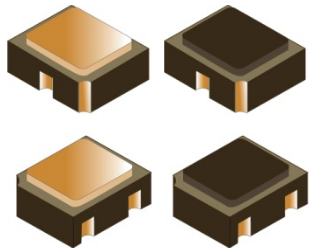
Rad Hard NPN Silicon Switching Transistor

Screened per MIL-PRF-19500 & ESCC 22900

Screened Levels:
MSR

QPL RANGE and RAD LEVEL	
Radiation Level	**MSR2N2222AUB**
TID	100 Krad
ELDRS	100 Krad



UB & UBC Package

DESCRIPTION

This RHA level high speed switching NPN transistor, 2N2222A in a UB or UBC ceramic 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 2N2222A
- 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	ºC
Thermal Resistance Junction-to-Solder Pad (Infinite Sink) (see Figure 4)	$R_{\Theta JSP(IS)}$	90	ºC/W
Thermal Resistance Junction-to-Ambient (see Figure 3) (1)	$R_{\Theta JA}$	325	ºC/W
Total Power Dissipation: @ T_A = +25 ºC (see Figures 1 and 2) @ $T_{SP(IS)}$ = +25 ºC	P_T	0.5 1.0	W
Collector-Base Voltage, Emitter Open	V_{CBO}	75	V
Emitter-Base Voltage, Collector Open	V_{EBO}	6	V
Collector-Emitter Voltage, Base Open	V_{CEO}	50	V
Collector Current, dc	I_C	800	mA
Solder Temperature @ 10 s	T_{SP}	260	ºC

Notes: 1. For non-thermal conductive PCB or unknown PCB surface mount conditions in free air, substitute MIL-PRF-19500/255 figures 8 and 13 and use $R_{\theta JA}$.

Also available in:

TO-206AA (TO-18) package
(leaded top-hat)
MSR2N2222A(L)

UA package
(surface mount)
MSR2N2222AUA

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MECHANICAL and PACKAGING

- CASE: Ceramic with metal lid. UBC is ceramic with ceramic lid.
- TERMINALS: Gold plating over nickel under plate.
- MARKING: Part number, date code, manufacturer's ID.
- TAPE & REEL option: Standard per EIA-418D. Consult factory for quantities.
- WEIGHT: < 0.04 grams
- See Package Dimensions on last page.

PART NOMENCLATURE

MSR 2N2222A UB

Reliability Level
MSR* – 100K Rads (Si)

Surface Mount package
UB = metal lid
UBC = ceramic lid

JEDEC type number

*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.
R_G	Gate drive impedance or Gate resistance
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 ºC unless otherwise noted.

Parameters / Test Conditions	Symbol	Min.	Max.	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage I_C = 10 mA	$V_{(BR)CEO}$	50		V
Collector-Base Cutoff Current V_{CB} = 75 V V_{CB} = 60 V	I_{CBO}		10 10	µA nA
Emitter-Base Cutoff Current V_{EB} = 6.0 V V_{EB} = 4.0 V	I_{EBO}		10 10	µA nA
Collector-Emitter Cutoff Current V_{CE} = 50 V	I_{CES}		50	nA
ON CHARACTERISTICS (1)				
Forward-Current Transfer Ratio I_C = 0.1 mA, V_{CE} = 10 V I_C = 1.0 mA, V_{CE} = 10 V I_C = 10 mA, V_{CE} = 10 V I_C = 150 mA, V_{CE} = 10 V I_C = 500 mA, V_{CE} = 10 V	h_{FE}	 50 75 100 100 30	 325 300 	
Collector-Emitter Saturation Voltage I_C = 150 mA, I_B = 15 mA I_C = 500 mA, I_B = 50 mA	$V_{CE(sat)}$		0.3 1.0	V
Base-Emitter Voltage I_C = 150 mA, I_B = 15 mA I_C = 500 mA, I_B = 50 mA	$V_{BE(sat)}$	0.6	1.2 2.0	V

DYNAMIC CHARACTERISTICS

Parameters / Test Conditions	Symbol	Min.	Max.	Unit
Small-Signal Short-Circuit Forward Current Transfer Ratio I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz	h_{fe}	50		
Magnitude of Small–Signal Short-Circuit Forward Current Transfer Ratio I_C = 20 mA, V_{CE} = 20 V, f = 100 MHz	$\|h_{fe}\|$	2.5		
Output Capacitance V_{CB} = 10 V, I_E = 0, 100 kHz $\leq$ f $\leq$ 1.0 MHz	C_{obo}		8.0	pF
Input Capacitance V_{EB} = 0.5 V, I_C = 0, 100 kHz $\leq$ f $\leq$ 1.0 MHz	C_{ibo}		25	pF

(1) Pulse Test: Pulse Width = 300 µs, Duty Cycle $\leq$ 2.0%.

SWITCHING CHARACTERISTICS

Parameters / Test Conditions	Symbol	Min.	Max.	Unit
Turn-On Time	t_{on}		35	ns
Turn-Off Time	t_{off}		300	ns

GRAPHS

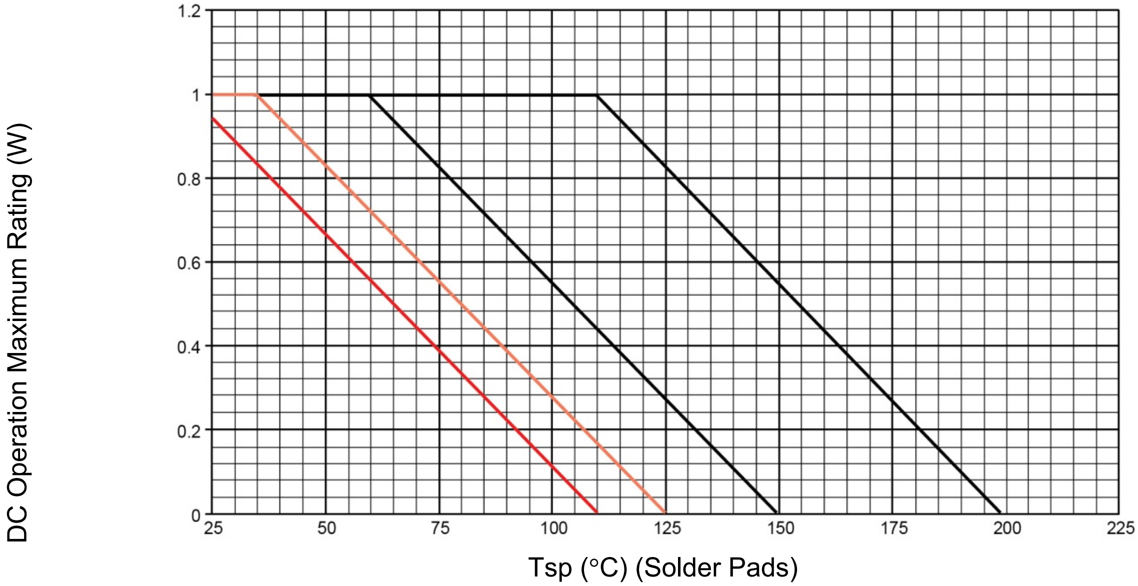


FIGURE 1
Temperature-Power Derating (Infinite sink mount to PCB)

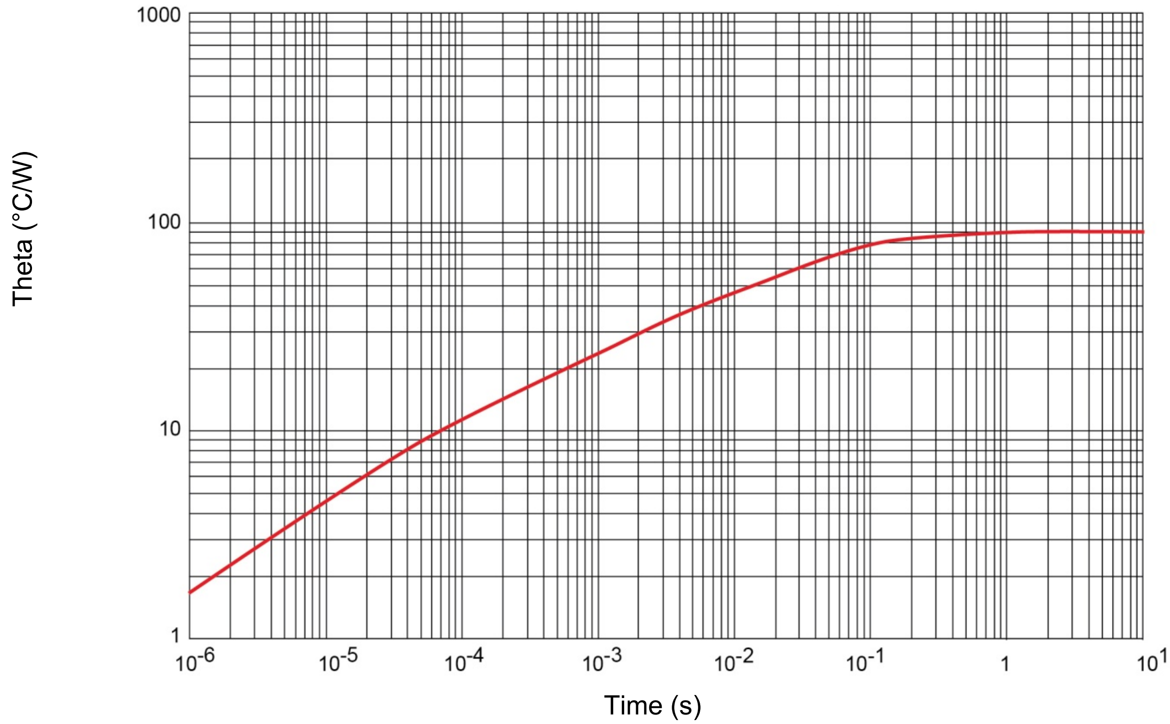


FIGURE 2
Thermal impedance graph ($R_{\Theta JSP(IS)}$)

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, between 50 and 300 rad/s. 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 °C, unless otherwise noted (continued)

POST RADIATION

Parameters / Test Conditions	Symbol	Min.	Max.	Unit
Collector to Base Cutoff Current V_{CB} = 75 V V_{CB} = 60 V	I_{CBO}		20 20	µA nA
Emitter to Base Cutoff Current V_{EB} = 6 V V_{EB} = 4 V	I_{EBO}		20 20	µA nA
Collector to Emitter Breakdown Voltage I_C = 10 mA	$V_{(BR)CEO}$	50		V
Forward-Current Transfer Ratio (1) I_C = 0.1 mA, V_{CE} = 10 V I_C = 1.0 mA, V_{CE} = 10 V I_C = 10 mA, V_{CE} = 10 V I_C = 150 mA, V_{CE} = 10 V I_C = 500 mA, V_{CE} = 10 V	[h_{FE}]	[25] [37.5] [50] [50] [15]	 325 300 	
Collector-Emitter Saturation Voltage I_C = 150 µA, I_B = 15 mA I_C = 500 mA, I_B = 50 mA	$V_{CE(sat)}$		0.35 1.15	V
Base-Emitter Saturation Voltage I_C = 150 µA, I_B = 15 mA I_C = 500 mA, I_B = 50 mA	$V_{BE(sat)}$	0.6	1.38	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 2N2222AUB/C)
- 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

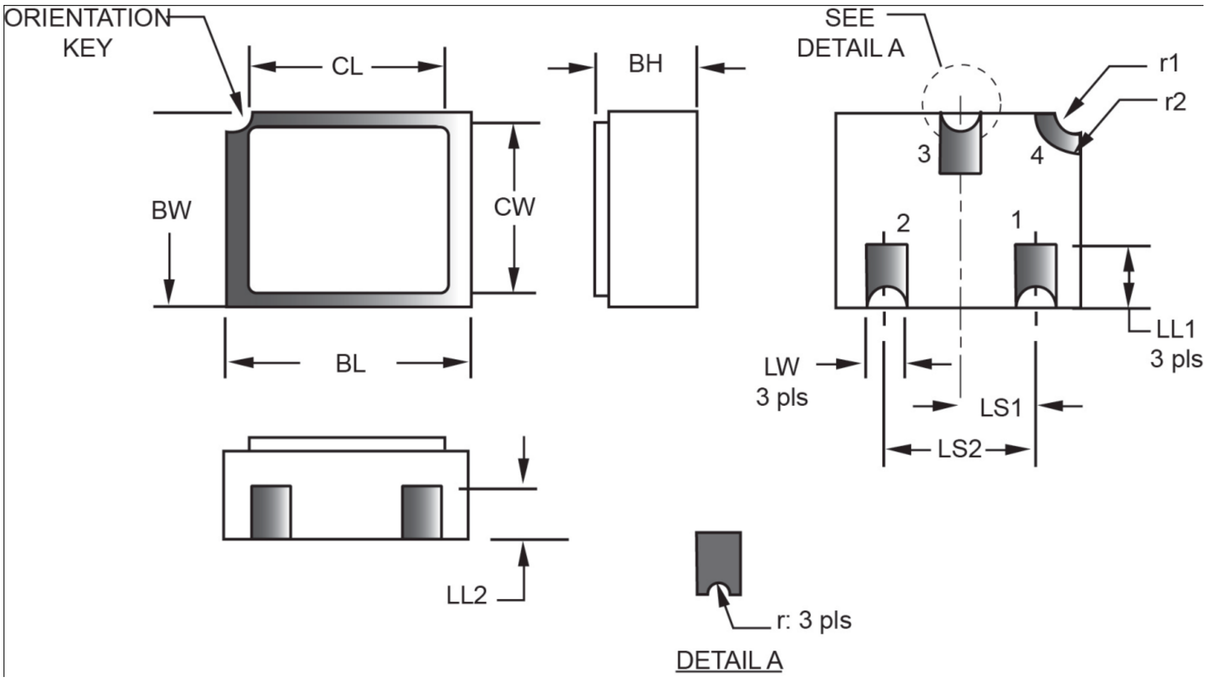
1. Microsemi MSR products will exceed required testing of *ESCC basic specification 22900*

POST RADIATION Table 4

Parameters / Test Conditions	Symbol	Min.	Max.	Unit
Collector to Base Cutoff Current V_{CB} = 75 V V_{CB} = 60 V	I_{CBO}		20 20	µA nA
Emitter to Base Cutoff Current V_{EB} = 6 V V_{EB} = 4 V	I_{EBO}		20 20	µA nA
Collector to Emitter Breakdown Voltage I_C = 10 mA	$V_{(BR)CEO}$	50		V
Forward-Current Transfer Ratio (1) I_C = 0.1 mA, V_{CE} = 10 V I_C = 1.0 mA, V_{CE} = 10 V I_C = 10 mA, V_{CE} = 10 V I_C = 150 mA, V_{CE} = 10 V I_C = 500 mA, V_{CE} = 10 V	[h_{FE}]	[25] [37.5] [50] [50] [15]	 325 300 	
Collector-Emitter Saturation Voltage I_C = 150 µA, I_B = 15 mA I_C = 500 mA, I_B = 50 mA	$V_{CE(sat)}$		0.35 1.15	V
Base-Emitter Saturation Voltage I_C = 150 µA, I_B = 15 mA I_C = 500 mA, I_B = 50 mA	$V_{BE(sat)}$	0.6	1.38	V

1. This value is determined from Δ(1/hfe) using pre & post radiation values of hfe. [hfe] should not exceed the pre- radiation minimum hfe.

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		**LS1**	0.035	0.039	0.89	0.99	
BL	0.115	0.128	2.92	3.25		**LS2**	0.071	0.079	1.80	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	-	0.20	
CW	-	0.108	-	2.74		**r1**	-	0.012	-	0.31	
LL1	0.022	0.038	0.56	0.97		**r2**	-	0.022	-	0.056	
LL2	0.017	0.035	0.43	0.89							

NOTES:
1. Dimensions are in inches. Millimeters are given for information only.
2. Ceramic package only.
3. Hatched areas on package denote metallized areas.
4. Pad 1 = Base, Pad 2 = Emitter, Pad 3 = Collector, Pad 4 = Shielding not connected to lid on UBC version.
5. In accordance with ASME Y14.5M, diameters are equivalent to Φx symbology.