PRELIMINARY
Reliability Analysis
for the
SVT Data Transmission System

Version 1.0

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General remarks:

- All estimates are based on the MIL–HDBK–217F handbook, version January 1991 unless otherwise indicated.
- For a conservative estimate the quality factor of the components is taken to be 'lower'.
- Any kind of solder joints are not included in the reliability analysis as well as failure of the printed circuit boards themselves.
- The cables from the power supplies to the MUX Modules are not included in the analysis.
- Units are failures per year assuming continuous running (1a = 8760 hours)

1. Matching Card

104 cards in assembly

	#/ board	failure rate/a per part	# of failures/a total assembly
1206 surface mount resistors	29	$7.0 \cdot 10^{-5}$	0.21
47 μF, 16 V tantalum bypass caps	8	$9.4 \cdot 10^{-5}$	0.08
100 nF, 100 V bypass caps	9	$8.5 \cdot 10^{-5}$	0.08
100 nF, 100 V bypass caps (n– and p–side)	6	$1.9 \cdot 10^{-4}$	0.12
1 nF, 100 V bypass caps (shield–bias)+temp	3	$1.2 \cdot 10^{-4}$	0.04
Power connectors (18 pins)	2	$2.7 \cdot 10^{-5}$	0.006
Signal connector (26 pins)	1	$3.7 \cdot 10^{-5}$	0.004
Berg connector (30 pins)	2	$8.8 \cdot 10^{-5}$	0.018
Failures per year all 104 cards			0.55

Notes:

- Calculations are done assuming a temperature of 30°C and with an environment factor G_B as the card is inside the detector volume.
- The above failure modes (with the exception of two of the 1 nF capacitors between the shield and analog 2V of the p– and n–side, respectively) do not lead to a catastrophic failure in the sense of endangering the front end IC's.
- For the power connector the pinout of the prototype forward Matching card is assumed (36 pins in total). This might change with the new chosen cable.

2. Cable Connectors

2 power cables and 1 signal cable per Matching Card,
1 connector each between support tube and exit cable

I assume here Roy Kerth's suggestion of connectors and cables
$\longrightarrow$ 36 pairs in 3 cables
$\longrightarrow$ 72 crimp connections $\times$ 4 ends = 288 pins/HDI
$\longrightarrow$ 29952 total assembly

Failure rate: $4.6 \cdot 10^{-5}$/a (quality factor of 10 assumed, environment factor G_F)

Total number of failures: $\underline{1.36/\text{a}}$

It should be noted that some of the power lines have more than 1 pair.

3. MUX Module

a. DAQ Link Card

26 cards in assembly

The design of this card is not yet finalized, so the parts list is preliminary and includes only a minimal design. No estimates are given for
— the FINISAR Optical Transmitter and Receivers
— fiber optics connectors
— any needed circuitry for a remote control selection of clock and command lines !!

	#/ board	failure rate/a per part	# of failures/a total assembly
Finisar optical transmitter/receiver	1	?	?
G–Link Transmitter $*$	1	$3.8 \cdot 10^{-7}$	$1 \cdot 10^{-5}$
G–Link Receiver $*$	1	$3.8 \cdot 10^{-7}$	$1 \cdot 10^{-5}$
100311 Clock fan out	1	$2.5 \cdot 10^{-3}$	0.065
DS1004 Silicon delay line	3	$2.0 \cdot 10^{-3}$	0.156
AD9696 Comparator	2	$4.1 \cdot 10^{-4}$	0.022
MC10114 ECL Buffer	3	$1.1 \cdot 10^{-3}$	0.084
0.1 μF, 50V bypass caps	20	$1.7 \cdot 10^{-4}$	0.090
Surface mount resistors	100	$1.5 \cdot 10^{-4}$	0.401
28 pin PLCC socket	1	$5.9 \cdot 10^{-5}$	0.002
8 pin socket	5	$2.5 \cdot 10^{-5}$	0.003
16 pin socket	3	$3.8 \cdot 10^{-5}$	0.003
96 pin VME connector	1	$5.2 \cdot 10^{-4}$	0.014
Failures per year all 26 cards			0.840

$*$ Information obtained from Hewlett–Packard for T=50^{o}C.

Notes:

- Calculations are done assuming a temperature of 40^{o}C and with an environment factor G_F. The Modules sit in a water–cooled crate just outside the detector.

3. MUX Module

b. HDI Link Card

26 cards in assembly

	#/ board	failure rate/a per part	# of failures/a total assembly
10130 D-Latches	16	$1.1 \cdot 10^{-3}$	0.449
MC10114 ECL Buffer	22	$1.1 \cdot 10^{-3}$	0.618
AD9696 Comparator	16	$4.1 \cdot 10^{-4}$	0.171
MC14011B	8	$1.0 \cdot 10^{-3}$	0.210
MC14175	8	$6.7 \cdot 10^{-4}$	0.140
MAX709M Voltage Monitor	8	$1.3 \cdot 10^{-4}$	0.027
ICM7242 Timer	8	$3.4 \cdot 10^{-4}$	0.072
HCPL–7101 Optocoupler	24	$5.3 \cdot 10^{-4}$	0.333
Q2N3904 resetting transistors	48	$2.3 \cdot 10^{-5}$	0.029
ZVN4206A driver en-/disable FET's	32	$1.2 \cdot 10^{-3}$	1.061
Q2N5109 diff driver transistors	64	$6.0 \cdot 10^{-5}$	0.010
BAV99 dual diode package	128	$1.8 \cdot 10^{-4}$	0.590
DIN4001 diodes	8	$1.8 \cdot 10^{-4}$	0.037
47 μF, 16 V tantalum bypass caps	24	$9.4 \cdot 10^{-5}$	0.059
100 nF, 100 V bypass caps (across 30V)	48	$1.9 \cdot 10^{-4}$	0.238
100 nF, 50 V bypass caps (across 5V)	292	$1.7 \cdot 10^{-4}$	1.316
1 nF, 100V caps	12	$1.0 \cdot 10^{-4}$	0.033
30 pF, 100V level shifting caps	64	$1.0 \cdot 10^{-4}$	0.166
160 pF, 100V level shifting caps	64	$1.3 \cdot 10^{-4}$	0.209
Surface mount resistors	360	$1.5 \cdot 10^{-4}$	1.441
16 pin socket	52	$3.8 \cdot 10^{-5}$	0.051
14 pin socket	8	$3.4 \cdot 10^{-5}$	0.007
96 pin VME connector	1	$5.2 \cdot 10^{-4}$	0.014
96 pin VME conn. (only 8 pins active)	1	$5.2 \cdot 10^{-5}$	0.001
24 pin signal connector	4	$1.6 \cdot 10^{-4}$	0.017
48 pin power connector	8	$4.3 \cdot 10^{-4}$	0.090
Failures per year all 26 cards			7.383

Notes:

- None of the above calculated failures applies the full bias voltage to the HDI's, bypassing and voltage translation have in every case 2 caps in series. To improve reliability capacitors with even higher rating than 100V might be considered.