

Radiation test results

PSI facility

Transceivers: SN74ACT245D (8 Bit)
SN74LVC16T245DGGR (16 Bit)

Preparation, development, test and analysis by

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SN74ACT245D (8 Bit)

- Asynchronous two-way communication
 - 4.5 to 5.5 V operation voltage
 - Inputs accept voltages up to 5.5 V
 - TTL compatible
 - Communication direction selectable
 - Outputs can be switched OFF (Hiz)
- 3 devices under test

SN74LVC16T245DGGR (16 Bit)

- Asynchronous two-way communication
 - - 0.5 to 6.5 V operation voltage
 - Inputs accept voltages up to 6.5 V
 - Ports of 16 Bit split into 2x 8 Bit ports
 - Dual supply transceiver
 - Ports A & B can track each an independent voltage V_{CCA} and V_{CCB}
 - Translation of signals to different voltage levels
 - 1.8 V, 2.5 V, 3.3 V, 5 V
 - Communication direction selectable
 - Outputs can be switch OFF (Hiz)
- 6 devices under test



Objective of the irradiation test

- Evaluate the voltage level & the signal recognition
- Test the functionality of both control pins
 - DIR = Direction
 - OE = Output enable
- Estimate sensitivity to SET and SEL
- Verify the device supply current

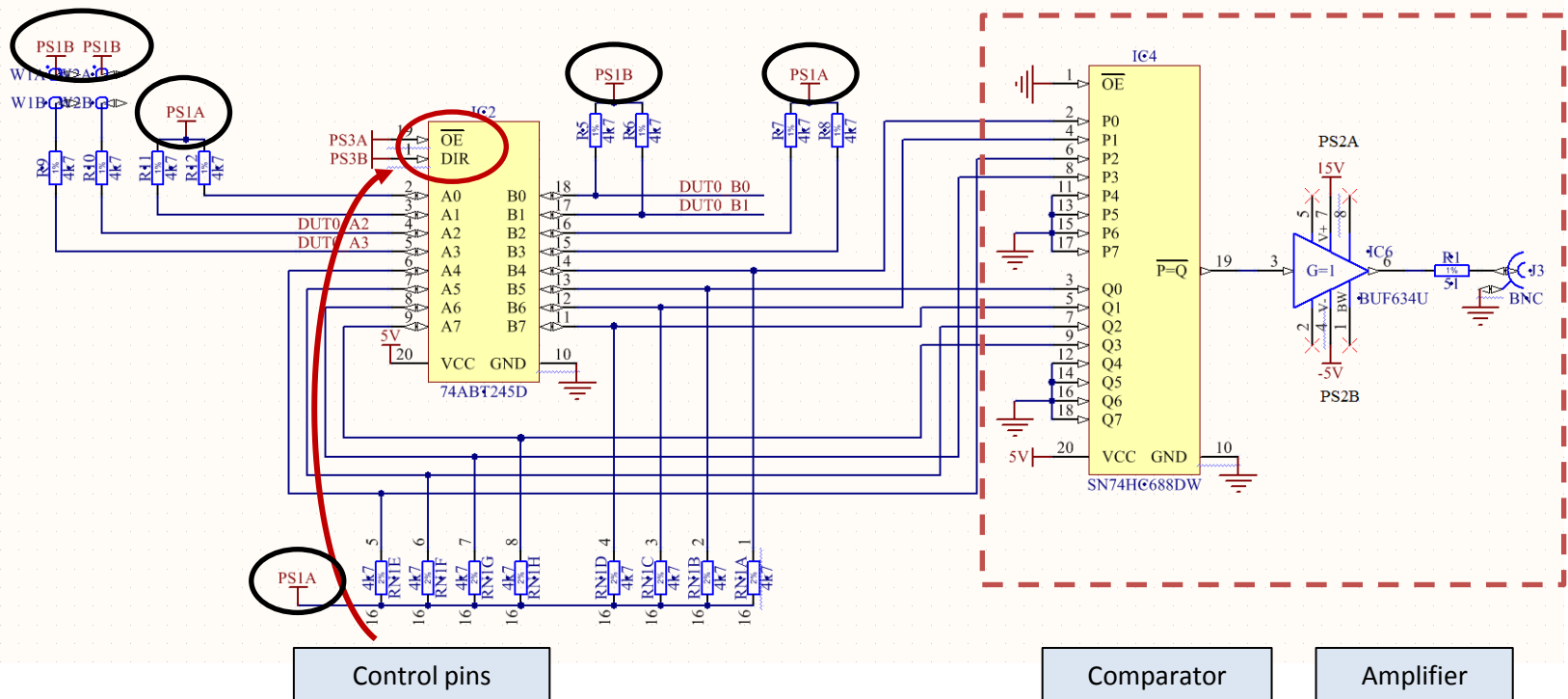
Beam condition

PIF facility at PSI

- Proton energy was set to 230 MeV
- Dose rate: 5 – 10 rad/s
- TID per device: ~ 400 Gy

Schematics – 8 Bit Transceiver

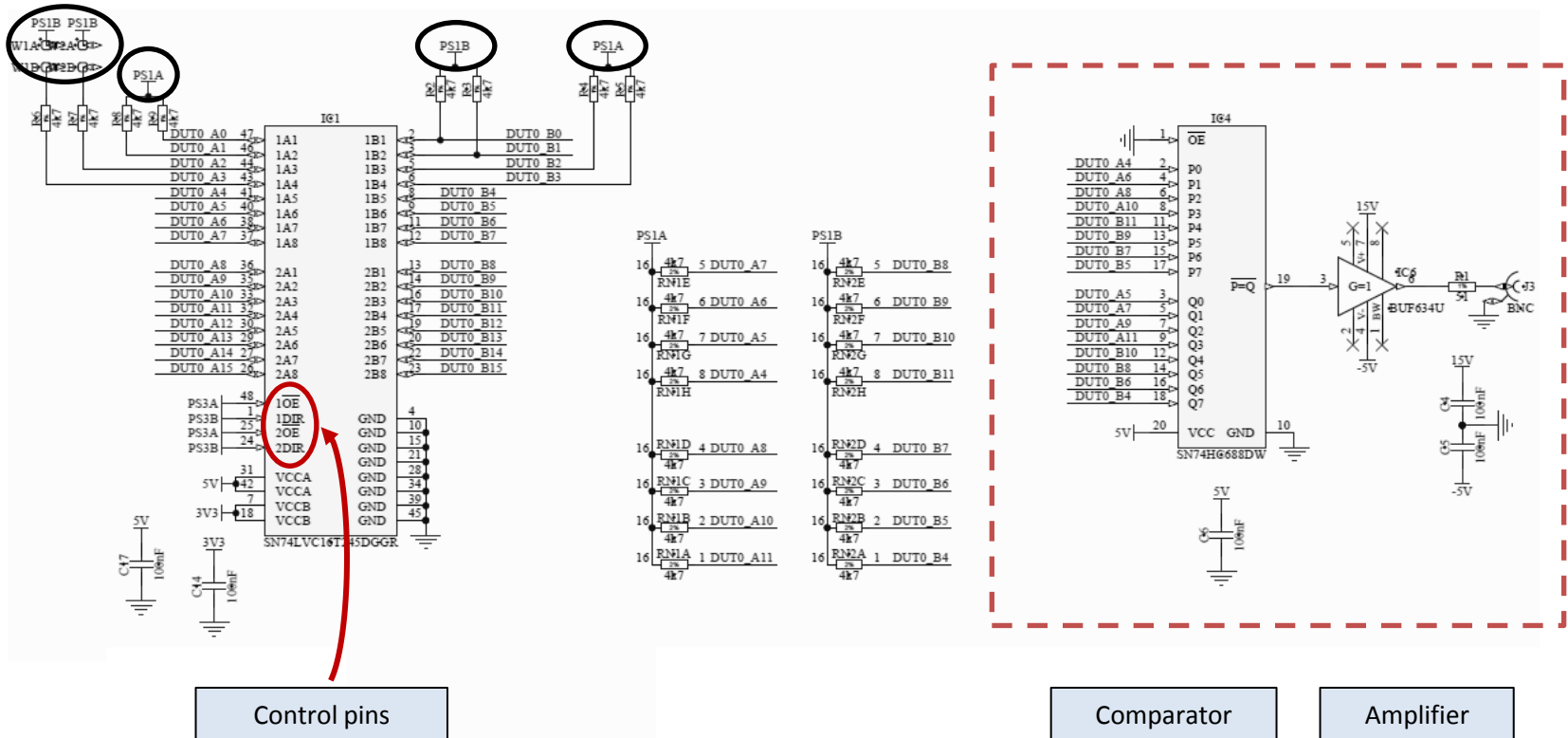
Outside beam



- Voltages levels on pins adjustable with PS1A/B
- $V_{CC} = 5\text{ V}$

Schematics – 16 Bit Transceiver

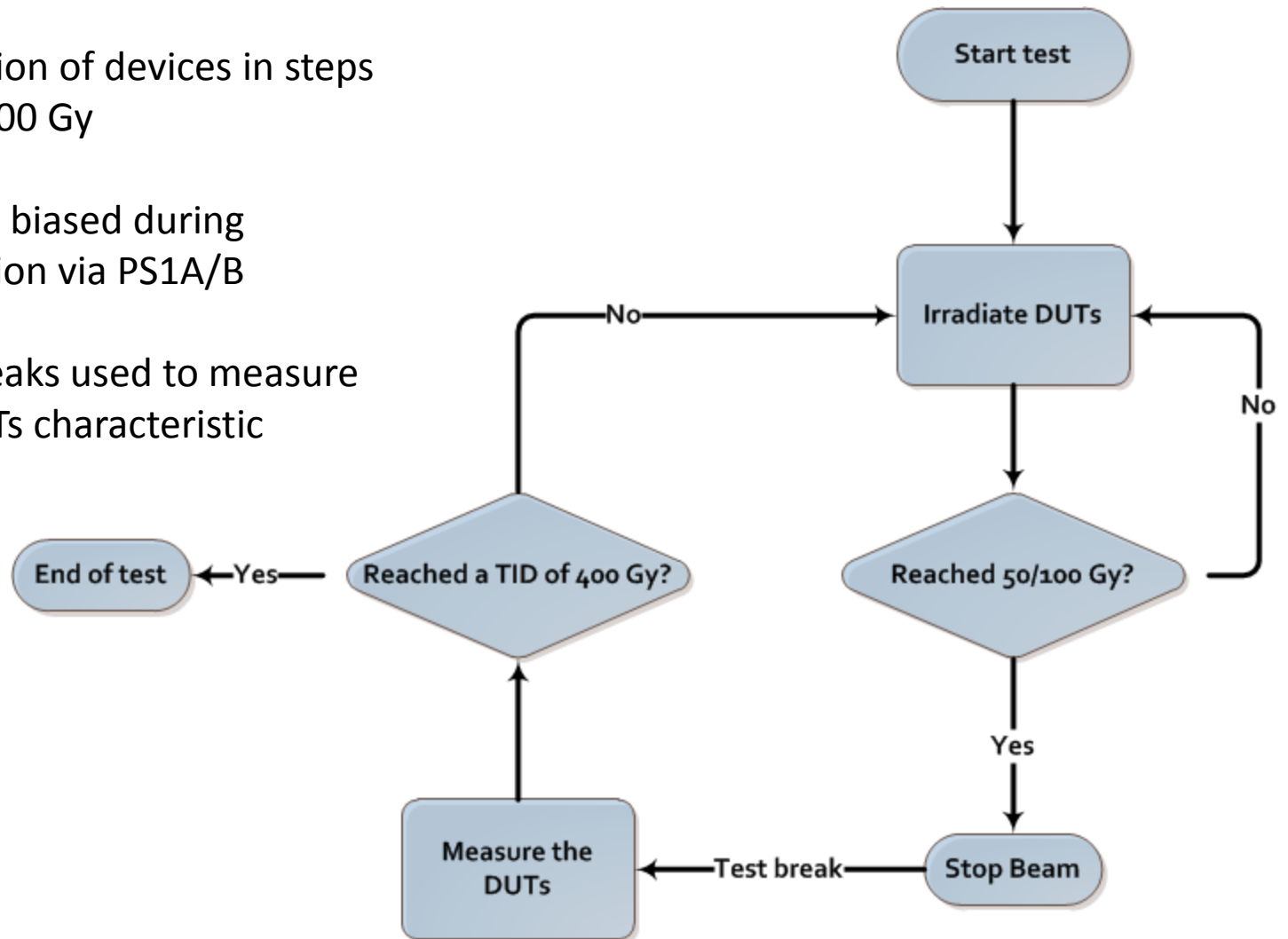
Outside beam



- Voltages levels on pins adjustable with PS1A/B
- $V_{CCA} = 5\text{ V}$, $V_{CCB} = 3.3\text{ V}$

Test procedure

- Irradiation of devices in steps of 50/100 Gy
- Devices biased during irradiation via PS1A/B
- Test breaks used to measure the DUTs characteristic

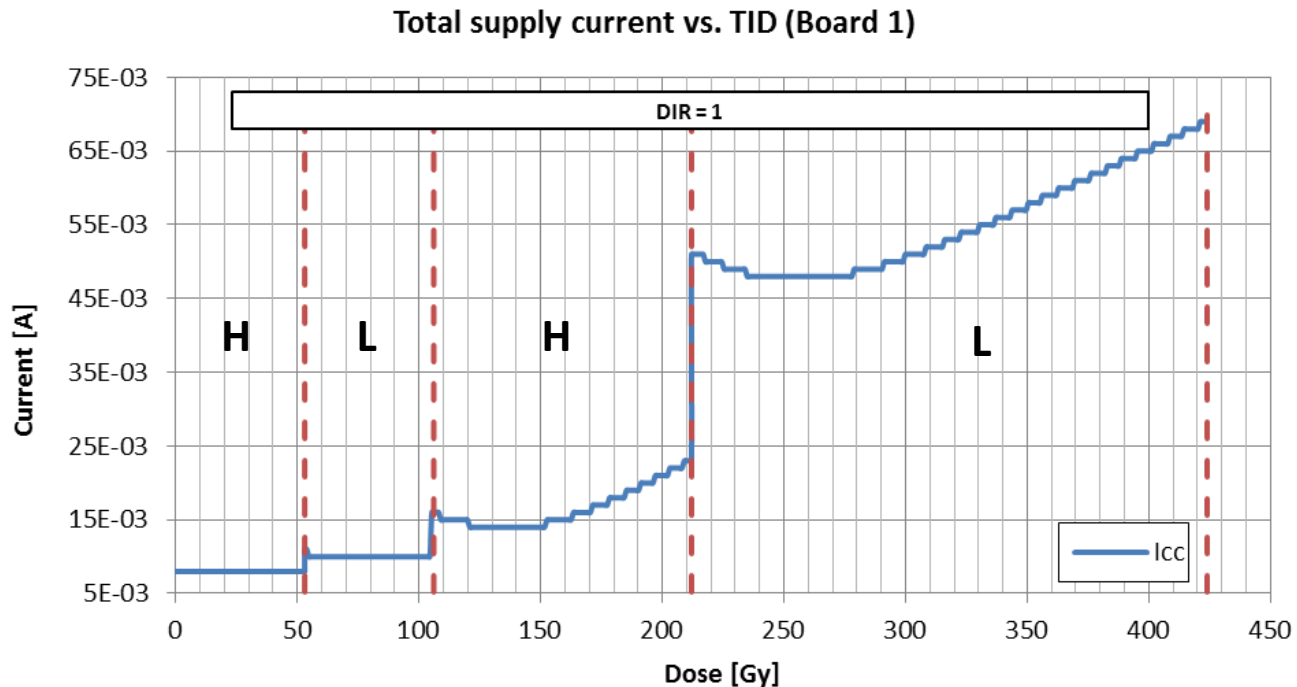


Test settings – Transceivers

Beam ON				
Function test	\overline{OE}	DIR	PS1A	PS1B
-	0	0 / 1	0 / 5 V	0 / 4 V
Beam OFF / Test break				
Function test	\overline{OE}	DIR	PS1A	PS1B
Direction A → B	0	1	5 V	4 V
Direction A ← B	0	0	5 V	4 V
Level detection	0	0 / 1	5...0 V 0...5 V	4 V
Enable pin (isolation)	1	0	5 V	4 V

Results – SN74ACT245D (8 Bit)

Total supply current during the irradiation:



- Current is increasing with dose → from 8 to 69 mA after 431 Gy
- Current doubles when switching to High level → from 69 to 140 mA at 431 Gy (not shown)
- ✓ Devices within the specification (max. tolerable $I_{cc} = 200$ mA)

Results – SN74ACT245D (8 Bit)

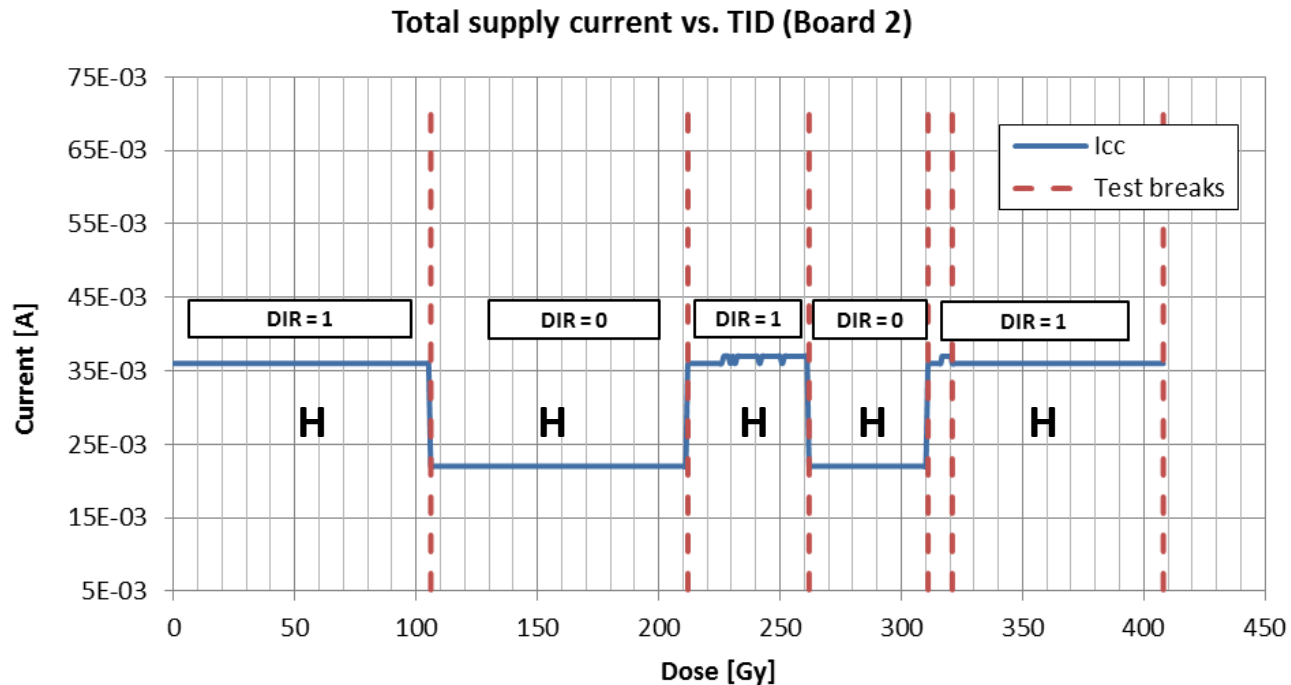
Measurements during test breaks:

Run	TID per run (Gy)	Cumulated TID (Gy)	Fluence per run (p/cm ²)	DIR	\overline{OE}	Test ok?													
21						Yes													
						Function test	DUT 1 [V]				DUT 2 [V]				DUT 3 [V]				Yes
							B0	B1	A2	A3	B0	B1	A2	A3	B0	B1	A2	A3	Yes
22						Yes													
						Transport A→B	4.9	4.9	3.2	3.5	4.9	4.9	3.5	3.5	4.8	4.8	3.4	3.4	Yes
23						Yes													
						Transport A←B	3.5	3.5	4.9	4.9	0.5	0.5	0	0	0.3	0.3	0	0	Yes
						Device OFF (pin isolation)	5.0	5.0	4.5	5.0	0.9	0.8	5.0	5.0	0.3	0.3	4.9	4.9	Yes
24						Yes													

Note: PS1B was set from 4 V to 3.5 V. Green = Ok, Orange = Within the tolerance range, Red = Out of specifications

- All devices stable until a TID of 212 Gy
- After 424 Gy:
 - 1) All devices failed when turning OFF the device (Pin isolation)
 - 2) Input voltage threshold exceeded limits: V_{IL} (1.3 V), V_{IH} (1.7 V); (max. specified limit: 0.8/2 V)

Total supply current during the irradiation:



- Current mainly changes when switching the transport direction → from 35 to 22 mA and vice versa
- ✓ Devices within the specification (max. tolerable $I_{cc} = 200$ mA)

Measurements during test breaks:

Run	TID (Gy)	Cumulated TID (Gy)	Fluence (p/cm ²)	DIR	\overline{OE}	Test ok?
26	106	106	2.00E+11	A→B	ON	Yes
				A←B	ON	Yes
				A←B	OFF	Yes
				A→B	OFF	Yes
27	-	-	-	-	-	No run
28	106	212	2.00E+11	A→B	ON	Yes
				A←B	ON	Yes
				A←B	OFF	Yes
				A→B	OFF	Yes
29	-	-	-	-	-	No run
30	50	262	9.48E+10	A→B	ON	Yes
				A←B	ON	Yes
				A←B	OFF	Yes
				A→B	OFF	Yes

Run	TID (Gy)	Cumulated TID (Gy)	Fluence (p/cm ²)	DIR	\overline{OE}	Test ok?
31	49	311	9.20E+10	A→B	ON	Yes
				A←B	ON	Yes
				A←B	OFF	Yes
				A→B	OFF	Yes
32	10	321	2.00E+10	No test due to beam crash		
33	87	408	1.65E+11	A→B	ON	Yes
				A←B	ON	Yes
				A←B	OFF	Yes
				A→B	OFF	Yes

- ✓ All devices stable until a TID of 408 Gy
- ✓ All tested parameters within the specifications

Summary – Transceivers

- 3x 8 Bit transceivers and 6x 16 Bit transceivers were tested
- All chips were irradiated by a 230 MeV proton beam
- All received a cumulated dose of 400 – 430 Gy at 5 – 10 rad/s
- No SETs or SELs observed

Functions	SN74ACT245 (8 Bit)	SN74LVC16T245DGGR (16 Bit)
Device supply current	High increase (+132 mA) Remains below specified limit (200 mA)	No increase Remains below specified limit (200 mA)
Direction (DIR) pin	Fails between 212 – 424 Gy	No errors
Output enable (OE) pin	Fails between 212 – 424 Gy	No errors
Input voltage thresholds V_{IL} & V_{OL}	Fail between 212 – 424 Gy	Stable
Input / Output levels	Went out of specification between 212 – 424 Gy	Stable
Level recognition	No errors	No errors

- **SN74ACT245 (8 Bit):**
 - Device stable until 212 Gy
 - Begins to fail at higher doses

- **SN74LVC16T245DGGR (16 Bit):**
 - Device stable until 408 Gy
 - No errors have been observed

Thank you for your attention!

Any questions?