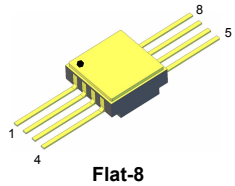
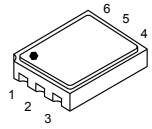
2N3810HR

Datasheet

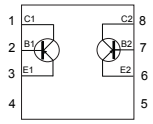
Rad-Hard 60 V, 0.05 A PNP dual matched transistor



Flat-8

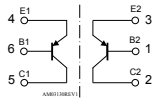


LCC-6



Flat-8

Pin 4 and pin 5
are connected together to the seal ring and lid



LCC-6

The upper metallic shield is not internally connected neither
to any pin nor to the die inside

Product status link
2N3810HR

Features

V_{ceo}	I_C(max.)	H_{FE} at 10 V, 150 mA	T_j(max.)
60 V	0.05 A	> 125	200 °C

- Hermetic packages
- ESCC qualified
- 100 krad

Description

The 2N3810K and SOC3810HR 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 5207/005 specification and available in Flat-8 and LCC-6 hermetic packages, they are specifically recommended for space and harsh environment applications and suitable for low current and high precision circuits such preamplifiers, oscillators, current mirror configuration.

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

Product summary

Product summary				
Device	**Qualification system**	**Agency specification**	**Package**	**Radiation level**
2N3810Kx	ESCC Flight	5207/005	Flat-8	-
2N3810RKx	ESCC Flight	5207/005	Flat-8	100 krad
SOC3810HRx	ESCC Flight	5207/005	LCC-6	-
SOC3810RHRx	ESCC Flight	5207/005	LCC-6	100 krad

Note: See Table 7 for ordering information.

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		-50	mA
P_{TOT}	Total dissipation at $T_{amb} \leq 25$ °C	for Flat-8 (1)	0.5	W
		for Flat-8 (2)	0.6	
		for LCC-6 (1)	0.5	
		for LCC-6 (2)	0.6	
T_{STG}	Storage temperature range		-65 to 200	°C
T_J	Max. operating junction temperature		200	°C

1. *One section.*
2. *Both sections.*

Table 2. Thermal data

Symbol	Parameter		Value	Unit
R_{thJA}	Thermal resistance junction-ambient max	for Flat-8(1)	350	°C/W
		for Flat-8 (2)	292	
		for LCC-6(1)	350	
		for LCC-6(2)	292	

1. *One section.*
2. *Both sections.*

2 Electrical characteristics

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

Table 3. Electrical characteristics

Symbol	Parameter	Test conditions	Min.	Max.	Unit
I_{CBO}	Collector-base cut-off current (I_E = 0)	V_{CB} = -50 V		-10	nA
		V_{CB} = -50 V T_C = 150 °C		-10	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		-0.2	V
		I_C = -1 mA I_B = -100 µA		-0.25	V
$V_{BE(sat)}$ (1)	Base-emitter saturation voltage	I_C = -100 µA I_B = -10 µA		-0.7	V
		I_C = -1 mA I_B = -100 µA		-0.8	V
h_{FE} (1)	DC current gain	I_C = 10 µA V_{CE} = 5 V	100		
		I_C = 100 µA V_{CE} = 5 V	150	450	
		I_C = 500 µA V_{CE} = 5 V	150	450	
		I_C = 1 mA V_{CE} = 5 V	150	450	
		I_C = 10 mA V_{CE} = 5 V	125		
		I_C = 100 µA V_{CE} = -5 V T_{amb} = -55 °C	60		
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	
$\Delta\lvert V_{BE1} - V_{BE2}\rvert$	Base-emitter voltage differential	V_{CE} = -5 V I_C = -10 µA		5	mV
		V_{CE} = -5 V I_C = -100 µA		3	mV
		V_{CE} = -5 V I_C = -10 mA		5	mV
$\Delta\lvert V_{BE1} - V_{BE2}\rvert$	Base-emitter voltage differential	V_{CE} = -5 V I_C = -100 µA T_{amb} = -55 °C to +25 °C		0.8	mV
		T_{amb} = +25 °C to +125 °C		1	mV
I_{Lks}	Leakage current between sections	V = -50 V to E_2, B_2, C_2 V = 0 V to E_1, B_1, C_1		-5	µA
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 f = 100 MHz	80	500	MHz

Symbol	Parameter	Test conditions	Min.	Max.	Unit
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
hie	Input impedance	I_C = -1 mA V_{CE} = -10 V f = 1 kHz	3	30	kΩ
NF1	Noise figure	V_{CE} = -5 V I_C = -200 µA R_S = 2 kΩ f = 100 Hz BW = 20 Hz		7	dB
NF2	Noise figure	V_{CE} = -5 V I_C = -200 µA R_S = 2 kΩ f = 1 kHz BW = 200 Hz		3	dB
NFw	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%*

2.1 Electrical characteristics (curves)

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

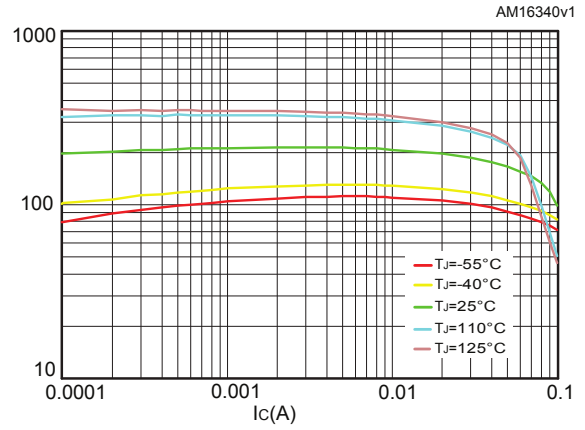


Figure 2. $V_{CE(sat)}$ @ h_{FE} = 10

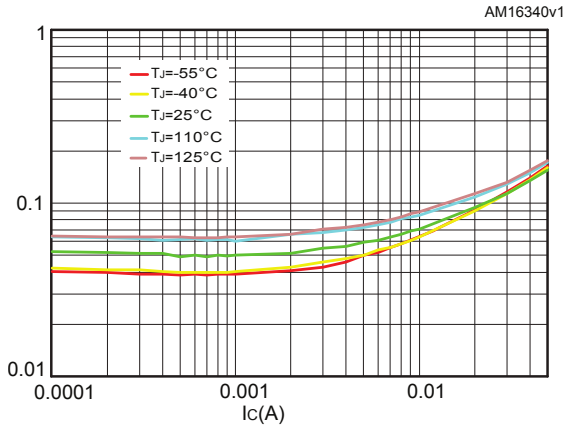
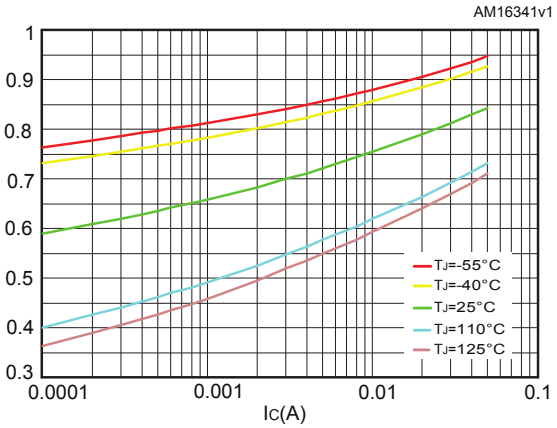


Figure 3. $V_{BE(sat)}$ @ h_{FE} = 10



3 Radiation hardness assurance

This products is guaranteed in radiation as per ESCC 22900 and in compliance with ESCC 5207/005 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 4.
- 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 post annealing at 168 hours / 100°C.

Table 4. ESCC5207/005 post radiation electrical characteristics

Symbol	Parameter	Test conditions	Min.	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)		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		0.2	V
		I_C= 1 mA, I_B = 100 µA		0.25	
$V_{BE(sat)}$(1)	Base-emitter saturation voltage	I_C=100 µA, I_B = 10 µA		0.7	V
		I_C= 1 mA, I_B = 100 µA		0.8	
[h_{FE}](1)	Post irradiation gain calculation (2)	I_C= 10 µA, V_{CE}= 5 V	[50]		
		I_C= 100 µA, V_{CE}= 5 V	[75]	450	
		I_C= 500 µA, V_{CE}= 5 V	[75]	450	
		I_C= 1 mA, V_{CE}= 5 V	[75]	450	
		I_C= 10 mA, V_{CE}= 5 V	[65]		

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 4. **Flat-8 package outline**

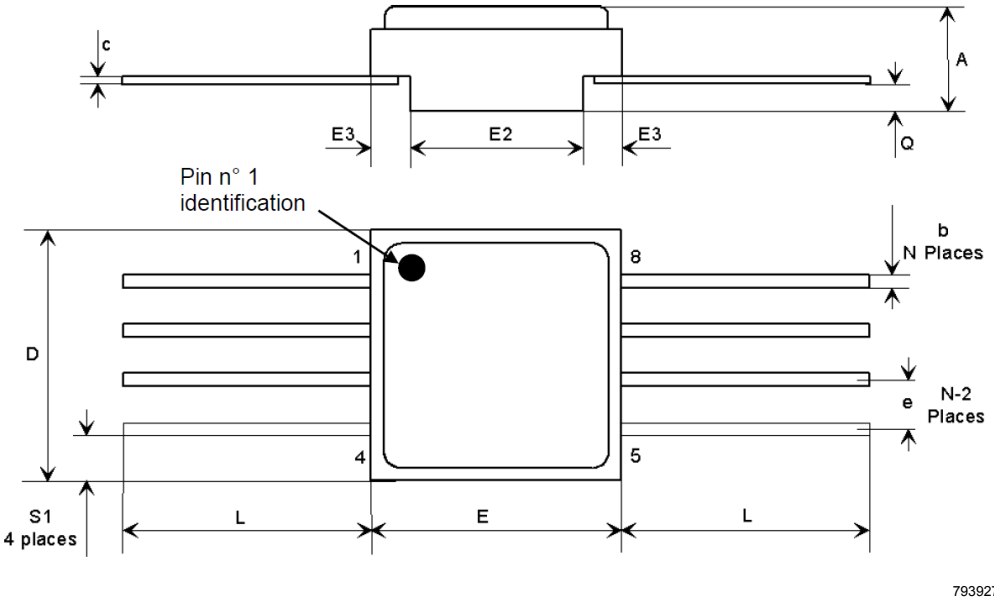


Table 5. **Flat-8 mechanical data**

Symbol	Millimeters			Inches		
	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		

4.2 LCC-6 package information

Figure 5. **LCC-6 package outline**

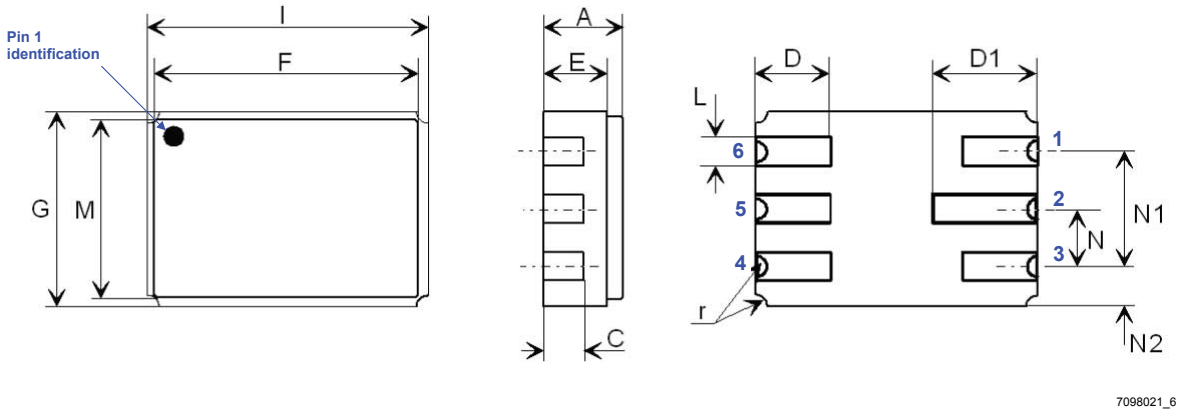


Table 6. **LCC-6 mechanical data**

Dim.	Milimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	1.53		1.96	0.060		0.077
C	0.78	0.89	0.99	0.031	0.035	0.039
D	1.52	1.65	1.78	0.060	0.065	0.070
D1	2.08	2.28	2.49	0.082	0.090	0.098
E	1.24	1.40	1.55	0.049	0.055	0.059
G	4.19	4.31	4.45	0.165	0.170	0.175
I	6.10	6.22	6.35	0.240	0.245	0.250
L	0.56	0.63	0.71	0.022	0.025	0.028
M	3.86	3.94	4.01	0.152	0.155	0.158
N	1.14	1.27	1.40	0.045	0.050	0.055
N1	2.41	2.54	2.67	0.095	0.100	0.105
N2	0.64	0.89	1.14	0.025	0.035	0.045
r		0.23			0.009	

5 Ordering information

Table 7. Ordering information

Part number	Agency specification	Quality level	Radiation level	Package	Mass	Lead finish	Marking[1]	Packing
2N3810K1	-	Engineering model	-	Flat-8	0.7 g	Gold	2N3810K1	Waffle pack
2N3810RKG	5207/005/10R	ESCC flight	100 krad			Gold	520700510R	
2N3810RKT	5207/005/11R	ESCC flight	100 krad			Solder dip	520700511R	
2N3810KG	5207/005/10	ESCC flight	-			Gold	520700510	
2N3810KT	5207/005/11	ESCC flight	-			Solder dip	520700511	
SOC38101	-	Engineering model	-	LCC-6	0.2 g	Gold	SOC38101	Waffle pack
SOC3810RHRG	5207/005/07R	ESCC flight	100 krad			Gold	520700507R	
SOC3810RHRT	5207/005/09R	ESCC flight	100 krad			Solder dip	520700509R	
SOC3810HRG	5207/005/07	ESCC flight	-			Gold	520700507	
SOC3810HRT	5207/005/09	ESCC flight	-			Solder dip	520700509	
SOC3810HRTW	5207/005/09	ESCC flight	-			Solder dip	520700509	Tape and reel
SOC3810RHRTW	5207/005/09R	ESCC flight	100 krad			Solder dip	520700509R	Tape and reel

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 the specific conditions for products in die form.

6 Other information

6.1 Traceability information

Table 8. Date codes

Quality level	Date code[1]
Engineering model (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
Flight model	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
10-Dec-2008	1	Initial release. Added Section 4: Ordering information.
08-Jan-2010	2	Modified Table 1 on page 1
14-Nov-2012	3	Added:Section 2.1: Electrical characteristics (curves) Updated: Section 3: Package mechanical data
13-May-2014	4	Updated section Table 1 Device summary. Added Section 4: Ordering information.
03-Nov-2015	5	Updated Table 2: Absolute maximum ratings and Table 4: Thermal data for LCC-6 package Minor text changes.
29-Jan-2016	6	Updated Table2: Absolute maximum ratings and Table 4: Thermal data for LCC-6 package. Minor text changes.
18-Jul-2018	7	Updated Absolute maximum ratings. Minor text changes.
04-Sep-2018	8	Updated cover image and Internal schematic diagrams. Minor text changes.
08-Sep-2020	9	Removed TO-78 information. Updated Ordering information. Minor text changes.
19-Sep-2023	10	Updated *Table 7. Ordering information*.
05-Apr-2024	11	Updated *Description*, Table 8, and Table 9.

Contents