ESA ESTEC
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The Netherlands

LM4050_TID_TEST_REPORT

LM4050QAEM3-2.5/NOPB
Date Code: 2118 and 1914
2.5V Bandgap Voltage Reference
Texas Instruments

Prepared by Florian Krimmel

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CHANGE LOG

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DISTRIBUTION

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Table of Contents

1. INTRODUCTION

The current report presents the TID results on the Bandgap Voltage Reference LM4041

- LM4050QAEM3-2.5/NOPB, date code: 2118, Texas Instruments
- LM4050QAEM3-2.5/NOPB, date code: 1914, Texas Instruments

The test campaign was performed between the 24th January and 18th February 2022 at the ESTEC 60Co facility.

Additional information on the context is provided in the test plan [RD01].

2. DOCUMENTS

2.1. Applicable documents

AD01 ESCC22900 Total Dose Steady-state irradiation test method, June 2016

2.2. Reference documents

RD01 TID_COTS_Bandgap-ref_test_plan

RD02 RA0005344 Radiation Test Summary

3. PART & PROCUREMENT INFORMATION

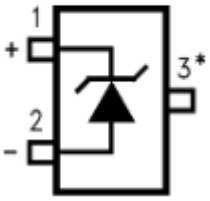
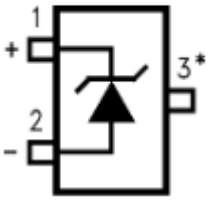
Part number	LM4050QAEM3-2.5/NOPB	LM4050QAEM3-2.5/NOPB
Manufacturer	Texas Instruments	Texas Instruments
Function	2.5V Bandgap Voltage Reference	2.5V Bandgap Voltage Reference
Technology	Bipolar	Bipolar
Package	DBZ Package 3-Pin SOT-23 Top View 	DBZ Package 3-Pin SOT-23 Top View 
Date Code [yyww]	2118	1914
Distributor	DigiKey	Mouser
Part # (sample n°) date code	5 samples unbiased (n° B70 to B74) 5 samples biased (n° B75 to B79) 1 reference unbiased (n° REF17) 1 reference biased (n° REF67)	5 samples unbiased (n° B80 to B84) 5 samples biased (n° B85 to B89) 1 reference unbiased (n° REF18) 1 reference biased (n° REF68)

Table 1: Part & procurement information

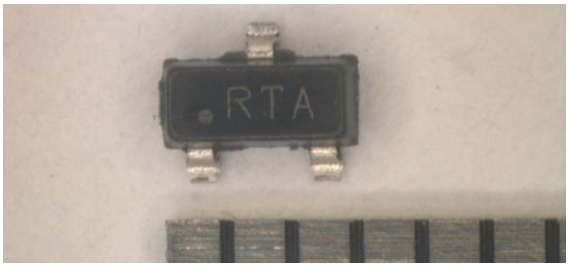
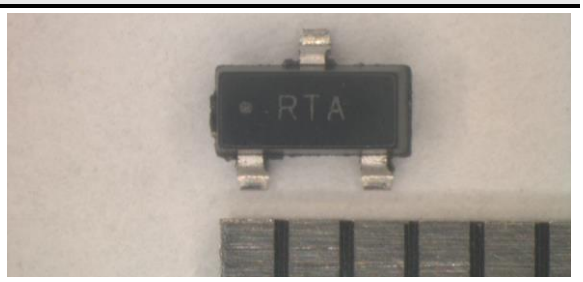
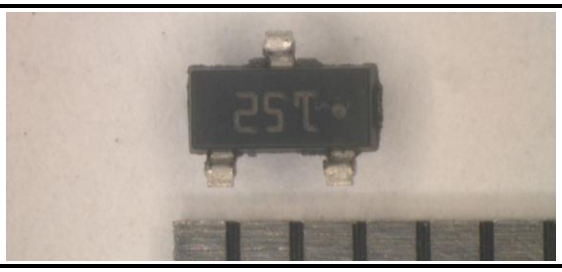
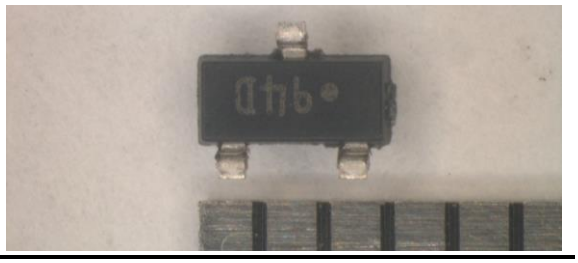
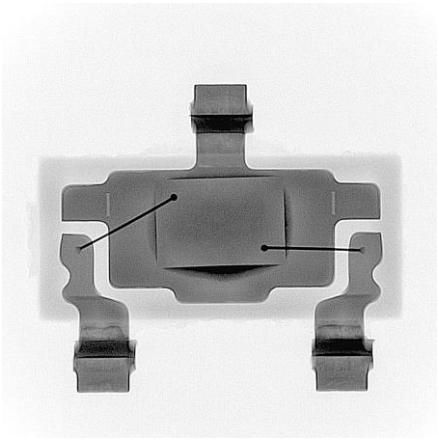
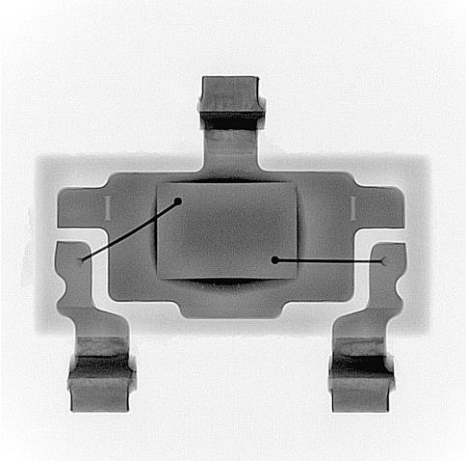
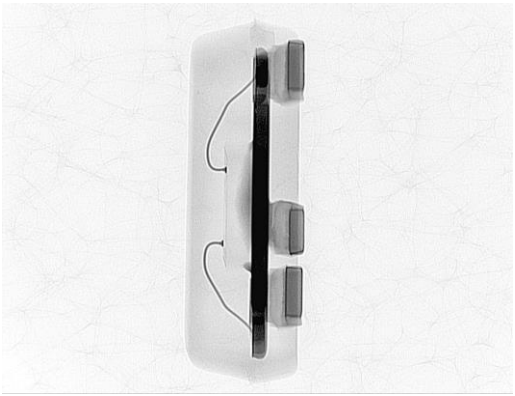
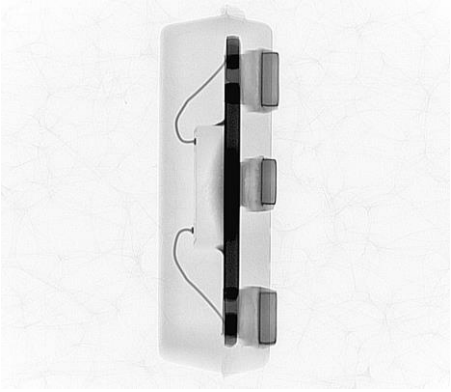
Part number	LM4050QAEM3-2.5/NOPB (2118)	LM4050QAEM3-2.5/NOPB (1914)
Package marking top		
Package marking bottom		
X-ray top view		
X-ray side view		

Table 2: Package marking X-ray of the DUT

4. DOSIMETRY AND IRRADIATION FACILITY

IRRADIATION FACILITY

Source:	C060
Localization:	ESTEC, Netherlands
Dosimetry:	Electrometer: Farmer model 2670 – s/n 491
	Ionisation chamber: PTW TW30012-10 s/n 000417

IRRADIATION TIMING

TID steps (krad(Si))	0, 5, 10, 15, 20, 38.2, 50, 80.5, 100
Dose rate (rad(Si)/h)	240 - 260

ANNEALING TIMING		Condition during annealing
Annealing 22°C	24 h	Biased for those tested biased
		Unbiased for those tested unbiased
Ageing 100°C	168h	ON for those tested ON
		Unbiased for those tested unbiased

Values are provided in TID(H_20), the conversion to TID(Si) is done using the conversion factor of: 0.898.

5. TEST SET-UP

5.1. Test set-up overview

The set-up to measure at specific TID steps outside the irradiation chamber is schematically depicted in the Figure 1. Inside the radiation chamber the component boards with the DUTs on it are connected to the biasing boards which have a determined resistor to create the right value of biasing current (typical current acc. to datasheet) from a 12V supply for each biased component. Additionally to that, there are also 0-Ohm resistors on the biasing boards to connect all pins of the unbiased components.

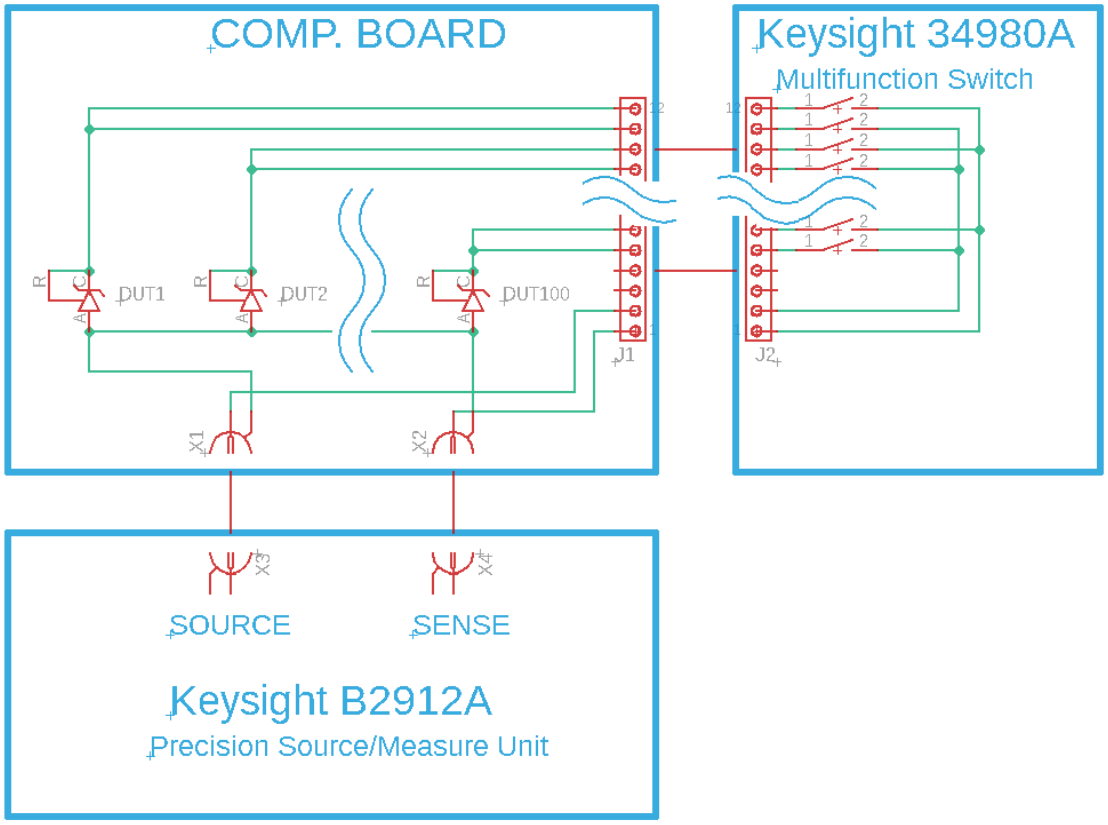


Figure 1: Simplified schematic of the overall test set-up

Four PCBs which were specially designed for this purpose could allow to accommodate both biased and unbiased components for this component and also other bandgap reference components at the same time on a 12 x 22 cm² PCB. This size of the boards limits the TID variation across board to less than 10%. Set-up pictures are provided in Annex B.

During each defined TID step a PC laptop was used to acquire the voltage (V_Z) as well as the input current (I_Z) of each of the samples from the source measure unit (SMU). The laptop time is synchronised to the time used for controlling the Co60 facility.

5.2. Test equipment

TEST EQUIPMENT	PARAMETER MEASURED
1 x Keysight B2912A 2412A Precision Source/Measure Unit (SMU)	Providing 6 different I_Z currents acc. to datasheet of the components: I_{min}, $0.8xI_{typ}$, I_{typ}, $3.14xI_{typ}$, $10xI_{typ}$, I_{max} V_{max} = 5.0 V
1 x Keysight 34980A Multifunction Switch	Switching through all up to 100 samples solder on one board.
1 x Laptop with LabView	Logging and saving the V_Z and I_Z measurements using an in-house VI.

6. TEST PARAMETERS

The following two parameters are measured:

PARAMETERS	SYMBOLS
Reverse Breakdown Voltage	V_Z
Reverse Current	I_Z

7. BIASING CONDITIONS

All biased samples are continuously biased with the typical value of I_Z according to the datasheet of each part type:

Table summarised the main biasing conditions

PART TYPE	Value	Unit
LM4050QAEM3-2.5/NOPB	100	µA

Table 2: Biasing conditions during irradiation

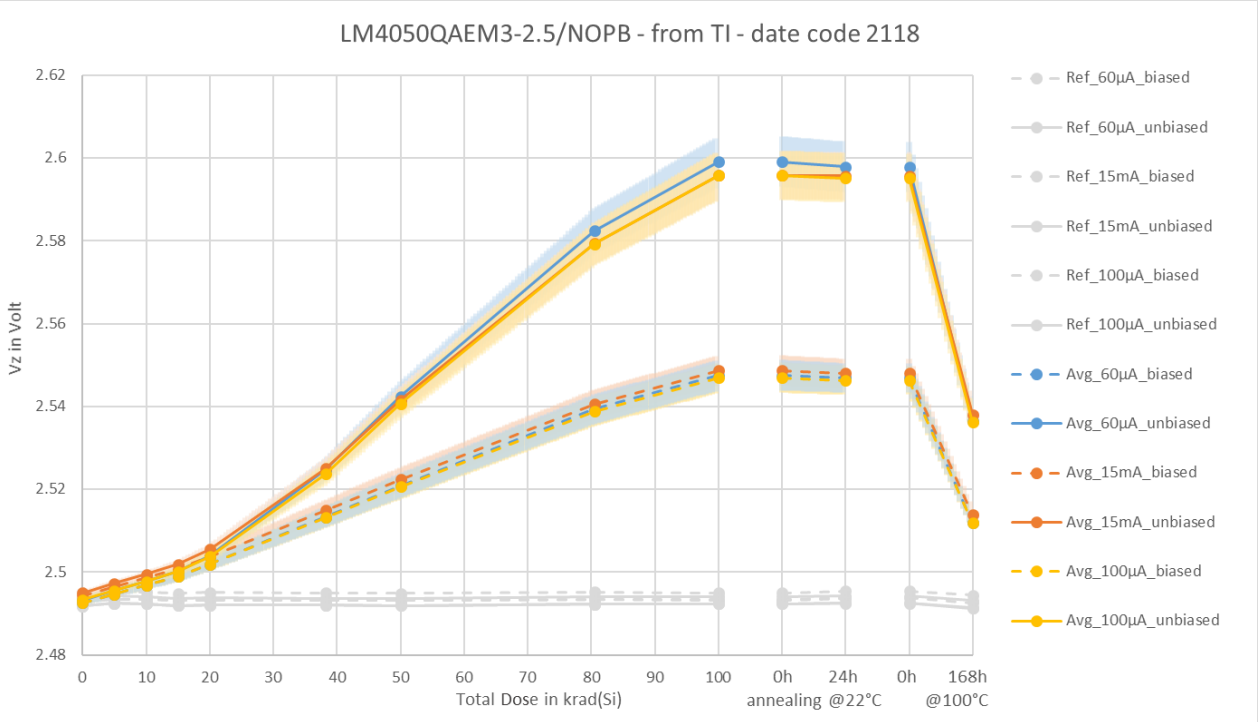
8. TID RESULTS

8.1. TID RESULTS - LM4050QAEM3-2.5/NOPB - from TI - date code 2118

LM4050QAEM3-2.5/NOPB - from TI - date code 2118 - @ I-min 60µA												
DUT No.	krad (Si)	0	5	10	15	20	38.2	50	80.5	100	Room Temp. annealing	100°C annealing
B70	unbiased	2.4924	2.4947	2.4970	2.4993	2.5031	2.5235	2.5411	2.5810	2.5978	2.5965	2.5364
B71		2.4932	2.4955	2.4977	2.5001	2.5039	2.5248	2.5424	2.5827	2.5994	2.5982	2.5373
B72		2.4940	2.4963	2.4986	2.5011	2.5050	2.5265	2.5447	2.5858	2.6032	2.6021	2.5379
B73		2.4938	2.4961	2.4986	2.5012	2.5054	2.5279	2.5466	2.5883	2.6055	2.6040	2.5392
B74		2.4932	2.4950	2.4968	2.4989	2.5021	2.5210	2.5374	2.5742	2.5897	2.5884	2.5316
B75	biased	2.4936	2.4958	2.4981	2.5005	2.5037	2.5163	2.5243	2.5431	2.5510	2.5502	2.5131
B76		2.4928	2.4949	2.4969	2.4990	2.5017	2.5126	2.5201	2.5388	2.5477	2.5473	2.5128
B77		2.4916	2.4934	2.4953	2.4972	2.4998	2.5102	2.5172	2.5349	2.5427	2.5423	2.5097
B78		2.4925	2.4949	2.4972	2.4997	2.5030	2.5154	2.5234	2.5428	2.5511	2.5502	2.5125
B79		2.4923	2.4945	2.4967	2.4987	2.5015	2.5122	2.5194	2.5372	2.5451	2.5445	2.5112
REF17	Ref unbiased	2.4918	2.4925	2.4924	2.4920	2.4920	2.4920	2.4919	2.4923	2.4924	2.4925	2.4913
REF67	Ref biased	2.4932	2.4935	2.4935	2.4931	2.4933	2.4932	2.4931	2.4934	2.4932	2.4937	2.4926

LM4050QAEM3-2.5/NOPB - from TI - date code 2118 - @ I-typ 100µA											Limit acc. DS: Vz = 2.5V ± 0.75% (2.4813V – 2.5187V)	
DUT No.	krad (Si)	0	5	10	15	20	38.2	50	80.5	100	Room Temp. annealing	100°C annealing
B70	unbiased	2.4925	2.4947	2.4970	2.4994	2.5030	2.5225	2.5394	2.5779	2.5945	2.5940	2.5360
B71		2.4932	2.4955	2.4977	2.5001	2.5039	2.5238	2.5407	2.5795	2.5961	2.5955	2.5369
B72		2.4940	2.4963	2.4986	2.5011	2.5049	2.5254	2.5428	2.5826	2.5999	2.5993	2.5376
B73		2.4938	2.4962	2.4985	2.5012	2.5051	2.5267	2.5446	2.5848	2.6019	2.6012	2.5388
B74		2.4932	2.4950	2.4968	2.4989	2.5021	2.5200	2.5356	2.5712	2.5865	2.5859	2.5314
B75	biased	2.4936	2.4958	2.4981	2.5005	2.5037	2.5161	2.5240	2.5425	2.5504	2.5496	2.5131
B76		2.4929	2.4949	2.4969	2.4989	2.5017	2.5125	2.5198	2.5384	2.5471	2.5467	2.5128
B77		2.4916	2.4935	2.4953	2.4972	2.4998	2.5101	2.5169	2.5344	2.5422	2.5417	2.5097
B78		2.4926	2.4949	2.4973	2.4997	2.5029	2.5152	2.5231	2.5423	2.5505	2.5496	2.5125
B79		2.4924	2.4946	2.4967	2.4987	2.5015	2.5121	2.5192	2.5367	2.5446	2.5439	2.5111
REF17	Ref unbiased	2.4919	2.4925	2.4924	2.4920	2.4921	2.4920	2.4920	2.4922	2.4924	2.4926	2.4914
REF67	Ref biased	2.4932	2.4935	2.4936	2.4931	2.4934	2.4933	2.4931	2.4935	2.4933	2.4938	2.4927

LM4050QAEM3-2.5/NOPB - from TI - date code 2118 - @ I-max 15mA												
DUT No.	krad (Si)	0	5	10	15	20	38.2	50	80.5	100	Room Temp. annealing	100°C annealing
B70	unbiased	2.4942	2.4965	2.4987	2.5011	2.5048	2.5240	2.5404	2.5782	2.5946	2.5945	2.5380
B71		2.4949	2.4972	2.4995	2.5018	2.5055	2.5250	2.5416	2.5796	2.5961	2.5960	2.5389
B72		2.4957	2.4980	2.5004	2.5029	2.5066	2.5267	2.5437	2.5825	2.5997	2.5996	2.5394
B73		2.4955	2.4979	2.5003	2.5029	2.5069	2.5280	2.5454	2.5848	2.6018	2.6016	2.5407
B74		2.4949	2.4968	2.4986	2.5007	2.5038	2.5215	2.5367	2.5717	2.5868	2.5867	2.5334
B75	biased	2.4953	2.4975	2.4998	2.5022	2.5054	2.5178	2.5257	2.5442	2.5521	2.5512	2.5151
B76		2.4948	2.4967	2.4987	2.5008	2.5036	2.5144	2.5217	2.5402	2.5489	2.5485	2.5149
B77		2.4934	2.4952	2.4971	2.4990	2.5017	2.5119	2.5188	2.5362	2.5441	2.5435	2.5118
B78		2.4943	2.4966	2.4991	2.5015	2.5047	2.5170	2.5249	2.5440	2.5522	2.5514	2.5145
B79		2.4940	2.4963	2.4984	2.5005	2.5032	2.5138	2.5208	2.5383	2.5462	2.5456	2.5131
REF17	Ref unbiased	2.4936	2.4942	2.4941	2.4937	2.4938	2.4937	2.4937	2.4941	2.4941	2.4943	2.4932
REF67	Ref biased	2.4950	2.4953	2.4953	2.4949	2.4951	2.4950	2.4949	2.4953	2.4950	2.4955	2.4944



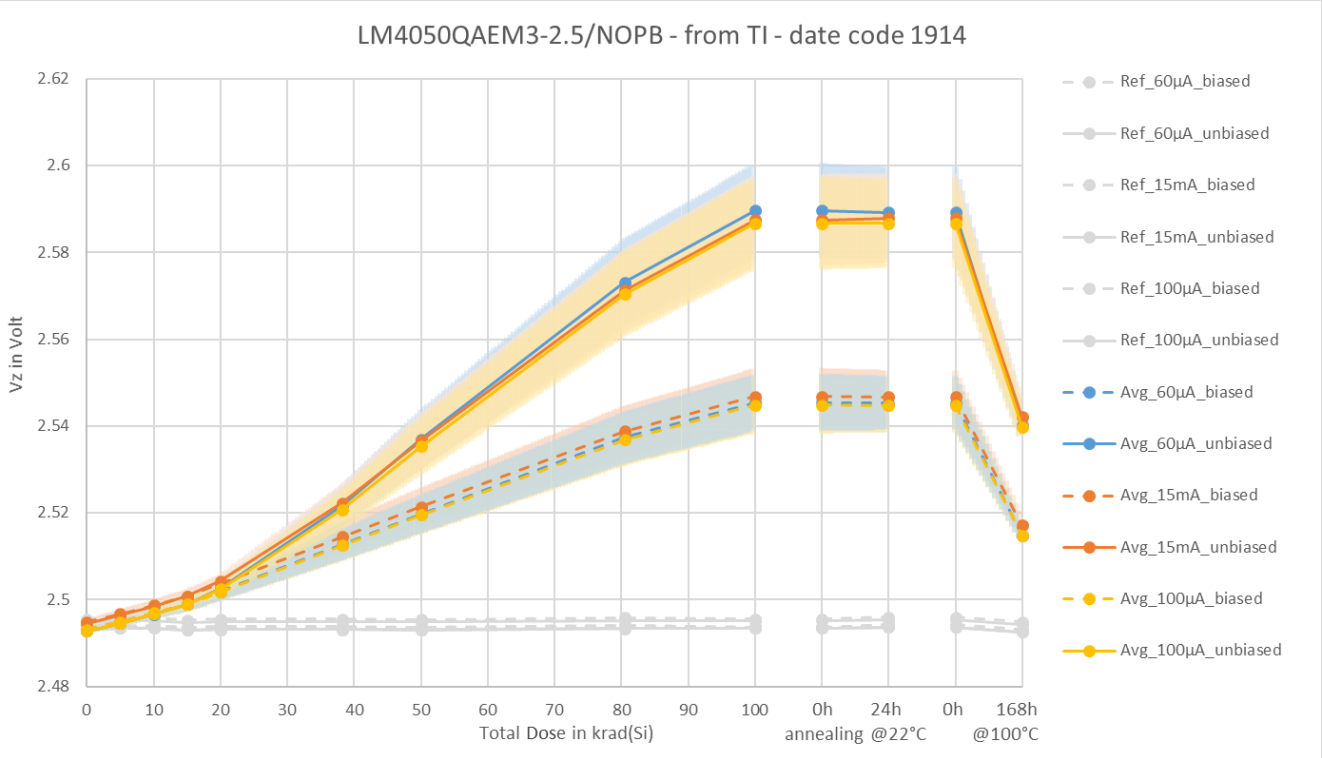
For all curves, which show an average over all measured samples, the coloured interval behind the curves represent +/- one standard deviation.

8.2. TID RESULTS - LM4050QAEM3-2.5/NOPB - from TI - date code 1914

LM4050QAEM3-2.5/NOPB - from TI - date code 1914 - @ I-min 60µA												
DUT No.	krad (Si)	0	5	10	15	20	38.2	50	80.5	100	Room Temp. annealing	100°C annealing
B80	unbiased	2.4925	2.4943	2.4964	2.4987	2.5024	2.5215	2.5367	2.5727	2.5890	2.5887	2.5407
B81		2.4923	2.4941	2.4961	2.4986	2.5024	2.5224	2.5384	2.5758	2.5927	2.5923	2.5416
B82		2.4931	2.4955	2.4980	2.5010	2.5054	2.5290	2.5475	2.5885	2.6063	2.6051	2.5465
B83		2.4928	2.4943	2.4961	2.4981	2.5011	2.5170	2.5302	2.5630	2.5786	2.5784	2.5353
B84		2.4933	2.4949	2.4968	2.4988	2.5020	2.5186	2.5320	2.5657	2.5815	2.5813	2.5367
B85	biased	2.4936	2.4953	2.4974	2.4994	2.5023	2.5131	2.5200	2.5378	2.5460	2.5460	2.5152
B86		2.4926	2.4943	2.4962	2.4982	2.5008	2.5108	2.5175	2.5342	2.5422	2.5422	2.5139
B87		2.4941	2.4963	2.4990	2.5018	2.5053	2.5188	2.5273	2.5475	2.5565	2.5558	2.5179
B88		2.4929	2.4943	2.4960	2.4977	2.5003	2.5103	2.5167	2.5330	2.5403	2.5405	2.5134
B89		2.4925	2.4941	2.4960	2.4979	2.5006	2.5107	2.5173	2.5342	2.5421	2.5421	2.5136
REF18	Ref unbiased	2.4929	2.4935	2.4935	2.4931	2.4931	2.4931	2.4931	2.4935	2.4935	2.4937	2.4926
REF68	Ref biased	2.4937	2.4940	2.4940	2.4936	2.4938	2.4937	2.4936	2.4940	2.4937	2.4942	2.4931

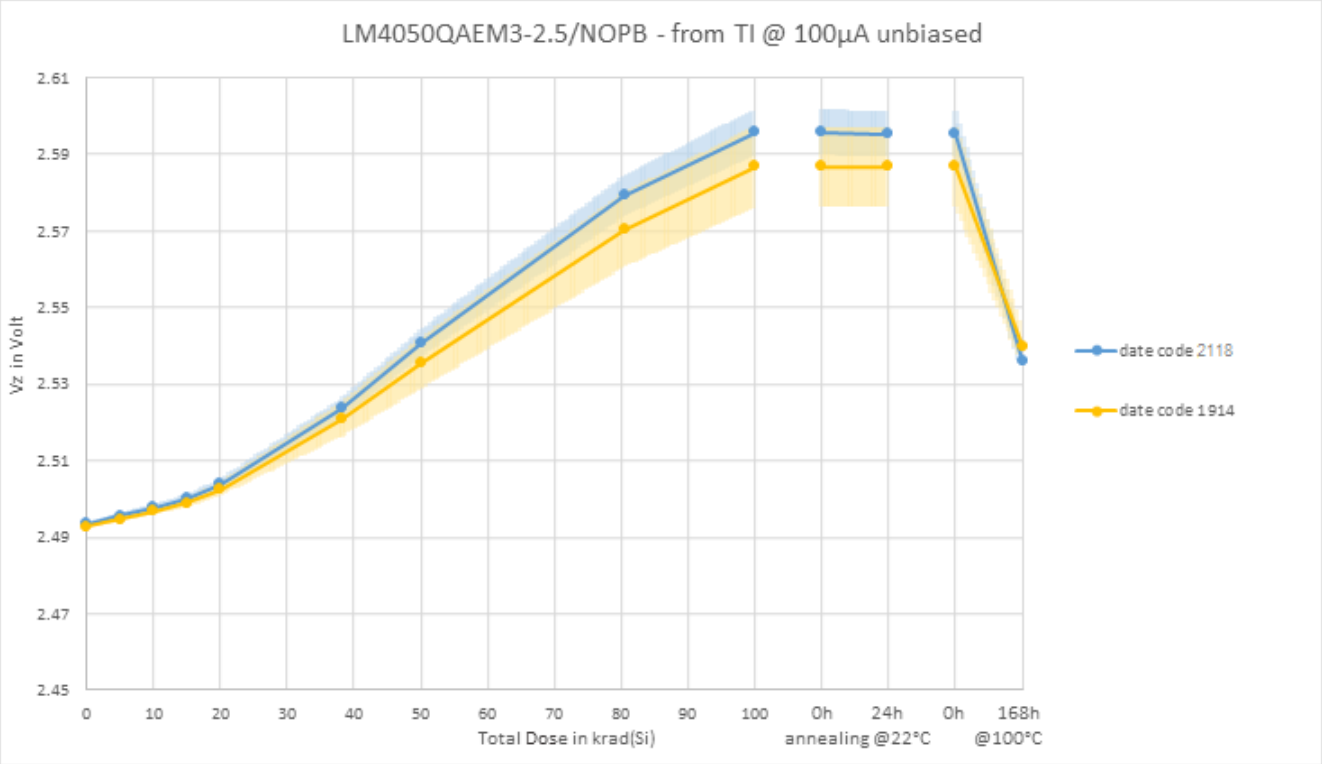
LM4050QAEM3-2.5/NOPB - from TI - date code 1914 - @ I-typ 100µA											Limit acc. DS: Vz = 2.5V ± 0.75% (2.4813V – 2.5187V)	
DUT No.	krad (Si)	0	5	10	15	20	38.2	50	80.5	100	Room Temp. annealing	100°C annealing
B80	unbiased	2.4925	2.4943	2.4964	2.4986	2.5022	2.5206	2.5351	2.5699	2.5861	2.5863	2.5403
B81		2.4923	2.4941	2.4962	2.4986	2.5022	2.5214	2.5367	2.5728	2.5896	2.5898	2.5412
B82		2.4932	2.4955	2.4981	2.5010	2.5053	2.5278	2.5456	2.5853	2.6029	2.6024	2.5460
B83		2.4928	2.4943	2.4962	2.4980	2.5009	2.5163	2.5289	2.5606	2.5760	2.5762	2.5350
B84		2.4933	2.4949	2.4968	2.4988	2.5019	2.5178	2.5306	2.5632	2.5788	2.5790	2.5363
B85	biased	2.4936	2.4953	2.4973	2.4995	2.5023	2.5129	2.5198	2.5374	2.5455	2.5454	2.5152
B86		2.4926	2.4943	2.4963	2.4982	2.5008	2.5106	2.5172	2.5338	2.5417	2.5416	2.5139
B87		2.4941	2.4964	2.4990	2.5018	2.5053	2.5186	2.5270	2.5469	2.5559	2.5552	2.5179
B88		2.4928	2.4943	2.4959	2.4977	2.5003	2.5101	2.5164	2.5325	2.5398	2.5400	2.5135
B89		2.4925	2.4942	2.4960	2.4979	2.5006	2.5105	2.5171	2.5338	2.5416	2.5416	2.5136
REF18	Ref unbiased	2.4929	2.4936	2.4935	2.4931	2.4931	2.4932	2.4931	2.4934	2.4934	2.4937	2.4926
REF68	Ref biased	2.4937	2.4940	2.4940	2.4936	2.4938	2.4938	2.4936	2.4940	2.4937	2.4942	2.4932

LM4050QAEM3-2.5/NOPB - from TI - date code 1914 - @ I-max 15mA												
DUT No.	krad (Si)	0	5	10	15	20	38.2	50	80.5	100	Room Temp. annealing	100°C annealing
B80	unbiased	2.4943	2.4960	2.4981	2.5004	2.5040	2.5220	2.5363	2.5707	2.5868	2.5875	2.5426
B81		2.4940	2.4959	2.4980	2.5004	2.5041	2.5229	2.5380	2.5737	2.5905	2.5909	2.5436
B82		2.4949	2.4973	2.4999	2.5028	2.5071	2.5292	2.5467	2.5859	2.6036	2.6036	2.5484
B83		2.4947	2.4961	2.4980	2.4999	2.5028	2.5180	2.5304	2.5617	2.5769	2.5776	2.5375
B84		2.4950	2.4967	2.4986	2.5005	2.5037	2.5193	2.5320	2.5641	2.5797	2.5802	2.5387
B85	biased	2.4954	2.4971	2.4992	2.5013	2.5041	2.5148	2.5218	2.5393	2.5474	2.5474	2.5176
B86		2.4945	2.4962	2.4981	2.5000	2.5027	2.5126	2.5192	2.5358	2.5437	2.5437	2.5163
B87		2.4959	2.4982	2.5008	2.5035	2.5071	2.5205	2.5289	2.5488	2.5578	2.5571	2.5202
B88		2.4946	2.4961	2.4977	2.4995	2.5021	2.5119	2.5182	2.5343	2.5417	2.5419	2.5156
B89		2.4943	2.4961	2.4979	2.4998	2.5025	2.5125	2.5191	2.5358	2.5437	2.5436	2.5161
REF18	Ref unbiased	2.4948	2.4953	2.4953	2.4948	2.4950	2.4949	2.4949	2.4952	2.4953	2.4955	2.4944
REF68	Ref biased	2.4955	2.4958	2.4958	2.4954	2.4956	2.4955	2.4954	2.4958	2.4955	2.4960	2.4949



8.1. Comparison Manufacturer and Date Code

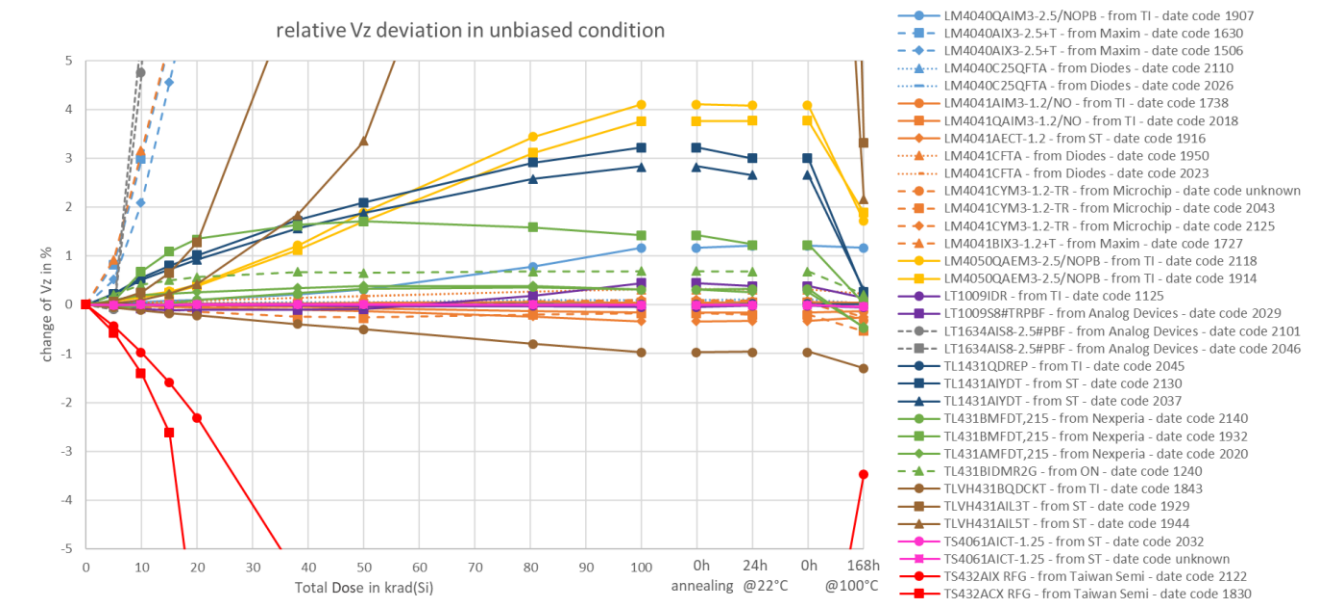
The following graph shows the different behaviour of all measured LM4050 voltage references with different date code.

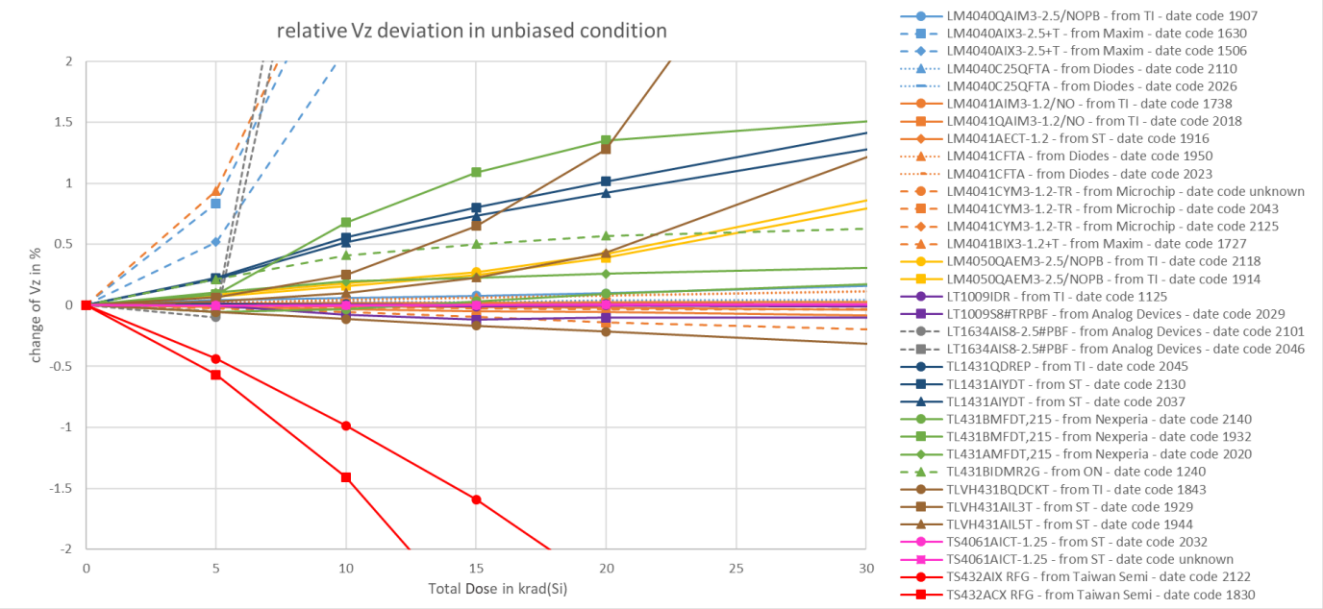


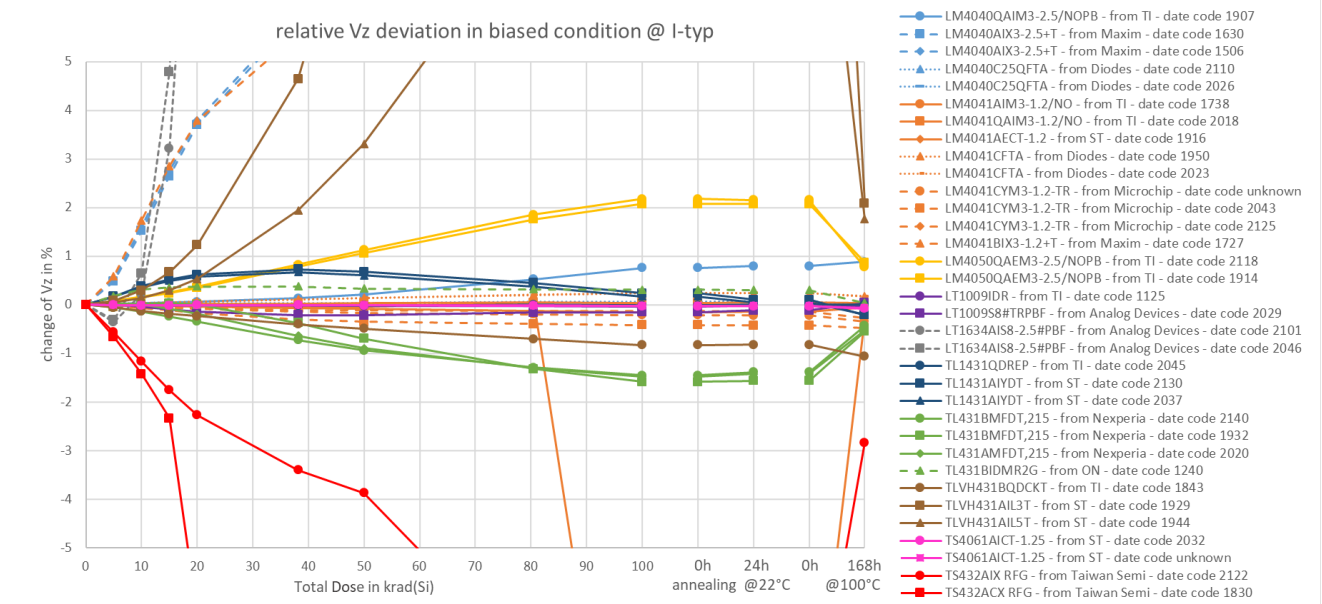
All curves plotted show the average value of all unbiased tested samples (worst case) and the interval behind the curves represent +/- one standard deviation.

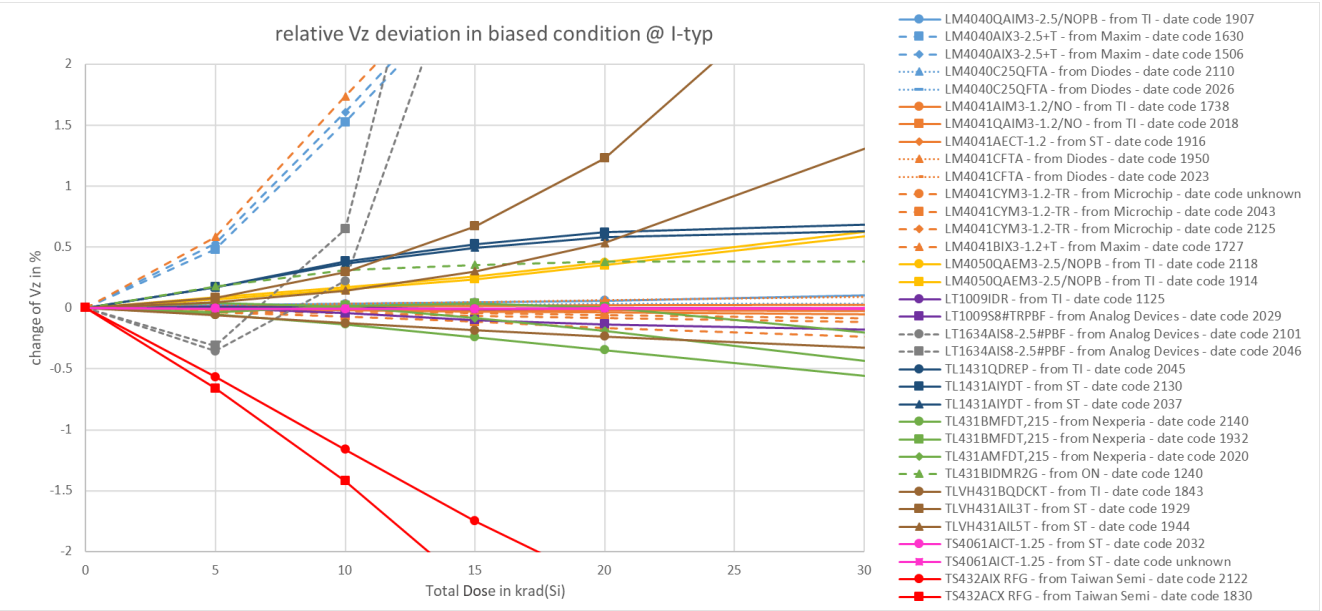
8.2. Comparison with other tested Bandgap References

The following four graphs show the results of the LM4050 Bandgap Voltage References compared to different Bandgap References part types, which were tested at the same time with the same test setup than the LM4050. Additional information on these tests is provided in the Radiation Test Summary [RD02].






relative Vz deviation in biased condition @ I-typ
change of Vz in %
Total Dose in krad(Si)
0h
24h
0h
168h
annealing @22°C
@100°C
LM4040QAIM3-2.5/NOPB - from TI - date code 1907
LM4040AIX3-2.5+T - from Maxim - date code 1630
LM4040AIX3-2.5+T - from Maxim - date code 1506
LM4040C25QFTA - from Diodes - date code 2110
LM4040C25QFTA - from Diodes - date code 2026
LM4041AIM3-1.2/NO - from TI - date code 1738
LM4041QAIM3-1.2/NO - from TI - date code 2018
LM4041AECT-1.2 - from ST - date code 1916
LM4041CFTA - from Diodes - date code 1950
LM4041CFTA - from Diodes - date code 2023
LM4041CYM3-1.2-TR - from Microchip - date code unknown
LM4041CYM3-1.2-TR - from Microchip - date code 2043
LM4041CYM3-1.2-TR - from Microchip - date code 2125
LM4041BIX3-1.2+T - from Maxim - date code 1727
LM4050QAEM3-2.5/NOPB - from TI - date code 2118
LM4050QAEM3-2.5/NOPB - from TI - date code 1914
LT1009IDR - from TI - date code 1125
LT1009S8#TRPBF - from Analog Devices - date code 2029
LT1634AIS8-2.5#PBF - from Analog Devices - date code 2101
LT1634AIS8-2.5#PBF - from Analog Devices - date code 2046
TL1431QDREP - from TI - date code 2045
TL1431AIYDT - from ST - date code 2130
TL1431AIYDT - from ST - date code 2037
TL431BMFDT,215 - from Nexperia - date code 2140
TL431BMFDT,215 - from Nexperia - date code 1932
TL431AMFDT,215 - from Nexperia - date code 2020
TL431BIDMR2G - from ON - date code 1240
TLVH431BQDCKT - from TI - date code 1843
TLVH431AIL3T - from ST - date code 1929
TLVH431AIL5T - from ST - date code 1944
TS4061AICT-1.25 - from ST - date code 2032
TS4061AICT-1.25 - from ST - date code unknown
TS432AIX RFG - from Taiwan Semi - date code 2122
TS432ACX RFG - from Taiwan Semi - date code 1830


relative Vz deviation in biased condition @ I-typ
change of Vz in %
Total Dose in krad(Si)
LM4040QAIM3-2.5/NOPB - from TI - date code 1907
LM4040AIX3-2.5+T - from Maxim - date code 1630
LM4040AIX3-2.5+T - from Maxim - date code 1506
LM4040C25QFTA - from Diodes - date code 2110
LM4040C25QFTA - from Diodes - date code 2026
LM4041AIM3-1.2/NO - from TI - date code 1738
LM4041QAIM3-1.2/NO - from TI - date code 2018
LM4041AECT-1.2 - from ST - date code 1916
LM4041CFTA - from Diodes - date code 1950
LM4041CFTA - from Diodes - date code 2023
LM4041CYM3-1.2-TR - from Microchip - date code unknown
LM4041CYM3-1.2-TR - from Microchip - date code 2043
LM4041CYM3-1.2-TR - from Microchip - date code 2125
LM4041BIX3-1.2+T - from Maxim - date code 1727
LM4050QAEM3-2.5/NOPB - from TI - date code 2118
LM4050QAEM3-2.5/NOPB - from TI - date code 1914
LT1009IDR - from TI - date code 1125
LT1009S8#TRPBF - from Analog Devices - date code 2029
LT1634AIS8-2.5#PBF - from Analog Devices - date code 2101
LT1634AIS8-2.5#PBF - from Analog Devices - date code 2046
TL1431QDREP - from TI - date code 2045
TL1431AIYDT - from ST - date code 2130
TL1431AIYDT - from ST - date code 2037
TL431BMFDT,215 - from Nexperia - date code 2140
TL431BMFDT,215 - from Nexperia - date code 1932
TL431AMFDT,215 - from Nexperia - date code 2020
TL431BIDMR2G - from ON - date code 1240
TLVH431BQDCKT - from TI - date code 1843
TLVH431AIL3T - from ST - date code 1929
TLVH431AIL5T - from ST - date code 1944
TS4061AICT-1.25 - from ST - date code 2032
TS4061AICT-1.25 - from ST - date code unknown
TS432AIX RFG - from Taiwan Semi - date code 2122
TS432ACX RFG - from Taiwan Semi - date code 1830

9. CONCLUSION

Up to a total dose of 20 krad the deviation of all tested samples stayed inside the tolerances according to the datasheet.

There is no significant difference seen in the behaviour of the different tested date codes.

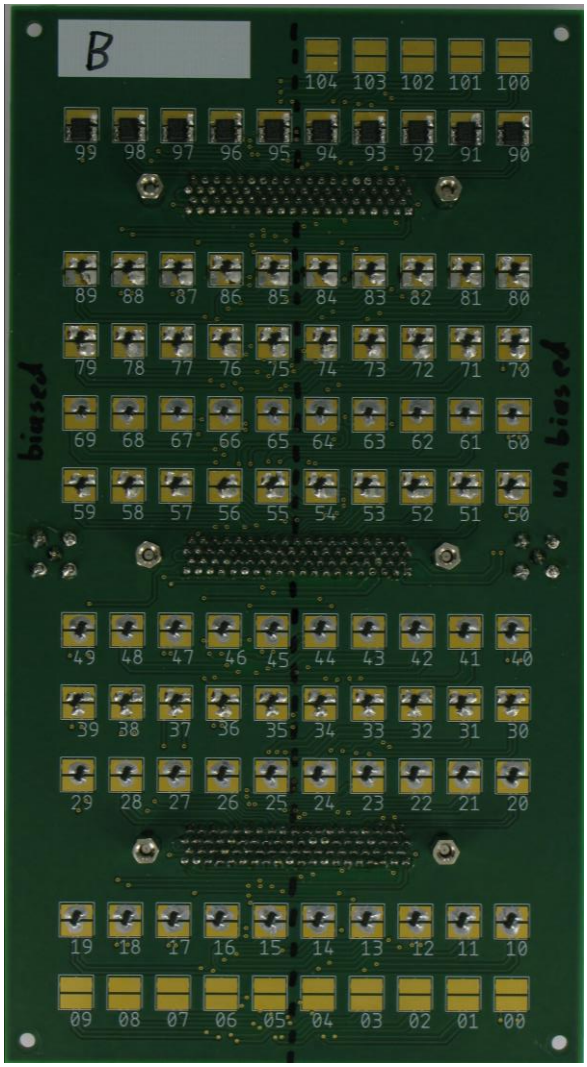
In general, a higher deviation was found for the unbiased samples.

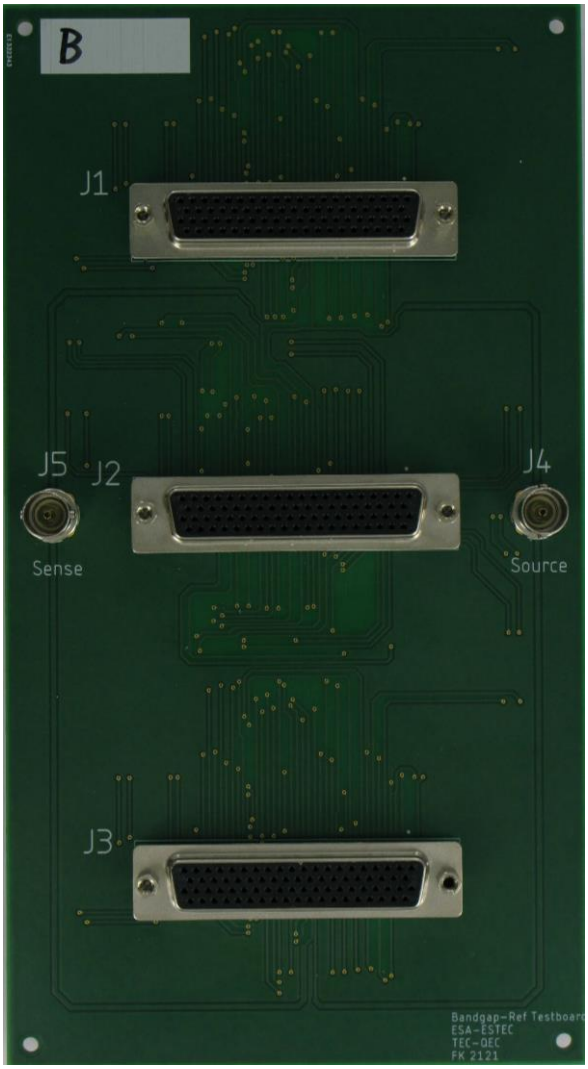
ANNEX A – DATASHEET

Part Type	Manufacturer	Link to Datasheet
LM4050QAEM3-2.5/NOPB	Texas Instruments	https://www.ti.com/general/docs/suppproductinfo.tsp?distId=10&gotoUrl=http%3A%2F%2Fwww.ti.com%2Flit%2Fgpn%2Flm4050-n-q1

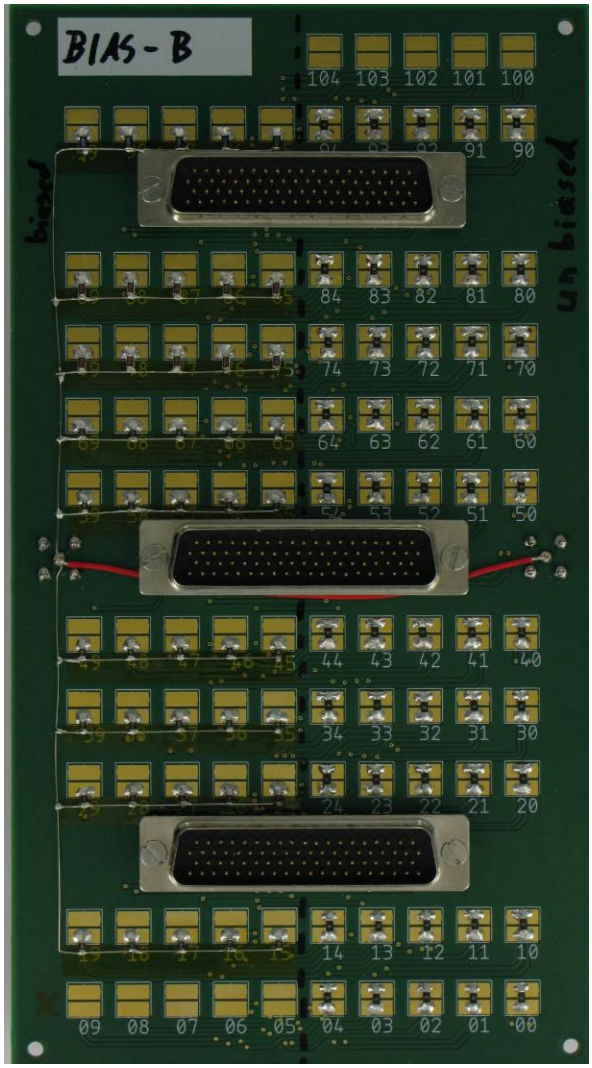
ANNEX B – SET-UP

Test board front- and backside with the LM4050 on position 70 to 89 on board B:

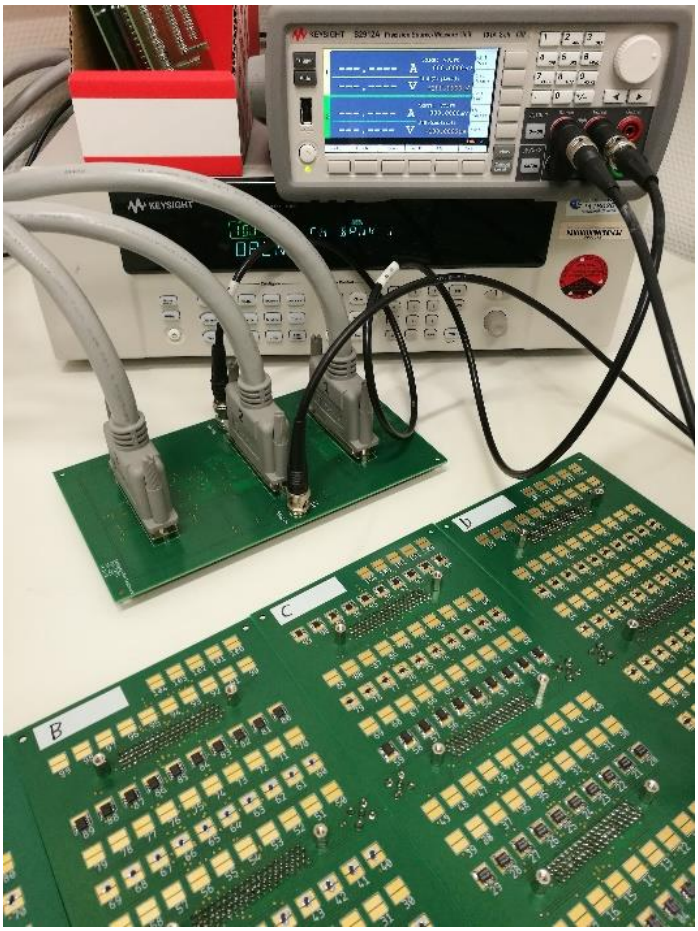




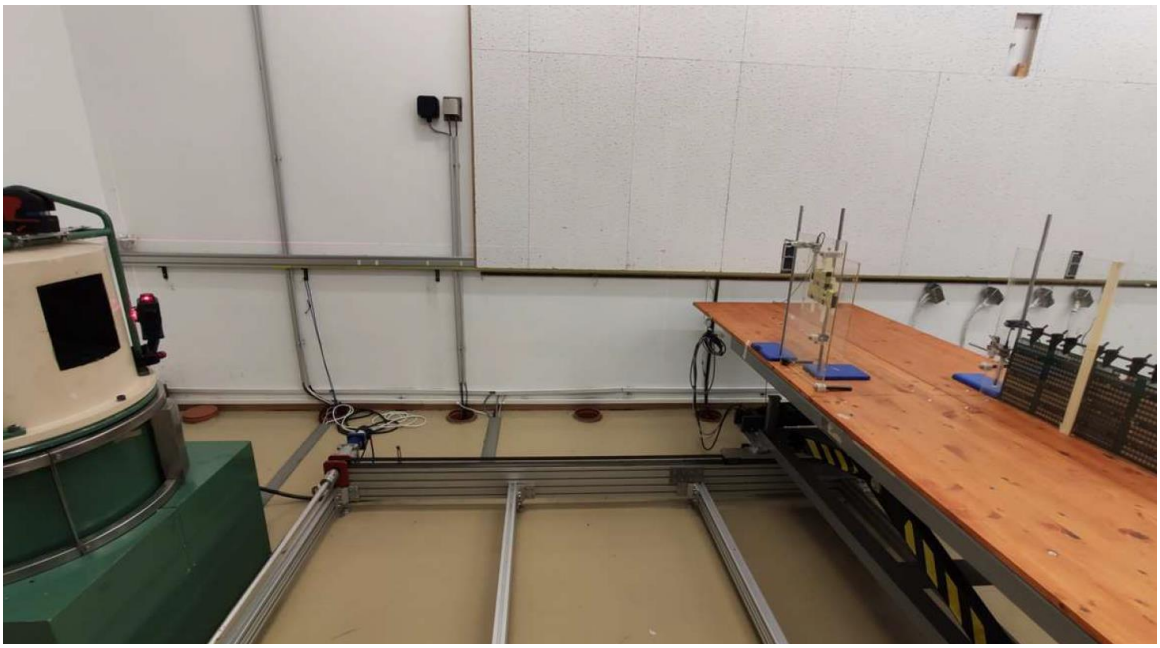
Biasing board front- and backside with the biasing resistors on it:

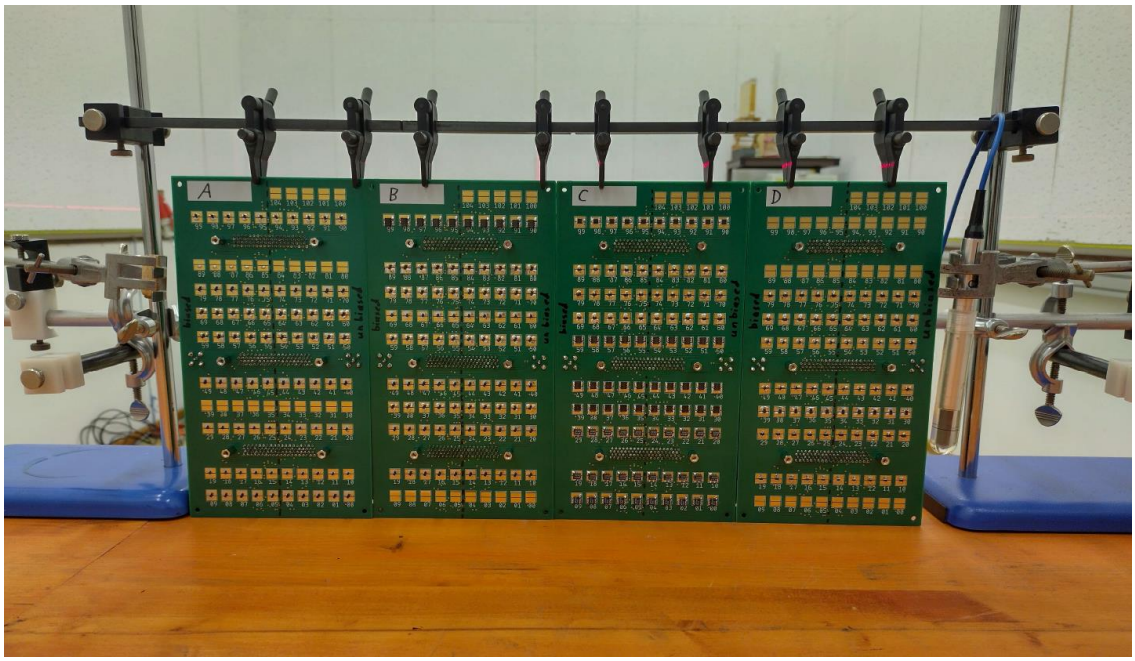


Measurement setup with the cable connection from the Test Board to the Switching Matrix and the Source Measure Unit:



Position of the boards inside the Co60 irradiation chamber:





ANNEX C – RADIATION TEST SUMMARY – IRRADIATION STEPS

Irr. Run	Start Date & Time (CET)	End Date & Time (CET)	Total Ionising Dose (water)	Dose Rate (water)
1	24-01-2022 18:11:39	25-01-2022 13:37:10	55.69 Gy	2.867 Gy/h
2	25-01-2022 15:13:42	26-01-2022 11:52:43	55.67 Gy	2.696 Gy/h
3	26-01-2022 13:30:18	27-01-2022 10:16:45	55.68 Gy	2.680 Gy/h
4	27-01-2022 12:11:47	28-01-2022 08:55:59	55.68 Gy	2.685 Gy/h
5	28-01-2022 10:31:55	31-01-2022 09:30:00	202.3 Gy	2.851 Gy/h
6	31-01-2022 11:18:44	02-02-2022 09:21:12	131.8 Gy	2.863 Gy/h
7	02-02-2022 11:05:44	07-02-2022 09:55:08	339.6 Gy	2.858 Gy/h
8	07-02-2022 11:41:36	10-02-2022 15:46:14	217.1 Gy	2.854 Gy/h
		Total	1.114 kGy	

Note: *The uncertainty budgets (according to TEC-QEC/PR001 section 12) are: 4.2 % (k=2) for absorbed dose to water and 4.4% (k=2) for absorbed dose rate to water*

	units	Min.	Max.	Time-weighted Average
Temperature	°C	20.9	21.2	20.93
Pressure	mbar	996.6	1034.5	1019.01
Relative Humidity	%	47.1	54	51.45

Dosimeter position relative to ^{60}Co source		
X	cm	36.5
Y	cm	292
Z	cm	-21

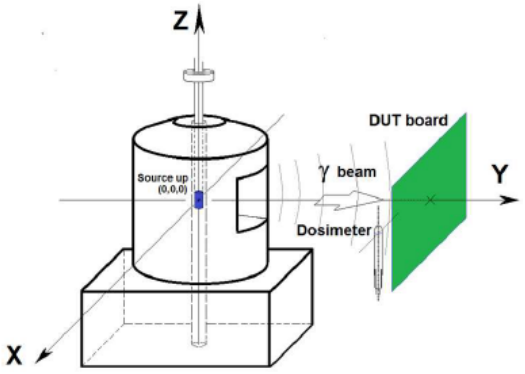


Figure 1 Co-60 irradiator head and board positioning sketch

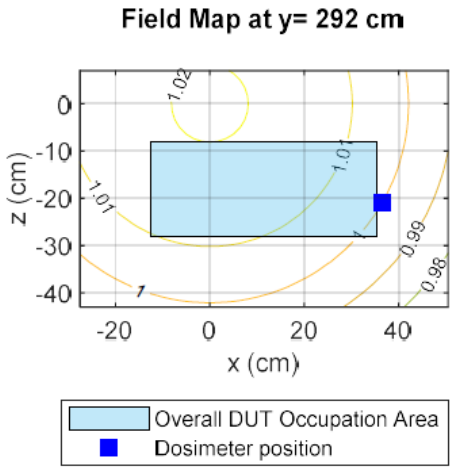


Figure 2: Qualitative indication of dose rate distribution normalized to dosemeter readings. Axes origin located at source centre. Graphs for information only, of the run with highest dose rate.