

## High voltage fast-switching NPN power transistor

### Features

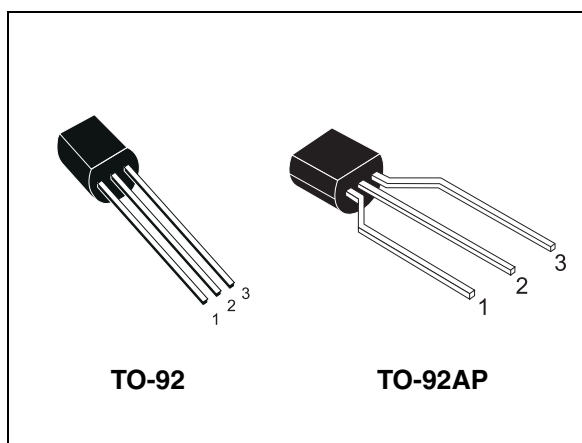
- High voltage capability
- Low spread of dynamic parameters
- Minimum lot-to-lot spread for reliable operation
- Very high switching speed

### Application

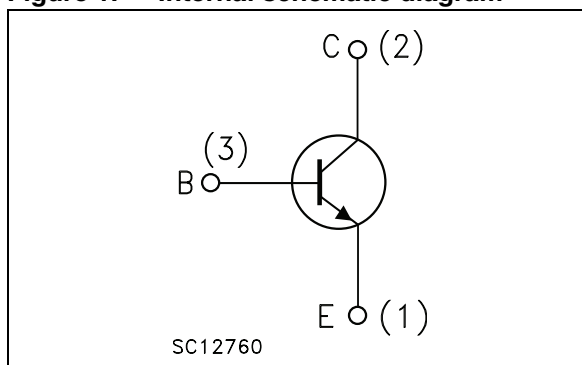
- SMPS for battery charger

### Description

The device is manufactured using high voltage multi epitaxial planar technology for high switching speeds and high voltage capability. It uses a cellular emitter structure with planar edge termination to enhance switching speeds while maintaining the wide RBSOA.



**Figure 1. Internal schematic diagram**



**Table 1. Device summary**

Order codes	Marking	Package	Packaging
STX13004	X13004	TO-92	Bulk
STX13004G <sup>(1)</sup>	X13004G	TO-92	Bulk
STX13004-AP	X13004	TO-92AP	Ammopack
STX13004G-AP <sup>(1)</sup>	X13004G	TO-92AP	Ammopack

1. The letter "G" in the order code identifies the product as ECOPACK@2 grade. Please see [Section 3](#) for details.

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{BE} = 0$ )	700	V
$V_{CEO}$	Collector-emitter voltage ( $I_B = 0$ )	400	V
$V_{EBO}$	Collector-base voltage ( $I_C = 0, I_B = 1\text{ A}, t_P < 10\text{ ms}$ )	$V_{(BR)EBO}$	V
$I_C$	Collector current	2	A
$I_{CM}$	Collector peak current ( $t_P < 5\text{ ms}$ )	4	A
$I_B$	Base current	1	A
$I_{BM}$	Base peak current ( $t_P < 5\text{ ms}$ )	2	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	2.5	W
$T_{STG}$	Storage temperature	-65 to 150	°C
$T_J$	Max. operating junction temperature	150	

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance junction-case max	50	°C/W
$R_{thJA}$	Thermal resistance junction-ambient max	150	°C/W

## 2 Electrical characteristics

$T_{\text{case}} = 25\text{ }^{\circ}\text{C}$ ; unless otherwise specified.

**Table 4. Electrical characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{\text{CES}}$	Collector cut-off current ( $V_{\text{BE}} = 0$ )	$V_{\text{CE}} = 700\text{ V}$			10	$\mu\text{A}$
$I_{\text{CEO}}$	Collector cut-off current ( $I_{\text{B}} = 0$ )	$V_{\text{CE}} = 400\text{ V}$			1	mA
$V_{(\text{BR})\text{EBO}}$	Emitter-base breakdown voltage ( $I_{\text{C}} = 0$ )	$I_{\text{E}} = 10\text{ mA}$	9		18	V
$V_{\text{CEO(sus)}}^{(1)}$	Collector-emitter sustaining voltage ( $I_{\text{B}} = 0$ )	$I_{\text{C}} = 10\text{ mA}$	400			V
$V_{\text{CE(sat)}}^{(1)}$	Collector-emitter saturation voltage	$I_{\text{C}} = 1\text{ A}$ $I_{\text{B}} = 200\text{ mA}$ $I_{\text{C}} = 2\text{ A}$ $I_{\text{B}} = 500\text{ mA}$			0.5 1	V V
$V_{\text{BE(sat)}}^{(1)}$	Base-emitter saturation voltage	$I_{\text{C}} = 1\text{ A}$ $I_{\text{B}} = 200\text{ mA}$ $I_{\text{C}} = 2\text{ A}$ $I_{\text{B}} = 500\text{ mA}$			1.2 1.6	V V
$h_{\text{FE}}$	DC current gain	$I_{\text{C}} = 0.5\text{ mA}$ $V_{\text{CE}} = 2\text{ V}$ $I_{\text{C}} = 400\text{ mA}$ $V_{\text{CE}} = 2\text{ V}$ $I_{\text{C}} = 1\text{ A}$ $V_{\text{CE}} = 5\text{ V}$ $I_{\text{C}} = 2\text{ A}$ $V_{\text{CE}} = 5\text{ V}$	15 26 10 6	35		
$t_{\text{s}}$ $t_{\text{f}}$	Resistive load Storage time Fall time	$I_{\text{C}} = 2\text{ A}$ $t_{\text{p}} = 30\text{ }\mu\text{s}$ $I_{\text{B(on)}} = -I_{\text{B(off)}} = 400\text{ mA}$ $V_{\text{CC}} = 125\text{ V}$ $V_{\text{BB(off)}} = -5\text{ V}$ (see <a href="#">Figure 12</a> )		1.1 300		$\mu\text{s}$ ns
$t_{\text{s}}$ $t_{\text{f}}$	Inductive load Storage time Fall time	$I_{\text{C}} = 1\text{ A}$ $V_{\text{clamp}} = 300\text{ V}$ $I_{\text{B(on)}} = 250\text{ mA}$ $V_{\text{BB(off)}} = -5\text{ V}$ $C_{\text{snuubber}} = 1\text{ nF}$ $R_{\text{BB(off)}} = 0$ (see <a href="#">Figure 13</a> )		2.4 200		$\mu\text{s}$ ns

1. Pulse test: pulse duration  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

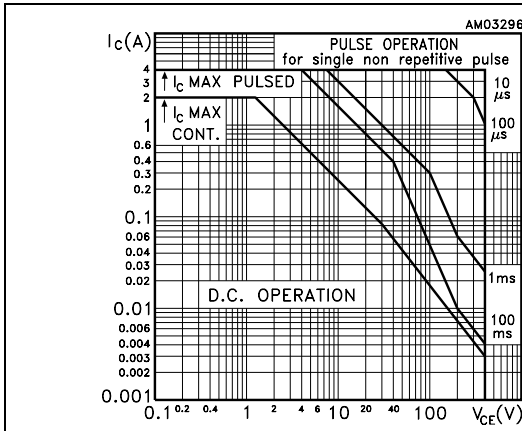


Figure 3. Derating curve

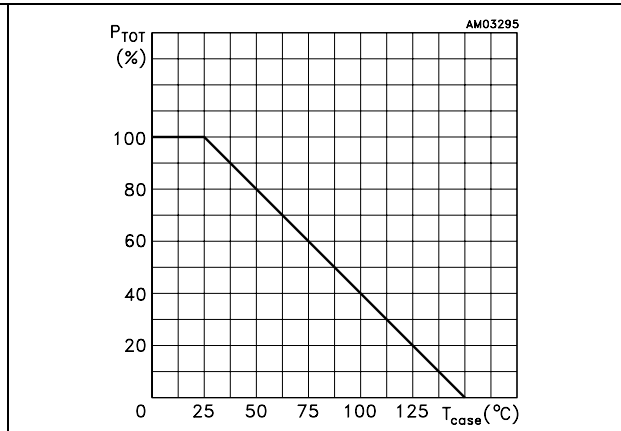


Figure 4. DC current gain @  $V_{CE} = 2$  V

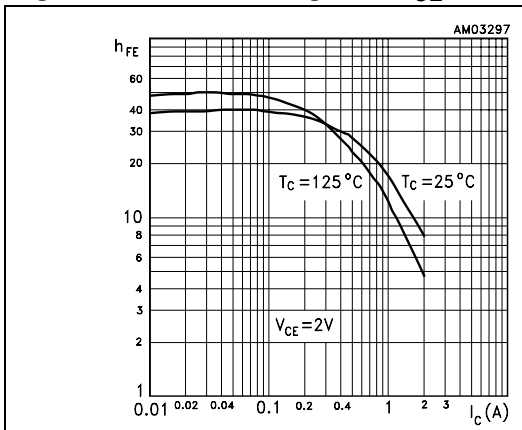


Figure 5. DC current gain @  $V_{CE} = 5$  V

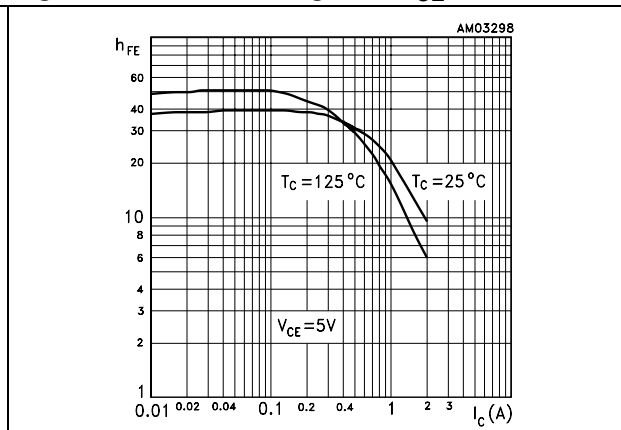


Figure 6. Collector-emitter saturation voltage

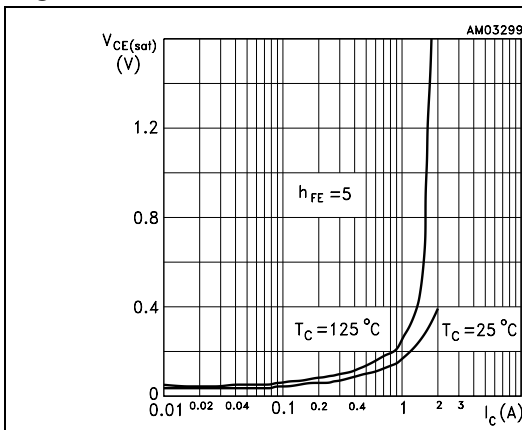


Figure 7. Base-emitter saturation voltage

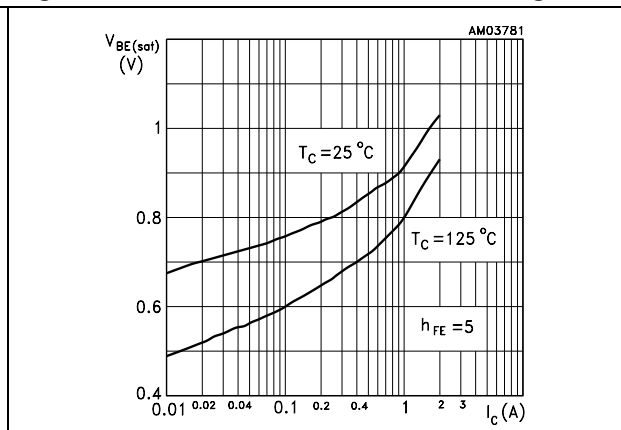


Figure 8. Output characteristics

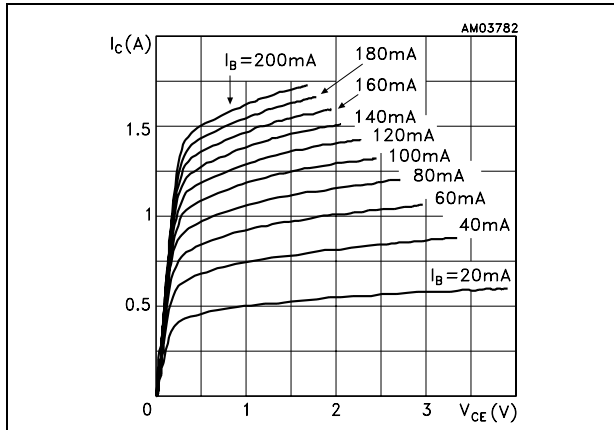


Figure 9. Reverse biased SOA

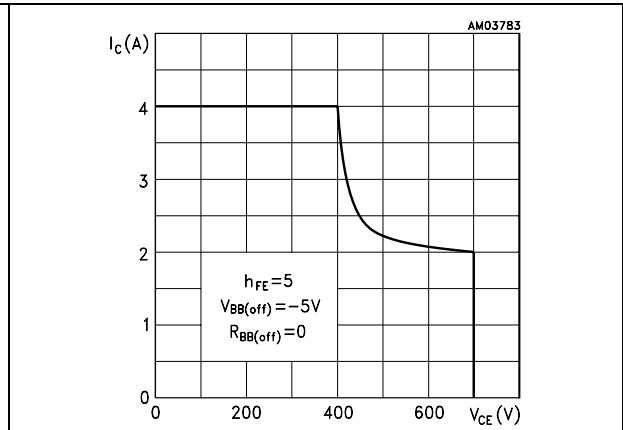


Figure 10. Resistive load switching times

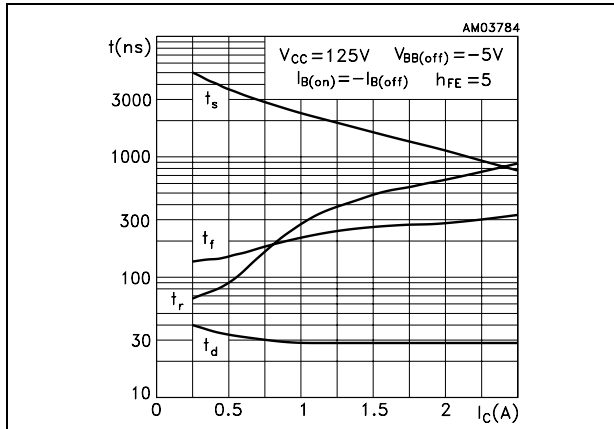
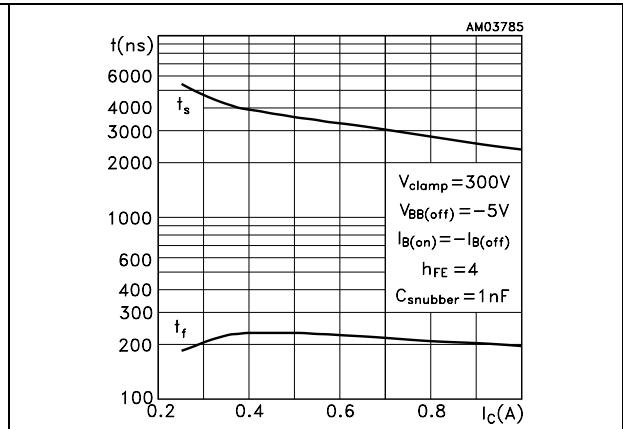
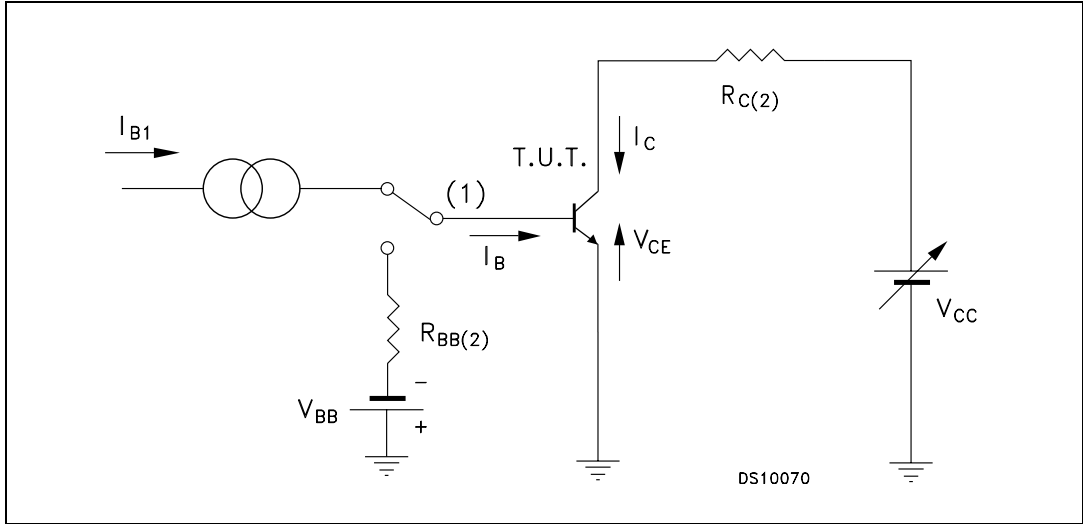


Figure 11. Inductive load switching times



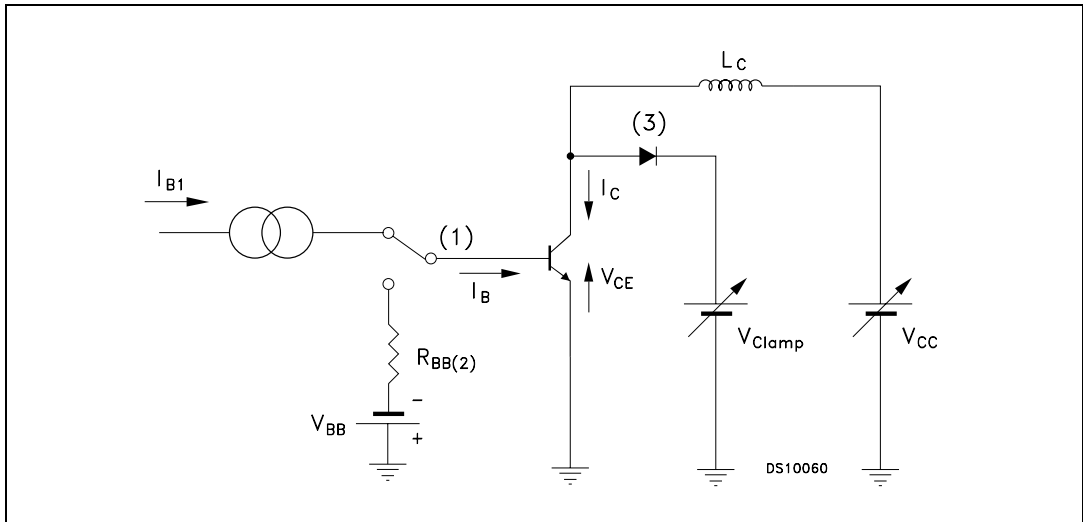
## 2.2 Test circuits

Figure 12. Resistive load switching test circuit



1. Fast electronic switch
2. Non-inductive resistor

Figure 13. Inductive load switching test circuit



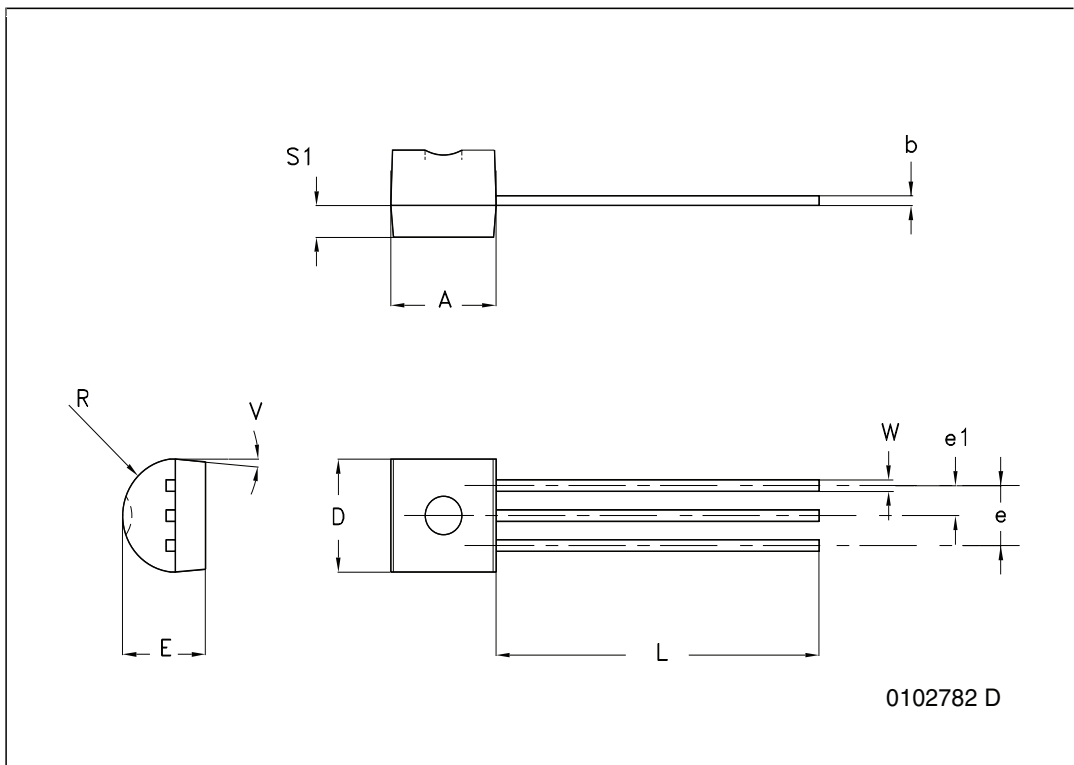
1. Fast electronic switch
2. Non-inductive resistor
3. Fast recovery rectifier

### 3 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

**TO-92 bulk shipment mechanical data**

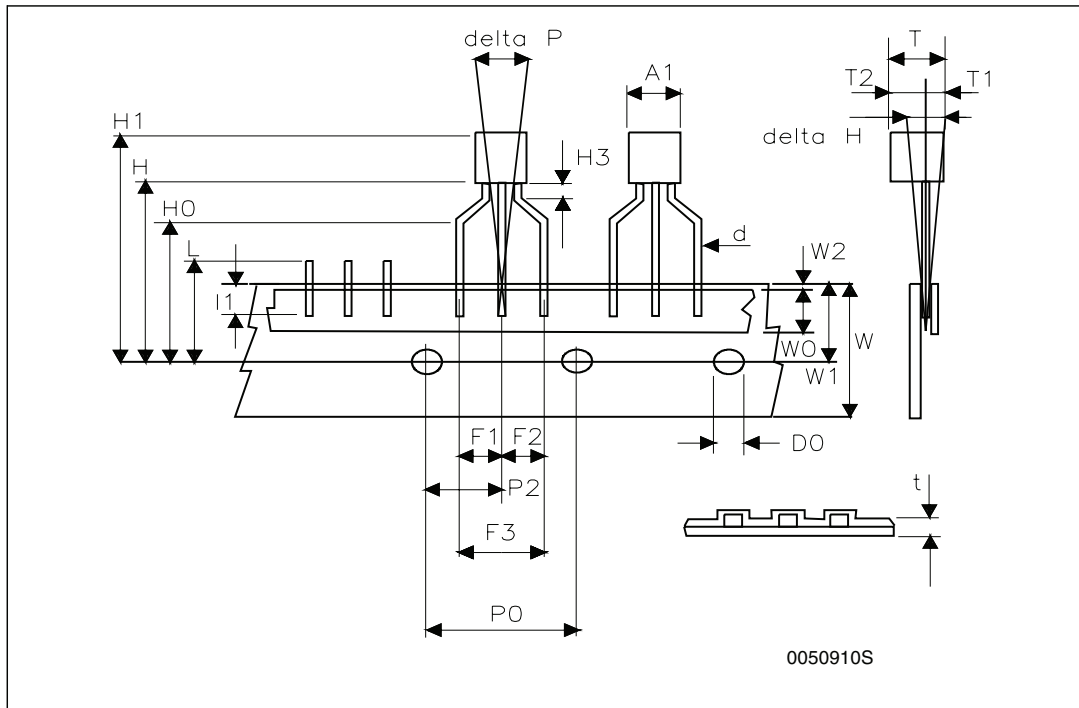
DIM.	mm.		
	MIN.	TYP	MAX.
A	4.32		4.95
b	0.36		0.51
D	4.45		4.95
E	3.30		3.94
e	2.41		2.67
e1	1.14		1.40
L	12.70		15.49
R	2.16		2.41
S1	0.92		1.52
W	0.41		0.56
V		5°	





**TO-92 ammopack shipment (suffix"-AP") mechanical data**

Dim.	mm		
	Min	Typ	Max
A1			4.80
T			3.80
T1			1.60
T2			2.30
d			0.48
P0	12.50	12.70	12.90
P2	5.65	6.35	7.05
F1,F2	2.44	2.54	2.94
F3	4.98	5.08	5.48
delta H	-2.00		2.00
W	17.50	18.00	19.00
W0	5.70	6.00	6.30
W1	8.50	9.00	9.25
W2			0.50
H	18.50		20.50
H3	0.5	1	1.5
H0	15.50	16.00	16.50
H1			25.00
D0	3.80	4.00	4.20
t			0.90
L			11.00
I1	3.00		
delta P	-1.00		1.00



## 4 Revision history

**Table 5. Document revision history**

Date	Revision	Changes
01-Apr-2009	1	First release.
21-Apr-2010	2	Updated $h_{FE}$ specification <a href="#">Table 4 on page 3</a> .
06-Jul-2010	3	Added $R_{thJA}$ value <a href="#">Table 3 on page 2</a> and updated $I_{CES}$ maximum value <a href="#">Table 4 on page 3</a> .

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