

RADIATION PERFORMANCE OF ACTEL PRODUCTS

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I. TOTAL IONIZATION DOSE (TID) PERFORMANCE

Table I lists the TID data of Actel products published in the open domain. Also included is the availability of each product. Comments about this table:

- Two criteria are used to define the TID tolerance. One is standby ICC exceeding the maximum specification (at 125 °C), and the other is if functional failure occurs.
- A1020S is an experiment lot using 1.2 μm mask set and wafer-fabricated by 1.0 μm process.
- RH products is QML qualified and guaranteed for 300 krad (Si). However, the actual testing passed much higher tolerance marks which are shown in the table.

TABLE I TOTAL IONIZATION DOSE PERFORMANCE OF ACTEL PRODUCTS

Foundry	Technology	Tolerance (rad (Si))		Dose Rate (rad(Si)/sec)	Annealing	Tester	Reference	Product Availability
		Standby ICC	Functional					
A1010/A1020								
MEC	2.0		>300k	13	yes	APL	JPL92	Obsolete
MEC	2.0	>100k	>100k	?	yes	GE ASTRO	JPL92	Obsolete
A1020A								
MEC	1.2		>100k	79	yes	TRW	JPL92	Obsolete
MEC	1.2		100k	13	yes	APL	JPL92	Obsolete
A1020B								
MEC	1.0	30k	>200k	0.036-0.14	yes	Unisys	UNI94	Yes
A1020S								
MEC	1.0	7k	20k	0.2-2		GSFC/Actel	RAD97	Yes
A1280								
MEC	1.2		20k			HAC	JPL92	Obsolete
MEC	1.2	5k		13	yes	APL	JPL92	Obsolete
A1280A								
MEC	1.0	5k-6k		0.003		HIREC	HIR95	Yes
MEC	1.0	5-10k		0.01-0.06		Unisys	EEE96	Yes
MEC	1.0		18k	0.16		SAAB/ESA	ESA96	Yes
MEC	1.0	10k		0.0028	yes	HIREC	HIR97	Yes
A1280XL								
Winbond	0.8	2.5k		0.2-2		GSFC/Actel	RAD97	Yes
CSM	0.6	2.5k		0.2-2		GSFC/Actel	RAD97	Yes
RH1280								
LMFS	0.8	2.0M		171	yes	LMFS	LM95a	Yes
LMFS	0.8	2.0M		164	yes	LMFS	LM95b	Yes
LMFS	0.8	> 600k		152	yes	LMFS	LM96a	Yes
A1460A								
MEC	0.8		54k-77k			SAAB/ESA	ESA96	Yes
MEC	0.8	28k		0.2-2		GSFC/Actel	RAD97	Yes
A32140DX								
CSM	0.6		2.2k	0.2-2		GSFC/Actel	RAD97	Yes
RT54SX16								
MEC	0.6	38k	>50k	0.2-2		GSFC/Actel	RAD97	Pre-prod
RH54SX16								
LMFS	0.5	>200k		0.2-2		GSFC/Actel	RAD97	Pre-prod

II. SINGLE EVENT UPSET (SEU) AND SINGLE EVENT LATCHUP (SEL) PERFORMANCE

Table II lists the SEU “soft error” data. Also included are the proton upset and single event latchup (SEL) data. Comments about this table:

- Devices with low ($< 37.5 \text{ MeV-cm}^2/\text{mg}$) SEL LET_{th} (column 7) are considered not suitable for space applications. Usually the SEU is not measured once SEL occurs. This is the reason why some of the devices in the table have only SEL data.
- SEU LET_{th} (column 5) is defined at when upset starts. Data with ‘*’ mark are defined at 10% of the saturation cross section (column 6).
- In the device column, C means flip-flop made of combinatorial modules, S is sequential module, I/O is input/output, and MS is the “modified sequential module” which only uses the combinatorial part of the sequential module.

TABLE II SINGLE EVENT UPSET AND SINGLE EVENT LATCHUP PERFORMANCE OF ACTEL PRODUCTS

Device	Technology /Foundry	Bias (volts)	Temperature (°C)	LET _{th} (MeV-cm ² /mg)	X-section (cm ² /bit)	Latchup LET _{th}	Proton Upset	Tester /Facility	Reference
ACT 1									
A1010	2.0/MEC	5.0	Room to 100	25*	5.0x10 ⁻⁶	No		Aerospace	JPL92
A1020	2.0/MEC	5.0	Room to 100	25*	5.0x10 ⁻⁶	No		Aerospace	JPL92
A1020A	1.2/MEC	5.0	Room	22*	3.0x10 ⁻⁶	No		APL	JPL92
A1020B	1.0/MEC	5.0	Room	28*	2.0x10 ⁻⁶	50		Aerospace	EEE96
A1020B	1.0/MEC	5.5	Room			37		GSFC/BNL	NS97
A1020B	1.0 / TI	5.5	Room			22		GSFC/BNL	NS97
ACT 2									
A1280 (C)	1.2/MEC	5.0	Room to 100	23	3.0x10 ⁻⁶	No		GSFC/BNL	EEE96
A1280 (S)	1.2/MEC	5.0	Room to 100	5	8.0x10 ⁻⁶	No		GSFC/BNL	EEE96
A1280A (C)	1.0/MEC	5.0	Room	27	2.0x10 ⁻⁶	No		Aerospace	Koga
A1280A (S)	1.0/MEC	5.0	Room	3	6.2x10 ⁻⁶	No		Aerospace	Koga
A1280A (C)	1.0/MEC	5.0	Room	28	2.0x10 ⁻⁶	No		GSFC/BNL	EEE96
A1280A (S)	1.0/MEC	5.0	Room	5	8.0x10 ⁻⁶	No		GSFC/BNL	EEE96
A1280A (I/O)	1.0/MEC	5.0	Room	28		No		GSFC/BNL	EEE96
A1280A (C)	1.0/MEC	5.0	Room	26	3.0x10 ⁻⁶	No		ESA/BNL	ESA96
A1280A (S)	1.0/MEC	5.0	Room	8	1.5x10 ⁻⁶	No		ESA/BNL	ESA96
A1280A (I/O)	1.0/MEC	5.0	Room	15	3.0x10 ⁻⁶	No		ESA/BNL	ESA96
A1280XL (C)	0.8/WIN	5.0	Room				No	GSFC	EEE97
A1280XL (S)	0.8/WIN	5.0	Room				Yes	GSFC	EEE97
A1280XL (I/O)	0.8/WIN	5.0	Room				No	GSFC	EEE97
A1280XL (C)	0.6/CSM	5.0	Room				No	GSFC	EEE97
A1280XL (S)	0.6/CSM	5.0	Room				Yes	GSFC	EEE97
A1280XL (I/O)	0.6/CSM	5.0	Room				No	GSFC	EEE97
ACT 3									
A1460A (C)	0.8/MEC	5.0	Room		2.0x10 ⁻⁷	No		GSFC/BNL	EEE96
A1460A (S)	0.8/MEC	5.0	Room	>6	1.0x10 ⁻⁶	No		GSFC/BNL	EEE96
A1460A (C)	0.8/MEC	5.0	Room	32	1.5x10 ⁻⁶	No		ESA/BNL	ESA96
A1460A (S)	0.8/MEC	5.0	Room	8	1.0x10 ⁻⁵	No		ESA/BNL	ESA96
A1460A (I/O)	0.8/MEC	5.0	Room	10	2.0x10 ⁻⁶	No		ESA/BNL	ESA96
A1460A (C)	0.8/MEC	3.3	Room	25	8.0x10 ⁻⁷	No		GSFC/BNL	EEE96
A1460A (S)	0.8/MEC	3.3	Room	<6	2.0x10 ⁻⁶	No		GSFC/BNL	EEE96
A1460A (C)	0.8/MEC	3.3	Room	20	3.0x10 ⁻⁶	No		ESA/BNL	ESA96
A1460A (S)	0.8/MEC	3.3	Room	6	3.0x10 ⁻⁶	No		ESA/BNL	ESA96
A1460A (I/O)	0.8/MEC	3.3	Room	8	7.0x10 ⁻⁶	No		ESA/BNL	ESA96
A1460A (C)	0.8/MEC	5.0	Room	21			No	GSFC	EEE97a
A1460A (S)	0.8/MEC	5.0	Room	8			Yes	GSFC	EEE97a
A1460A (I/O)	0.8/MEC	5.0	Room	8			Yes	GSFC	EEE97a
A14100A (C)	0.8/MEC	5.0	Room	28	1.0x10 ⁻⁶	No	No	GSFC	EEE97
A14100A (S)	0.8/MEC	5.0	Room	8			Yes	GSFC	EEE97
A14100A (I/O)	0.8/MEC	5.0	Room	8			Yes	GSFC	EEE97
A14100A (C)	0.8/MEC	5.0	Room	21			No	GSFC	EEE97a
A14100A (S)	0.8/MEC	5.0	Room	8			Yes	GSFC	EEE97a
A14100A (I/O)	0.8/MEC	5.0	Room	8			Yes	GSFC	EEE97a

<i>DX</i>									
A32140DX	0.6/CSM	5.5	Room			No		GSFC/BNL	NS97
A32200DX	0.6/CSM	5.5	Room			16		GSFC/BNL	NS97
<i>RH</i>									
RH1280 (C)	0.8/LMFS	4.5	Room	17	1.1×10^{-6}	No		LMFS/BNL	LM96
RH1280 (S)	0.8/LMFS	4.5	Room	4	3.2×10^{-6}	No		LMFS/BNL	LM96
RH1280 (MS)	0.8/LMFS	4.5	Room	26	5.1×10^{-6}	No		LMFS/BNL	LM96
RH1280 (C)	0.8/LMFS	4.5	Room	24	2.0×10^{-6}	No		LMFS/Texas	LM95
RH1280 (S)	0.8/LMFS	4.5	Room	5	8.5×10^{-6}	No		LMFS/Texas	LM95
RH1280 (C)	0.8/LMFS	5.0	Room to 100	22	8.0×10^{-6}	No		GSFC/BNL	EEE96
RH1280 (S)	0.8/LMFS	5.0	Room to 100	3	9.0×10^{-6}	No		GSFC/BNL	EEE96
RH1280 (C)	0.8/LMFS	5.0	Room	27	1.7×10^{-6}	No		ESA/BNL	ESA96
RH1280 (S)	0.8/LMFS	5.0	Room	8	6.0×10^{-6}	No		ESA/BNL	ESA96
RH1280 (I/O)	0.8/LMFS	5.0	Room	15	1.0×10^{-6}	No		ESA/BNL	ESA96
RH1280 (C)	0.8/LMFS	3.3	Room	15	4.0×10^{-6}	No		ESA/BNL	ESA96
RH1280 (S)	0.8/LMFS	3.3	Room	5	1.0×10^{-6}	No		ESA/BNL	ESA96
RH1280 (I/O)	0.8/LMFS	3.3	Room	10	2.0×10^{-6}	No		ESA/BNL	ESA96
<i>SX</i>									
RT54SX16 (FF)	0.6/MEC	3.0	Room	17	3.0×10^{-6}	No	No	GSFC/Actel	RAD97
RH54SX16 (FF)	0.5/LMFS	3.0	Room	19	1.5×10^{-6}	No	No	GSFC/Actel	RAD97

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