

Rad Hard Low Power NPN Silicon Transistor

Screened per MIL-PRF-19500 & ESCC 22900

Screened Levels:
MSR

QPL RANGE and RAD LEVEL	
Radiation Level	MSR2N3700UB
TID	100 Krad
ELDRS	100 Krad

DESCRIPTION

This RHA level low power NPN switching transistor, 2N3700 device in a UB and UBC package, is ideal to drive many high-reliability applications. This device is constructed and screened to a JANSR performance level with radiation test method 1019 wafer lot acceptance conducted on all die lots. Fully compliant to **GSFC EEE-INST-002** reliability, screening and radiation hardness assurance requirements for space flight projects.

Important: For the latest information, visit our website <http://www.microsemi.com>.

FEATURES

- JEDEC registered 2N3700
- TID level screened per MIL-PRF-19500
- Also available with ELDRS testing to 0.01 Rad(s)/ sec
- MKCR/MHCR chip die available
- RHA (Radiation hardness assured) lot by lot validation testing via ELDR 0.1 Rad (SI)/sec dose rate

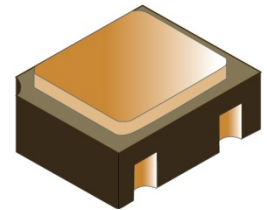
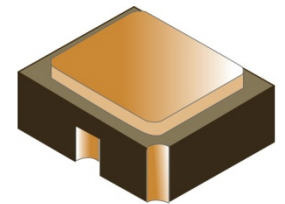
APPLICATIONS / BENEFITS

- Rad-Hard power supplies
- Rad-Hard motor controls
- General purpose switching
- Instrumentation Amps
- EPS Satellite switching power applications


MAXIMUM RATINGS

Parameters/Test Conditions	Symbol	Value	Unit
Junction and Storage Temperature	T_J and T_{STG}	-65 to +200	°C
Thermal Resistance Junction-to-Case	$R_{\theta JSP}$	90	°C/W
Thermal Resistance Junction-to-Ambient	$R_{\theta JA}$	325	°C/W
Power Dissipation: @ $T_A = +25\text{ °C}^{(1)}$	P_D	0.5	W
Collector-Base Voltage, Emitter Open	V_{CBO}	140	V
Emitter-Base Voltage, Collector Open	V_{EBO}	7.0	V
Collector-Emitter Voltage, Base Open	V_{CEO}	80	V
Collector Current, dc	I_C	1.0	A
Solder Temperature @ 10 s	T_{SP}	260	°C

Notes: 1. Derate linearly 6.6 mW/°C for $T_A \geq +25\text{ °C}$.



UB Package

Also available in:
TO-18 (TO-206AA)
(leadless)
 MSR2N3700

MSC – Lawrence

6 Lake Street,
Lawrence, MA 01841
Tel: 1-800-446-1158 or
(978) 620-2600
Fax: (978) 689-0803

MSC – Ireland

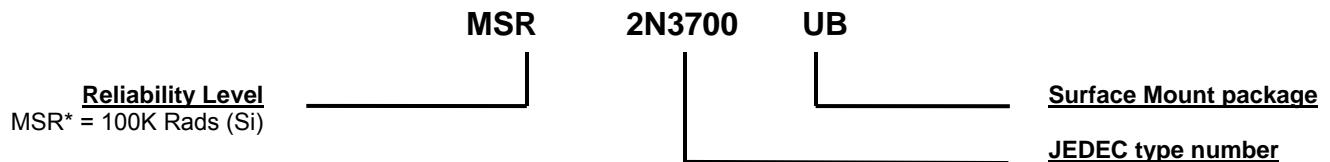
Gort Road Business Park,
Ennis, Co. Clare, Ireland
Tel: +353 (0) 65 6840044
Fax: +353 (0) 65 6822298

Website:

www.microsemi.com

MECHANICAL and PACKAGING

- CASE: Ceramic
- TERMINALS: Gold plating over nickel under plate.
- MARKING: Part number, date code, manufacturer's ID, and serial number
- TAPE & REEL option: Standard per EIA-418D. Consult factory for quantities.
- WEIGHT: < 0.04 Grams
- See [Package Dimensions](#) on last page.

PART NOMENCLATURE


*The MSR designator is our internal part nomenclature assigned to this family of parts, in lieu of pending JANSR submissions through DLA (Defense Logistic Agency).

SYMBOLS & DEFINITIONS

Symbol	Definition
I_B	Base current: The value of the dc current into the base terminal.
I_C	Collector current: The value of the dc current into the collector terminal.
I_E	Emitter current: The value of the dc current into the emitter terminal.
T_A	Ambient temperature
T_C	Case temperature
V_{CB}	Collector-base voltage: The dc voltage between the collector and the base.
V_{CBO}	Collector-base voltage, base open: The voltage between the collector and base terminals when the emitter terminal is open-circuited.
V_{CE}	Collector-emitter voltage: The dc voltage between the collector and the emitter.
V_{CEO}	Collector-emitter voltage, base open: The voltage between the collector and the emitter terminals when the base terminal is open-circuited.
V_{EB}	Emitter-base voltage: The dc voltage between the emitter and the base
V_{EBO}	Emitter-base voltage, collector open: The voltage between the emitter and base terminals with the collector terminal open-circuited.

ELECTRICAL CHARACTERISTICS @ $T_A = 25\text{ }^\circ\text{C}$ unless otherwise noted.

Parameters / Test Conditions	Symbol	Min.	Max.	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Current $I_C = 30\text{ mA}$	$V_{(BR)CEO}$	80		V
Collector-Base Cutoff Current $V_{CB} = 140\text{ V}$	I_{CBO}		10	μA
Emitter-Base Cutoff Current $V_{EB} = 7\text{ V}$	I_{EBO1}		10	μA
Collector-Emitter Cutoff Current $V_{CE} = 90\text{ V}$	I_{CES}		10	ηA
Emitter-Base Cutoff Current $V_{EB} = 5.0\text{ V}$	I_{EBO2}		10	ηA
ON CHARACTERISTICS ⁽¹⁾				
Forward-Current Transfer Ratio $I_C = 150\text{ mA}, V_{CE} = 10\text{ V}$ $I_C = 0.1\text{ mA}, V_{CE} = 10\text{ V}$ $I_C = 10\text{ mA}, V_{CE} = 10\text{ V}$ $I_C = 500\text{ mA}, V_{CE} = 10\text{ V}$ $I_C = 1.0\text{ A}, V_{CE} = 10\text{ V}$	h_{FE}	100 50 90 50 15	300 300 300 300	
Collector-Emitter Saturation Voltage $I_C = 150\text{ mA}, I_B = 15\text{ mA}$ $I_C = 500\text{ mA}, I_B = 50\text{ mA}$	$V_{CE(sat)}$		0.2 0.5	V
Base-Emitter Saturation Voltage $I_C = 150\text{ mA}, I_B = 15\text{ mA}$	$V_{BE(sat)}$		1.1	V

DYNAMIC CHARACTERISTICS

Parameters / Test Conditions	Symbol	Min.	Max.	Unit
Small-Signal Short-Circuit Forward Current Transfer Ratio $I_C = 1.0\text{ mA}, V_{CE} = 5.0\text{ V}, f = 1.0\text{ kHz}$	h_{fe}	80	400	
Magnitude of Small-Signal Short-Circuit Forward Current Transfer Ratio $I_C = 50\text{ mA}, V_{CE} = 10\text{ V}, f = 20\text{ MHz}$	$ h_{fe} $	5.0	20	
Output Capacitance $V_{CB} = 10\text{ V}, I_E = 0, 100\text{ kHz} \leq f \leq 1.0\text{ MHz}$	C_{obo}		12	pF
Input Capacitance $V_{EB} = 0.5\text{ V}, I_C = 0, 100\text{ kHz} \leq f \leq 1.0\text{ MHz}$	C_{ibo}		60	pF

(1) Pulse Test: Pulse Width = 300 μs , duty cycle $\leq 2.0\%$

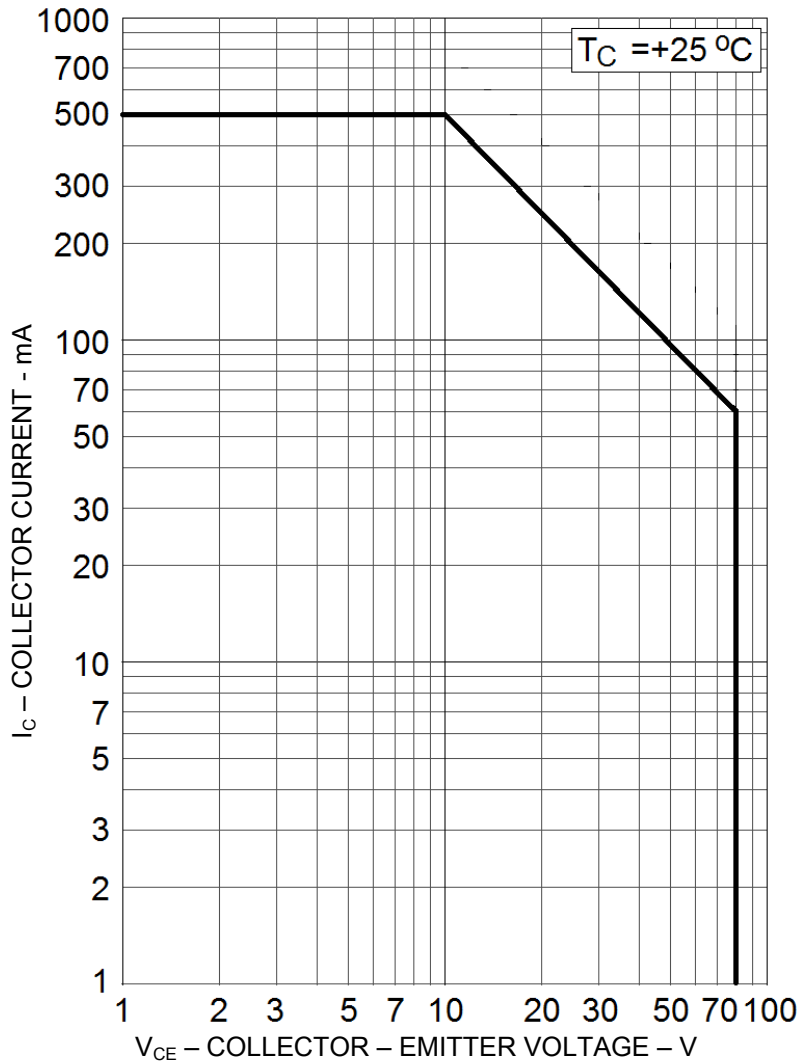
ELECTRICAL CHARACTERISTICS @ $T_A = +25\text{ }^\circ\text{C}$, unless otherwise noted (continued)
SAFE OPERATION AREA (See SOA graph below and [MIL-STD-750 method 3053](#))

DC Tests
 $T_C = 25\text{ }^\circ\text{C}$, 1 cycle, $t = 10\text{ ms}$

Test 1	$V_{CE} = 10\text{ V}$
2N3700UB	$I_C = 180\text{ mA}$

Test 2	$V_{CE} = 40\text{ V}$
2N3700UB	$I_C = 45\text{ mA}$

Test 3	$V_{CE} = 80\text{ V}$
2N3700UB	$I_C = 22.5\text{ mA}$


Maximum Safe Operating Area

GRAPHS

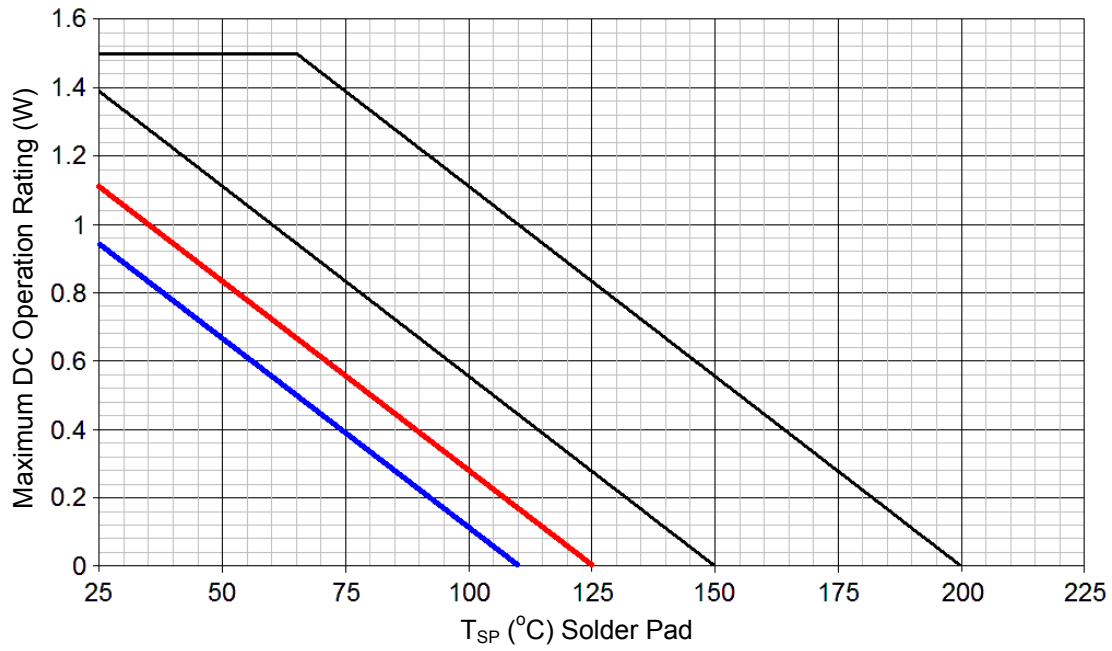


FIGURE 1

Temperature-Power Derating ($R_{\theta JSP}$)

Radiation hardness assurance

The MSR series product are guaranteed in radiation with full compliance to MIL-PRF-19500 specification JANSR level and also guaranteed to meet ESCC 22900 specifications (General specifications)

Radiation assurance MIL-PRF-19500.

MSR parts are guaranteed at 100 krad (Si), tested, in full compliancy with the MIL-PRF-19500 specification, specifically the Group D, subgroup 2 inspection. All test are performed in accordance to MIL-PRF-19500 and test method 1019 of MIL-STD-750 for total Ionizing dose.

- Each wafer of each lot is tested, (note 1). The table below provides for each monitored parameters of the test conditions and the acceptance criteria

ELECTRICAL CHARACTERISTICS @ $T_A = +25\text{ }^\circ\text{C}$, unless otherwise noted (continued)

POST RADIATION ELECTRICAL CHARACTERISTICS

Parameters / Test Conditions	Symbol	Min.	Max.	Unit
Collector to Base Cutoff Current $V_{CB} = 140\text{ V}$	I_{CBO}		20	μA
Emitter to Base Cutoff Current $V_{EB} = 7\text{ V}$	I_{EBO}		20	μA
Collector to Emitter Breakdown Voltage $I_C = 30\text{ mA}$	$V_{(BR)CEO}$	80		V
Collector-Emitter Cutoff Current $V_{CE} = 90\text{ V}$	I_{CES}		20	ηA
Emitter-Base Cutoff Current $V_{EB} = 5.0\text{ V}$	I_{EBO}		20	ηA
Forward-Current Transfer Ratio ⁽¹⁾ $I_C = 150\text{ mA}, V_{CE} = 10\text{ V}$ $I_C = 0.1\text{ mA}, V_{CE} = 10\text{ V}$ $I_C = 10\text{ mA}, V_{CE} = 10\text{ V}$ $I_C = 500\text{ mA}, V_{CE} = 10\text{ V}$ $I_C = 1\text{ A}, V_{CE} = 10\text{ V}$	$[h_{FE}]$	[50] [25] [45] [25] [7.5]	300 300 300	
Collector-Emitter Saturation Voltage $I_C = 150\text{ mA}, I_B = 15\text{ mA}$ $I_C = 500\text{ mA}, I_B = 50\text{ mA}$	$V_{CE(sat)}$		0.23 0.58	V
Base-Emitter Saturation Voltage $I_C = 150\text{ mA}, I_B = 15\text{ mA}$	$V_{BE(sat)}$		1.27	V

(1) See method 1019 of MIL-STD-750 for how to determine $[h_{FE}]$ by first calculating the delta ($1/h_{FE}$) from the pre- and post-radiation h_{FE} . Notice the $[h_{FE}]$ is not the same as h_{FE} and cannot be measured directly. The $[h_{FE}]$ value can never exceed the pre-radiation minimum h_{FE} that it is based upon.

ESCC radiation assurance

Each product lot is tested according to the ESCC basic specification 22900, with a minimum of 21 samples per diffusion lot and 10 samples per wafer, one sample being kept as un- irradiated sample, all of them being fully compliant with the applicable ESCC generic and/or detailed specification.

- Test of 10 pieces by wafer, 10 biased at least 80% of $V_{(BR)CEO}$, 10 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 20 samples comply with the post radiation electrical characteristics provided in [Table 4](#) (post radiation electrical characteristics for the 2N3700UB)
- 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.

Radiation summary

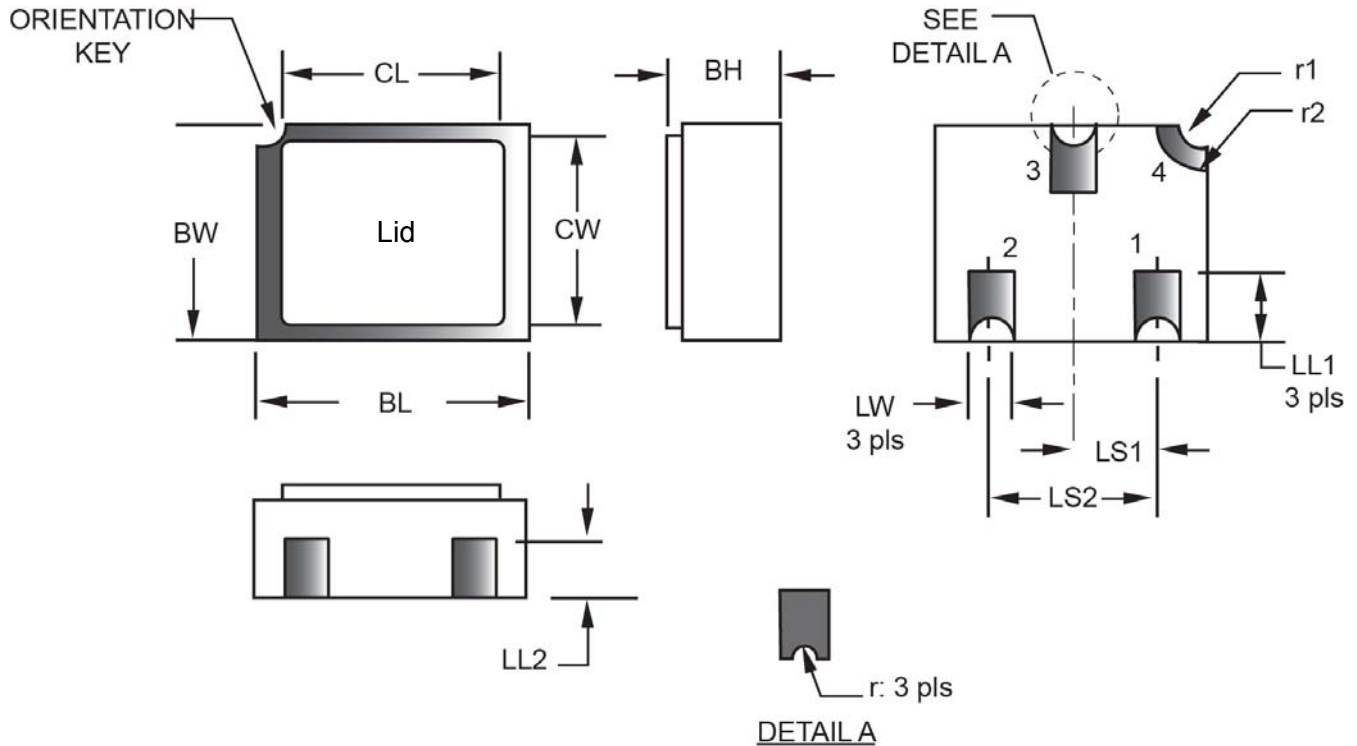
Radiation test (Note 1)	100 krad ESCC
Wafer test	each
Part tested	10 biased + 10 unbiased
Dose rate	0.1 rad/s
Acceptance	Mil- Std-750 Method 1019
Displacement damage	Optional

1. Microsemi MSR products will exceed required testing of *ESCC basic specification 22900*

POST RADIATION ELECTRICAL CHARACTERISTICS Table 4

Parameters / Test Conditions	Symbol	Min.	Max.	Unit
Collector to Base Cutoff Current $V_{CB} = 140 \text{ V}$	I_{CBO}		20	μA
Emitter to Base Cutoff Current $V_{EB} = 7 \text{ V}$	I_{EBO}		20	μA
Collector to Emitter Breakdown Voltage $I_C = 30 \text{ mA}$	$V_{(BR)CEO}$	80		V
Collector-Emitter Cutoff Current $V_{CE} = 90 \text{ V}$	I_{CES}		20	ηA
Emitter-Base Cutoff Current $V_{EB} = 5.0 \text{ V}$	I_{EBO}		20	ηA
Forward-Current Transfer Ratio ⁽¹⁾ $I_C = 150 \text{ mA}, V_{CE} = 10 \text{ V}$ $I_C = 0.1 \text{ mA}, V_{CE} = 10 \text{ V}$ $I_C = 10 \text{ mA}, V_{CE} = 10 \text{ V}$ $I_C = 500 \text{ mA}, V_{CE} = 10 \text{ V}$ $I_C = 1 \text{ A}, V_{CE} = 10 \text{ V}$	$[h_{FE}]$	[50] [25] [45] [25] [7.5]	300 300 300 300	
Collector-Emitter Saturation Voltage $I_C = 150 \text{ mA}, I_B = 15 \text{ mA}$ $I_C = 500 \text{ mA}, I_B = 50 \text{ mA}$	$V_{CE(sat)}$		0.23 0.58	V
Base-Emitter Saturation Voltage $I_C = 150 \text{ mA}, I_B = 15 \text{ mA}$	$V_{BE(sat)}$		1.27	V

1. This value is determined from $\Delta(1/h_{fe})$ using pre & post radiation values of h_{fe} . $[h_{fe}]$ should not exceed the pre- radiation minimum h_{fe} .

PACKAGE DIMENSIONS


Symbol	Dimensions				Note	Symbol	Dimensions				Note
	Inch		Millimeters				Inch		Millimeters		
	Min	Max	Min	Max			Min	Max	Min	Max	
BH	0.046	0.056	1.17	1.42		LS ₁	0.036	0.040	0.091	1.02	
BL	0.115	0.128	2.92	3.25		LS ₂	0.071	0.079	1.81	2.01	
BW	0.085	0.108	2.16	2.74		LW	0.016	0.024	0.41	0.61	
CL	-	0.128	-	3.25		r	-	0.008	-	0.203	
CW	-	0.108	-	2.74		r ₁	-	0.012	-	0.305	
LL ₁	0.022	0.038	0.56	0.96		r ₂	-	0.022	-	0.559	
LL ₂	0.017	0.035	0.43	0.89							

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for information only.
3. Hatched areas on package denote metallized areas.
4. Pad 1 = Base, Pad 2 = Emitter, Pad 3 = Collector, Pad 4 = Shielding connected to the lid.
5. In accordance with ASME Y14.5M, diameters are equivalent to Φ x symbology.