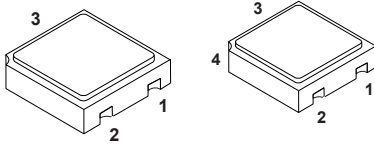


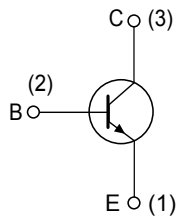
Rad-Hard 80 V, 1 A NPN transistor



LCC-3

UB

Pin 4 in UB is connected to the metallic lid.



DS10450

Product status link

[2N3700HR](#)

Features

V_{CEO}	$I_C(\text{max.})$	h_{FE} at 10 V, 150 mA	$T_j(\text{max.})$
80 V	1 A	> 100	200 °C

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

Description

The 2N3700HR is a silicon planar NPN transistor specifically designed and housed in hermetic packages for aerospace and Rad-Hard 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 summary				
Part-number	Qualification system	Agency specification	Package	Radiation level
JANSR2N3700UBx	JANSR	MIL-PRF-19500/391	UB	100 krad
JANS2N3700UBx	JANS	MIL-PRF-19500/391	UB	-
2N3700RUBx	ESCC Flight	5201/004	UB	100 krad
2N3700UBx	ESCC Flight	5201/004	UB	-
SOC3700RHRx	ESCC Flight	5201/004	LCC-3	100 krad
SOC3700HRx	ESCC Flight	5201/004	LCC-3	-

Note: See [Table 9](#) for ordering information.

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CBO}	Collector-base voltage ($I_E = 0$)	140	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	80	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7	V
I_C	Collector current	1	A
P_{TOT}	Total dissipation at $T_{amb} \leq 25\text{ °C}$	ESCC	W
		LCC-3 and UB	
		LCC-3 and UB ⁽¹⁾	
	JANS: UB	0.5	
Total dissipation at $T_{SP(IS)} = 25\text{ °C}$	JANS: UB	1.5	W
	Operating 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)	325	
	Thermal resistance junction-ambient (max) for ESCC	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.

2.1 JANS electrical characteristics

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

Symbol	Parameter	Test conditions	Min.	Max.	Unit
I_{CBO}	Collector-base cut-off current ($I_E = 0$)	$V_{CB} = 140\text{ V}$		10	μA
I_{CES}	Collector-base cut-off current ($I_E = 0$)	$V_{CE} = 90\text{ V}$		10	nA
		$V_{CE} = 90\text{ V}, T_{amb} = 150\text{ °C}$		5	μA
I_{EBO}	Emitter-base cut-off current ($I_C = 0$)	$V_{EB} = 5\text{ V}$		10	nA
		$V_{EB} = 7\text{ V}$		10	μA
$V_{(BR)CEO}^{(1)}$	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 30\text{ mA}$		80	V
$V_{CE(sat)}^{(1)}$	Collector-emitter saturation voltage	$I_C = 150\text{ mA}, I_B = 15\text{ mA}$		0.2	V
		$I_C = 500\text{ mA}, I_B = 50\text{ mA}$		0.5	V
$V_{BE(sat)}^{(1)}$	Base-emitter saturation voltage	$I_C = 150\text{ mA}, I_B = 15\text{ mA}$		1.1	V
$h_{FE}^{(1)}$	DC current gain	$I_C = 0.1\text{ mA}, V_{CE} = 10\text{ V}$	50	300	
		$I_C = 10\text{ mA}, V_{CE} = 10\text{ V}$	90		
		$I_C = 150\text{ mA}, V_{CE} = 10\text{ V}$	100	300	
		$I_C = 150\text{ mA}, V_{CE} = 10\text{ V}, T_{amb} = -55\text{ °C}$	40		
		$I_C = 500\text{ mA}, V_{CE} = 10\text{ V}$	50	300	
		$I_C = 1\text{ A}, V_{CE} = 10\text{ V}$	15		
h_{fe}	Small signal current gain	$I_C = 1\text{ mA}, f = 1\text{ kHz}, V_{CE} = 5\text{ V}$	80	400	
		$I_C = 50\text{ mA}, f = 20\text{ MHz}, V_{CE} = 10\text{ V}$	5	20	
C_{obo}	Output capacitance, ($I_E = 0$)	$100\text{ kHz} \leq f \leq 1\text{ MHz}, V_{CB} = 10\text{ V}$		12	pF
C_{ibo}	Input capacitance, ($I_C = 0$)	$100\text{ kHz} \leq f \leq 1\text{ MHz}, V_{EB} = 0.5\text{ V}$		60	pF
NF	Noise figure	$V_{CE} = 10\text{ V}, I_C = 100\text{ }\mu\text{A},$ $R_g = 1\text{ k}\Omega, \text{ power bandwidth} = 200\text{ Hz},$ $f = 1\text{ kHz}$		4	dB
$r'_{b,Cc}^{(2)}$	Collector-base time constant	$I_C = 10\text{ mA}, V_{CB} = 10\text{ V}, f = 79.8\text{ MHz}$		400	ps
$t_{on} + t_{off}$	Switching time	see Figure 5		30	ns

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

2. base terminals, and measuring the ac voltage drop (V_{eb}) with a high-impedance rf voltmeter across the emitter-base terminals. With $f = 79.8\text{ MHz}$ used for the 1.0 volt signal, the following computation applies: $r'_{b,Cc}(\text{ps}) = 2 \times V_{eb}(\text{mV})$.

2.2 ESCC electrical characteristics

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

Symbol	Parameter	Test conditions	Min.	Max.	Unit
I_{CBO}	Collector-base cut-off current ($I_E = 0$)	$V_{CB} = 90\text{ V}$		10	nA
		$V_{CB} = 90\text{ V}, T_{amb} = 150\text{ °C}$		10	μA
I_{EBO}	Emitter cut-off current ($I_C = 0$)	$V_{EB} = 5\text{ V}$		10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\text{ }\mu\text{A}$	140		V
$V_{(BR)CEO}^{(1)}$	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 30\text{ mA}$	80		V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\text{ }\mu\text{A}$	7		V
$V_{CE(sat)}^{(1)}$	Collector-emitter saturation voltage	$I_C = 150\text{ mA}, I_B = 15\text{ mA}$		0.2	V
		$I_C = 500\text{ mA}, I_B = 50\text{ mA}$		0.5	
$V_{BE(sat)}^{(1)}$	Base-emitter saturation voltage	$I_C = 150\text{ mA}, I_B = 15\text{ mA}$		1.1	V
$h_{FE}^{(1)}$	DC current gain	$I_C = 10\text{ mA}, V_{CE} = 10\text{ V}$	90		
		$I_C = 150\text{ mA}, V_{CE} = 10\text{ V}$	100	300	
		$I_C = 500\text{ mA}, V_{CE} = 10\text{ V}$	50		
		$I_C = 150\text{ mA}, V_{CE} = 10\text{ V}, T_{amb} = -55\text{ °C}$	40		
h_{fe}	Small signal current gain	$I_C = 50\text{ mA}, f = 20\text{ MHz}, V_{CE} = 10\text{ V}$	5		
C_{obo}	Output capacitance ($I_E = 0$)	$f = 1\text{ MHz}, V_{CB} = 10\text{ V}$		12	pF
C_{ibo}	Input capacitance ($I_C = 0$)	$f = 1\text{ MHz}, V_{EB} = 0.5\text{ V}$		60	pF

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

2.3 Electrical characteristics (curves)

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

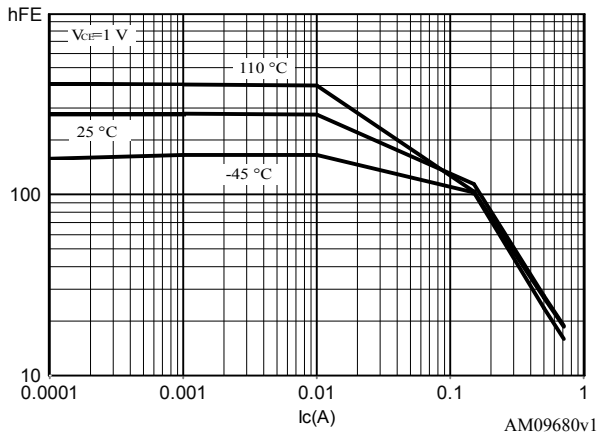


Figure 2. DC current gain ($V_{CE} = 10\text{ V}$)

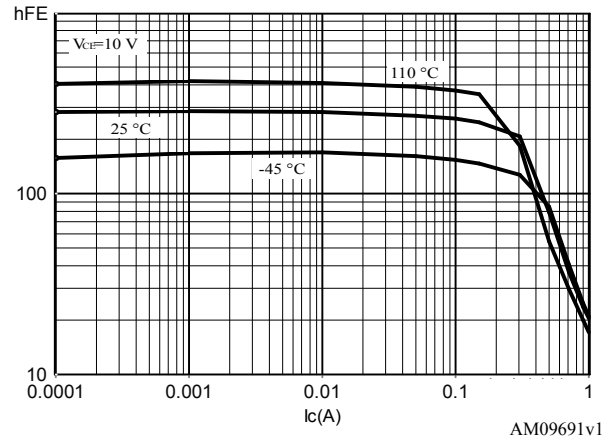


Figure 3. Collector emitter saturation voltage

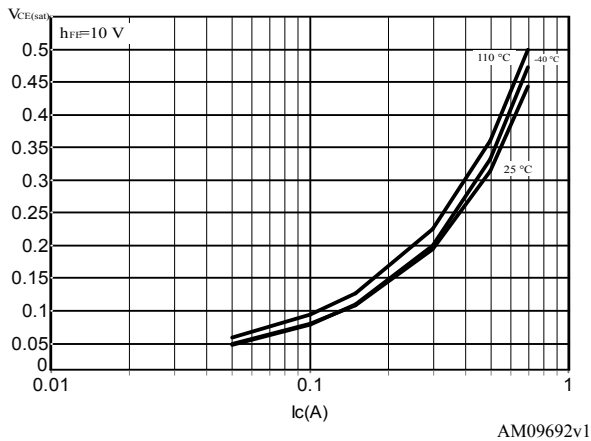
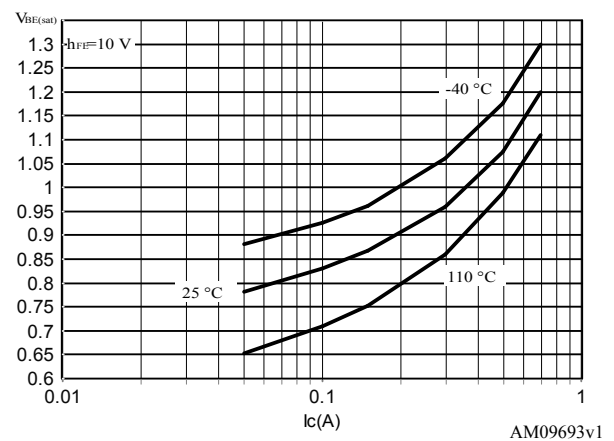
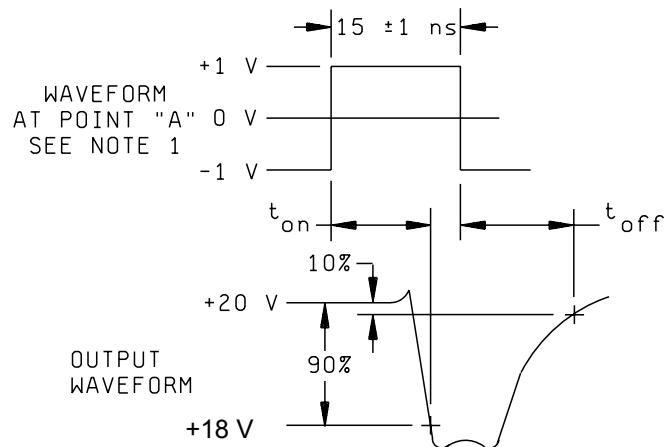
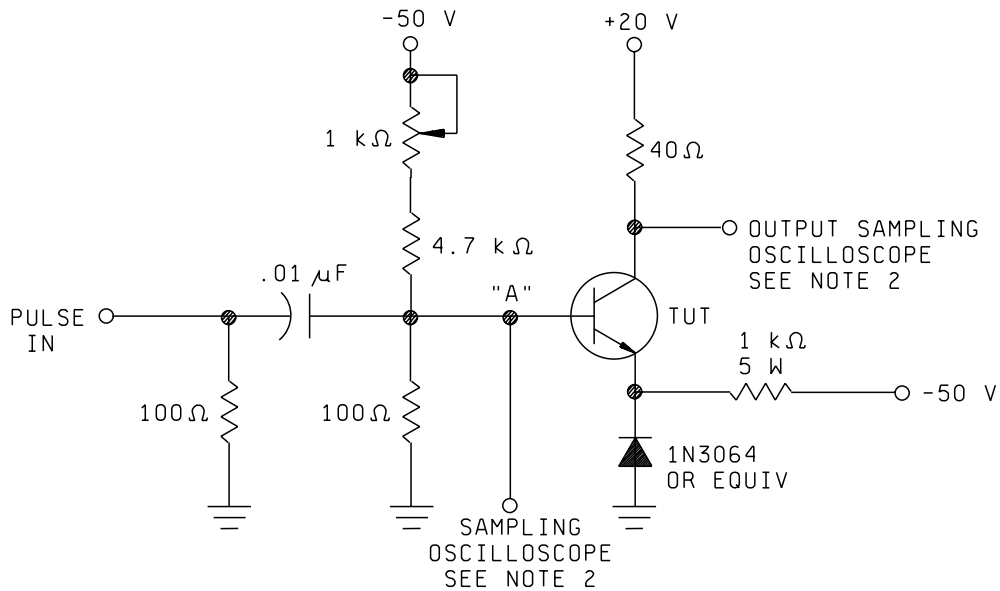


Figure 4. Base emitter saturation voltage ($h_{FE} = 10$)



2.4 Test circuits

Figure 5. JANS non saturated switching-time test circuit

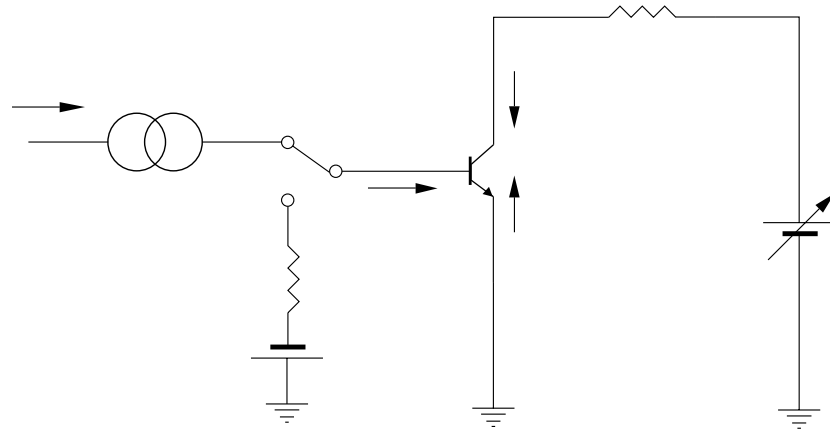


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Note: (1) The rise time (t_r) of the applied pulse should be ≤ 2.0 ns, duty cycle ≤ 2 percent, and the generator source impedance shall be 50Ω .

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

Figure 6. 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

JANSR2N3700 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.

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

Symbol	Parameter	Test conditions	Min.	Max	Unit
I_{CBO}	Collector cut-off current ($I_E = 0$)	$V_{CB} = 140\text{ V}$		20	μA
I_{CES}	Collector-emitter cutoff current	$V_{CE} = 90\text{ V}$		20	nA
I_{EBO}	Emitter cut-off current ($I_C = 0$)	$V_{EB} = 5\text{ V}$		20	nA
		$V_{EB} = 7\text{ V}$		20	μA
$V_{(BR)CEO}^{(1)}$	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 30\text{ mA}$	80		V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$I_C = 150\text{ mA}, I_B = 15\text{ mA}$		0.23	V
		$I_C = 500\text{ mA}, I_B = 50\text{ mA}$		0.58	
$V_{BE(sat)}$	Base-emitter saturation voltage	$I_C = 150\text{ mA}, I_B = 15\text{ mA}$		1.27	V
$[h_{FE}]$	Post irradiation gain calculation	$I_C = 150\text{ mA}, V_{CE} = 10\text{ V}$	$[50]^{(2)}$	300	
		$I_C = 0.1\text{ mA}, V_{CE} = 10\text{ V}$	$[25]^{(2)}$	300	
		$I_C = 10\text{ mA}, V_{CE} = 10\text{ V}$	$[45]^{(2)}$		
		$I_C = 500\text{ mA}, V_{CE} = 10\text{ V}$	$[25]^{(2)}$	300	
		$I_C = 0.1\text{ A}, V_{CE} = 10\text{ V}$	$[7.5]^{(2)}$		

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 5201/004 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.

Table 6. ESCC 5201/004 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 ($I_E = 0$)	$V_{CB} = 90\text{ V}$		10	nA
I_{EBO}	Emitter cut-off current ($I_C = 0$)	$V_{EB} = 5\text{ V}$		10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\text{ }\mu\text{A}$	140		V
$V_{(BR)CEO}^{(1)}$	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 30\text{ mA}$	80		V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\text{ }\mu\text{A}$	7		V
$V_{CE(sat)}^{(1)}$	Collector-emitter saturation voltage	$I_C = 150\text{ mA}, I_B = 15\text{ mA}$		0.2	V
		$I_C = 500\text{ mA}, I_B = 50\text{ mA}$		0.5	
$V_{BE(sat)}^{(1)}$	Base-emitter saturation voltage	$I_C = 150\text{ mA}, I_B = 15\text{ mA}$		1.1	V
$[h_{FE}]^{(1)}$	Post irradiation gain calculation ⁽²⁾	$I_C = 10\text{ mA}, V_{CE} = 10\text{ V}$	[45]		
		$I_C = 150\text{ mA}, V_{CE} = 10\text{ V}$	[50]	300	
		$I_C = 500\text{ mA}, V_{CE} = 10\text{ V}$	[25]		

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

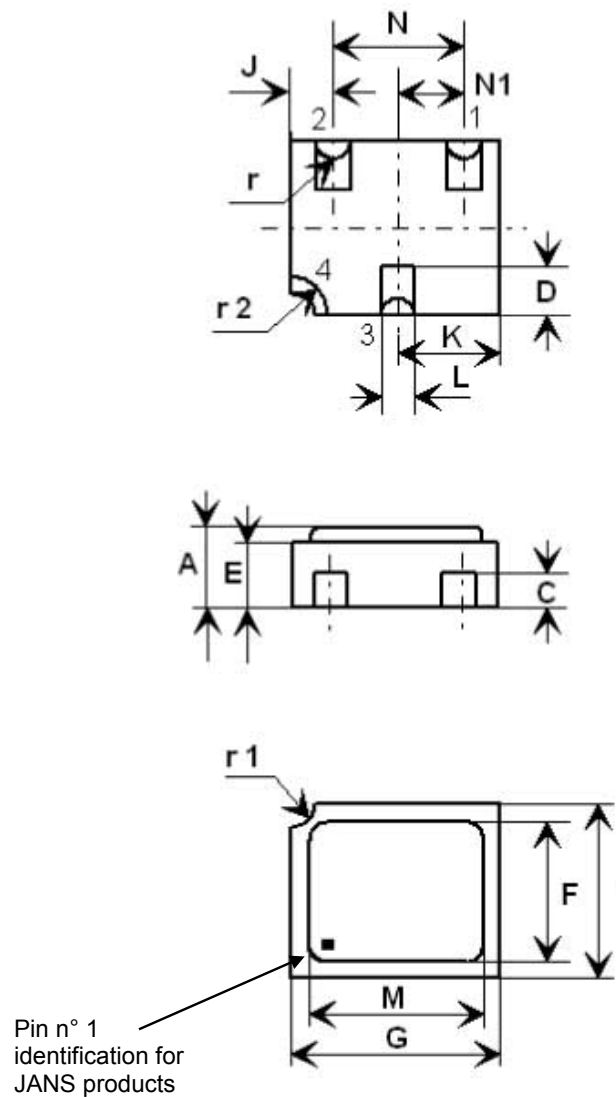
2. The post-irradiation gain calculation of $[h_{FE}]$, made using h_{FE} measurements from prior to and on completion of irradiation testing and after each annealing step if any, shall be as specified in MILSTD-750 method 1019.

4 Package 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 7. UB package outline



Pad 1: Emitter

Pad 2: Base

Pad 3: Collector

Pad 4: Shielding connected to the lid

8206487 rev.6

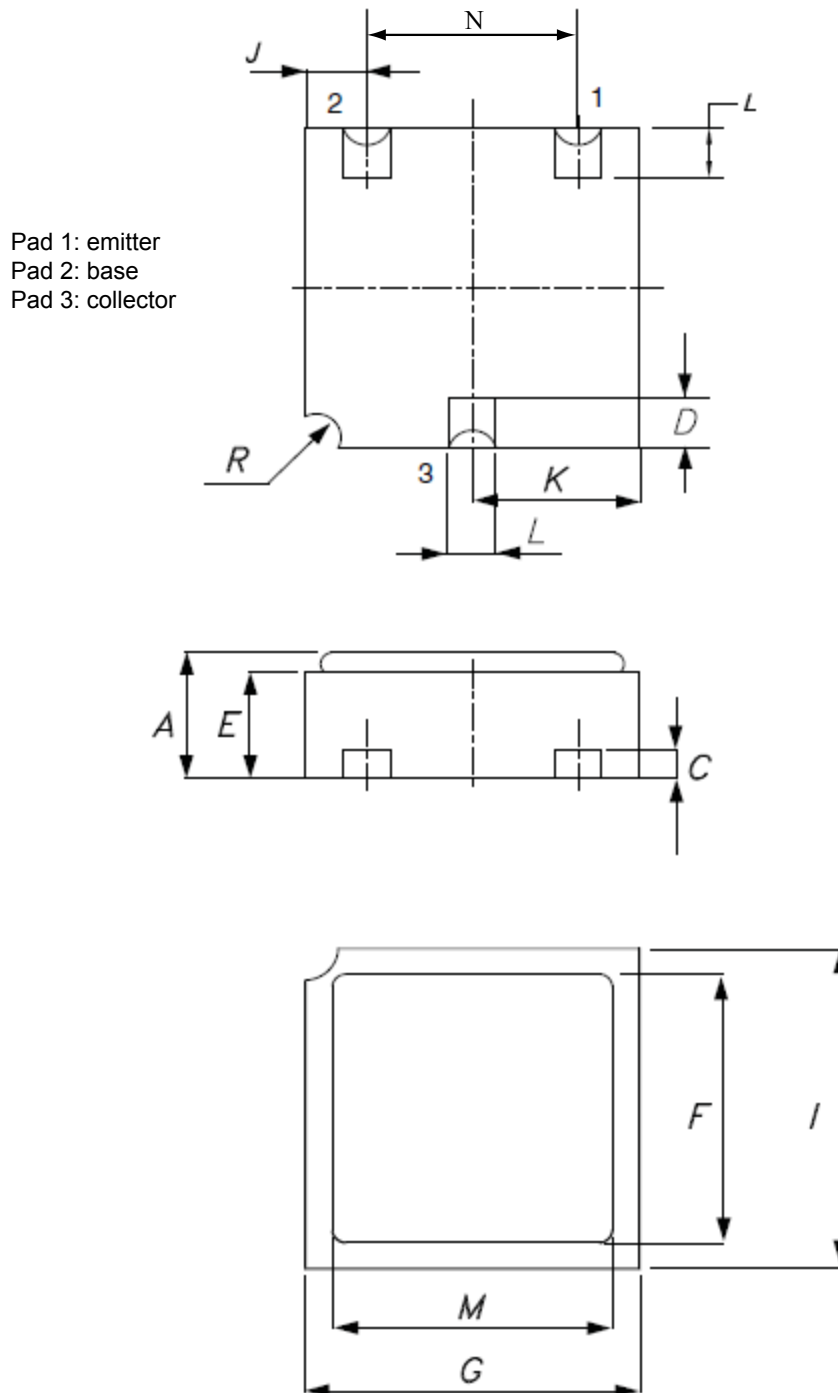
Note: For JANS products: the pin out numbering for emitter and base is inverted (base is designated pin 1 and emitter pin 2)

Table 7. 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 8. LCC-3 package outline



0041211 rev.14

Table 8. 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	0.56	0.96	0.024	0.022	0.038
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 9. Ordering information

Part number	Agency specification	Quality level	Radiation level ⁽¹⁾	Package	Mass	Lead finish	Marking				
J2N3700UB1	-	Engineering model JANS	-	UB	0.6 g	Gold	J37				
2N3700UB1	-	Engineering model ESCC	-				2N3				
SOC37001	-	Engineering model ESCC	-	LCC-3			SOC				
JANSR2N3700UBG	MIL-PRF-19500/391	JANSR	100 krad	UB			0.6 g	Solder Dip	JSR		
JANSR2N3700UBT		JANSR	high and low dose rate			JSR					
JANS2N3700UBG		JANS	-			JS					
JANS2N3700UBT		JANS	-			JS					
2N3700RUBG	5201/004/06R	ESCC Flight	100 krad - low dose rate			LCC-3		0.6 g	Gold	5201	
2N3700RUBT	5201/004/07R									5201	
2N3700UBG	5201/004/06		-						520		
2N3700UBT	5201/004/07		-		520						
SOC3700RHRG	5201/004/04R		100 krad - low dose rate		LCC-3				0.6 g	Gold	5201
SOC3700RHRT	5201/004/05R										Solder Dip
SOC3700RHRTW	5201/004/05R		-	Solder Dip	5201						
SOC3700HRG	5201/004/04		-	Gold	520						
SOC3700HRT	5201/004/05		-	Solder Dip	520						
SOC3700HRTW	5201/004/05		-	Solder Dip	520						

1. High dose rate as per MIL-PRF-19500 specification group D, subgroup 2 inspection. Low dose rate as per ESCC specification 2290.
2. Specific marking only. The full marking includes in addition: For the Engineering Models: ST logo, date code; country of origin (FR). For the ESCC Models: 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 10. Date codes

Model	Date code
EM	3yywwN
ESCC	yywwN
JANS FLIGHT	WyywwN

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

6.2 Documentation

Table 11. Documentation provided for each type of product

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

Revision history

Table 12. Document revision history

Date	Revision	Changes
10-Jan-2008	1	Initial release.
07-Jan-2010	2	Modified Table 1: Device summary
26-Jul-2010	3	Modified Table 1: Device summary, added Table 10 on page 15
30-Nov-2011	4	<ul style="list-style-type: none"> – Modified: Table 6 on page 9 – Added: Section 2.3: Electrical characteristics (curves) – Minor text change in the document title on the coverpage
17-Apr-2013	5	Added: Section 3: Radiation hardness assurance
11-Jun-2013	6	<ul style="list-style-type: none"> Updated order codes in Table 1: Device summary and Table 12: Ordering information. Updated Section 3: Radiation hardness assurance. Minor text changes.
18-Sep-2013	7	Updated order codes in Table 1: Device summary and Table 12: Ordering information.
25-Mar-2014	8	<ul style="list-style-type: none"> Updated order codes in Table 1: Device summary and Table 12: Ordering information. Updated Section 3: Radiation hardness assurance.
29-May-2014	9	Updated Table 1: Device summary and Table 12: Ordering information.
29-Jul-2014	10	Updated Table 5: ESCC 5201/004 electrical characteristics.
20-Jul-2015	11	<ul style="list-style-type: none"> Updated Section 4: Package information. Minor text changes.
19-Aug-2015	12	<ul style="list-style-type: none"> Updated Section 4.3: TO-18 package information. Minor text changes.
29-Apr-2020	13	<ul style="list-style-type: none"> Removed TO-18 package information. Minor text changes.
03-Feb-2021	14	<ul style="list-style-type: none"> Updated Table 1, Table 6, Figure 8, Table 9 and Table 11. Removed Radiation summary table. Minor text changes.

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