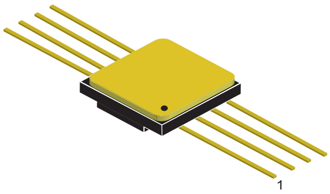
2N3810K

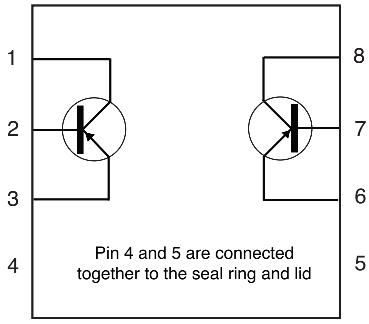
Hi-Rel PNP dual matched bipolar transistor 60 V, 0.05 A

Datasheet - production data



Flat-8

Figure 1. Internal schematic diagram



Features

BV_{CEO}	60 V
I_C (max)	0.05 A
H_{FE} at 5 V - 1 mA	> 150
Operating temperature range	-65°C to +200°C

- Hi-Rel PNP dual matched bipolar transistor
- Linear gain characteristics
- Manufactured according to ESCC 5000 specifications
- Up to 100 krad(Si) low dose rate

Description

The 2N3810K is a silicon planar epitaxial PNP transistor in Flat-8 package. It is specifically designed for aerospace Hi-Rel applications and available according to ESCC quality level.

Table 1. Device summary

Order code	Agency specification	EPPL	Quality level	Radiation level	Lead Finish	Marking	Packing	Mass
2N3810K1	-	Y	EM	-	Gold	2N2920AK1	Strip pack	0.7 g
2N3810KG	5207/005/10	Y	ESCC Flight	-	Gold	520700510	Strip pack	0.7 g
2N3810KT	5207/005/11	Y	ESCC Flight	-	Solder dip	520700511	Strip pack	0.7 g
2N3810RKG	5207/005/10R	Y	ESCC Flight	100 Krad	Gold	520700510R	Strip pack	0.7 g
2N3810RKT	5207/005/11R	Y	ESCC Flight	100 Krad	Solder dip	520700511R	Strip pack	0.7 g

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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	-50	mA
P_{TOT}	Total dissipation at $T_{amb} \leq 25$ °C (1)	0.5	W
	Total dissipation at $T_{amb} \leq 25$ °C (2)	0.6	W
T_{STG}	Storage temperature	-65 to 200	°C
T_J	Max. operating junction temperature	200	°C

1. One section
2. Both sections

Table 3. Thermal data

Symbol	Parameter	Value	Unit
R_{thJA}	Thermal resistance junction-ambient (1)max Thermal resistance junction-ambient (2) max	350 291.7	°C/W °C/W

1. One section.
2. Both sections.

2 Electrical characteristics

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

Table 4. Electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector-base cut-off current (I_E = 0)	V_{CB} = -50 V V_{CB} = -50 V T_C = 150 °C			-10 -10	nA µA
I_{EBO}	Emitter-base cut-off current (I_C = 0)	V_{EB} = -4 V			-20	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 = -100 µA I_B = -10 µA I_C = -1 mA I_B = -100 µA			-0.2 -0.25	V V
$V_{BE(sat)}$ (1)	Base-emitter saturation voltage	I_C = -100 µA I_B = -10 µA I_C = -1 mA I_B = -100 µA			-0.7 -0.8	V V
h_{FE} (1)	DC current gain	I_C = -10 µA V_{CE} = -5 V I_C = -100 µA V_{CE} = -5 V I_C = -500 µA V_{CE} = -5 V I_C = -1 mA V_{CE} = -5 V I_C = -10 mA V_{CE} = -5 V I_C = -100 µA V_{CE} = -5 V T_{amb} = -55 °C	100 150 150 150 125 60		 450 450 450	
h_{FE2-1} / h_{FE2-2}	DC current ratio comparison	I_C = -100 µA V_{CE} = -5 V	0.9		1.1	
h_{FE2-1} / h_{FE2-2}	DC current ratio comparison	I_C = -100 µA V_{CE} = -5 V T_{amb} = -55 °C to +125 °C	0.85		1.18	
$\Delta \vert V_{BE1} - V_{BE2} \vert$	Base-emitter voltage differential	V_{CE} = -5 V I_C = -10 µA V_{CE} = -5 V I_C = -100 µA V_{CE} = -5 V I_C = -10 mA			5 3 5	mV mV mV
$\Delta \vert V_{BE1} - V_{BE2} \vert$	Base-emitter voltage differential	V_{CE} = -5 V I_C = -100 µA T_{amb} = -55 °C to +25 °C T_{amb} = +25 °C to +125 °C			 0.8 1	 mV mV
I_{Lk}	Leakage current between active devices	V = -50 V to E_2, B_2, C_2 V = 0 V to E_1, B_1, C_1			-5	µA

Table 4. Electrical characteristics (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	Small signal current gain	V_{CE} = -10 V I_C = -1 mA f = 1 kHz	150		600	
f_T	Transition frequency	I_C = -1 mA V_{CE} = -5 V	80		500	MHz
C_{obo}	Output capacitance (I_E = 0)	V_{CB} = -5 V 100 kHz ≤ f ≤ 1 MHz			6	pF
C_{ibo}	Input capacitance (I_C = 0)	V_{EB} = -0.5 V 100 kHz ≤ f ≤ 1 MHz			15	pF
h_{ie}	Input impedance	I_C = -1 mA V_{CE} = -10 V f = 1 kHz	3		30	kΩ
NF	Noise figure	V_{CE} = -5 V I_C = -200 µA R_S = 2 kΩ f = 100 Hz			7	dB
NF	Noise figure	V_{CE} = -5 V I_C = -200 µA R_S = 2 kΩ f = 1 kHz			3	dB
NF	Noise figure	V_{CE} = -5 V I_C = -200 µA R_S = 2 kΩ Bandwidth = 10 Hz to 15.7 kHz			3.5	dB

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

3 Radiation hardness assurance

The products guaranteed in radiation within the ESCC system fully comply with the ESCC 5207/005 and ESCC 22900 specifications.

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 6: ESCC 5207/005 post radiation electrical characteristics*
- 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 5. Radiation summary

Radiation test	100 Krad ESCC
Wafer test	each
Part tested	5 biased + 5 unbiased
Dose rate	0.1 rad/s
Acceptance	Acceptance MIL-STD-750 method 1019
Displacement damage	Optional
Agency part number (ex)	5207/005/10R(1)
ST part number (ex)	2N3810RKG
Documents	CoC + RVT

1. Example of the 2N3810RKG gold finish.

Table 6. ESCC 5207/005 post radiation electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cut-off current ($I_E = 0$)	V_{CB} = 60 V			10	nA
I_{EBO}	Emitter cut-off current ($I_C = 0$)	V_{EB} = 4 V			20	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 ($I_E = 0$)	I_C = 10 mA	-60			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (Ic = 0)	I_E = 10 µA	-5			V
$V_{CE(sat)}$(1)	Collector-emitter saturation voltage	I_C= 100 µA, I_b = 10 µA I_C= - 1 mA, I_b = -100 µA			0.2 0.25	V V
$V_{BE(sat)}$(1)	Base-emitter saturation voltage	I_C= 100 µA I_b = 10 µA I_C= - 1 mA I_b = -100 µA			0.7 0.8	V V
[h_{FE}](1)	Post irradiation gain calculation(2)	I_C = -10 µA, V_{CE}= -5 V I_C= -100µA, V_{CE}= -5V I_C= -500µA, V_{CE}= 5V I_C= -1mA, V_{CE}= -5V I_C= -10mA, V_{CE}= -5V	[50] [75] [75] [75] [65]		 450 450 450 	

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 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 Flat-8 package information

Figure 2. Package outline

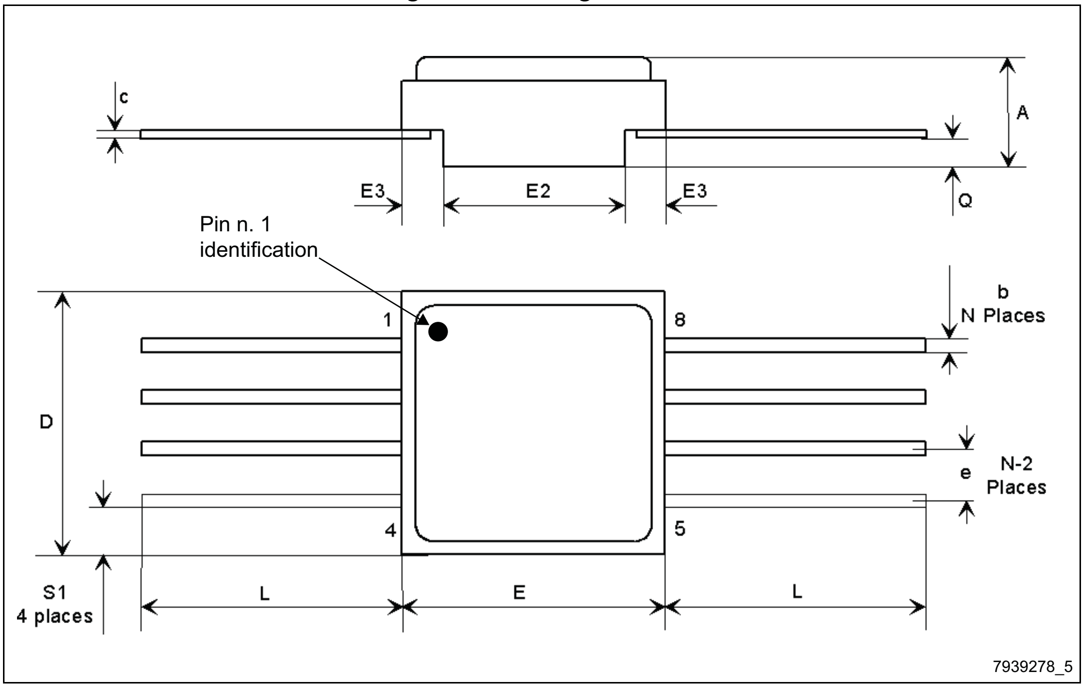

Table 7. Flat-8 package mechanical data

Dim.	mm			inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.24	2.44	2.64	0.088	0.096	0.104
b	0.38	0.43	0.48	0.015	0.017	0.019
c	0.10	0.13	0.16	0.004	0.005	0.006
D	6.35	6.48	6.61	0.250	0.255	0.260
E	6.35	6.48	6.61	0.250	0.255	0.260
E2	4.32	4.45	4.58	0.170	0.175	0.180
E3	0.88	1.01	1.14	0.035	0.040	0.045
e		1.27			0.050	
L	6.51	-	7.38	0.256	-	0.291
Q	0.66	0.79	0.92	0.026	0.031	0.036
S1	0.92	1.12	1.32	0.036	0.044	0.052
N	08			08		

5 Revision history

Table 8. Document revision history

Date	Revision	Changes
04-Apr-2013	1	Initial release.
09-Oct-2017	2	Updated *Figure 1: Internal schematic diagram*. Updated *Table 1: Device summary*. Updated *Table 2: Absolute maximum ratings* and *Table 3: Thermal data*. Added *Chapter 3: Radiation hardness assurance*. Updated *Section 4.1: Flat-8 package information*. Minor text changes.