



# PHPT60606NY

60 V, 6 A NPN high power bipolar transistor

8 December 2014

Product data sheet

## 1. General description

NPN high power bipolar transistor in a SOT669 (LFPAK56) Surface-Mounted Device (SMD) power plastic package.

PNP complement: PHPT60606PY

## 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
- Relay replacement
- Motor drive

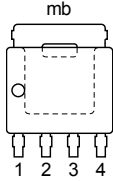
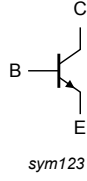
## 4. Quick reference data

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		-	-	6	A
$I_{CM}$	peak collector current	single pulse; $t_p \leq 1$ ms	-	-	14	A
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = 6$ A; $I_B = 600$ mA; pulsed; $t_p \leq 300$ $\mu$ s; $\delta \leq 0.02$ ; $T_{amb} = 25$ °C	-	34	45	m $\Omega$

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	E	emitter	 <p><b>LFPAK56; Power-SO8 (SOT669)</b></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
PHPT60606NY	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
PHPT60606NY	0606NAB

## 8. Limiting values

**Table 5. Limiting values**

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

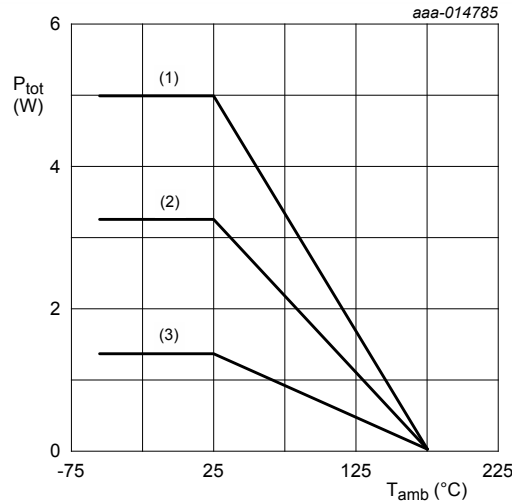
Symbol	Parameter	Conditions		Min	Max	Unit
$V_{CBO}$	collector-base voltage	open emitter		-	60	V
$V_{CEO}$	collector-emitter voltage	open base		-	60	V
$V_{EBO}$	emitter-base voltage	open collector		-	7	V
$I_C$	collector current			-	6	A
$I_{CM}$	peak collector current	single pulse; $t_p \leq 1$ ms		-	14	A
$I_B$	base current			-	800	mA
$I_{BM}$	peak base current	single pulse; $t_p \leq 1$ ms		-	1.4	A
$P_{tot}$	total power dissipation	$T_{amb} \leq 25$ °C	[1]	-	1.35	W
			[2]	-	3.25	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.



- (1) Ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint
- (2) FR4 PCB, mounting pad for collector 6 cm<sup>2</sup>
- (3) FR4 PCB, standard footprint

Fig. 1. Power derating curves

## 9. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
R <sub>th(j-a)</sub>	thermal resistance from junction to ambient	in free air	[1]	-	-	111	K/W
			[2]	-	-	46	K/W
			[3]	-	-	30	K/W
R <sub>th(j-mb)</sub>	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.

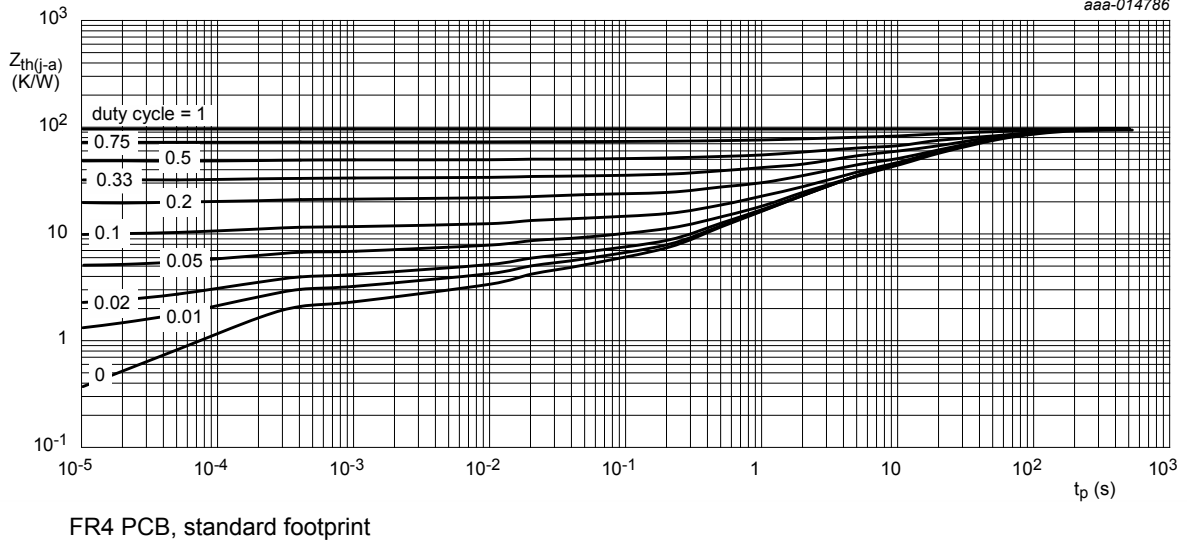


Fig. 2. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

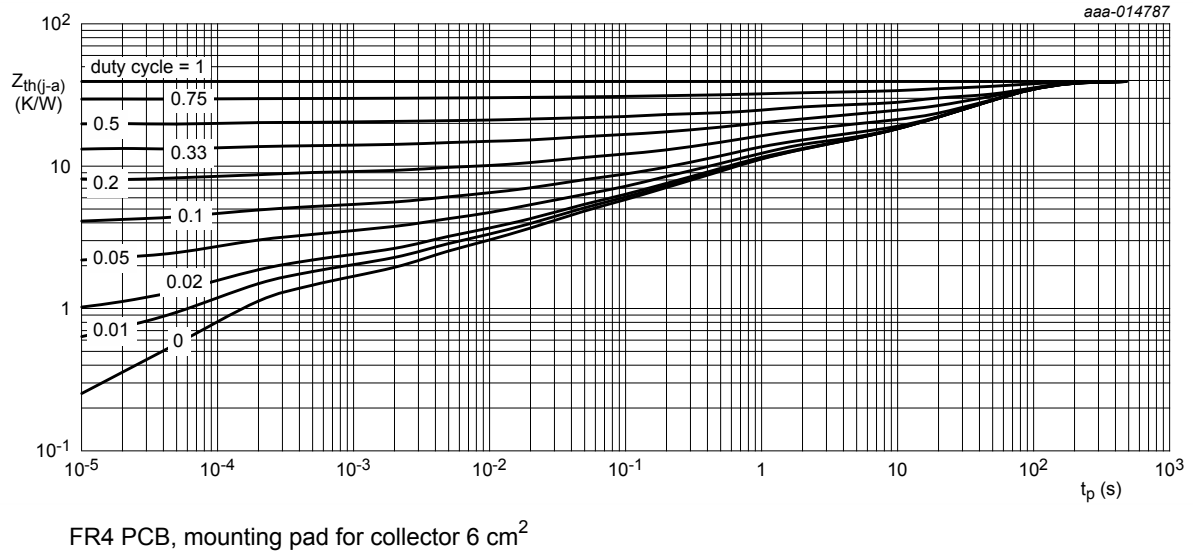


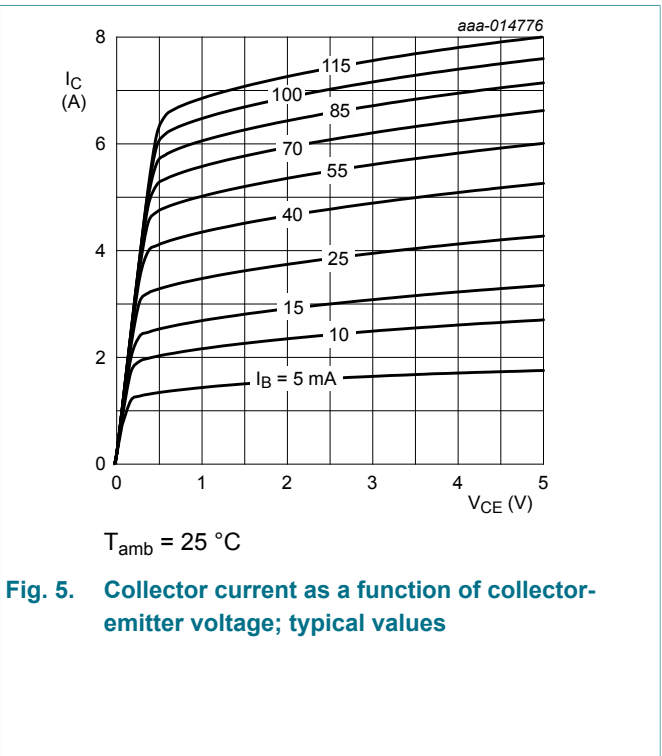
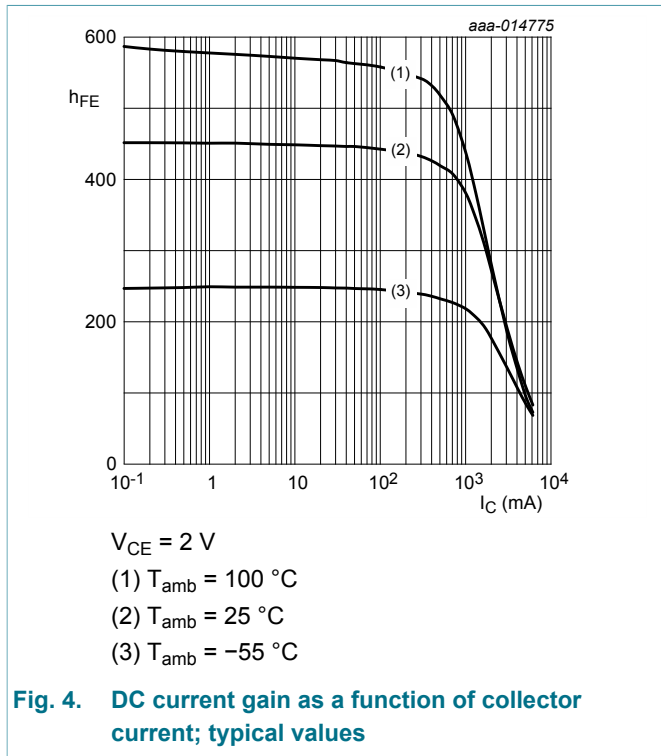
Fig. 3. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

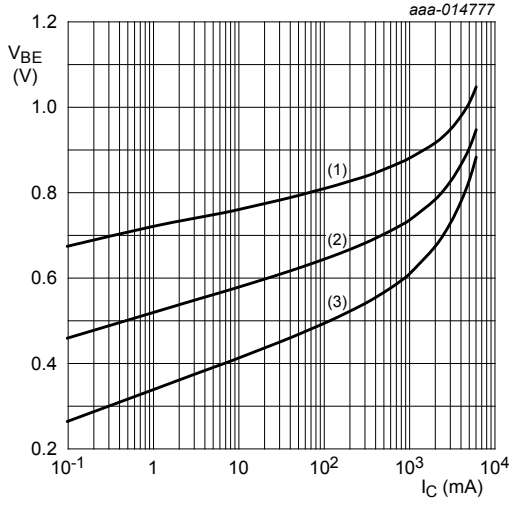
## 10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I <sub>CB0</sub>	collector-base cut-off current	V <sub>CB</sub> = 48 V; I <sub>E</sub> = 0 A; T <sub>amb</sub> = 25 °C	-	-	100	nA
		V <sub>CB</sub> = 48 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> = 48 V; V <sub>BE</sub> = 0 V; T <sub>amb</sub> = 25 °C	-	-	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> = 2 V; I <sub>C</sub> = 500 mA; T <sub>amb</sub> = 25 °C	240	390	-	
		V <sub>CE</sub> = 2 V; I <sub>C</sub> = 1 A; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	210	340	-	
		V <sub>CE</sub> = 2 V; I <sub>C</sub> = 3 A; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	100	160	-	
		V <sub>CE</sub> = 2 V; I <sub>C</sub> = 6 A; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C; pulsed	40	70	-	
V <sub>CEsat</sub>	collector-emitter saturation voltage	I <sub>C</sub> = 1 A; I <sub>B</sub> = 50 mA; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C; pulsed	-	50	75	mV
		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	-	110	160	mV
		I <sub>C</sub> = 6 A; I <sub>B</sub> = 300 mA; pulsed; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	-	240	360	mV
R <sub>CEsat</sub>	collector-emitter saturation resistance	I <sub>C</sub> = 6 A; I <sub>B</sub> = 600 mA; pulsed; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	-	34	45	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	-	0.85	0.95	V
		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	-	1	1.15	V
		I <sub>C</sub> = 6 A; I <sub>B</sub> = 300 mA; pulsed; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C	-	1.05	1.2	V
V <sub>BEon</sub>	base-emitter turn-on voltage	V <sub>CE</sub> = 2 V; I <sub>C</sub> = 0.5 A; T <sub>amb</sub> = 25 °C	-	0.7	0.8	V
t <sub>d</sub>	delay time	V <sub>CC</sub> = 12.5 V; I <sub>C</sub> = 3 A; I <sub>Bon</sub> = 0.15 A; I <sub>Boff</sub> = -0.15 A; T <sub>amb</sub> = 25 °C	-	10	-	ns
t <sub>r</sub>	rise time		-	135	-	ns
t <sub>on</sub>	turn-on time		-	145	-	ns
t <sub>s</sub>	storage time		-	465	-	ns
t <sub>f</sub>	fall time		-	225	-	ns
t <sub>off</sub>	turn-off time		-	690	-	ns

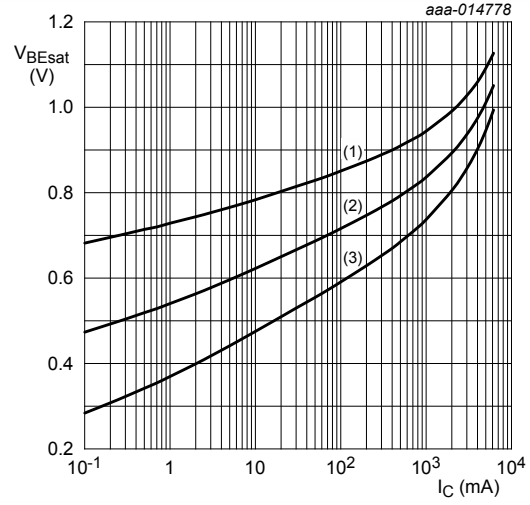
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f_T$	transition frequency	$V_{CE} = 10\text{ V}; I_C = 500\text{ mA}; f = 100\text{ MHz}; T_{amb} = 25\text{ }^\circ\text{C}$	-	180	-	MHz
$C_c$	collector capacitance	$V_{CB} = 10\text{ V}; I_E = 0\text{ A}; i_e = 0\text{ A}; f = 1\text{ MHz}; T_{amb} = 25\text{ }^\circ\text{C}$	-	23	-	pF





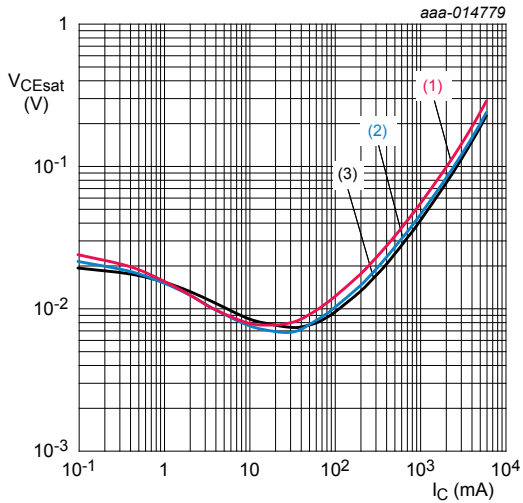
$V_{CE} = 2\text{ V}$   
 (1)  $T_{amb} = -55\text{ }^{\circ}\text{C}$   
 (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$   
 (3)  $T_{amb} = 100\text{ }^{\circ}\text{C}$

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



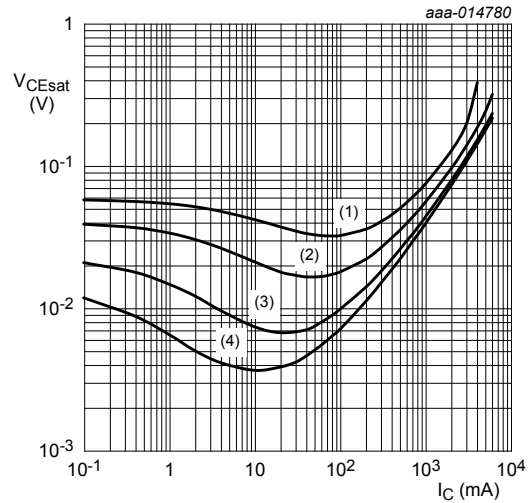
$I_C/I_B = 20$   
 (1)  $T_{amb} = -55\text{ }^{\circ}\text{C}$   
 (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$   
 (3)  $T_{amb} = 100\text{ }^{\circ}\text{C}$

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



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

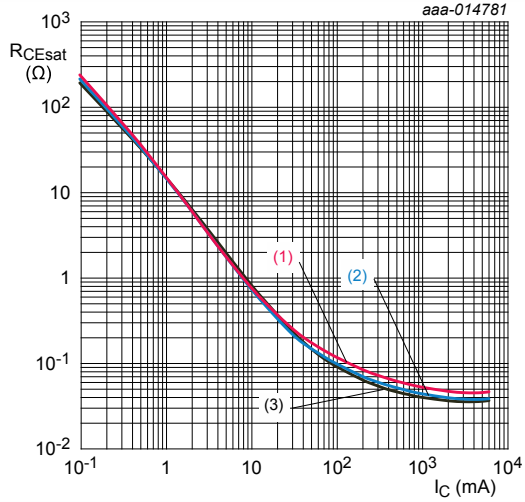
**Fig. 8. Collector-emitter saturation voltage as a function of collector current; typical values**



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

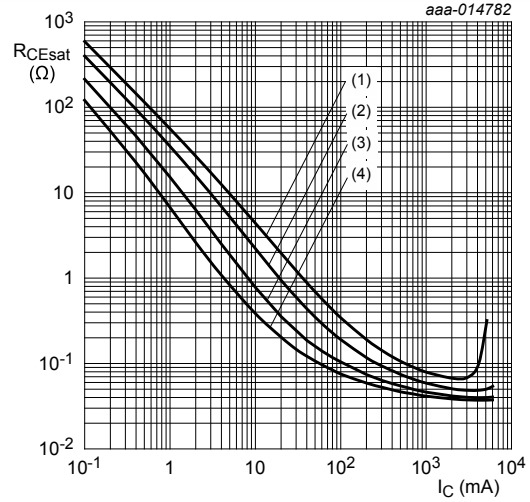




$I_C/I_B = 20$

- (1)  $T_{amb} = 100\text{ °C}$
- (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)  $I_C/I_B = 100$
- (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

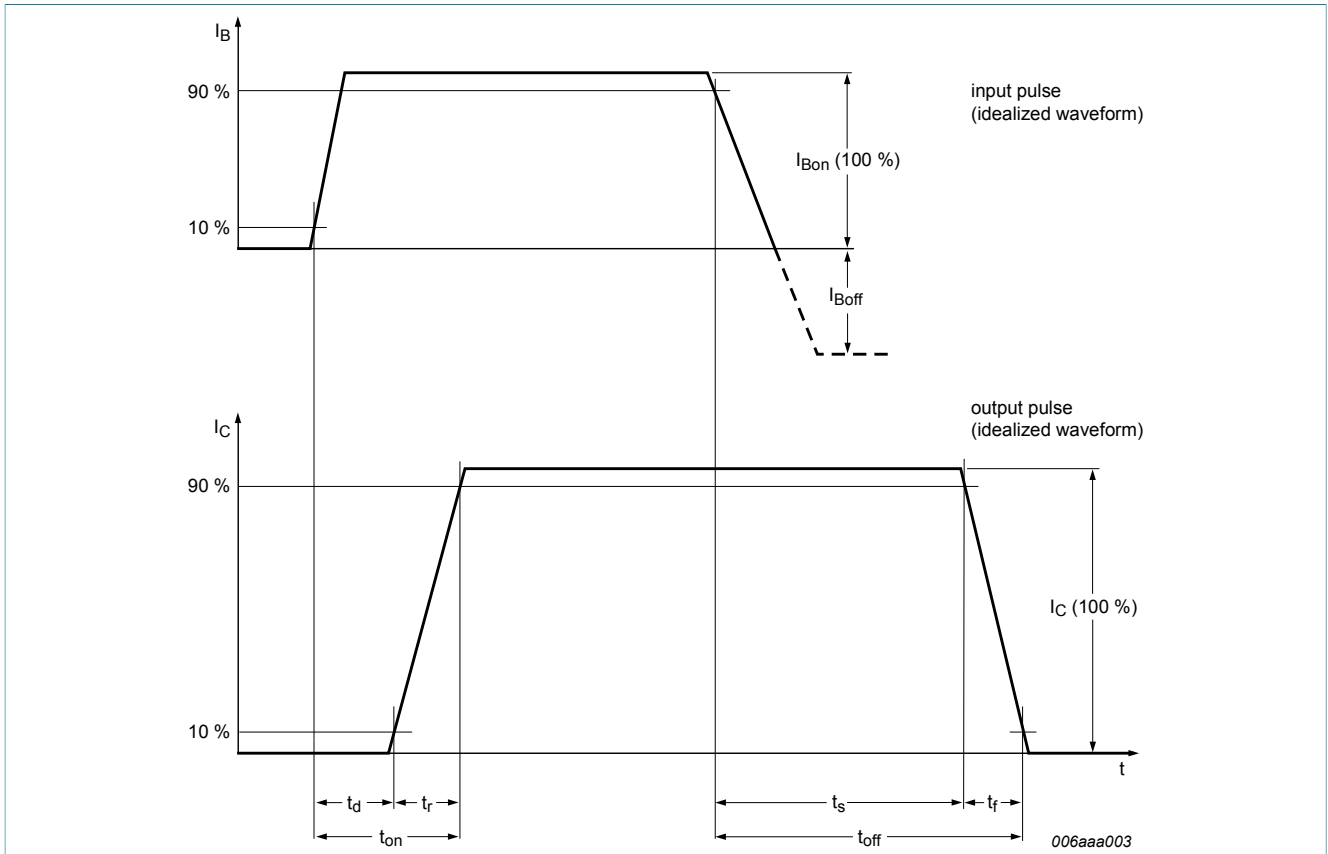


Fig. 12. BISS transistor switching time definition

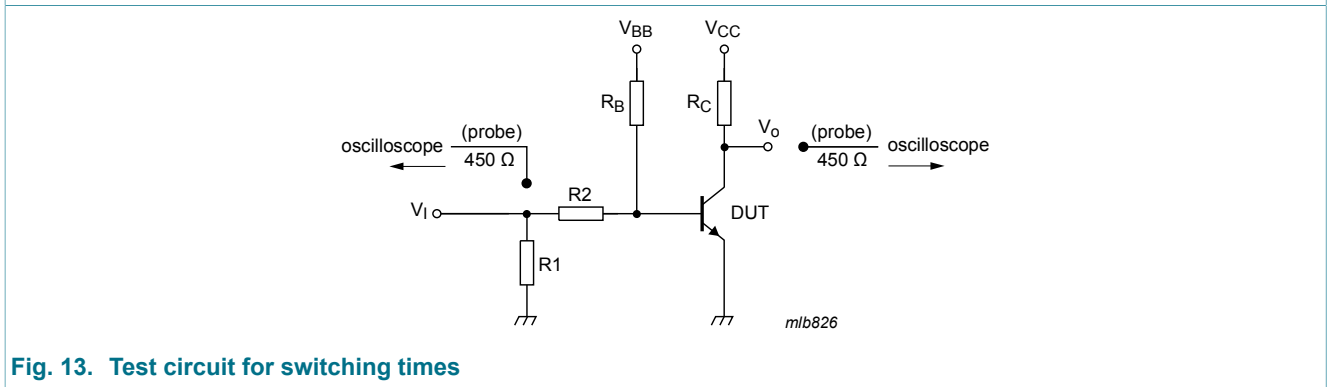


Fig. 13. Test circuit for switching times

#### 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

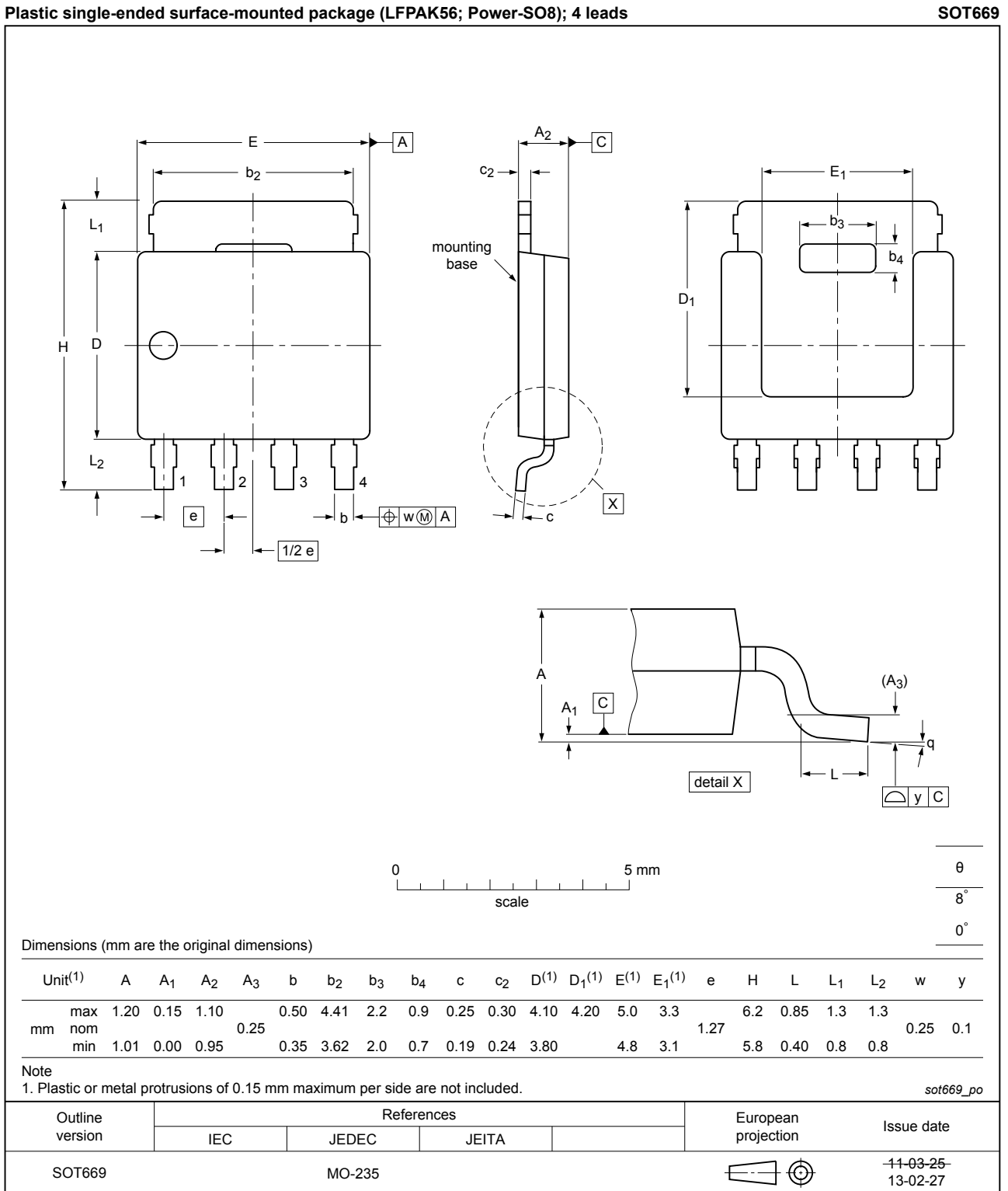


Fig. 14. Package outline LFAK56; Power-SO8 (SOT669)

### 13. Soldering

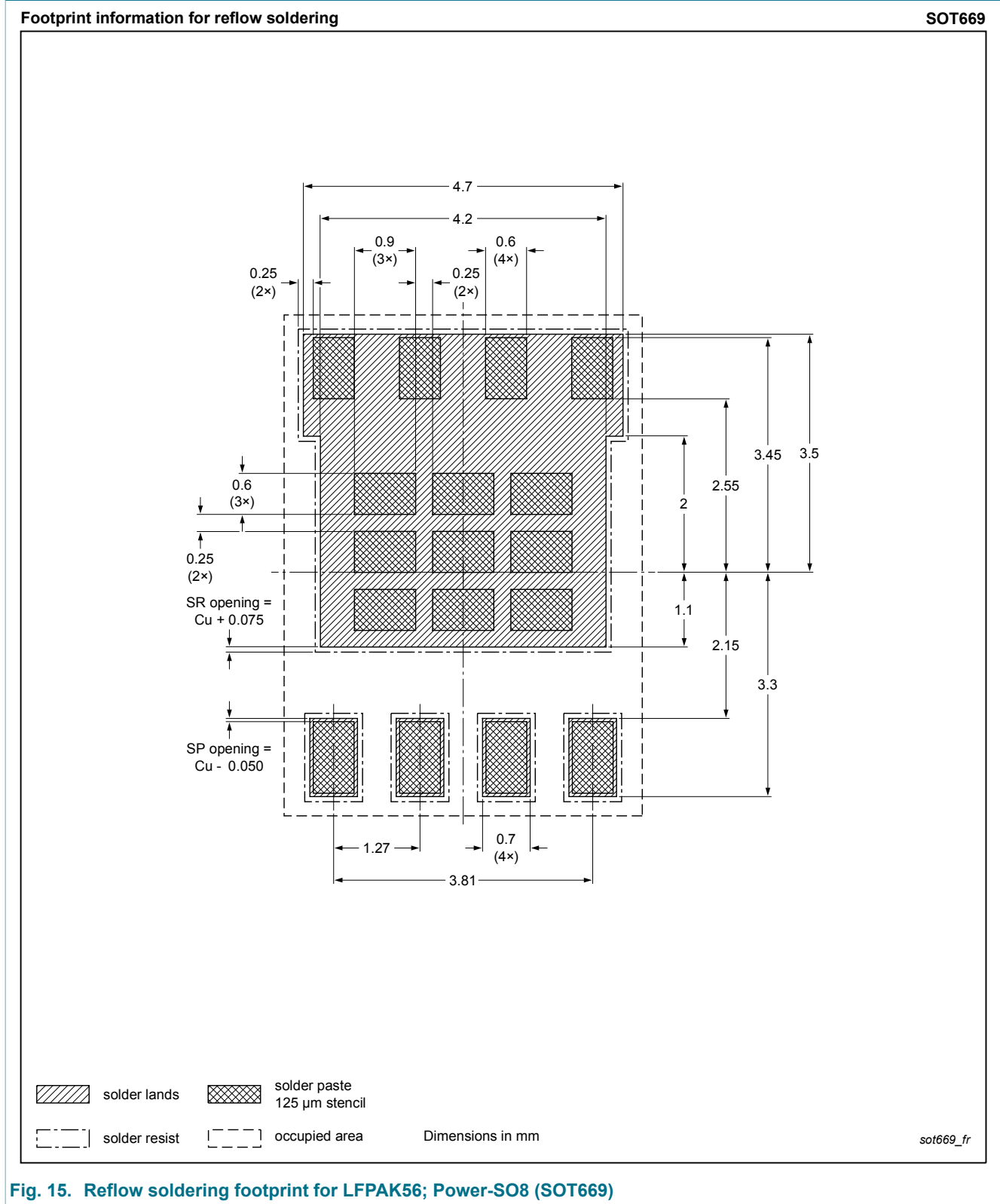


Fig. 15. Reflow soldering footprint for LFPAK56; Power-SO8 (SOT669)

## 14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PHPT60606NY v.1	20141208	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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