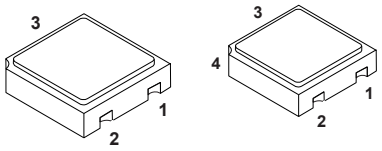
2N5401HR

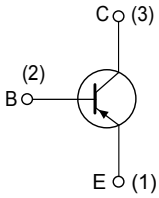
Datasheet

Rad-Hard 150 V, 0.5 A PNP transistor



LCC-3 **UB**

Pin 4 in UB is connected to the metallic lid.



DS10460

Product status link
2N5401HR

Features

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

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

Description

The 2N5401HR 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

Device	Qualification system	Agency specification	Package	Radiation level
JANSR2N5401UBx	JANSR	MIL-PRF-19500/766	UB	100 krad
JANS2N5401UBx	JANS	MIL-PRF-19500/766	UB	-
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 8 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} ≤ 25 °C	LCC-3 and UB for ESCC and JANS LCC-3 and UB(1)	0.36 0.58	W
	Total dissipation at $T_{SP(IS)}$ = 25 °C	UB for JANS	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 for SMD package

Symbol	Parameter	LCC-3 and UB value	Unit
$R_{thJSP(IS)}$	Thermal resistance junction-solder pad (infinite sink) for JANS	85	°C/W
RthJA	Thermal resistance junction-ambient for JANS	280	°C/W
	Thermal resistance junction-ambient for ESCC	486	
	Thermal resistance junction-ambient(1)	302	

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

2 Electrical characteristics

2.1 JANS and ESCC electrical characteristics

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

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

1. *Pulsed duration = 300 µs, duty cycle ≤ 1.5%*

2.2 Electrical characteristics (curves)

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

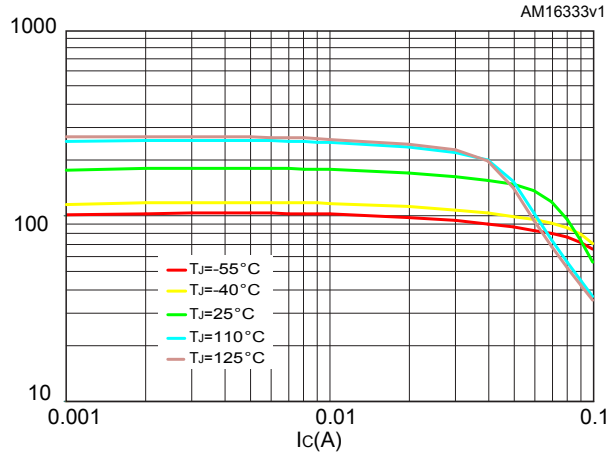


Figure 2. $V_{CE(sat)}$ at h_{FE} = 10

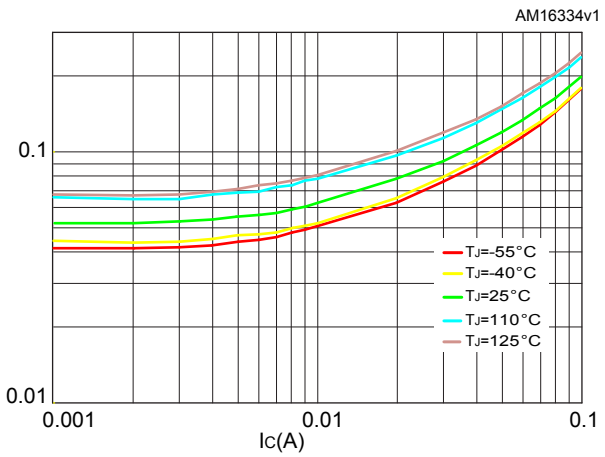
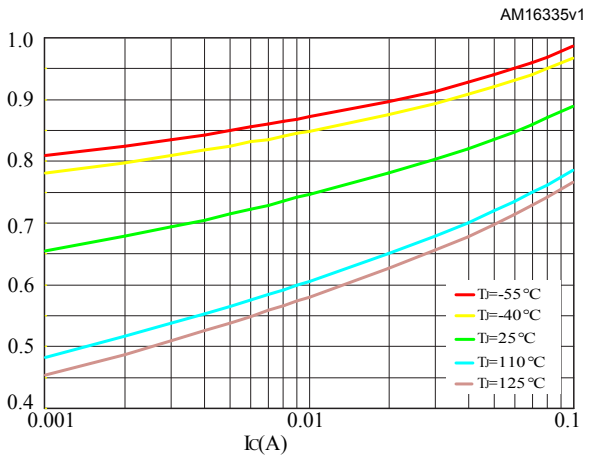


Figure 3. $V_{BE(sat)}$ at h_{FE} = 10



3 Radiation hardness assurance

3.1 JANS radiation assurance

JANSR2N5401 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 4. MIL-PRF-19500 post radiation electrical characteristics (T_{amb} = 25 °C unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Max	Unit
I_{CBO}	Collector to base cutoff current	V_{CB}= 120 V		100	nA
I_{EBO}	Emitter to base cutoff current	V_{EB}= 3 V		100	nA
$V_{(BR)CEO}$(1)	Collector-emitter breakdown voltage	I_C = 1 mA	150		V
$V_{(BR)BCO}$	Base-collector breakdown voltage	I_C = 100 µA	160		V
$V_{(BR)EBO}$	Emitter-base breakdown voltage	I_{EB} = 10 µA	5		V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = 10 mA, I_B = 1 mA		0.23	V
		I_C= 50 mA, I_B = 5 mA		0.575	
$V_{BE(sat)}$	Base-emitter saturation voltage	I_C = 10 mA, I_B = 1 mA		1.15	V
		I_C= 50 mA, I_B = 5 mA		1.15	
[h_{FE}]	Post irradiation gain calculation	I_C= 1 mA, V_{CE}= 5 V	[25](2)		
		I_C= 10 mA, V_{CE}= 5 V	[30](2)	240	
		I_C= 50 mA, V_{CE}= 5 V	[30](2)		

1. *Pulsed duration = 300 µs, duty cycle ≥ 2 %*
2. *[hFE] calculated according to method 1019 of MIL-STD-750.*

3.2 ESCC radiation assurance

This products is guaranteed in radiation as per ESCC 22900 and in compliance with ESCC 5202/014 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 5.

Table 5. ESCC 5201/019 post radiation electrical characteristics (T_{amb} = 25 °C unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Max	Unit
I_{CBO}	Collector cut-off current (I_E = 0)	V_{CB}= 120 V		100	nA
I_{EBO}	Emitter cut-off current (I_C= 0)	V_{EB} = 7 V		100	nA
$V_{(BR)BCO}$	Base-collector breakdown voltage (I_E= 0)	I_C= 100 µA	160		V
$V_{(BR)CEO}$(1)	Collector-emitter breakdown voltage (I_B = 0)	I_C = 1 mA	150		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=10 mA, I_B = 1 mA		0.2	V
		I_C= 50 mA, I_B = 5 mA		0.5	
$V_{BE(sat)}$(1)	Base-emitter saturation voltage	I_C=10 mA, I_B = 1 mA		1	V
		I_C= 50 mA, I_B = 5 mA		1	
[h_{FE}](1)	Post irradiation gain calculation (2)	I_C= 1 mA, V_{CE}= 5 V	[25]		
		I_C= 10 mA, V_{CE}= 5 V	[30]	240	
		I_C= 50 mA, V_{CE}= 5 V	[30]		

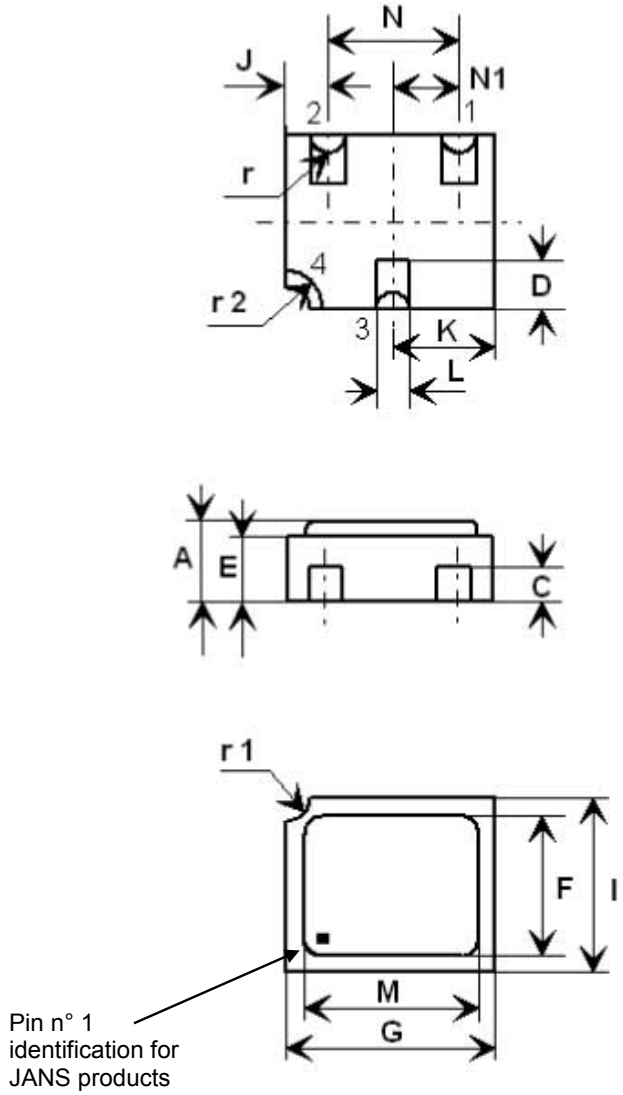
1. *Pulsed duration = 300 µs, duty cycle ≥ 2 %*
2. *[hFE] calculated according to method 1019 of MIL-STD-750.*

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

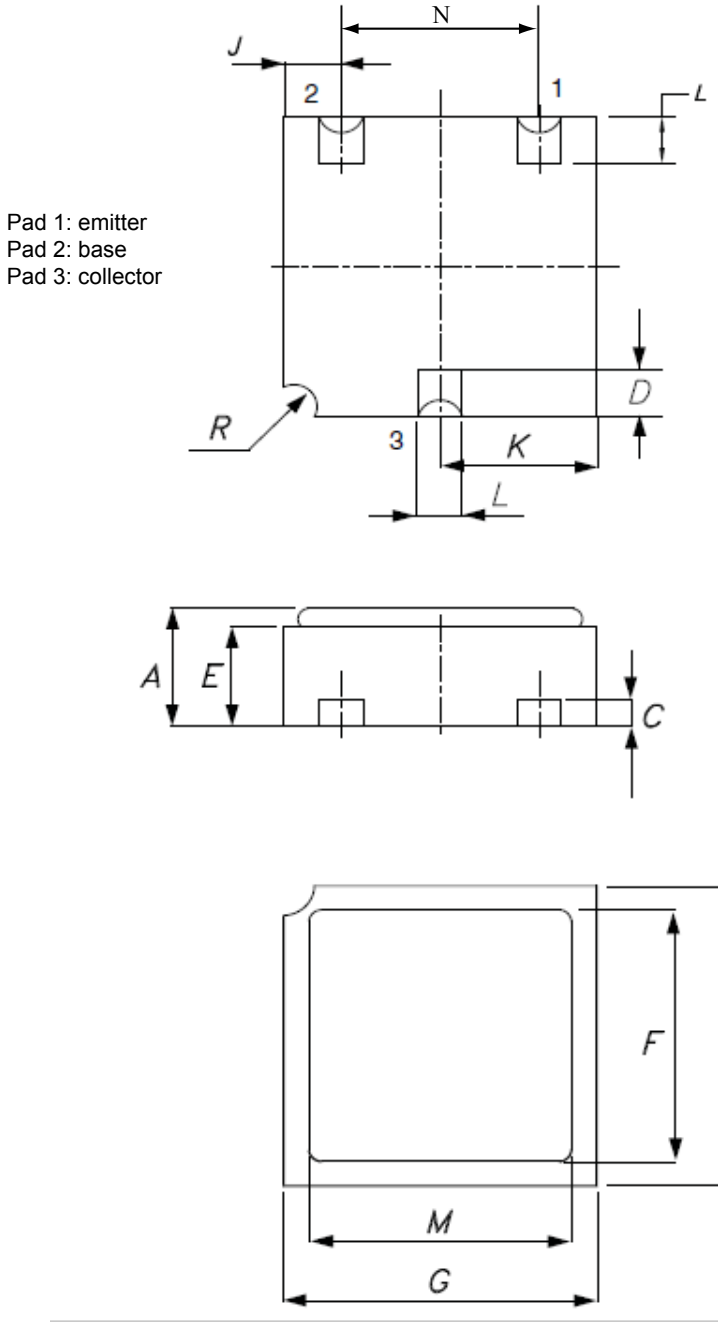
8206487 rev.6

Table 6. **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 7. **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 8. Ordering information

Part number	Agency specification	Quality level	Radiation level[1]	Package	Mass	Lead finish	Marking[2]	Packing
J2N5401UB1	-	Engineering model JANS	-	UB	0.6 g	Gold	J5401UB1	WafflePack
2N5401UB1	-	Engineering model ESCC	-				2N5401UB1	
SOC54011	-	Engineering model ESCC	-	LCC-3			SOC54011	
JANSR2N5401UBG	MIL-PRF-19500/766	JANSR	100 krad high and low dose rate	UB		Gold	JSR5401	
JANSR2N5401UBT		JANSR				Solder Dip	JSR5401	
JANS2N5401UBG		JANS	-			Gold	JS5401	
JANS2N5401UBT		JANS				Solder Dip	JS5401	
2N5401RUBG	5202/014/06R	ESCC Flight	100 krad - low dose rate			Gold	520201406R	
2N5401RUBT	5202/014/07R					Solder Dip	520201407R	
2N5401UBG	5202/014/06					Gold	520201406	
2N5401UBT	5202/014/07		-			Solder Dip	520201407	WafflePack
SOC5401RHRG	5202/014/04R		100 krad - low dose rate			Gold	520201404R	
SOC5401RHRT	5202/014/05R		100 krad - low dose rate	LCC-3		Solder Dip	520201405R	
SOC5401RHRTW	5202/014/05R		100 krad - low dose rate			Solder Dip	520201405R	Tape and reel
SOC5401HRG	5202/014/04		-			Gold	520201404	WafflePack
SOC5401HRT	5202/014/05		-			Solder Dip	520201405	

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

Date code information is described in the table below.

Table 9. 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 10. 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 krad at 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 11. **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 °C unless otherwise specified), Table 4. MIL-PRF-19500 post radiation electrical characteristics (T_{amb} = 25 °C unless otherwise specified), Figure 5. LCC-3 package outline and Table 10. Documentation provided for each type of product.

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