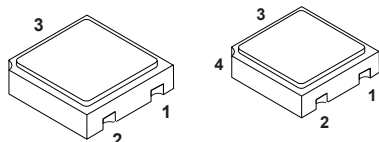


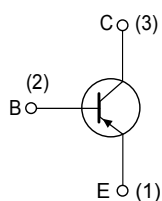
Rad-Hard 150 V, 0.5 A PNP transistor



LCC-3

UB

Pin 4 in UB is connected to the metallic lid.



DS10460

Features

V_{CE0}	$I_C(\text{max.})$	H_{FE} at 5 V, 10 mA	$T_j(\text{max.})$
150 V	0.5 A	> 60	200 °C

- Hermetic packages
- ESCC qualified
- 100 krad

Description

The 2N5401 and SOC5401 are bipolar transistors able to operate under severe environment conditions and radiation exposure providing high immunity to total ionizing dose (TID).

Qualified as per ESCC 5202/014 specification and available in LCC-3 and UB hermetic packages, they are specifically recommended for space and harsh environment applications and suitable for low current and high precision circuits such as preamplifiers, oscillators, current mirror configuration.

In case of discrepancies between this datasheet and the relevant agency specification, the latter takes precedence.

Product status link

[2N5401HR](#)

Product summary

Device	Qualification system	Agency specification	Package	Radiation level
2N5401RUBx	ESCC Flight	5202/014	UB	100 krad
2N5401UBx	ESCC Flight	5202/014	UB	-
SOC5401RHRx	ESCC Flight	5202/014	LCC-3	100 krad
SOC5401HRx	ESCC Flight	5202/014	LCC-3	-

Note: See [Table 7](#) for ordering information.

1 Electrical ratings

For PNP transistor voltage and current polarity is reversed.

Table 1. Absolute maximum ratings

Symbol	Parameter		Value	Unit
V_{CBO}	Collector-base voltage ($I_E = 0$)		160	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)		150	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)		5	V
I_C	Collector current for LCC-3 and UB		0.5	A
P_{TOT}	Total dissipation at $T_{amb} \leq 25^\circ\text{C}$	LCC-3 and UB	0.36	W
		LCC-3 and UB ⁽¹⁾	0.58	
T_{OP}	Operating temperature range		-65 to 200	$^\circ\text{C}$
T_J	Max. operating junction temperature		200	$^\circ\text{C}$

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

Table 2. Thermal data for SMD package

Symbol	Parameter	LCC-3 and UB value	Unit
R_{thJA}	Thermal resistance junction-ambient (max) for LCC-3 and UB	302 ⁽¹⁾	$^\circ\text{C/W}$
		486	

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

2 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 ($I_E = 0$)	$V_{CB} = 120\text{ V}$		50	nA
		$V_{CB} = 120\text{ V}, T_{amb} = 150\text{ °C}$		50	μA
I_{EBO}	Emitter-base cut-off current ($I_C = 0$)	$V_{EB} = 3\text{ V}$		50	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\text{ }\mu\text{A}$	160		V
$V_{(BR)CEO}^{(1)}$	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 1\text{ mA}$	150		V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\text{ }\mu\text{A}$	5		V
$V_{CE(sat)}^{(1)}$	Collector-emitter saturation voltage	$I_C = 10\text{ mA}, I_B = 1\text{ mA}$		0.2	V
		$I_C = 50\text{ mA}, I_B = 5\text{ mA}$		0.5	
$V_{BE(sat)}^{(1)}$	Base-emitter saturation voltage	$I_C = 10\text{ mA}, I_B = 1\text{ mA}$		1	V
		$I_C = 50\text{ mA}, I_B = 5\text{ mA}$		1	
$h_{FE}^{(1)}$	DC current gain	$I_C = 1\text{ mA}, V_{CE} = 5\text{ V}$	50		
		$I_C = 10\text{ mA}, V_{CE} = 5\text{ V}$	60	240	
		$I_C = 50\text{ mA}, V_{CE} = 5\text{ V}$	60		
		$I_C = 10\text{ mA}, T_{amb} = -55\text{ °C}, V_{CE} = 5\text{ V}$	20		
h_{fe}	Small signal current gain	$I_C = 10\text{ mA}, f = 10\text{ MHz}, V_{CE} = 10\text{ V}$	5		
C_{OBO}	Output capacitance, ($I_E = 0$)	$f = 10\text{ MHz}, V_{CB} = 10\text{ V}$		6	pF

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

2.1 Electrical characteristics (curves)

Figure 1. h_{FE} at $V_{CE} = 5\text{ V}$

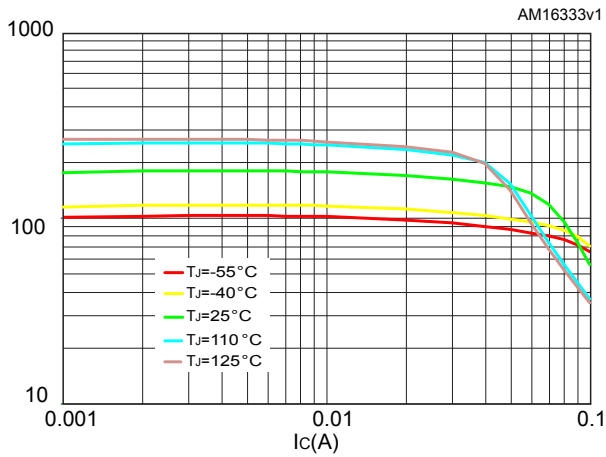


Figure 2. $V_{CE(sat)}$ at $h_{FE} = 10$

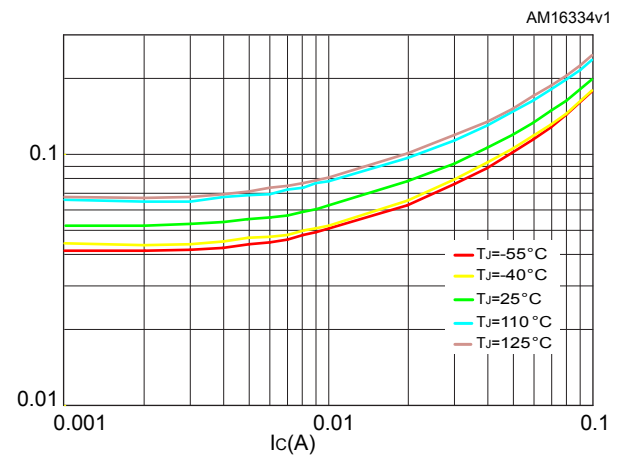
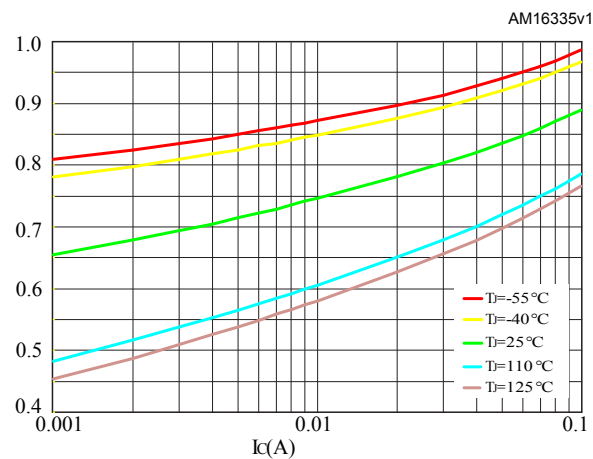


Figure 3. $V_{BE(sat)}$ at $h_{FE} = 10$



3 Radiation assurance

Radiation test are guaranteed in compliance with ESCC 22900 and ESCC 5202/014 specifications.

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 in compliance with the post radiation electrical characteristics as per [Table 4](#).

Table 4. ESCC 5201/014 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 ($I_E = 0$)	$V_{CB} = 120\text{ V}$		100	nA
I_{EBO}	Emitter cut-off current ($I_C = 0$)	$V_{EB} = 7\text{ V}$		100	nA
$V_{(BR)BCO}$	Base-collector breakdown voltage ($I_E = 0$)	$I_C = 100\text{ }\mu\text{A}$	160		V
$V_{(BR)CEO}^1$	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 1\text{ mA}$	150		V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\text{ }\mu\text{A}$	5		V
$V_{CE(sat)}^1$	Collector-emitter saturation voltage	$I_C = 10\text{ mA}, I_B = 1\text{ mA}$		0.2	V
		$I_C = 50\text{ mA}, I_B = 5\text{ mA}$		0.5	
$V_{BE(sat)}^1$	Base-emitter saturation voltage	$I_C = 10\text{ mA}, I_B = 1\text{ mA}$		1	V
		$I_C = 50\text{ mA}, I_B = 5\text{ mA}$		1	
$[h_{FE}]^1$	Post irradiation gain calculation ²	$I_C = 1\text{ mA}, V_{CE} = 5\text{ V}$	[25]		
		$I_C = 10\text{ mA}, V_{CE} = 5\text{ V}$	[30]	240	
		$I_C = 50\text{ mA}, V_{CE} = 5\text{ V}$	[30]		

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

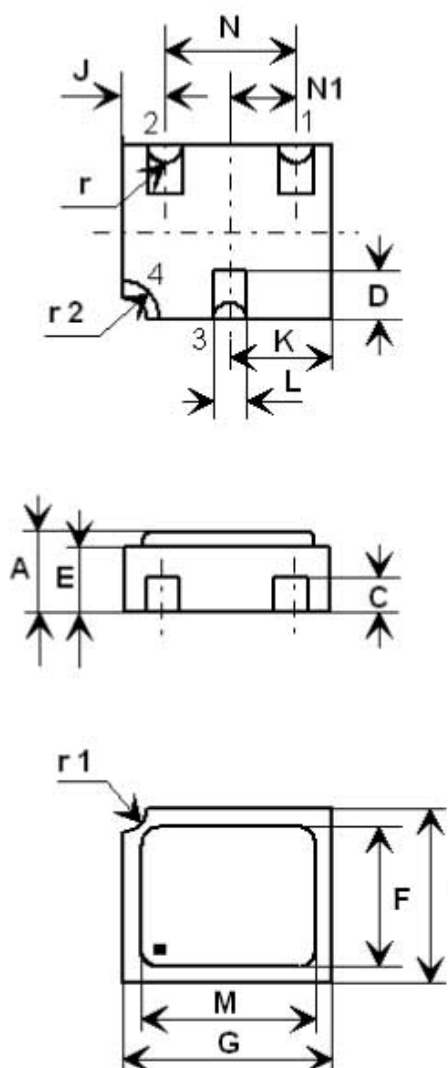
2. $[h_{FE}]$ calculated according to method 1019 of MIL-STD-750.

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 4. UB package outline



Pad 1: Emitter

Pad 2: Base

Pad 3: Collector

Pad 4: Shielding connected to the lid

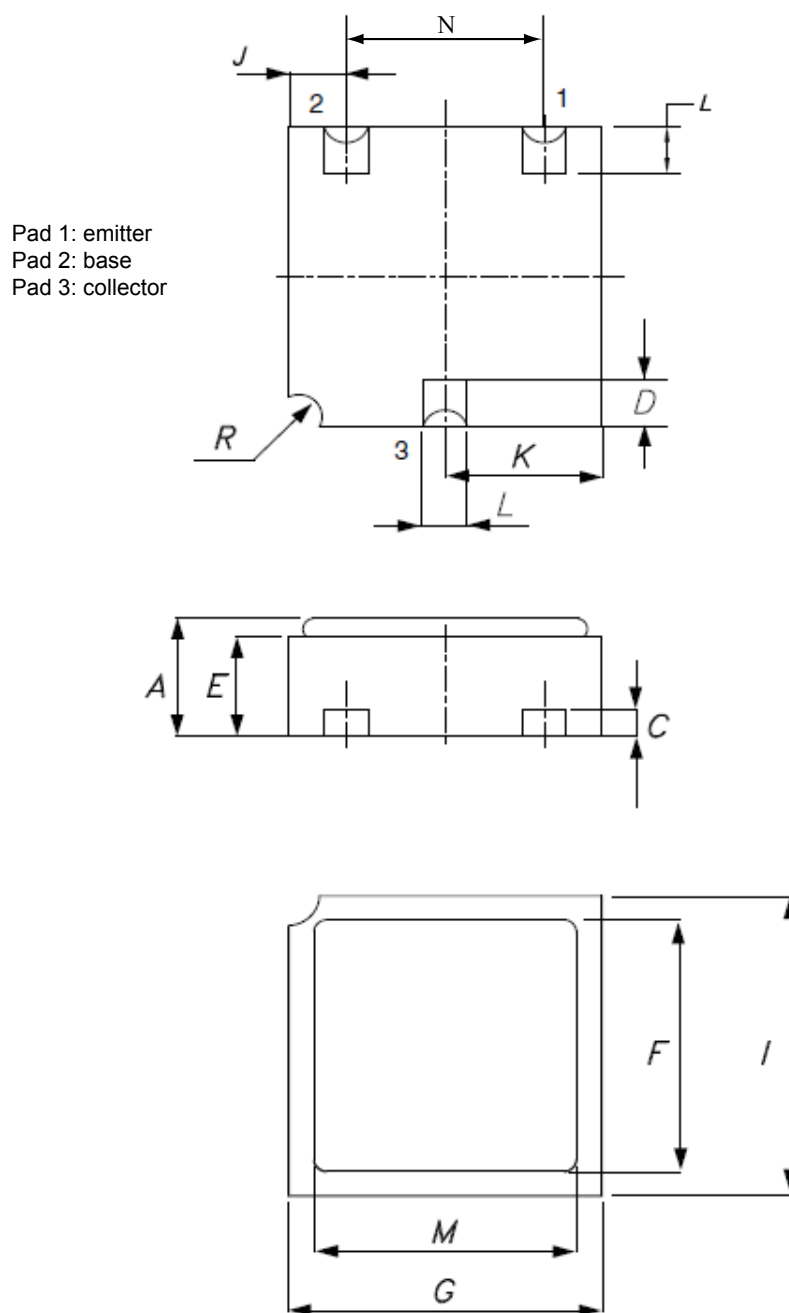
8206487 rev.6

Table 5. 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 5. LCC-3 package outline



0041211 rev.14

Table 6. 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 7. Ordering information

Part number	Agency specification	Quality level	Radiation level	Package	Mass	Lead finish	Marking ⁽¹⁾	Packing
2N5401UB1	-	Engineering model	-	UB	0.6 g	Gold	2N5401UB1	WafflePack
SOC54011	-	Engineering model	-	LCC-3			SOC54011	
2N5401RUBG	5202/014/06R	Flight model	100 krad	UB		Gold	520201406R	
2N5401RUBT	5202/014/07R					Solder Dip	520201407R	
2N5401UBG	5202/014/06		-			Gold	520201406	
2N5401UBT	5202/014/07		-			Solder Dip	520201407	
SOC5401RHRG	5202/014/04R		100 krad	LCC-3		Gold	520201404R	WafflePack
SOC5401RHRT	5202/014/05R		100 krad			Solder Dip	520201405R	
SOC5401RHRTW	5202/014/05R		100 krad			Solder Dip	520201405R	Tape and reel
SOC5401HRG	5202/014/04		-			Gold	520201404	WafflePack
SOC5401HRT	5202/014/05		-			Solder Dip	520201405	

1. 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

Table 8. Date codes

Model	Date code ⁽¹⁾
EM	3yywwN
ESCC	yywwN

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

6.2 Documentation

Table 9. Documentation provided for each type of product

Quality level	Radiation level	Documentation
Engineering model	-	Certificate of conformance
Flight model	-	Certificate of conformance ESCC qualification maintenance lot reference
	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 10. Document revision history

Date	Revision	Changes
04-Jan-2010	1	Initial release.
13-Jul-2010	2	Modified Table 1: Device summary, added Table 11: Order codes.
10-Oct-2012	3	Table 1: Device summary and Section 5: Order codes have been updated. Section 4: Package mechanical data has been updated.
12-Nov-2012	4	Added: Section 2.1: Electrical characteristics (curves).
22-Oct-2013	5	Updated Table 1: Device summary and Table 11: Order codes. Minor text changes.
01-Apr-2014	6	Updated Table 1: Device summary, Table 5: Electrical characteristics and Table 11: Order codes. Added Section 3: Radiation hardness assurance and Section 6: Shipping details. Minor text changes.
14-Jul-2014	7	Updated Table 1: Device summary and Table 11: Order codes.
20-Aug-2015	8	Updated: Section 4.3: TO-18 package information. Minor text changes.
06-Oct-2020	9	Removed TO-18 package information. Minor text changes.
25-Mar-2021	10	Updated Table 1, Table 2. Thermal data for SMD package, Table 3. Electrical characteristics ($T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified), Table 4. MIL-PRF-19500 post radiation electrical characteristics ($T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified), Figure 5. LCC-3 package outline and Table 10. Documentation provided for each type of product.
02-Jan-2023	11	Updated Table 8.
22-Sep-2023	12	Removed JANS products. Minor text changes.
08-Feb-2024	13	Updated Section Description , Table 7 , and Table 9 .

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