{ A}; I_B = 500 \text{ mA}; t_p \leq 300 \text{ } \mu\text{s}; \text{pulsed}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	1.2	V
		$I_C = 10 \text{ A}; I_B = 1 \text{ A}; t_p \leq 300 \text{ } \mu\text{s}; \text{pulsed}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	1.4	V
$V_{BEon}$	base-emitter turn-on voltage	$V_{CE} = 2 \text{ V}; I_C = 500 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	0.8	V
$t_d$	delay time	$V_{CC} = 12.5 \text{ V}; I_C = 5 \text{ A}; I_{B(on)} = 250 \text{ mA}; I_{B(off)} = -250 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	20	-	ns
$t_r$	rise time		-	180	-	ns
$t_{on}$	turn-on time		-	200	-	ns
$t_s$	storage time		-	340	-	ns
$t_f$	fall time		-	165	-	ns
$t_{off}$	turn-off time		-	505	-	ns
$f_T$	transition frequency		$V_{CE} = 10 \text{ V}; I_C = 500 \text{ mA}; f = 100 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	140	-
$C_c$	collector capacitance	$V_{CB} = 10 \text{ V}; I_E = 0 \text{ A}; i_e = 0 \text{ A}; f = 1 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	50	-	pF



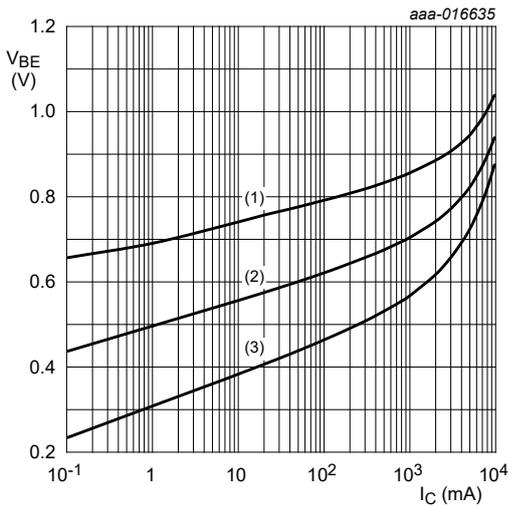
$V_{CE} = 2\text{ V}$   
 (1)  $T_{amb} = 100\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (3)  $T_{amb} = -55\text{ }^\circ\text{C}$

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



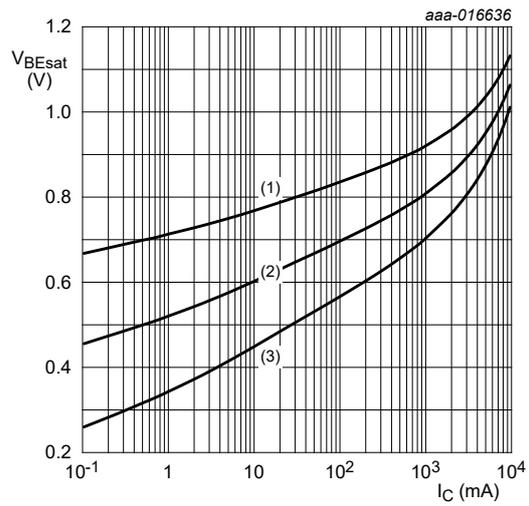
$T_{amb} = 25\text{ }^\circ\text{C}$

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



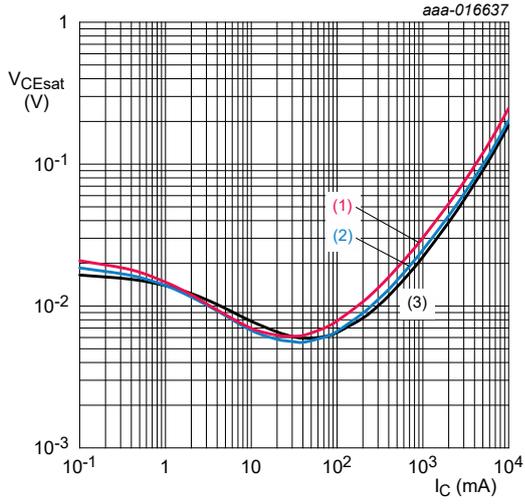
$V_{CE} = 2\text{ V}$   
 (1)  $T_{amb} = -55\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100\text{ }^\circ\text{C}$

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



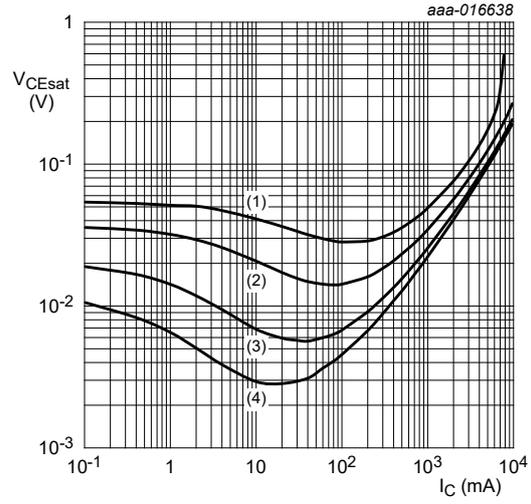
$I_C/I_B = 20$   
 (1)  $T_{amb} = -55\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100\text{ }^\circ\text{C}$

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



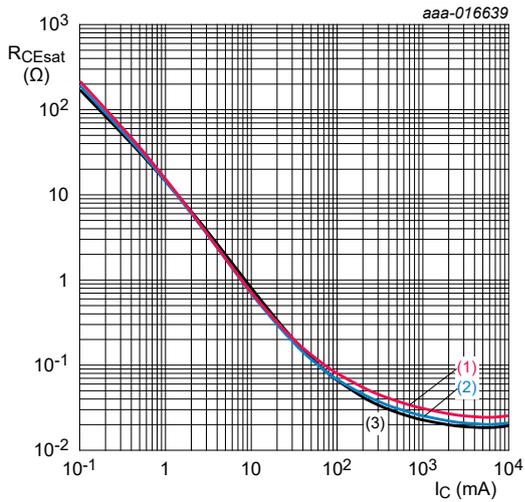
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100^\circ\text{C}$   
 (2)  $T_{amb} = 25^\circ\text{C}$   
 (3)  $T_{amb} = -55^\circ\text{C}$

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



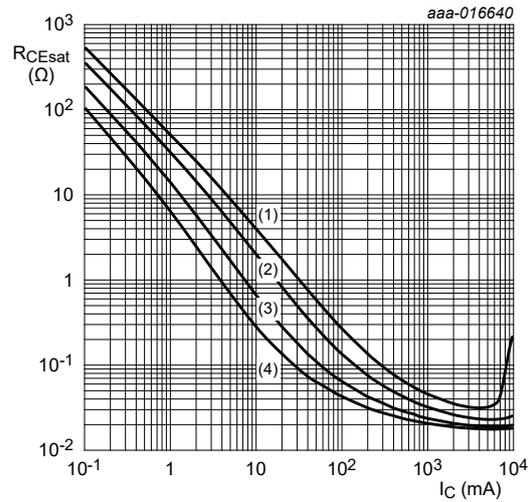
$T_{amb} = 25^\circ\text{C}$   
 (1)  $I_C/I_B = 100$   
 (2)  $I_C/I_B = 50$   
 (3)  $I_C/I_B = 20$   
 (4)  $I_C/I_B = 10$

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



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

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



$T_{amb} = 25^\circ\text{C}$   
 (1)  $I_C/I_B = 100$   
 (2)  $I_C/I_B = 50$   
 (3)  $I_C/I_B = 20$   
 (4)  $I_C/I_B = 10$

**Fig. 11. Collector-emitter saturation resistance as a function of collector current; typical values**

### 11. Test information

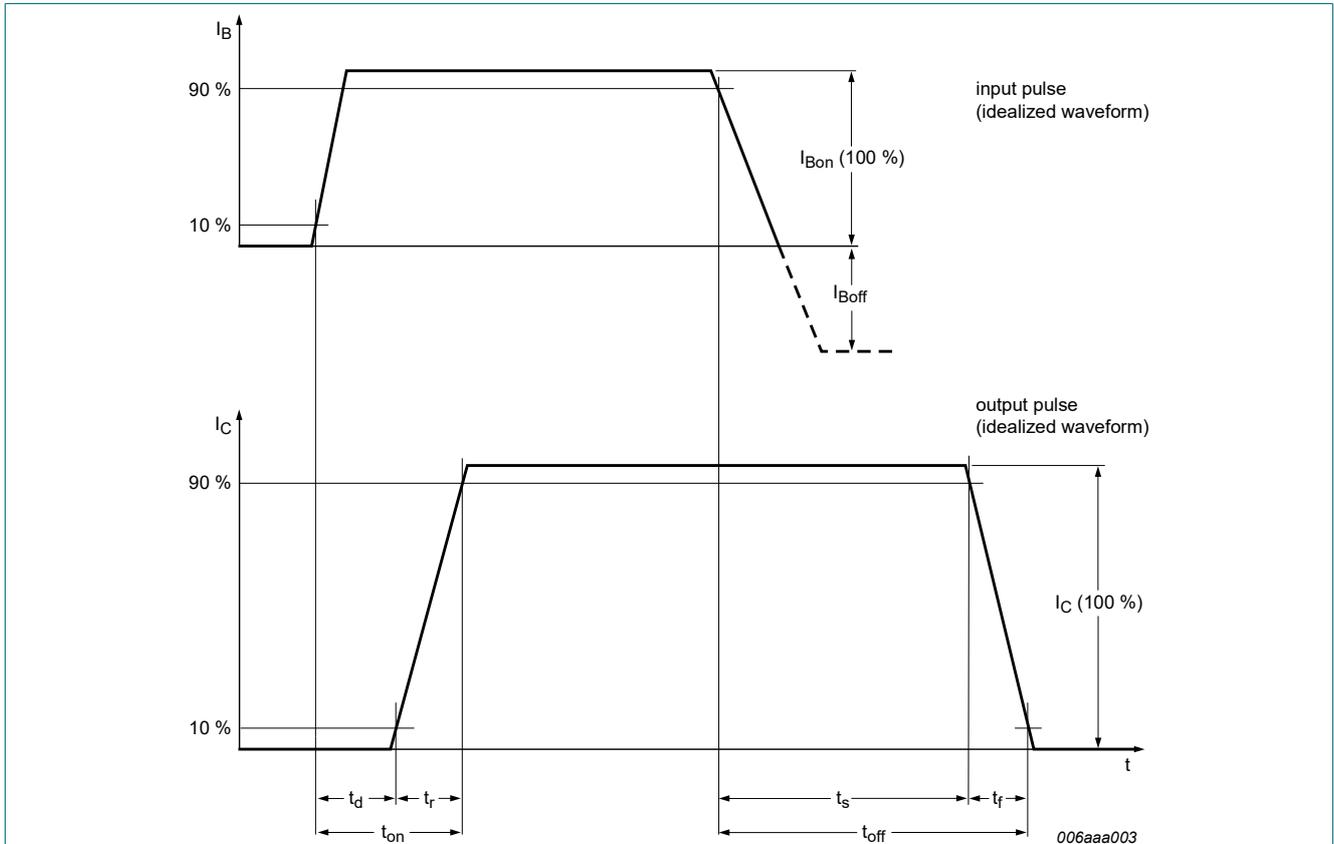


Fig. 12. BISS transistor switching time definition

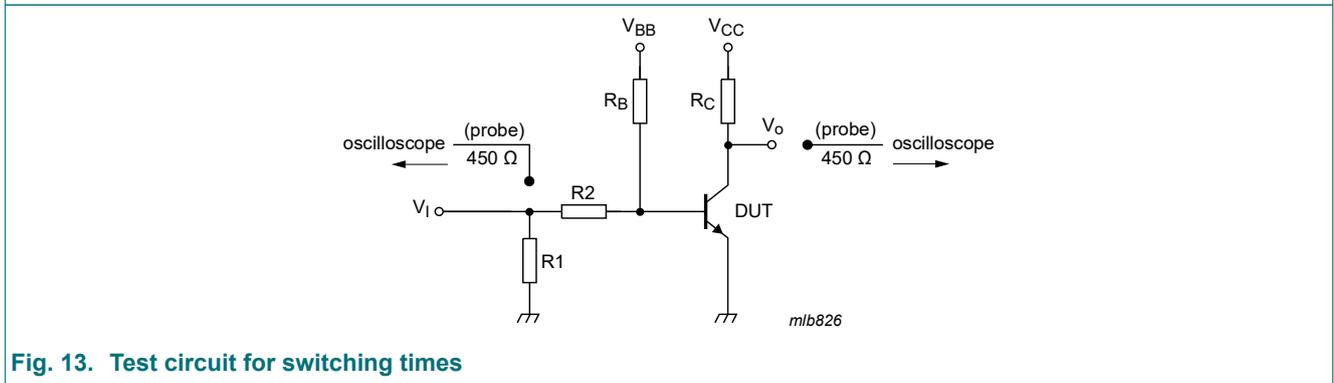


Fig. 13. Test circuit for switching times

### 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

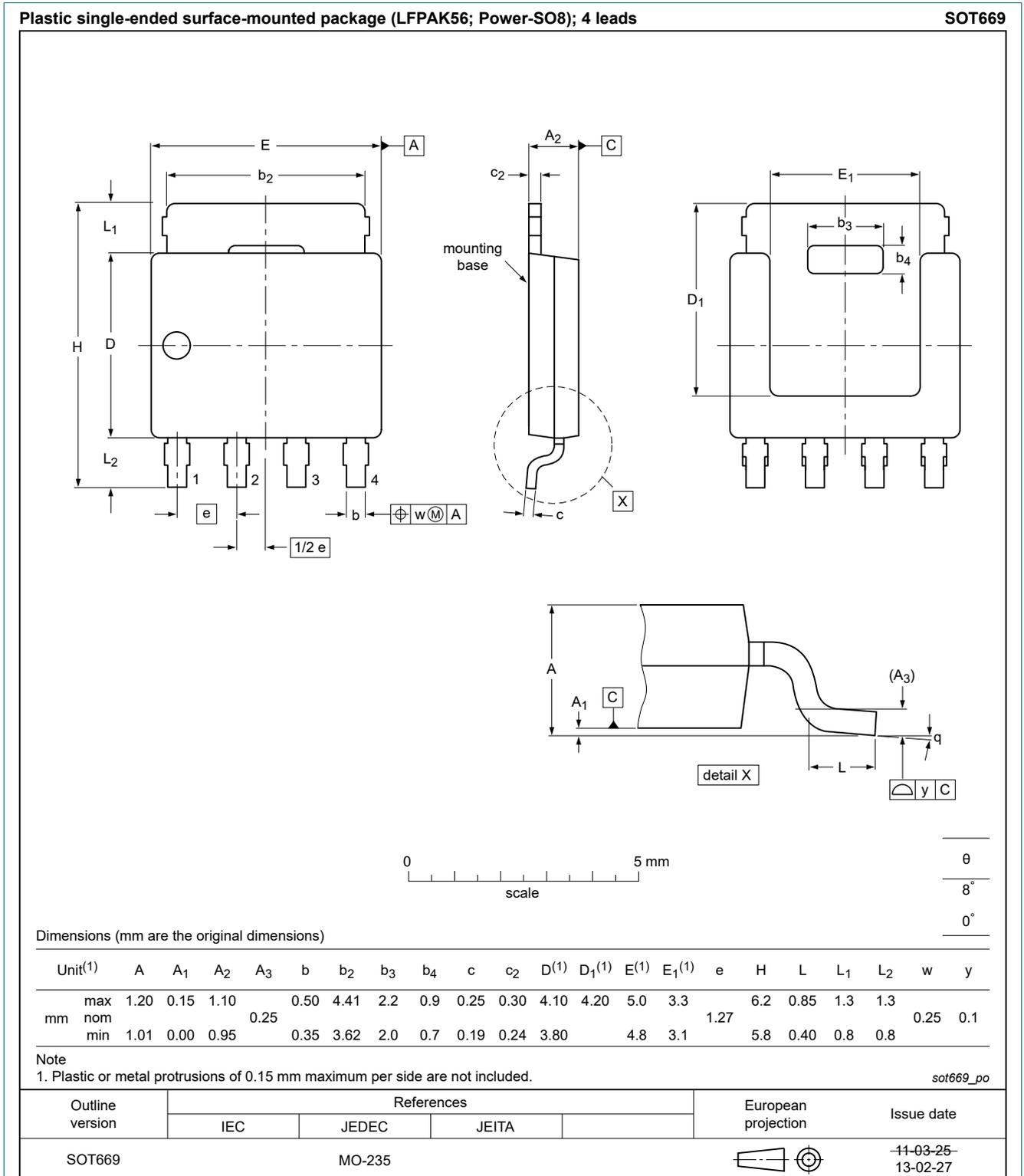


Fig. 14. Package outline LFAK56; Power-SO8 (SOT669)



## 14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PHPT60610NY v.2	20190115	Product data sheet	-	PHPT60610NY v.1
Modifications:	• Typo at figures 2 and 3: unit corrected from ns to s at x-scale			
PHPT60610NY v.1	20150527	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.
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Date of release: 15 January 2019

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