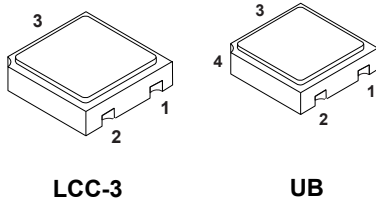
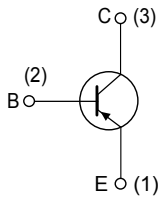


Hi-Rel 60 V, 0.6 A PNP transistor



Pin 4 in UB is connected to the metallic lid.



DS10460

Features

V_{CBO}	$I_C(max.)$		H_{FE} at 10 V, 150 mA	$T_J(max.)$
60 V	ESCC	0.5 A	> 100	200 °C
	JANS	0.6 A		

- Hermetic packages
- ESCC and JANS qualified
- Up to 100 krad(Si) low dose rate

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.

Product summary

Product status link
2N2907AHR

Product summary				
Device	Qualification system	Agency specification	Package	Radiation level
JANSR2N2907AUBx	JANSR	MIL-PRF-19500/291	UB	100 krad
JANS2N2907AUBx	JANS	MIL-PRF-19500/291	UB	-
2N2907ARUBx	ESCC Flight	5202/001	UB	100 krad
2N2907AUBx	ESCC Flight	5202/001	UB	-
SOC2907ARHRx	ESCC Flight	5202/001	LCC-3	100 krad
SOC2907AHRx	ESCC Flight	5202/001	LCC-3	-

1 Electrical ratings

Table 1. 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	ESCC	0.5
		JANS	0.6
P_{TOT}	Total dissipation at $T_{amb} \leq 25\text{ °C}$	ESCC	0.4
		LCC-3 and UB	
	Total dissipation at $T_{SP(IS)} = 25\text{ °C}$	LCC-3 and UB ⁽¹⁾	0.73
		JANS: UB	0.5
	JANS: UB	1	W
T_{STG}	Storage temperature range	-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 2. Thermal data

Symbol	Parameter	LCC-3 and UB Value	Unit
$R_{thJSP(IS)}$	Thermal resistance junction-solder pad (infinite sink) (max) for JANS	90	°C/W
R_{thJA}	Thermal resistance junction-ambient (max) for JANS	325	
	Thermal resistance junction-ambient (max) for ESCC	437.5 240 ⁽¹⁾	

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

2 Electrical characteristics

JANS and ESCC version of the products are assembled and tested in compliance with the agency specification. The electrical characteristics of each version are provided in dedicated tables. Voltage and current values are intended as negative.

2.1 JANS electrical characteristics

Table 3. Electrical characteristics ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector-base cut-off current ($I_E = 0$)	$V_{CB} = 60\text{ V}$		-	10	μA
		$V_{CB} = 50\text{ V}$		-	10	nA
		$V_{CB} = 50\text{ V}, T_{amb} = 150\text{ °C}$		-	10	μA
I_{CES}	Collector-base cut-off current ($I_E = 0$)	$V_{CE} = 50\text{ V}$		-	50	nA
I_{EBO}	Emitter-base cut-off current ($I_C = 0$)	$V_{EB} = 5\text{ V}$		-	10	μA
		$V_{EB} = 4\text{ V}$		-	50	nA
$V_{(BR)CEO}^{(1)}$	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 10\text{ mA}$	60	-		V
$V_{CE(sat)}^{(1)}$	Collector-emitter saturation voltage	$I_C = 150\text{ mA}, I_B = 15\text{ mA}$		-	0.4	V
		$I_C = 500\text{ mA}, I_B = 50\text{ mA}$		-	1.6	V
$V_{BE(sat)}^{(1)}$	Base-emitter saturation voltage	$I_C = 150\text{ mA}, I_B = 15\text{ mA}$	0.6	-	1.3	V
		$I_C = 500\text{ mA}, I_B = 50\text{ mA}$		-	2.6	V
$h_{FE}^{(1)}$	DC current gain	$I_C = 0.1\text{ mA}, V_{CE} = 10\text{ V}$	75			
		$I_C = 1\text{ mA}, V_{CE} = 10\text{ V}$	100		450	
		$I_C = 10\text{ mA}, V_{CE} = 10\text{ V}$	100			
		$I_C = 150\text{ mA}, V_{CE} = 10\text{ V}$	100	-	300	
		$I_C = 500\text{ mA}, V_{CE} = 10\text{ V}$	50			
		$I_C = 10\text{ mA}, T_{amb} = -55\text{ °C}, V_{CE} = 10\text{ V}$	50			
h_{fe}	Small signal current gain	$I_C = 20\text{ mA}, f = 100\text{ MHz}, V_{CE} = 20\text{ V}$	2	-		
		$I_C = 1\text{ mA}, f = 1\text{ kHz}, V_{CE} = 10\text{ V}$	100	-		
C_{OBO}	Output capacitance, ($I_E = 0$)	$100\text{ kHz} \leq f \leq 1\text{ MHz}, V_{CB} = 10\text{ V}$		-	8	pF
C_{IBO}	Input capacitance, ($I_C = 0$)	$100\text{ kHz} \leq f \leq 1\text{ MHz}, V_{EB} = 2\text{ V}$		-	30	pF
t_{on}	Turn-on time	$I_{CC} = 150\text{ mA}, I_{B1} = 15\text{ mA}, V_{CC} = 30\text{ V}$		-	45	ns
t_{off}	Turn-off time	$I_{CC} = 150\text{ mA}, I_{B1} = -I_{B2} = 15\text{ mA}, V_{CC} = 30\text{ V}$		-	300	ns

1. Pulsed duration = 300 μs , duty cycle $\leq 1.5\%$

2.2 ESCC electrical characteristics

Table 4. Electrical characteristics ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector-base cut-off current ($I_E = 0$)	$V_{CB} = 50\text{ V}$		-	10	nA
		$V_{CB} = 50\text{ V}, T_{amb} = 150\text{ °C}$		-	10	μA
I_{CEX}	Collector-emitter cut-off current	$V_{CE} = 30\text{ V}, V_{BE} = -0.5\text{ V}$		-	50	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\text{ }\mu\text{A}$	60	-		V
$V_{(BR)CEO}^{(1)}$	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 10\text{ mA}$	60	-		V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_C = 10\text{ }\mu\text{A}$	5	-		V
$V_{CE(sat)}^{(1)}$	Collector-emitter saturation voltage	$I_C = 150\text{ mA}, I_B = 15\text{ mA}$		-	0.4	V
$V_{BE(sat)}^{(1)}$	Base-emitter saturation voltage	$I_C = 150\text{ mA}, I_B = 15\text{ mA}$		-	1.3	V
$h_{FE}^{(1)}$	DC current gain	$I_C = 0.1\text{ mA}, V_{CE} = 10\text{ V}$	75	-		
		$I_C = 10\text{ mA}, V_{CE} = 10\text{ V}$	100			
		$I_C = 150\text{ mA}, V_{CE} = 10\text{ V}$	100		300	
		$I_C = 500\text{ mA}, V_{CE} = 10\text{ V}$	50			
h_{fe}	Small signal current gain	$I_C = 20\text{ mA}, f = 100\text{ MHz}, V_{CE} = 20\text{ V}$	2	-		
C_{OBO}	Output capacitance ($I_E = 0$)	$100\text{ kHz} \leq f \leq 1\text{ MHz}, V_{CB} = 10\text{ V}$		-	8	pF
t_{on}	Turn-on time	$I_{CC} = 150\text{ mA},$ $I_{B1} = 15\text{ mA},$ $V_{CC} = 30\text{ V}$		-	45	ns
t_{off}	Turn-off time	$I_{CC} = 150\text{ mA},$ $I_{B1} = -I_{B2} = 15\text{ mA},$ $V_{CC} = 30\text{ V}$		-	300	ns

1. Pulsed duration = 300 μs , duty cycle $\leq 1.5\%$

2.3 Electrical characteristics (curves)

Figure 1. DC current gain ($V_{CE} = 1\text{ V}$)

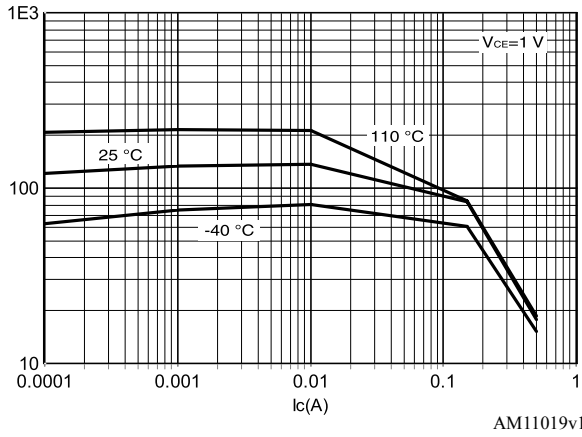


Figure 2. DC current gain ($V_{CE} = 10\text{ V}$)

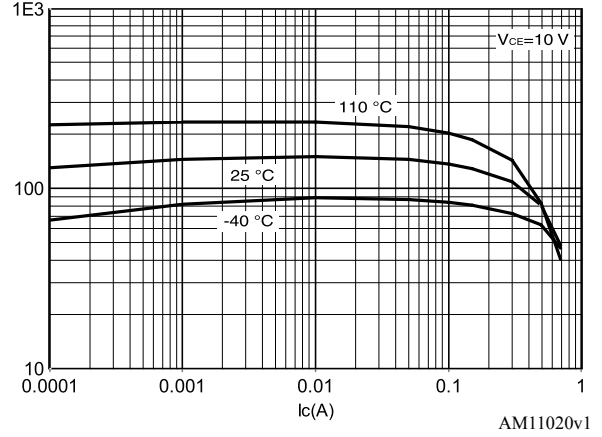


Figure 3. Collector emitter saturation voltage

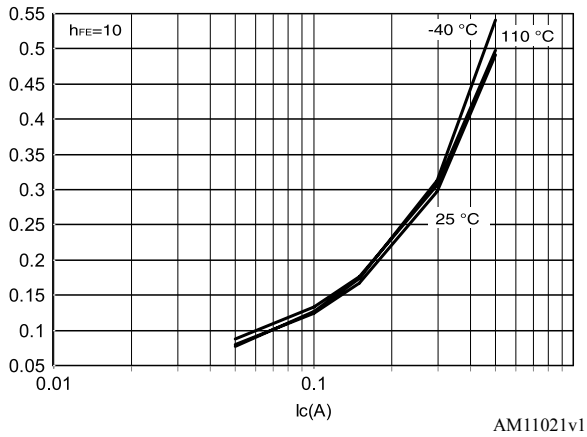
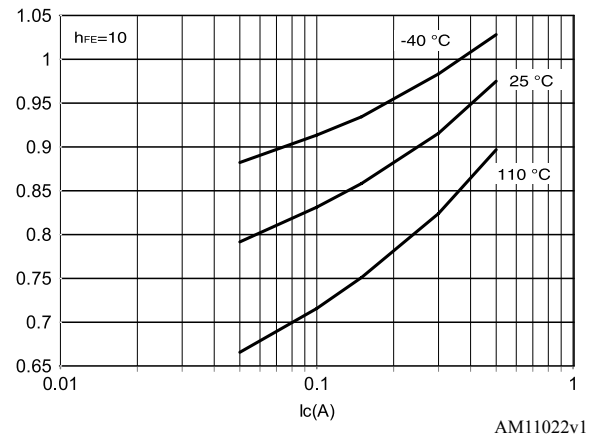
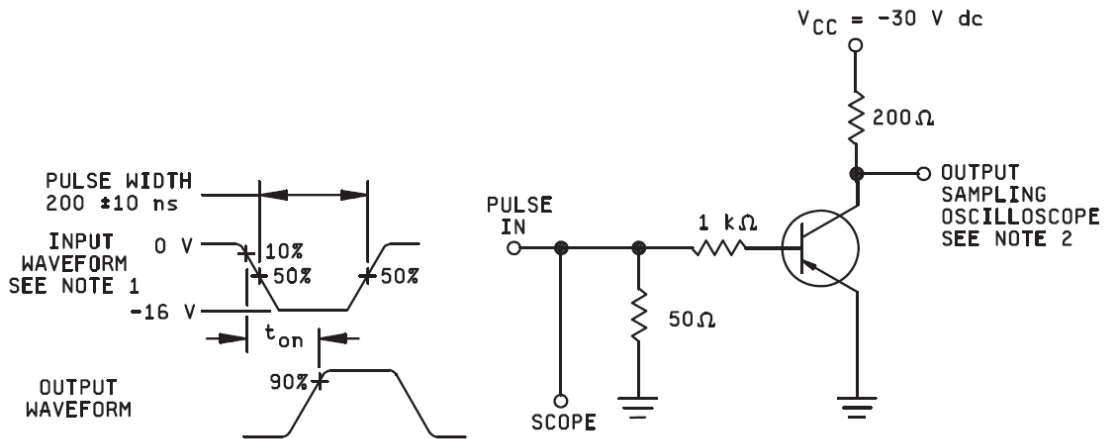


Figure 4. Base emitter saturation voltage ($h_{FE} = 10$)



2.4 Test circuits

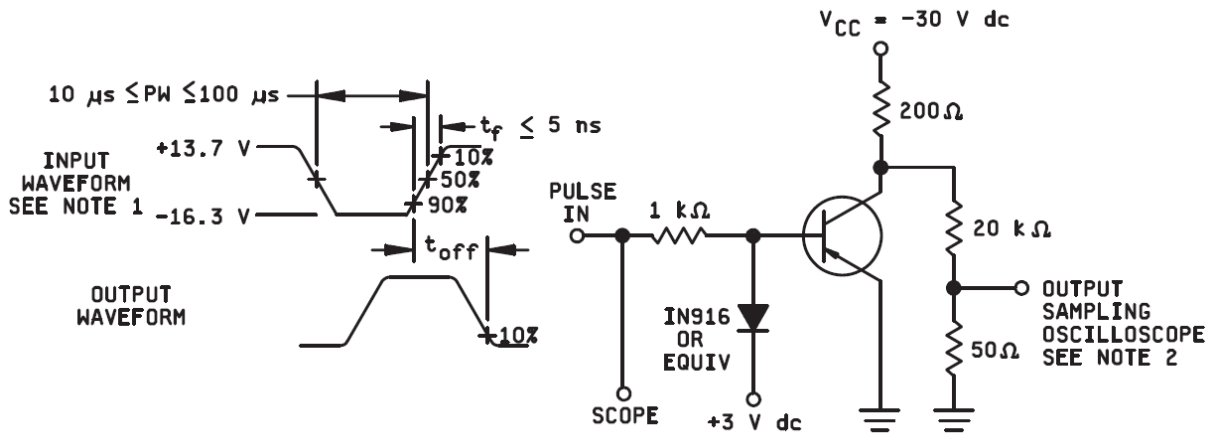
Figure 5. JANS saturated turn-on switching time test circuit



Note: (1) The rise time (t_r) of the applied pulse should be ≤ 2.0 ns, duty cycle ≤ 2 percent, and the generator source impedance shall be 50Ω .

Note: (2) Sampling oscilloscope: $Z_{IN} \geq 100$ k Ω , $C_{IN} \leq 12$ pF, rise time ≤ 5 ns.

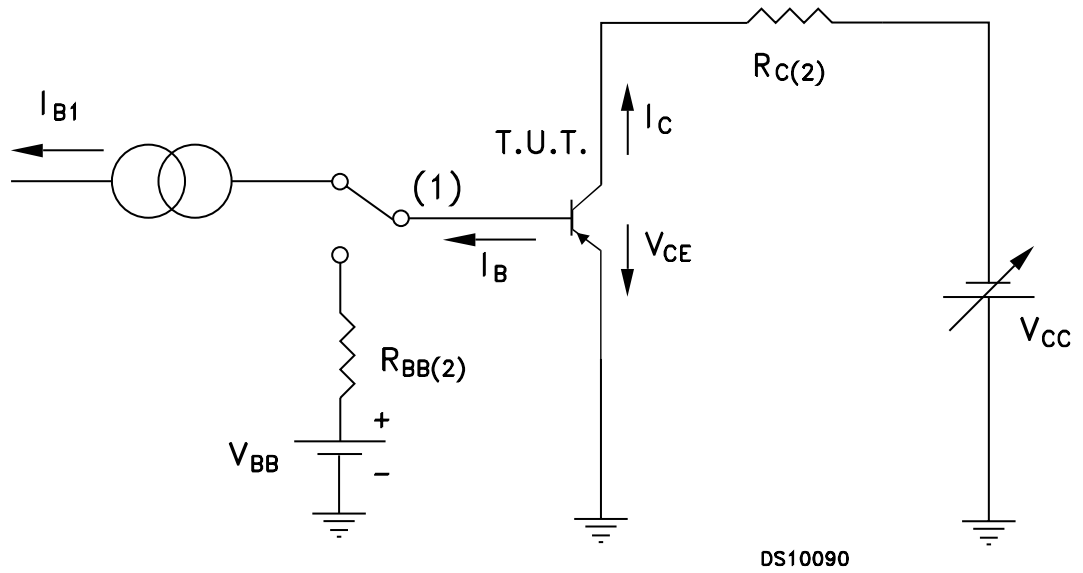
Figure 6. JANS saturated turn-off switching time test circuit



Note: (1) The rise time (t_r) of the applied pulse should be ≤ 2.0 ns, duty cycle ≤ 2 percent, and the generator source impedance shall be 50Ω .

Note: (2) Sampling oscilloscope: $Z_{IN} \geq 100$ k Ω , $C_{IN} \leq 12$ pF, rise time ≤ 5 ns.

Figure 7. ESCC resistive load switching test circuit



- Note: (1) Fast electronic switch
 Note: (2) Non-inductive resistor

3 Radiation hardness assurance

3.1 JANS radiation assurance

JANSR2N2907A is guaranteed at 100 krad in compliance with the MIL-PRF-19500, Group D between 50 and 300 rad/s with an additional guarantee at 0.1 rad/s as per ESCC 22900.

Radiation verification test report is provided with each shipment.

Table 5. MIL-PRF-19500 post radiation electrical characteristics ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Max	Unit
I_{CBO}	Collector cut-off current ($I_E = 0$)	$V_{CB} = 60\text{ V}$		20	μA
		$V_{CB} = 50\text{ V}$		20	nA
I_{EBO}	Emitter cut-off current ($I_C = 0$)	$V_{EB} = 5\text{ V}$		20	μA
		$V_{EB} = 4\text{ V}$		100	nA
$V_{(BR)CEO}^{(1)}$	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 10\text{ mA}$	60		V
I_{CES}	Collector to emitter cut-off current	$V_{CE} = 50\text{ V}$		100	nA
$V_{CE(sat)}$	Collector-emitter saturation voltage	$I_C = 150\text{ mA}, I_B = 15\text{ mA}$		0.46	V
		$I_C = 500\text{ mA}, I_B = 50\text{ mA}$		1.84	
$V_{BE(sat)}$	Base-emitter saturation voltage	$I_C = 150\text{ mA}, I_B = 15\text{ mA}$	0.6	1.5	V
		$I_C = 500\text{ mA}, I_B = 50\text{ mA}$		3	
$[h_{FE}]$	Post irradiation gain calculation	$I_C = 0.1\text{ mA}, V_{CE} = 10\text{ V}$	$[37.5]^{(2)}$		
		$I_C = 1.0\text{ mA}, V_{CE} = 10\text{ V}$	$[50]^{(2)}$	450	
		$I_C = 10\text{ mA}, V_{CE} = 10\text{ V}$	$[50]^{(2)}$		
		$I_C = 150\text{ mA}, V_{CE} = 10\text{ V}$	$[50]^{(2)}$	300	
		$I_C = 500\text{ mA}, V_{CE} = 10\text{ V}$	$[25]^{(2)}$		

1. Pulsed duration = 300 μs , duty cycle $\geq 2\%$

2. 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.

3.2 ESCC radiation assurance

This products is guaranteed in radiation as per ESCC 22900 and in compliance with ESCC 5202/001 specification.

Each lot is tested in radiation according to the following procedure:

- Radiation condition of 0.1 rad (Si)/s.
- Test of 11 samples by wafer, 5 biased at 80% of V(BR)CEO, 5 unbiased and for reference.
- Acceptance criteria of each wafer at 100 krad if all 10 samples comply with the post radiation electrical characteristics as per Table 6.
- Radiation verification test (RVT) report is delivered with the lot manufactured with the wafer of the tested samples.

RVT includes the value of each parameter at 30, 50, 70 and 100 krad (Si), post annealing at 24 hour / 25°C and and post annealing at 168 hours / 100°C.

Table 6. ESCC 5202/001 post radiation electrical characteristics (T_{amb} = 25 °C unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
I _{CBO}	Collector cut-off current (I _E = 0)	V _{CB} = 50 V		-	10	nA
I _{CEX}	Collector-emitter cut-off current	V _{CE} = 30 V, V _{BE} = -0.5 V		-	50	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 _{(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	[30]	-		
		I _C = 10 mA, V _{CE} = 10 V	[50]	-		
		I _C = 150 mA, V _{CE} = 10 V	[50]	-	300	
		I _C = 500 mA, V _{CE} = 10 V	[25]	-		

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.

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	ESCC 22900 and ESCC 5202/001
Displacement damage	Optional
Agency part number (ex)	5202/001/04R ⁽¹⁾
ST part number (ex)	SOC2907ARHRG
Documents	CoC + RVT

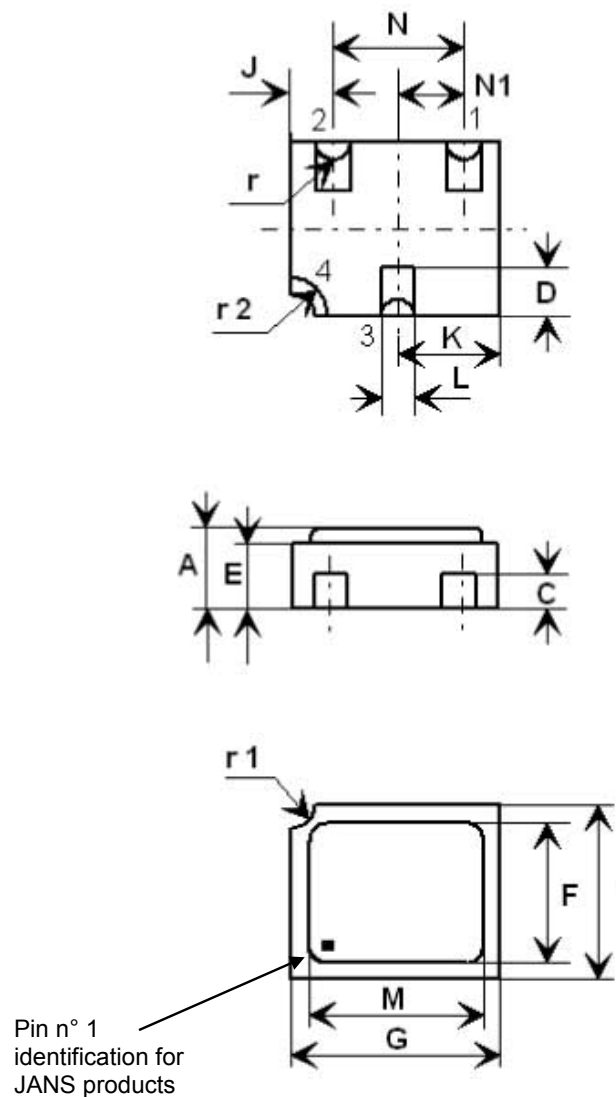
1. Example of the 2N2907A in LCC-3 gold finish.

4 Package information

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.

4.1 UB package information

Figure 8. UB package outline



Pad 1: Emitter

Pad 2: Base

Pad 3: Collector

Pad 4: Shielding connected to the lid

8206487 rev.6

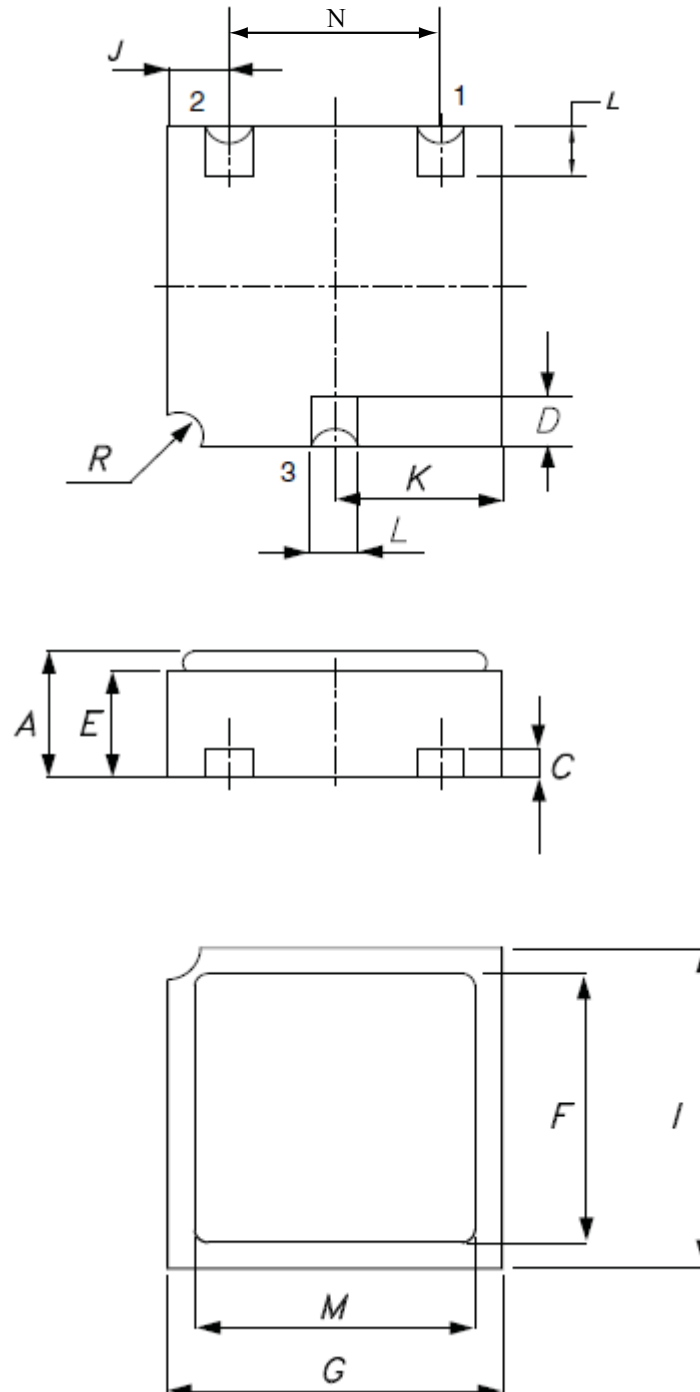
Note: For JANS products: the pin out numbering for emitter and base is inverted (base is designated pin 1 and emitter pin 2)

Table 8. UB package mechanical data

Symbols	Dimensions in mm			Dimensions in inches (for reference only)		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	1.16		1.42	0.045		0.056
C	0.46	0.51	0.56	0.018	0.020	0.022
D	0.56	0.76	0.96	0.024	0.030	0.036
E	0.92	1.02	1.12	0.036	0.040	0.044
F	1.95	2.03	2.11	0.077	0.080	0.083
G	2.92	3.05	3.18	0.115	0.120	0.125
I	2.41	2.54	2.67	0.095	0.100	0.105
J	0.42	0.57	0.72	0.0165	0.0225	0.0285
K	1.37	1.52	1.67	0.054	0.060	0.066
L	0.41	0.51	0.61	0.016	0.020	0.024
M	2.46	2.54	2.62	0.097	0.100	0.103
N	1.81	1.91	2.01	0.071	0.075	0.079
N1	0.91	0.96	1.02	0.036	0.038	0.040
r		0.20			0.008	
r1		0.30			0.012	
r2		0.56			0.022	

4.2 LCC-3 package information

Figure 9. LCC-3 package outline



0041211 rev.13

Table 9. LCC-3 package mechanical data

Symbols	Dimensions in mm			Dimensions in inches (for reference only)		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	1.16		1.42	0.046		0.056
C	0.45	0.50	0.56	0.018	0.020	0.022
D	0.60	0.76	0.91	0.024	0.030	0.036
E	0.91	1.01	1.12	0.036	0.040	0.044
F	1.95	2.03	2.11	0.077	0.080	0.083
G	2.92	3.05	3.17	0.115	0.120	0.125
I	2.41	2.54	2.66	0.095	0.100	0.105
J	0.42	0.57	0.72	0.0165	0.0225	0.0285
K	1.37	1.52	1.67	0.054	0.060	0.066
L	0.40	0.50	0.60	0.016	0.020	0.024
M	2.46	2.54	2.62	0.097	0.100	0.103
N	1.80	1.90	2.00	0.071	0.075	0.079
R		0.30			0.012	

5 Ordering information

Table 10. Ordering information

Part number	Agency specification	EPPL	Quality level	Radiation level ⁽¹⁾	Package	Mass	Lead finish	Marking ⁽²⁾	Packing		
J2N2907AUB1	-	-	Engineering model JANS	-	UB	0.6 g	Gold	J2907AUB1	WafflePack		
2N2907AUB1	-	-	Engineering model ESCC	-				2N2907AUB1			
SOC2907A1	-	-	Engineering model ESCC	-	LCC-3			SOC2907A1			
JANSR2N2907AUBG	MIL-PRF-19500/291	-	JANSR	100 krad	UB			Solder Dip		JSR2907	
JANSR2N2907AUBT		-	JANSR	high and low dose rate			JSR2907				
JANS2N2907AUBG		-	JANS	-			JS2907				
JANS2N2907AUBT		-	JANS	-			JS2907				
2N2907ARUBG	5202/001/06R	Yes	ESCC Flight	100 krad - low dose rate			LCC-3	Gold		520200106R	WafflePack
2N2907ARUBT	5202/001/07R									520200107R	
2N2907ARUBTW	5202/001/07R			520200107R						Tape and reel	
2N2907AUBG	5202/001/06			520200106		WafflePack					
2N2907AUBT	5202/001/07			520200107							
SOC2907ARHRG	5202/001/04R			100 krad - low dose rate		520200104R		Tape and reel			
SOC2907ARHRT	5202/001/05R				520200105R						
SOC2907ARHRTW	5202/001/05R			-	-	520200105R		Tape and reel			
SOC2907AHRG	5202/001/04					520200104		WafflePack			
SOC2907AHRT	5202/001/05					520200105					

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.

Contact ST sales office for information about specific conditions for products in die form.



6 Other information

6.1 Traceability information

The date code information is structured as described in the table below.

Table 11. Date codes

Model	Date code ⁽¹⁾
EM	3yywwN
ESCC	yywwN
JANS FLIGHT	WyywwN

1. yy = year, ww = week number, N = lot index in the week.

6.2 Documentation

Table 12. Documentation provided for each type of product

Quality level	Radiation level	Documentation
JANS Flight	-	Certificate of conformance
JANSR Flight	100 krad	Certificate of conformance RVT report (50 rad/s and 0.1 rad/s)
Engineering model	-	-
ESCC	-	Certificate of conformance ESCC qualification maintenance lot reference
ESCC	100 krad	Certificate of conformance ESCC qualification maintenance lot reference Radiation data ⁽¹⁾ at 25 / 50 / 70 / 100 krad at 0.1 rad / s.

1. For key parameters on 5 biased parts + 5 unbiased parts from the same wafer as the delivered part. See Radiation hardness assurance for details.

Revision history

Table 13. 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.
16-Apr-2020	11	Removed TO-18 package information. Minor text changes.

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