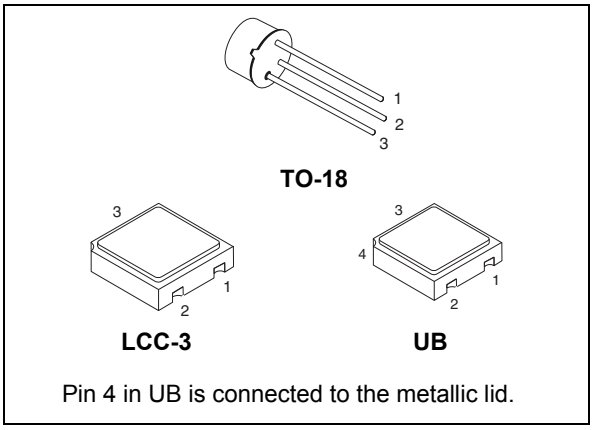
2N2907AHR

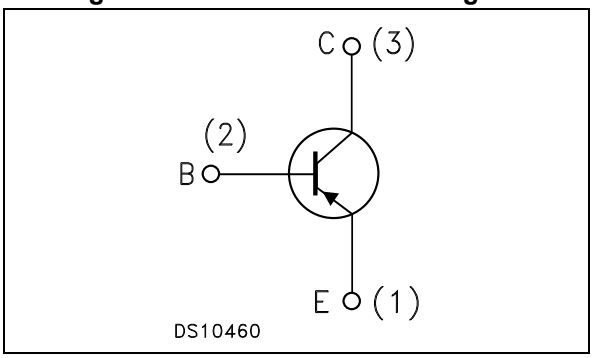
Hi-Rel 60 V, 0.6 A PNP transistor

Datasheet - production data



Pin 4 in UB is connected to the metallic lid.

Figure 1. Internal schematic diagram



Features

Parameter	Value
BV_{CEO}	60 V
I_C (max)	0.6 A
H_{FE} at 10 V - 150 mA	> 100

- Hermetic packages
- ESCC and JANS qualified
- European preferred part list EPPL

Description

The 2N2907AHR is a silicon planar PNP transistor specifically designed and housed in hermetic packages for aerospace and Hi-Rel applications. It is available in the JAN qualification system (MIL-PRF19500 compliance) and in the ESCC qualification system (ESCC 5000 compliance). In case of discrepancies between this datasheet and the relevant agency specification, the latter takes precedence.

Table 1. Device summary

Device	Qualification system	Agency specification	Package	Radiation level	EPPL
JANSR2N2907AUBx	JANSR	MIL-PRF-19500/291	UB	100 krad - high and low dose rate	-
JANS2N2907AUBx	JANS	MIL-PRF-19500/291	UB	-	-
2N2907ARUBx	ESCC Flight	5202/001	UB	100 krad - low dose rate	Target
2N2907AUBx	ESCC Flight	5202/001	UB	-	Target
SOC2907ARHRx	ESCC Flight	5202/001	LCC-3	100 krad - low dose rate	Yes
SOC2907AHRx	ESCC Flight	5202/001	LCC-3	-	Yes
2N2907ARHRx	ESCC Flight	5202/001	TO-18	100 krad - low dose rate	-
2N2907AHRx	ESCC Flight	5202/001	TO-18	-	-

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CBO}	Collector-base voltage (I_E = 0)	-60	V
V_{CEO}	Collector-emitter voltage (I_B = 0)	-60	V
V_{EBO}	Emitter-base voltage (I_C = 0)	-5	V
I_C	Collector current for TO-18 for LCC-3 and UB	 -0.6 -0.5	 A A
P_{TOT}	Total dissipation at $T_{amb} \leq 25$ °C ESCC: TO-18 LCC-3 and UB LCC-3 and UB (1) JANS: UB Total dissipation at $T_{case} \leq 25$ °C ESCC: TO-18	 0.4 0.4 0.73 0.5 1.8	W
	Total dissipation at $T_{sp(IS)}$ = 25 °C JANS: UB	1	
T_{stg}	Storage temperature	-65 to 200	°C
T_J	Max. operating junction temperature	200	°C

1. When mounted on a 15 x 15 x 0.6 mm ceramic substrate.

Table 3. Thermal data

Symbol	Parameter	LCC-3 UB	TO-18	Unit
R_{thJC}	Thermal resistance junction-case (max) for JANS	-	-	°C/W
	Thermal resistance junction-case (max) for ESCC	-	97	
$Rt_{hJSP(IS)}$	Thermal resistance junction-solder pad (infinite sink) (max) for JANS	90	-	
	Thermal resistance junction-solder pad (infinite sink) (max) for ESCC	-	-	
R_{thJA}	Thermal resistance junction-ambient (max) for JANS	325	-	
	Thermal resistance junction-ambient (max) for ESCC	437 240(1)	437	

1. When mounted on a 15 x 15 x 0.6 mm ceramic substrate.

2 Electrical characteristics[(a)]

JANS and ESCC version of the products are assembled and tested in compliance with the agency specification it is qualified in. The electrical characteristics of each version are provided in dedicated tables.

T_{case} = 25 °C unless otherwise specified.

2.1 JANS electrical characteristics

Table 4. JANS electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cut-off current (I_E = 0)	V_{CB} = 60 V		-	10	µA
		V_{CB} = 50 V		-	10	nA
		V_{CB}= 50 V, T_{amb} = 150 °C		-	10	µA
I_{CES}	Collector cut-off current (I_E = 0)	V_{CE} = 50 V		-	50	nA
I_{EBO}	Emitter cut-off current (I_C = 0)	V_{EB} = 5 V		-	10	µA
		V_{EB} = 4 V		-	50	nA
$V_{(BR)CEO}$ (1)	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA	60	-		V
$V_{CE(sat)}$ (1)	Collector-emitter saturation voltage	I_C = 150 mA, I_B = 15 mA		-	0.4	V
		I_C = 500 mA, I_B = 50 mA		-	1.6	V
$V_{BE(sat)}$ (1)	Base-emitter saturation voltage	I_C = 150 mA, I_B = 15 mA	0.6	-	1.3	V
		I_C= 500 mA, I_B= 50 mA		-	2.6	V
h_{FE} (1)	DC current gain	I_C = 0.1 mA, V_{CE} = 10 V	75	-		
		I_C = 1 mA, V_{CE} = 10 V	100	-	450	
		I_C = 10 mA, V_{CE} = 10 V	100	-		
		I_C = 150 mA, V_{CE} = 10 V	100	-	300	
		I_C = 500 mA, V_{CE} = 10 V	50	-		
		I_C = 10 mA, V_{CE} = 10 V T_{amb} = -55 °C	50	-		
h_{fe}	Small signal current gain	V_{CE} = 20 V I_C = 20 mA f = 100 MHz	2	-		
		V_{CE} = 10 V, I_C =1 mA f = 1 kHz	100	-		

a. For PNP type, voltage and current values are negative.

Table 4. JANS electrical characteristics (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{obo}	Output capacitance (I_E = 0)	V_{CB} = 10 V 100 kHz ≤ f ≤ 1 MHz		-	8	pF
C_{ibo}	Output capacitance (I_E = 0)	V_{EB} = 2 V 100 kHz ≤ f ≤ 1 MHz		-	30	pF
t_{on}	Turn-on time	V_{CC} = 30 V, I_C = 150 mA I_{B1} = 15 mA		-	45	ns
t_{off}	Turn-off time	V_{CC} = 30 V, I_C = 150 mA I_{B1} = -I_{B2} = 15 mA		-	300	ns

1. Pulsed duration = 300 µs, duty cycle ≤ 2%

2.2 ESCC electrical characteristics

Table 5. ESCC electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cut-off current (I_E = 0)	V_{CB} = 50 V, V_{CB} = 50 V, T_{amb} = 150 °C			10 10	nA µA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 µA	60			V
$V_{(BR)CEO}$ (1)	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA	60			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 µA	5			V
$V_{CE(sat)}$ (1)	Collector-emitter saturation voltage	I_C = 150 mA, I_B = 15 mA			0.4	V
$V_{BE(sat)}$ (1)	Base-emitter saturation voltage	I_C = 150 mA, I_B = 15 mA		0.87	1.3	V
h_{FE} (1)	DC current gain	I_C = 0.1 mA, V_{CE} = 10 V	75			
		I_C = 10 mA, V_{CE} = 10 V	100			
		I_C = 150 mA, V_{CE} = 10 V	100		300	
		I_C = 500 mA, V_{CE} = 10 V	50			
h_{fe}	Small signal current gain	V_{CE} = 20 V, I_C = 20 mA f = 100 MHz	2			
C_{obo}	Output capacitance (I_E = 0)	V_{CB} = 10 V 100 kHz ≤ f ≤ 1 MHz			8	pF

Table 5. ESCC electrical characteristics (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t_{on}	Turn-on time	V_{CC} = 30 V, I_C = 150 mA I_{B1} = 15 mA			45	ns
t_{off}	Turn-off time	V_{CC} = 30 V, I_C = 150 mA I_{B1} = -I_{B2} = 15 mA			300	ns

1. Pulsed duration = 300 µs, duty cycle ≤ 2 %

2.3 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-18

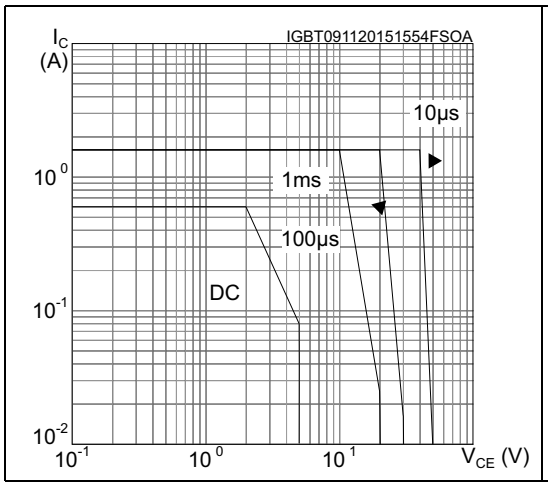


Figure 3. Safe operating area for LCC-3

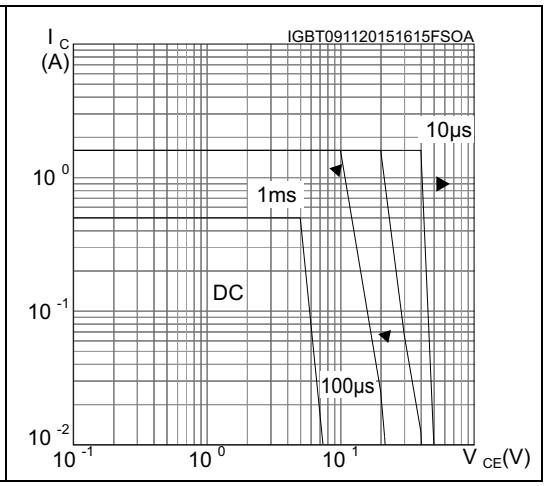


Figure 4. DC current gain (V_{CE} = 1 V)

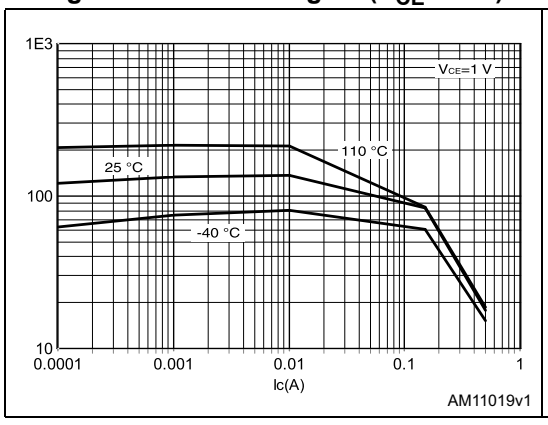


Figure 5. DC current gain (V_{CE} = 10 V)

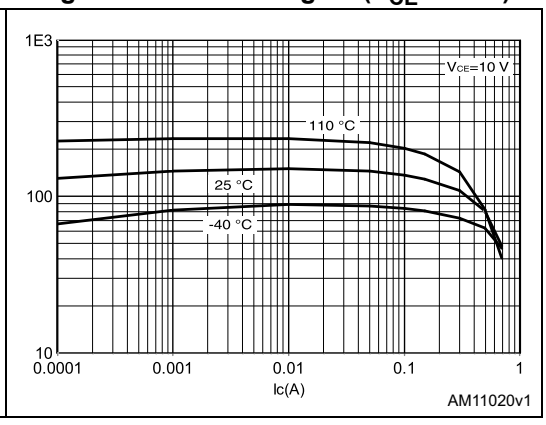


Figure 6. Collector emitter saturation voltage

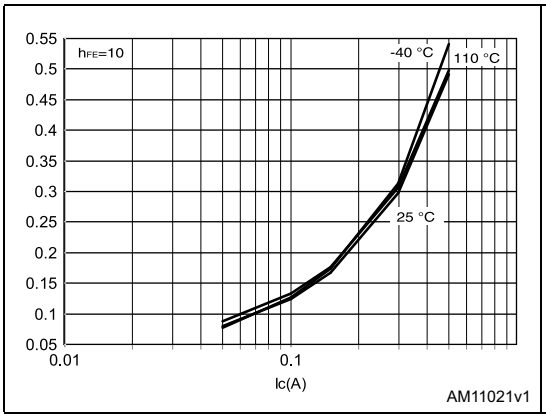
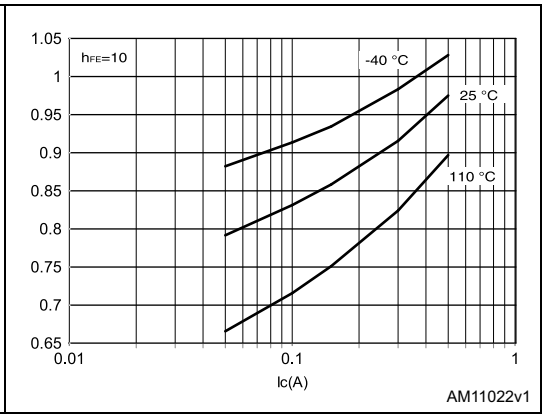
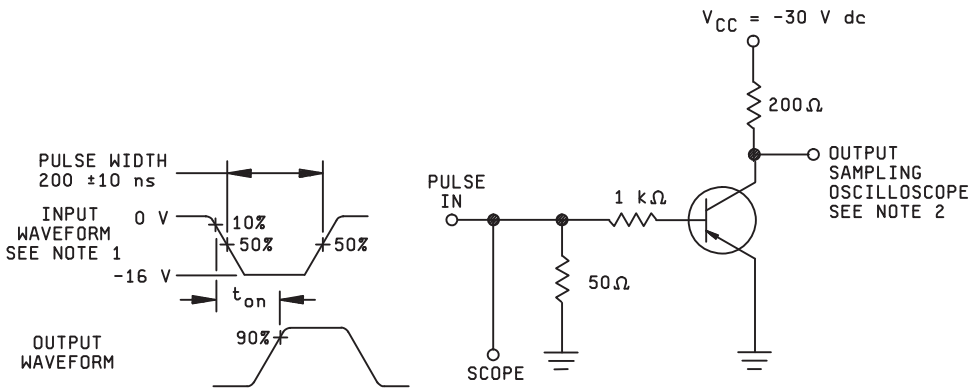


Figure 7. Base emitter saturation voltage (h_{FE} = 10)



2.4 Test circuits

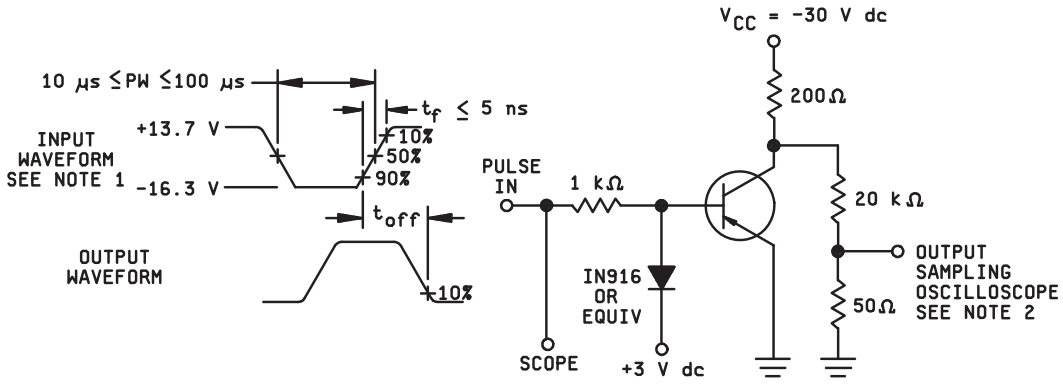
Figure 8. JANS saturated turn-on switching time test circuit



NOTES:

1. The rise time (t_r) of the applied pulse shall be ≤ 2.0 ns, duty cycle ≤ 2 percent and the generator source impedance shall be 50 ohms.
2. Sampling oscilloscope: Z_{in} ≥ 100 K ohms, C_{in} ≤ 12 pF, rise time ≤ 5 ns.

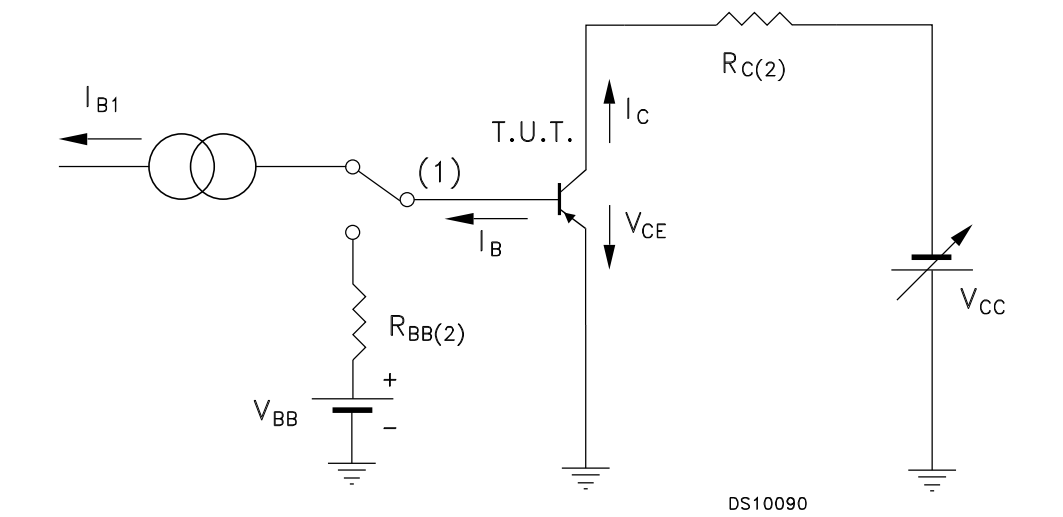
Figure 9. JANS saturated turn-off switching time test circuit



NOTES:

1. The rise time (t_r) of the applied pulse shall be ≤ 2.0 ns, duty cycle ≤ 2 percent and the generator source impedance shall be 50 ohms.
2. Sampling oscilloscope: Z_{in} ≥ 100 K ohms, C_{in} ≤ 12 pF, rise time ≤ 5 ns.

Figure 10. ESCC resistive load switching test circuit



1. Fast electronic switch
2. Non-inductive resistor

3 Radiation hardness assurance

The products guaranteed in radiation within the JANS system fully comply with the MIL-PRF-19500/291 specification.

The products guaranteed in radiation within the ESCC system fully comply with the ESCC 5202/001 and ESCC 22900 specifications.

JANS radiation assurance

ST JANS parts guaranteed at 100 krad (Si), tested, in full compliancy with the MIL-PRF-19500 specification, specifically the Group D, subgroup 2 inspection, between 50 and 300 rad/s. On top of the standard JANSR high dose rate by wafer lot guarantee, ST 2N2907AHR series include an additional wafer by wafer 100 krad Low dose rate guarantee at 0.1 rad/s, identical to the ESCC 100 krad guarantee. It is supported with the same Radiation Verification Test report provided with each shipment. A brief summary of the standard High Dose Rate by wafer lot JANSR guarantee is provided below:

– All test are performed in accordance to MIL-PRF-19500 and test method 1019 of MIL-STD-750 for total Ionizing dose.

The table below provides for each monitored parameters of the test conditions and the acceptance criteria

Table 6. MIL-PRF-19500 (test method 1019) post radiation electrical characteristics

Symbol	Parameter	Test conditions	Value		Unit
			Min.	Max.	
I_{CBO}	Collector to base cutoff current	V_{CB} = 60		20	µA
		V_{CB} = 50 V		20	nA
I_{EBO}	Emitter to base cutoff current	V_{EB} = 5 V		20	µA
		V_{EB} = 4 V		100	nA
$V_{(BR)CEO}$	Breakdown voltage, collector to emitter	I_C = 10 mA	60		V
I_{CES}	Collector to emitter cutoff current	V_{CE} = 50 V		100	nA
h_{FE}	Forward-current transfer ratio	V_{CE} = 10 V; I_C = 0.1 mA	[37.5](1)		
		V_{CE} = 10 V; I_C = 1.0 mA	[50](1)	400	
		V_{CE} = 10 V; I_C = 10 mA	[50](1)		
		V_{CE} = 10 V; I_C = 150 mA	[50](1)	300	
		V_{CE} = 10 V; I_C = 500 mA	[25](1)		
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = 150 mA; I_B = 15 mA		0.46	V
		I_C = 500 mA; I_B = 50 mA		1.84	
$V_{BE(sat)}$	Base-emitter saturation voltage	I_C = 150 mA; I_B = 15 mA	0.6	1.5	V
		I_C = 500 mA; I_B = 50 mA		3	

1. See method 1019 of MIL-STD-750 for how to determine [h_{FE}] by first calculating the delta ($1/h_{FE}$) from the pre- and Post-radiation h_{FE}. Notice the [h_{FE}] is not the same as h_{FE} and cannot be measured directly. The [h_{FE}] value can never exceed the pre-radiation minimum h_{FE} that it is based upon.

ESCC radiation assurance

Each product lot is tested according to the ESCC basic specification 22900, with a minimum of 11 samples per diffusion lot and 5 samples per wafer, one sample being kept as unirradiated sample, all of them being fully compliant with the applicable ESCC generic and/or detailed specification.

ST goes beyond the ESCC specification by performing the following procedure:

- Test of 11 pieces by wafer, 5 biased at least 80% of $V_{(BR)CEO}$, 5 unbiased and 1 kept for reference
- Irradiation at 0.1 rad (Si)/s
- Acceptance criteria of each individual wafer if as 100 krad guaranteed if all 10 samples comply with the post radiation electrical characteristics provided in *Table 8*.

Delivery together with the parts of the radiation verification test (RVT) report of the particular wafer used to manufacture the products. This RVT includes the value of each parameter at 30, 50, 70 and 100 krad (Si) and after 24 hour annealing at room temperature and after an additional 168 hour annealing at 100°C.

Table 7. Radiation summary

Radiation test	100 krad ESCC
Wafer test	each
Part tested	5 biased + 5 unbiased
Dose rate	0.1 rad/s
Acceptance	MIL-STD-750 method 1019
Displacement damage	Optional
Agency part number (ex)	5202/001/04R (1)
ST part number (ex)	SOC2N2907ARHRG
Documents	CoC + RVT

1. Example of the 2N2907A in LCC-3 Gold finish.

Table 8. ESCC 5202/001R post radiation electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cut-off current (I_E = 0)	V_{CB} = 50 V		-	10	nA
I_{EBO}	Emitter cut-off current (I_C = 0)	V_{EB} = 3 V		-	10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 µA	60	-		V
$V_{(BR)CEO}$ (1)	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA	60	-		V V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 µA	5	-		V
$V_{CE(sat)}$ (1)	Collector-emitter saturation voltage	I_C = 150 mA I_B = 15 mA		-	0.4	V
$V_{BE(sat)}$ (1)	Base-emitter saturation voltage	I_C = 150 mA I_B = 15 mA		-	1.3	V
$[h_{FE}]$ (1)	Post irradiation gain calculation (2)	I_C = 0.1 mA V_{CE} = 10 V I_C = 10 mA V_{CE} = 10 V I_C = 150 mA V_{CE} = 10 V I_C = 500 mA V_{CE} = 10 V	[37.5] [50] [100] [25]	-	300	

1. Pulsed duration = 300 µs, duty cycle ≤ 2%
2. The post-irradiation gain calculation of $[h_{FE}]$, made using h_{FE} measurements from prior to and on completion of irradiation testing and after each annealing step if any, shall be as specified in MILSTD-750 method 1019.

4 Package mechanical data

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

Table 9. Product mass summary

Package	Mass (g)
UB	0.06
LCC-3	0.06
TO-18	0.40

4.1 UB package information

Figure 11. UB package outline

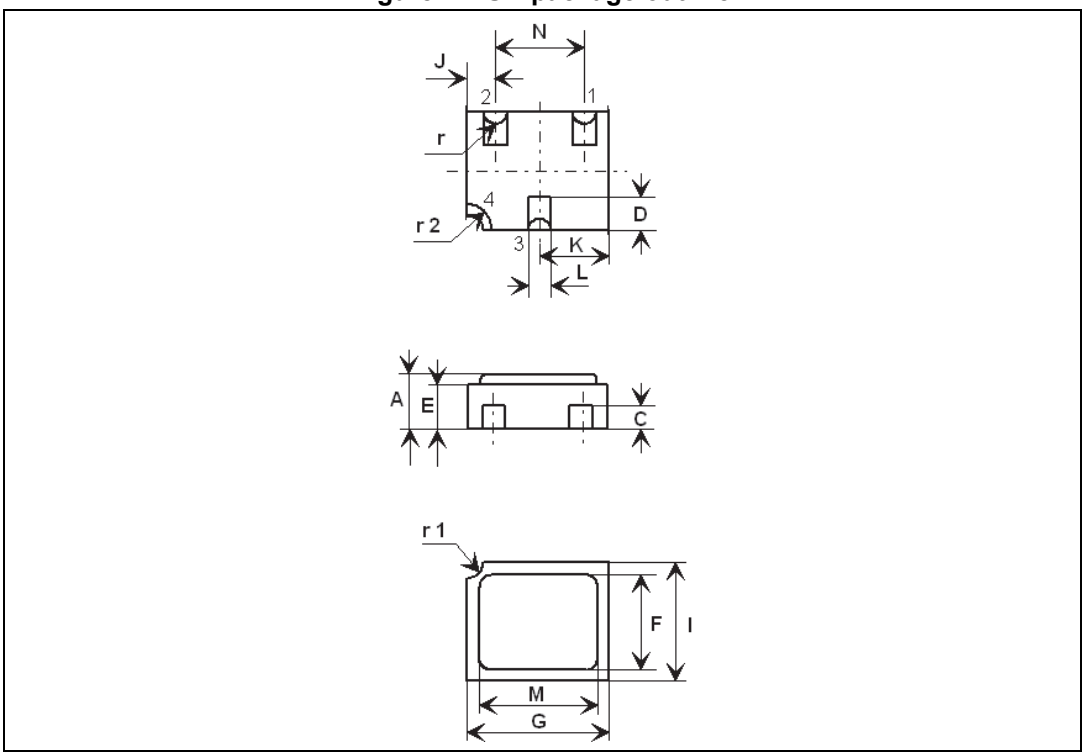


Table 10. UB mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	1.16		1.42
C	0.46	0.51	0.56
D	0.56	0.76	0.96
E	0.92	1.02	1.12
F	1.95	2.03	2.11
G	2.92	3.05	3.18
I	2.41	2.54	2.67
J	0.42	0.57	0.72
K	1.37	1.52	1.67
L	0.41	0.51	0.61
M	2.46	2.54	2.62
N	1.81	1.91	2.01
r		0.20	
r1		0.30	
r2		0.56	

4.2 LCC-3 package information

Figure 12. LCC-3 package outline

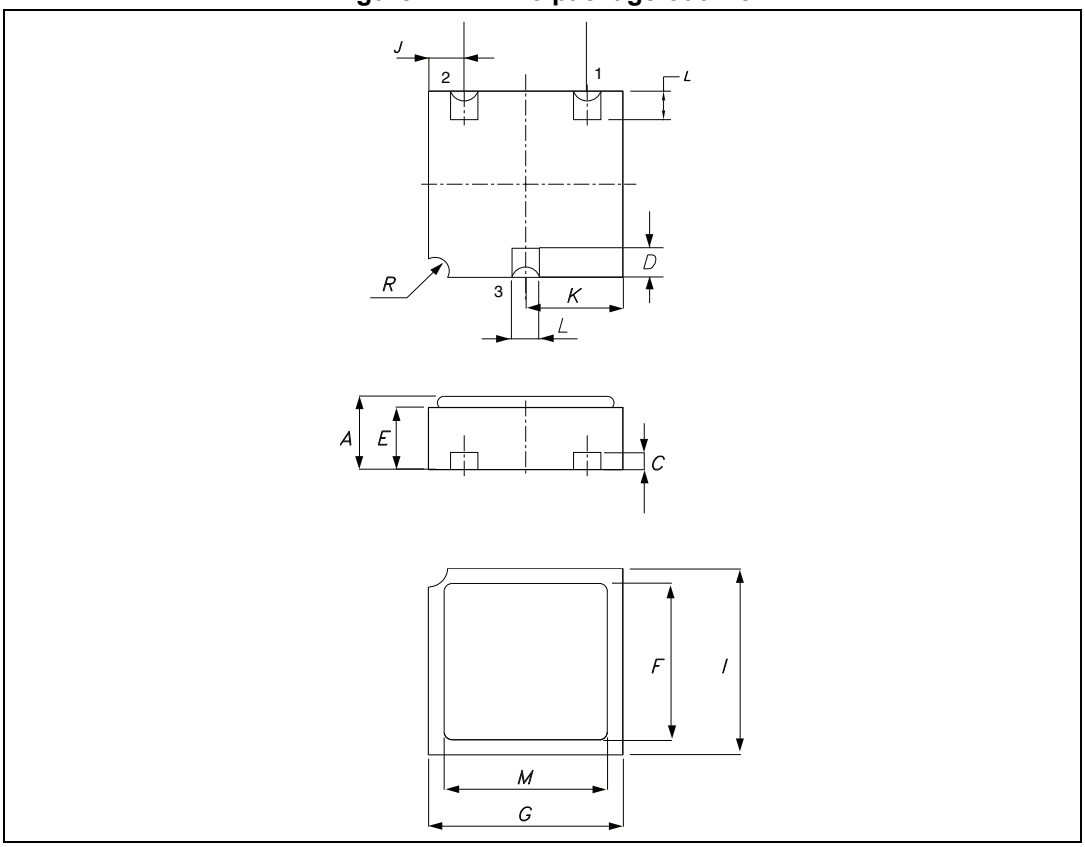


Table 11. LCC-3 mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	1.16		1.42
C	0.45	0.50	0.56
D	0.60	0.76	0.91
E	0.91	1.01	1.12
F	1.95	2.03	2.11
G	2.92	3.05	3.17
I	2.41	2.54	2.66
J	0.42	0.57	0.72
K	1.37	1.52	1.67
L	0.40	0.50	0.60
M	2.46	2.54	2.62
N	1.80	1.90	2.00
R		0.30	

4.3 TO-18 package information

Figure 13. TO-18 package outline

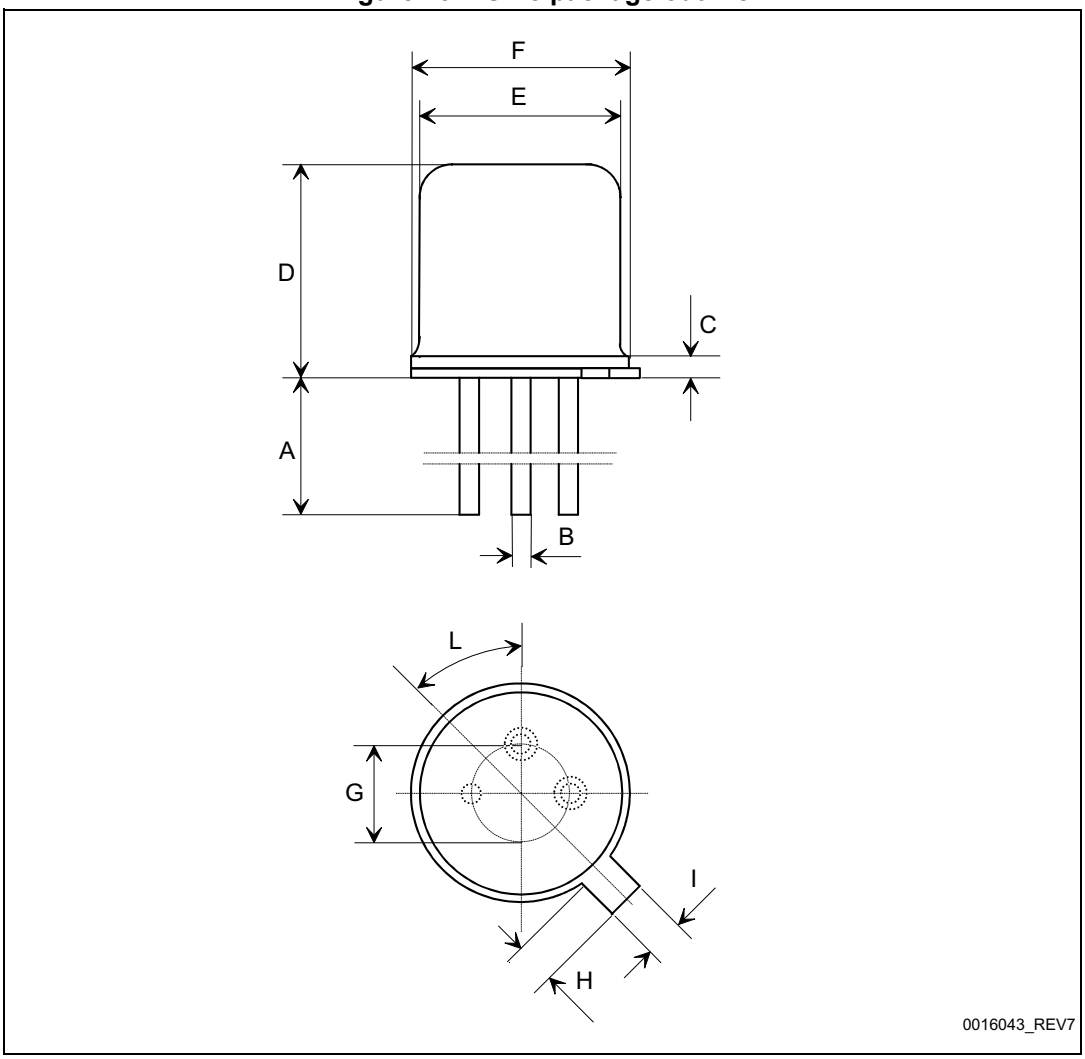


Table 12. TO-18 mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	12.70	13.20	14.20
B	0.41	0.45	0.48
C	0.36		0.47
D	4.88		5.33
E	4.63		4.70
F	5.31		5.45
G	2.49	2.54	2.59
H	0.80	0.90	1.00
I	0.95	1.00	1.05
L	42°	45°	48°

5 Order codes

Table 13. Ordering information

CPN	Agency specification	EPPL	Quality level	Radiation level(1)	Package	Lead finish	Marking(2)	Packing
J2N2907AUB1	-	-	Engineering Model JANS	-	UB	Gold	J2907AUB1	Waffle Pack
2N2907AUB1	-	-	Engineering Model ESCC	-	UB	Gold	2N2907AUB1	Waffle Pack
SOC2907A1	-	-	Engineering Model ESCC	-	LCC-3	Gold	SOC2907A1	Waffle Pack
2N2907A1	-	-	Engineering Model ESCC	-	TO-18	Solder Dip	2N2907A1	Strip Pack
JANSR2N2907AUBG	MIL-PRF-19500/291	-	JANSR	100krad - high and low dose rate	UB	Gold	JSR2907	Waffle Pack
JANSR2N2907AUBT	MIL-PRF-19500/291	-	JANSR	100krad - high and low dose rate	UB	Solder Dip	JSR2907	Waffle Pack
JANS2N2907AUBG	MIL-PRF-19500/291	-	JANS	-	UB	Gold	JS2907	Waffle Pack
JANS2N2907AUBT	MIL-PRF-19500/291	-	JANS	-	UB	Solder Dip	JS2907	Waffle Pack
2N2907ARUBG	5202/001/06R	Target	ESCC Flight	100krad - low dose rate	UB	Gold	520200106R	Waffle Pack
2N2907ARUBT	5202/001/07R	Target	ESCC Flight	100krad - low dose rate	UB	Solder Dip	520200107R	Waffle Pack
2N2907AUBG	5202/001/06	Target	ESCC Flight	-	UB	Gold	520200106	Waffle Pack
2N2907AUBT	5202/001/07	Target	ESCC Flight	-	UB	Solder Dip	520200107	Waffle Pack
SOC2907ARHRG	5202/001/04R	Yes	ESCC Flight	100krad - low dose rate	LCC-3	Gold	520200104R	Waffle Pack
SOC2907ARHRT	5202/001/05R	Yes	ESCC Flight	100krad - low dose rate	LCC-3	Solder Dip	520200105R	Waffle Pack
SOC2907AHRG	5202/001/04	Yes	ESCC Flight	-	LCC-3	Gold	520200104	Waffle Pack

Table 13. Ordering information

CPN	Agency specification	EPPL	Quality level	Radiation level(1)	Package	Lead finish	Marking(2)	Packing
SOC2907AHRT	5202/001/05	Yes	ESCC Flight	-	LCC-3	Solder Dip	520200105	Waffle Pack
2N2907ARHRG	5202/001/01R	-	ESCC Flight	100krad - low dose rate	TO-18	Gold	520200101R	Strip Pack
2N2907ARHRT	5202/001/02R	-	ESCC Flight	100krad - low dose rate	TO-18	Solder Dip	520200102R	Strip Pack
2N2907AHRG	5202/001/01	-	ESCC Flight	-	TO-18	Gold	520200101	Strip Pack
2N2907AHRT	5202/001/02	-	ESCC Flight	-	TO-18	Solder Dip	520200102	Strip Pack

1. High dose rate as per MIL-PRF-19500 specification group D, subgroup 2 inspection. Low dose rate as per ESCC specification 22900.
2. Specific marking only. The full marking includes in addition: For the Engineering Models: ST logo, date code; country of origin (FR). For ESCC flight parts: ST logo, date code, country of origin (FR), ESA logo, serial number of the part within the assembly lot. For JANS flight parts: ST logo, date code, country of origin (FR), manufacturer code (CSTM), serail number of the part within the assembly lot.

Contact ST sales office for information about the specific conditions for:

- Products in die form
- Other JANS quality levels
- Tape and reel packing

6 Shipping details

6.1 Date code

Date code xyywwz is structured as below table:

Table 14. Date code

	x	yy	ww	z
EM (ESCC & JANS)	3	last two digits of the year	week digits	lot index in the week
ESCC FLIGHT	-			
JANS FLIGHT (diffused in Singapore)	W			

6.2 Documentation

Table 15. Documentation provided for each type of product

Quality level	Radiation level	Documentation
Engineering model	-	-
JANS Flight	-	Certificate of conformance
JANS Flight	100 krad	Certificate of conformance 50 rad/s radiation verification test report
ESCC Flight	-	Certificate of conformance
ESCC Flight	100 krad	Certificate of conformance 0.1 rad/s radiation verification test report

7 Revision history

Table 16. Document revision history

Date	Revision	Changes
09-Feb-2009	1	Initial release
05-Jan-2010	2	Modified *Table 1: Device summary*
30-Nov-2011	3	Minor text changes in the document title and description on the coverpage
14-May-2012	4	New package inserted (UB). Updated: – *Table 1: Device summary*, *Table 2: Absolute maximum ratings* and *Table 3: Thermal data*. – *Section 2: Electrical characteristics* and *Section 4: Package mechanical data*. Added: – *Section :* and *Section 6: Shipping details*.
03-Jun-2013	5	Added: – New section *Radiation hardness assurance* – Corrected the revision number and dates of revision 3
18-Sep-2013	6	Updated *Table 1: Device summary* and *Table 13: Ordering information*
05-May-2014	7	Updated *Table 1: Device summary*, *Table 13: Ordering information* and *Section 3: Radiation hardness assurance*. Added *Figure 2: Safe operating area for TO-18* and *Figure 3: Safe operating area for LCC-3*
29-May-2014	8	Added note *1* in *Table 13: Ordering information*.
21-Aug-2015	9	Modified: *Section 4.3: TO-18 package information* Minor text changes
02-Dec-2015	10	Updated *Figure 2.: Safe operating area for TO-18* and *Figure 3.: Safe operating area for LCC-3*. Minor text chages.