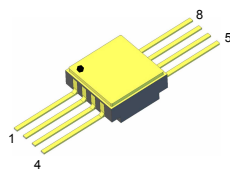
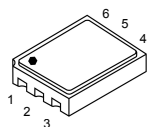


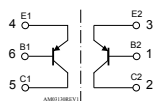
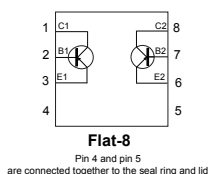
Rad-Hard 60 V, 0.05 A PNP dual matched transistor



Flat-8



LCC-6



LCC-6

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

Features

V_{CE0}	$I_C(max.)$	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.

Product status link

[2N3810HR](#)

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 $T_{amb} \leq 25\text{ °C}$	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

$T_{\text{case}} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified.

Table 3. Electrical characteristics

Symbol	Parameter	Test conditions	Min.	Max.	Unit
I_{CBO}	Collector-base cut-off current ($I_{\text{E}} = 0$)	$V_{\text{CB}} = -50\text{ V}$		-10	nA
		$V_{\text{CB}} = -50\text{ V}$ $T_{\text{C}} = 150\text{ }^{\circ}\text{C}$		-10	μA
I_{EBO}	Emitter-base cut-off current ($I_{\text{C}} = 0$)	$V_{\text{EB}} = -4\text{ V}$		-20	nA
$V_{(\text{BR})\text{CBO}}$	Collector-base breakdown voltage ($I_{\text{E}} = 0$)	$I_{\text{C}} = -10\text{ }\mu\text{A}$	-60		V
$V_{(\text{BR})\text{CEO}}^{(1)}$	Collector-emitter breakdown voltage ($I_{\text{B}} = 0$)	$I_{\text{C}} = -10\text{ mA}$	-60		V
$V_{(\text{BR})\text{EBO}}$	Emitter-base breakdown voltage ($I_{\text{C}} = 0$)	$I_{\text{E}} = -10\text{ }\mu\text{A}$	-5		V
$V_{\text{CE(sat)}}^{(1)}$	Collector-emitter saturation voltage	$I_{\text{C}} = -100\text{ }\mu\text{A}$ $I_{\text{B}} = -10\text{ }\mu\text{A}$		-0.2	V
		$I_{\text{C}} = -1\text{ mA}$ $I_{\text{B}} = -100\text{ }\mu\text{A}$		-0.25	V
$V_{\text{BE(sat)}}^{(1)}$	Base-emitter saturation voltage	$I_{\text{C}} = -100\text{ }\mu\text{A}$ $I_{\text{B}} = -10\text{ }\mu\text{A}$		-0.7	V
		$I_{\text{C}} = -1\text{ mA}$ $I_{\text{B}} = -100\text{ }\mu\text{A}$		-0.8	V
$h_{\text{FE}}^{(1)}$	DC current gain	$I_{\text{C}} = 10\text{ }\mu\text{A}$ $V_{\text{CE}} = 5\text{ V}$	100		
		$I_{\text{C}} = 100\text{ }\mu\text{A}$ $V_{\text{CE}} = 5\text{ V}$	150	450	
		$I_{\text{C}} = 500\text{ }\mu\text{A}$ $V_{\text{CE}} = 5\text{ V}$	150	450	
		$I_{\text{C}} = 1\text{ mA}$ $V_{\text{CE}} = 5\text{ V}$	150	450	
		$I_{\text{C}} = 10\text{ mA}$ $V_{\text{CE}} = 5\text{ V}$	125		
		$I_{\text{C}} = 100\text{ }\mu\text{A}$ $V_{\text{CE}} = -5\text{ V}$ $T_{\text{amb}} = -55\text{ }^{\circ}\text{C}$	60		
$h_{\text{FE2-1}} / h_{\text{FE2-2}}$	DC current ratio comparison	$I_{\text{C}} = -100\text{ }\mu\text{A}$ $V_{\text{CE}} = -5\text{ V}$	0.9	1.1	
$h_{\text{FE2-1}} / h_{\text{FE2-2}}$	DC current ratio comparison	$I_{\text{C}} = -100\text{ }\mu\text{A}$ $V_{\text{CE}} = -5\text{ V}$ $T_{\text{amb}} = -55\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	0.85	1.18	
$\Delta V_{\text{BE1}} - V_{\text{BE2}} $	Base-emitter voltage differential	$V_{\text{CE}} = -5\text{ V}$ $I_{\text{C}} = -10\text{ }\mu\text{A}$		5	mV
		$V_{\text{CE}} = -5\text{ V}$ $I_{\text{C}} = -100\text{ }\mu\text{A}$		3	mV
		$V_{\text{CE}} = -5\text{ V}$ $I_{\text{C}} = -10\text{ mA}$		5	mV
$\Delta V_{\text{BE1}} - V_{\text{BE2}} $	Base-emitter voltage differential	$V_{\text{CE}} = -5\text{ V}$ $I_{\text{C}} = -100\text{ }\mu\text{A}$ $T_{\text{amb}} = -55\text{ }^{\circ}\text{C}$ to $+25\text{ }^{\circ}\text{C}$		0.8	mV
		$T_{\text{amb}} = +25\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$		1	mV
I_{Lks}	Leakage current between sections	$V = -50\text{ V}$ to E_2, B_2, C_2 $V = 0\text{ V}$ to E_1, B_1, C_1		-5	μA
h_{fe}	Small signal current gain	$V_{\text{CE}} = -10\text{ V}$ $I_{\text{C}} = -1\text{ mA}$ $f = 1\text{ kHz}$	150	600	
f_{T}	Transition frequency	$I_{\text{C}} = -1\text{ mA}$ $V_{\text{CE}} = -5\text{ V}$ $f = 100\text{ MHz}$	80	500	MHz

Symbol	Parameter	Test conditions	Min.	Max.	Unit
C_{OBO}	Output capacitance ($I_E = 0$)	$V_{CB} = -5\text{ V}$ $100\text{ kHz} \leq f \leq 1\text{ MHz}$		6	pF
C_{IBO}	Input capacitance ($I_C = 0$)	$V_{EB} = -0.5\text{ V}$ $100\text{ kHz} \leq f \leq 1\text{ MHz}$		15	pF
h_{ie}	Input impedance	$I_C = -1\text{ mA}$ $V_{CE} = -10\text{ V}$ $f = 1\text{ kHz}$	3	30	k Ω
NF1	Noise figure	$V_{CE} = -5\text{ V}$ $I_C = -200\text{ }\mu\text{A}$ $R_S = 2\text{ k}\Omega$ $f = 100\text{ Hz}$ $BW = 20\text{ Hz}$		7	dB
NF2	Noise figure	$V_{CE} = -5\text{ V}$ $I_C = -200\text{ }\mu\text{A}$ $R_S = 2\text{ k}\Omega$ $f = 1\text{ kHz}$ $BW = 200\text{ Hz}$		3	dB
NFw	Noise figure	$V_{CE} = -5\text{ V}$ $I_C = -200\text{ }\mu\text{A}$ $R_S = 2\text{ k}\Omega$ Bandwidth = 10 Hz to 15.7 kHz		3.5	dB

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

2.1 Electrical characteristics (curves)

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

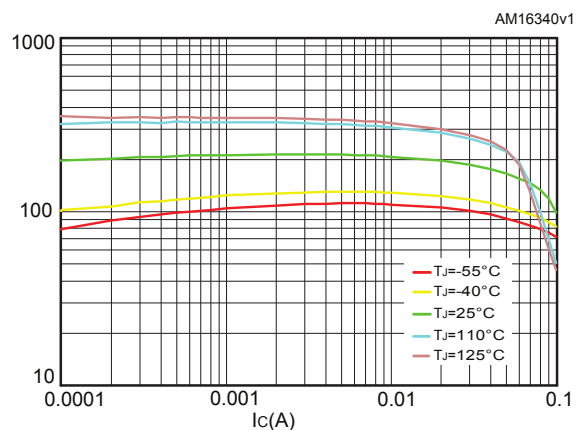


Figure 2. $V_{CE(sat)}$ @ $h_{FE} = 10$

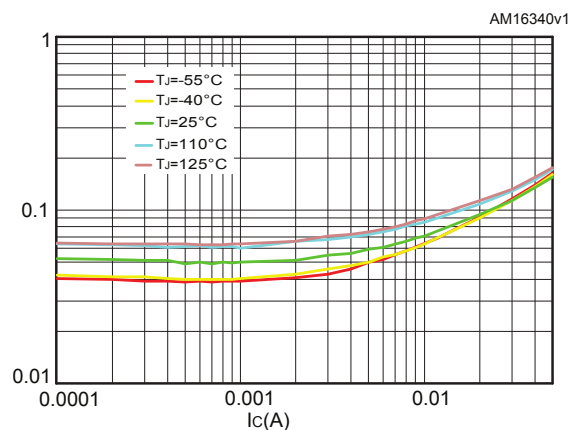
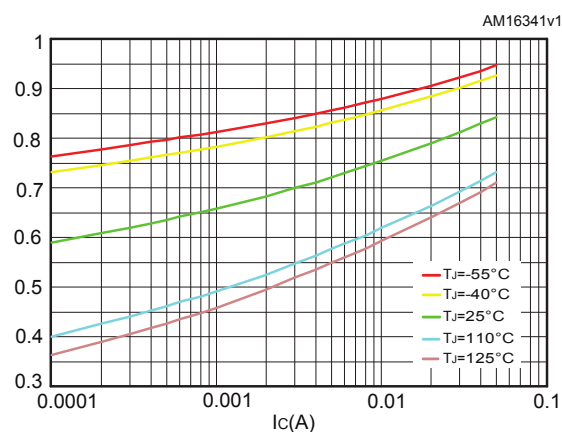


Figure 3. $V_{BE(sat)}$ @ $h_{FE} = 10$



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 ($I_E=0$)	$V_{CB}= 60\text{ V}$		10	nA
I_{EBO}	Emitter cut-off current ($I_C= 0$)	$V_{EB}= 4\text{ V}$		20	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E= 0$)	$I_C=10\text{ }\mu\text{A}$	60		V
$V_{(BR)CEO}^{(1)}$		$I_C= 10\text{ mA}$	60		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	$I_C=100\text{ }\mu\text{A}, I_B= 10\text{ }\mu\text{A}$		0.2	V
		$I_C= 1\text{ mA}, I_B= 100\text{ }\mu\text{A}$		0.25	
$V_{BE(sat)}^{(1)}$	Base-emitter saturation voltage	$I_C=100\text{ }\mu\text{A}, I_B= 10\text{ }\mu\text{A}$		0.7	V
		$I_C= 1\text{ mA}, I_B= 100\text{ }\mu\text{A}$		0.8	
$[h_{FE}]^{(1)}$	Post irradiation gain calculation ⁽²⁾	$I_C= 10\text{ }\mu\text{A}, V_{CE}= 5\text{ V}$	[50]		
		$I_C= 100\text{ }\mu\text{A}, V_{CE}= 5\text{ V}$	[75]	450	
		$I_C= 500\text{ }\mu\text{A}, V_{CE}= 5\text{ V}$	[75]	450	
		$I_C= 1\text{ mA}, V_{CE}= 5\text{ V}$	[75]	450	
		$I_C= 10\text{ mA}, V_{CE}= 5\text{ V}$	[65]		

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

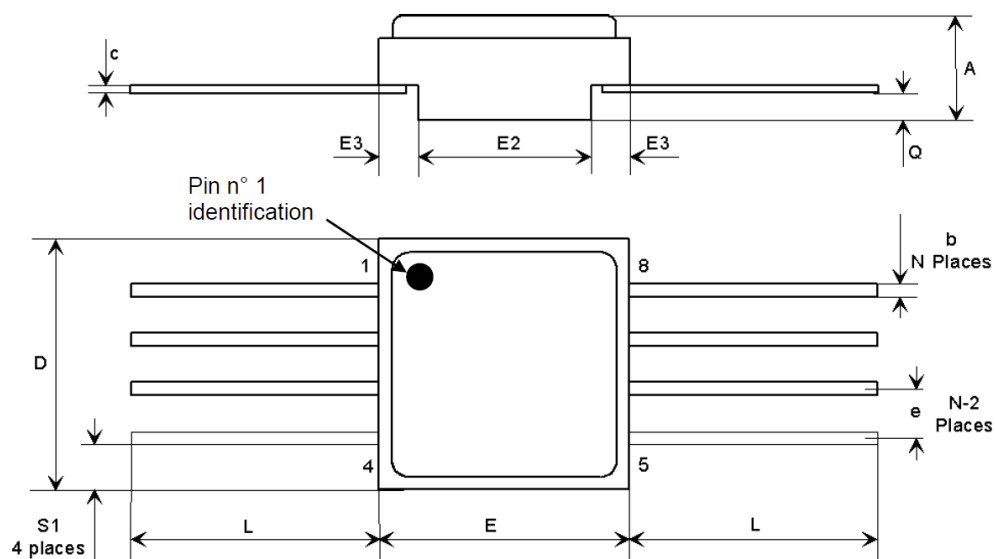
2. The post-irradiation gain calculation of $[h_{FE}]$, made using h_{FE} measurements from prior to and on completion of irradiation testing and after each annealing step if any, shall be as specified in MILSTD-750 method 1019.

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 Flat-8 package information

Figure 4. Flat-8 package outline



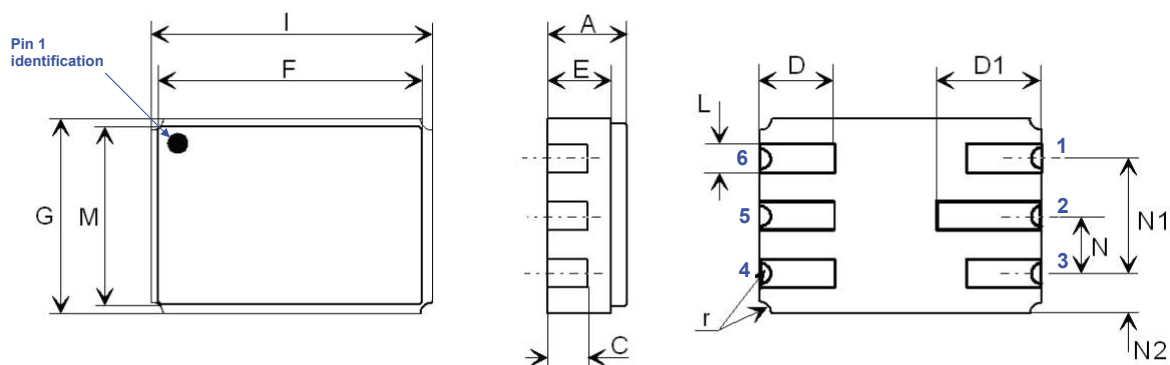
7939278_6

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



7098021_6

Table 6. LCC-6 mechanical data

Dim.	Millimeters			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 <i>Table 7. Ordering information</i> .
05-Apr-2024	11	Updated <i>Description</i> , <i>Table 8</i> , and <i>Table 9</i> .

Contents

1	Electrical ratings	2
2	Electrical characteristics.....	3
2.1	Electrical characteristics (curves)	5
3	Radiation hardness assurance	6
4	Package information.....	7
4.1	Flat-8 package information.	8
4.2	LCC-6 package information	9
5	Ordering information	10
6	Other information.....	11
6.1	Traceability information.	11
6.2	Documentation	11
	Revision history	12

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