Irradiation Test Report

for

Selected Electronic Components

used in the Materials Science Laboratory

for ISS/COF

Project Document No.: MSL-TR-038-DO

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Released QA: _____ Date: _____
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Issue/ Revision	Date	Change	Page
1	22.10.01	New document	All

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1 GENERAL INFORMATION

1.1 Scope

This document gives the results of Single Event Latch-up (SEL) testing performed on selected EEE components using the ESA Heavy Ion Test Facility (HIF) at Université catholique de Louvain (UCL) in Louvain-la-Neuve, Belgium. The results include the effective LET levels used for testing each component and the LET levels at which any latch-up occurred up to a level twice that required by the project.

The main purpose of the testing was to give confidence that the SEL Linear Energy Transfer (LET) threshold level of each tested component type was above the minimum of 36 MeV cm²/mg required by the MSL project Product Assurance Plan. The detection of Single Event Upsets was not a purpose of the testing, even though some of the tested components were potentially sensitive to SEU. Although not a specific purpose of the testing the test configuration allowed for the detection of some other Single Event Effects, such as Single Event Burn-out or Single Event Gate Rupture.

The selection of components to be tested and details of the test plan and procedure are described fully in Astrium GmbH Document “Irradiation Test Plan for Selected Electronic Components used in the Materials Science Laboratory for ISS/COF”, ITP/01-01, Issue 1A of 07.09.2001 (Project Document No. MSL-PL-022-DO). Where it is considered relevant to the understanding and interpretation of the test results this document repeats information already given in the Irradiation Test Plan, e.g. the electrical bias applied during irradiation and the monitoring conditions used to detect any latch-up during irradiation.

1.2 Applicable Documents

ESA/SCC Basic Specification No. 25100, “Single Event Effects Test Method and Guidelines”.

Astrium Proposal A.2000-2002-0-1 dated 17.01.2000. “Project MSL : SEE Radiation Assessment and Test”.

REP-001 Issue 1 dated 12.07.2000. “Latch-Up Assessment for Electronic Components used in Materials Science Laboratory (MSL) for ISS/COF”.

Astrium Document ITP/01-02 Issue 1A dated 07.09.2001 (MSL Project Document No. MSL-PL-022-DO). “Irradiation Test Plan for Selected Electronic Components used in the Materials Science Laboratory for ISS/COF”

MSL Project Document No. MSL-PL-1000-002-DOR. “Product Assurance Plan”

1.3 Definition of Terms

Single Event Latch-Up (SEL):
SEL is defined as the heavy ion induced firing of a parasitic structure inherent in some monolithic integrated circuit technologies which exhibits negative differential resistance. Firing of the structure results in an uncontrolled increase of component supply current which might subsequently lead to component destruction (burnout).

Single Event Burnout (SEB):
SEB occurs if an SEL in a component allows sufficient current to pass to cause irreversible catastrophic damage to the component.
SEB can also be the breakdown and subsequent burnout of the parasitic bipolar transistor inherent in a power MOSFET structure (resulting from a heavy ion hit on the parasitic transistor).

Single Event Gate Rupture (SEGR):
SEGR is defined as direct breakdown and subsequent destructive rupture of the gate dielectric layer of a power MOSFET along the track of a heavy ion hit.

Single Event Upset (SEU):
SEU is a form of soft error. It is expressed by the changed state of a bit due to the impact of a heavy ion or proton. The transition of the charged particle causes ionisation, which in turn leads to the flipping of bits. The effect can be corrected after the transition of the ion or proton.

Single Event Effect (SEE):
SEE is a generic term covering all single event occurrences such as latch-up, burnout, gate rupture, upset, etc.

Linear Energy Transfer (LET):
LET is the energy loss of a particle passing through the material of an absorber with a thickness such that a portion of it with a 1 cm^2 surface area normal to the particle direction has a mass of 1 mg. It is expressed in units of MeV/(mg/cm²) or MeV cm²/mg.

Effective LET:

This is the equivalent LET obtained by tilting the device under test so that the beam axis is no longer normal to it, hence increasing the path length of the ion and the total energy deposited. It is calculated by:

$LET_{eff} = LET / \cos T$

where T is the tilt angle of the device, i.e. the angle between the beam axis and the normal to the die surface

Threshold LET:

The threshold LET is the LET at which the cross-section has a value of 1% of the saturated cross-section.

Flux:

The rate of incidence of particles on a material is given in terms of the particle flux, expressed in particles/(cm^2/s).

Fluence:

The time integral of the flux is referred to as the particle fluency, expressed in particles/cm².

Total dose:

Total dose is defined as the energy deposited in materials by ionising radiation, expressed in terms of rad (radiation absorbed dose). One rad is equal to an absorbed energy of 100 ergs per gram of the material. Using this unit the material in which the energy is deposited must be specified, e.g. rad(Si) for silicon. The Si unit of absorbed dose is the gray (Gy), which is equal to an absorbed energy of 1 Joule per Kg, or 100 rads.

2 TEST COMPONENT DETAILS

The total number of different component types tested was twenty. These types were selected as they were considered to be the ones potentially most SEL sensitive of all the components included in the MSL parts lists supplied to Astrium Ottobrunn (refer to applicable document REP-001).

The following table shows the types selected, approved and procured for testing, together with the type of package in which they are housed and the number of samples available. The package type generally differs from that used in the MSL equipment because, to make opening of the parts easier, preference was given to procuring ceramic or large plastic packages. The procured variant sometimes also differs from that used in MSL in terms of parameters such as operating frequency or temperature range. Such alternative variants were only procured when this was necessary to meet planned project schedules and where the variants were known to use the same die as the MSL parts. The number of samples procured was frequently dictated by minimum order quantities imposed by manufacturers or suppliers.

In this table the component types are listed in the order in which they appear in the consolidated parts list given in paragraph 2.1 of the Latch-Up Assessment Report for the MSL components which was issued in July 2000. This will facilitate any desired comparison between ordered variants and variants given in the Users' Parts Lists.

Item No.	Description	Part Type	Package Type	Number of Samples
1	**Infineon** 16-bit CMOS microcontroller	SAB80C166M	100-pin plastic flatpack	10
2	**STM** 8-bit CMOS microcontroller	ST62C65CB6 *	28-pin plastic DIP	10
3	**NSC** CMOS operational amplifier	LMC6062/883	8-pin ceramic DIP	40
4	**NSC** CMOS operational amplifier	LMC662AIN	8-pin plastic DIP	10
5	**TI** CMOS operational amplifier	TLC272BCP	8-pin plastic DIP	10
6	**Linear Technology** 12-bit A/D converter	LT1298IN8	8-pin plastic DIP	5
7	**Maxim** 12-bit D/A converter	MAX538BEPA	8-pin plastic DIP	50
8	**Fairchild** 2k CMOS EEPROM	FM93C56EN	8-pin plastic DIP	120
9	**TI** bipolar voltage supervisor	TL7705ACP	8-pin plastic DIP	50
10	**Microchip Technology** 8-bit CMOS microcontroller	PIC16-F84-04I/P	18-pin plastic DIP	10
11	**Maxim** 8-channel CMOS analog multiplexer	MAX328CJE	16-pin ceramic DIP	50
12	**AD** octal 8-bit BiCMOS D/A converter	AD7228ACQ	24-pin ceramic DIP	5
13	**AD** 16-bit BiCMOS D/A converter	AD7846AQ	28-pin ceramic DIP	5

Item No.	Description	Part Type	Package Type	Number of Samples
14	**Intel** 16-bit CMOS microcontroller	80C196KC-20	80-pin plastic flatpack	10
15	**Dallas** 64k CMOS SRAM	DS1225Y-200	28-pin plastic DIP	10
16	**Standard Microsystems** 8-bit CMOS LAN controller	COM20020IP	28-pin plastic DIP	10
17	**Wafer Scale Integration** CMOS programmable peripheral	PSD301-B-90JI	44-pin plastic chip carrier	30
18	**Samsung** 1M CMOS SRAM	K6T1008C2E-DB70 **	32-pin plastic DIP	10
19	**NSC** CMOS operational amplifier	LMC6482AMJ/883	8-pin ceramic DIP	6
20	**Maxim** CMOS analog timer	ICM7555MJA	8-pin ceramic DIP	11

***** When test samples were procured only parts with revision C dice were available whereas parts with revision B dice have been used for MSL. It was decided to perform testing on the samples which had been procured, and to try to obtain information from the manufacturer concerning the applicability of the test results to the parts actually used in the MSL equipment.

****** Although the user's parts list showed that Samsung parts had been used it was later discovered that an equivalent Hitachi part had actually been used in the MSL equipment. Satisfactory test results already exist for the Hitachi part and therefore it did not need to be tested. As all the preparations had already been made to test the Samsung part the decision was made to proceed with the testing even though it had not been used in the MSL equipment.

3 TEST SET UP

3.1 Irradiation Facility

The test facility used for this testing was the ESA Heavy Ion Test Facility at UCL in Belgium. This uses the CYCLONE accelerator which is a multiparticle, variable energy, cyclotron capable of accelerating protons (up to 85 MeV), alpha particles and heavy ions. For the heavy ions the energy range covered is between 0.6 MeV/AMU and 27.5 MeV/AMU with a maximum energy of 110 Q^2/M, where Q is the ion charge state and M is the mass in Atomic Mass Units. The heavy ions are produced in a single stage (6.4 GHz) Electron Cyclotron Resonance (ECR) source and an analysing magnet is then used to select the desired M/Q ratio before the ions are injected axially for subsequent acceleration. The use of an ECR source allows the production of highly charged ions and of ion "cocktails", composed of ions with the same or similar M/Q ratios, which are accelerated together but extracted separately by fine tuning the magnetic field or slightly changing the RF frequency.

The following ion cocktail from those available at UCL was used for the testing.

Cocktail Number	M/Q	Ion	DUT energy (MeV)	Range (µm Si)	LET (MeV cm²/mg)
1	5.07	$^{132}Xe^{26+}$	459	43	55.9
	4.94	$^{84}Kr^{17+}$	316	43	34
	5	$^{40}Ar^{8+}$	150	42	14.1
		$^{20}Ne^{4+}$	78	45	5.85
		$^{15}N^{3+}$	62	64	2.97
		$^{10}B^{2+}$	41	80	1.7

For each of the ions the effective LET could be increased from the LET value given in the table by tilting the test sample so that the ion beam was no longer normal (perpendicular) to the die surface.

The sample chamber has the general shape of a cylinder lying on its side and stretched vertically, with internal dimensions of 71 cm high, 54 cm wide and 76 cm deep. The opening end of the cylinder can be moved 1 m away from the cylinder on a rail system for sample installation. It also supports an internal frame for holding the test samples and contains connectors for electrical connections. During operation the complete chamber can pump down to operating vacuum in less than ten minutes. Photographs showing the chamber set up for the MSL component testing are included in Appendix C to this report.

To set up, control and monitor the beam flux and homogeneity a box in front of the chamber contains a Faraday cup, four scintillators and two parallel plate avalanche counters (PPAC). Two additional surface barrier detectors are placed in the test chamber.

3.2 Preparation of Components

All of the component samples were serialised and then subjected to some basic parametric measurements to check that they were functional. One component of each type was retained as a control and two of the remaining components were opened using appropriate mechanical or chemical techniques to expose the die surface. After they were opened the components were again subjected to the basic parametric measurements to determine if there were any significant changes which might indicate that they had been damaged by opening.

Photographs of one opened component of each type are shown in Appendix A to this report.

3.3 Test Sockets and Printed Circuit Board Layout

The test chamber is able to take a printed circuit board up to 250 x 250 mm, of which an area of 250 x 120 mm can be scanned by the heavy ion beam. Although the remaining board area cannot be irradiated, and therefore is unusable for mounting test components, it can be used for any connectors or components needed for the biasing and monitoring of the test components.

For testing the MSL components in the vacuum chamber a “piggy-back” configuration was used with one mother board and separate daughter boards for each component type to be tested. The mother board had four identical socket pairs into which four individual daughter boards could be plugged. The daughter boards contained the components to be irradiated and also any wire links, resistors or capacitors necessary for the correct biasing and monitoring of the test samples. A photograph of the mother board with four daughter boards is included in Appendix C to this report and is shown schematically in Appendix D.

Based on the availability of suitable sockets, and the requirements for providing additional mechanical stability for some plastic packages before opening them, the test samples were either plugged into sockets on the daughter boards or were soldered to small carrier boards which were then mounted on the daughter boards.

3.4 Biasing and Monitoring Circuit

The basic biasing and monitoring circuit was located in a box outside the vacuum chamber and had been designed to fulfil the following main functions:

- To supply to the piggy-backed daughter boards the necessary positive, negative and ground voltages for biasing the components under test.
- To monitor the currents flowing in the positive and negative supply lines.
- To allow preset limits to be set for the supply currents using controls on the monitor box.
- To remove the bias voltages from the components under test if the monitored currents exceed the preset limits.
- To indicate using LEDs outside the chamber when the preset negative and/or positive current limits have been exceeded.
- To allow the circuit to be reset from outside the vacuum chamber thereby re-applying biasing to the components under test.

It should be noted that the circuit could be switched between the different test components which were in the chamber at the same time and was used to bias and monitor only the one component which was being irradiated. Therefore if a latch-up occurred it was obvious which component had failed as only one component was being biased, irradiated and monitored at any one time. As the circuit was designed to remove the biasing before any permanent damage could occur it was possible to re-apply the bias as soon as the component which latched-up was no longer being irradiated.

The circuitry on the daughter boards was intended only to direct the bias voltages to the correct pins on the component under test and to provide any necessary load resistors or capacitors.

The biasing and monitoring circuit is shown schematically in Appendix D at the end of this document and a photograph is included in Appendix C. Part type specific information and schematics of the daughter board circuits for each component type are given in Appendix E.

4 TEST PERFORMANCE

4.1 Electrical Check at UCL

Immediately before the components were placed in the vacuum chamber at UCL they were subjected to a very simple electrical check based on the measurement of supply currents and, where appropriate, output voltages. This was performed to ensure that the components were functional and to allow for selection of a suitable current monitoring threshold.

4.2 Heavy Ion Irradiation with Monitoring for SEL

The test samples on the appropriate daughter boards were mounted four at a time on the mother board and placed in the vacuum chamber where they could be individually exposed to a calibrated heavy ion beam. Each sample was subjected to a number of different LET_{eff} levels which were obtained by using different ion species and various tilts of the die with reference to the axis of the impinging ion beam. At each LET_{eff} level the irradiation was continued until a fluence of 10^6 particles/cm² had been reached or until a latch-up had been detected. The initial and subsequent LET_{eff} levels used for the irradiation of each component were individually decided using engineering judgement together with available information covering:

- Existing SEL sensitivity results for other devices manufactured using similar technology
- Results of previous test runs on the same component at other LET_{eff} levels
- Results of testing the first component of a particular type if a second component of the same type was being tested
- Results of test runs on other MSL components

During exposure each component was biased using conditions which were based on those which it would experience in the MSL project and those which were most likely to support latch-up. These bias conditions were defined and agreed in the “test plan” and are shown for each component type in Appendix E of this report. During testing the supply current(s) to the irradiated component were monitored to detect any large and sudden increase which would indicate the occurrence of a latch-up. For each component type an appropriate latch-up threshold current level was selected and if the current increased above this level the voltage biasing was automatically cut off to prevent permanent device damage due to latch-up. The threshold levels were all set in the mA range and where possible were about an order of magnitude higher than the measured pre-irradiation supply current.

If the biasing to a component was automatically cut off by the monitoring circuit the irradiating heavy ion beam was closed. The biasing was then re-applied to check whether the current increase was due

to a reversible latch-up or whether permanent damage had been caused by any other effect such as device burnout, SEB, SEGR, etc. Reapplying the irradiating beam to the component with the biasing applied then allowed an assessment to be made of whether it was only noise in the system which had triggered the monitoring circuit.

Each component was tested up to an LET level at which latch-up clearly occurred, or up to a level at least twice the MSL project required threshold of 36 MeV cm²/mg. For each component an assessment was also made of the total radiation dose which it had experienced during exposure to the heavy ion beam.

Two components of each type were exposed to the heavy ion irradiation, even though Astrium Proposal A.2000.2002-0-1 from Astrium GmbH, Ottobrunn to Astrium GmbH, Friedrichshafen required the irradiation of only one component. Testing of a second component within the originally agreed costs and schedule was possible because sufficient test samples had been procured and because the available beam time was used very efficiently.

All irradiation test activities were performed in accordance with the requirements of ESA/SCC Basic Specification No. 25100 except where the Astrium GmbH Irradiation Test Plan gave an alternative.

4.3 Astrium GmbH, Ottobrunn Responsibilities

Astrium was responsible for supplying all the necessary test samples, test boards, biasing and monitoring circuits, power supplies, and the test equipment needed for setting up and checking the test circuits. Astrium was also responsible for performing the actual testing including all controlling of the irradiation facility which could be performed using the BOARD POSITION, DATA BEAM and BEAM LINE screens on the user interface system.

4.4 UCL Responsibilities

A qualified operator for the HIF was present at all times that the beam was operational and was responsible for all operations which could not be controlled using the BOARD POSITION, DATA BEAM and BEAM LINE screens on the user interface system. The UCL operator was also responsible for ensuring that the Astrium personnel did not inadvertently misuse the system due to inadequate information or instructions.

5 TEST RESULTS

5.1 Summary of Test Results

The following table summarises the test results obtained for the individual components.

Item No.	Part Type	Serial No.	SEL Detected?	Minimum LET_{eff} which caused SEL (if detected) (MeV.cm²/mg)	Maximum LET_{eff} used which did not cause SEL (MeV.cm²/mg)	Total Dose (over all test runs) (kRad)	Comments
1	SAB80C166M	011	Yes	14.1	9.1	0.26	
		012	Yes	14.1	9.1	0.27	
2	ST62T65CB6	021	Yes	14.1	9.1	0.30	
		022	Yes	14.1	9.1	0.34	
3	LMC6062	031	No		73.0	2.48	
		032	No		73.0	2.48	
4	LMC662AIM	041	No		73.0	2.48	
		042	No		73.0	2.48	
5	TLC272BCD	051	No		73.0	2.48	
		052	No		73.0	2.48	
6	LTC1298IN8	061	Yes	9.1	5.9	0.11	
		062	Yes	9.1	5.9	0.20	See note 1
7	MAX538	071	No		73.0	2.48	
		073	No		73.0	2.48	
8	93C56EN	081	Yes	14.1	9.1	0.39	
		082	Yes	14.1	9.1	0.33	
9	TL7705ACP	091	No		73.0	2.48	
		092	No		73.0	2.48	
10	PIC16F84-04	101	Yes	14.1	9.1	0.27	
		103	Yes	14.1	9.1	0.29	
11	MAX328CWE	111	No		73.0	2.48	
		112	No		73.0	2.48	
12	AD7228ACQ	121	No		73.0	2.48	
		122	No		73.0	2.48	
13	AD7846AQ	131	No		73.0	2.48	
		132	No		73.0	2.48	
14	80C196KC	141	Yes	19.9	14.1	0.44	
		142	Yes	19.9	14.1	0.33	
15	DS1225Y	151	Yes	34.0	14.1	0.23	See note 2
		152	Yes	34.0	14.1	0.23	See note 2

Item No.	Part Type	Serial No.	SEL Detected?	Minimum LET_{eff} which caused SEL (if detected) (MeV.cm²/mg)	Maximum LET_{eff} used which did not cause SEL (MeV.cm²/mg)	Total Dose (over all test runs) (kRad)	Comments
16	COM20020IP	161	Yes	14.1	9.1	0.27	
		162	Yes	14.1	9.1	0.29	
17	PSD301-B	171	Yes	28.2	19.9	0.97	
		172	Yes	28.2	19.9	0.86	See note 3
18	K6T1008C2E	181	No		73.0	2.48	
		182	No		73.0	2.48	
19	LMC6482LIM	191	No		73.0	2.48	
		192	No		73.0	2.48	
20	ICM7555MJA	201	No		73.0	2.48	
		202	No		73.0	2.48	

Notes

1. Possible latch-up at 5.9 MeV cm²/mg on one run but not repeatable and probably spurious indication caused by noise
2. Latch-up occurred when the parts were initially tested at 34.0 MeV cm²/mg. Testing was then performed using the next lighter ion and zero tilt to give an LET_{eff} of 14.1 MeV cm²/mg. It was found that the supply current slowly increased to about 150 mA which prevented any reliable detection of latch-up. This effect might be related to malfunctioning of the internal power regulating chip.
3. Possible latch-up at 19.9 MeV cm²/mg on one run but not repeatable and probably spurious indication caused by noise

These results indicate that there could be a latch-up problem with the following component types if they are subjected to the minimum levels of heavy ion irradiation specified for the MSL project.

- Infineon 16-bit CMOS microcontroller type SAB80C166M
- STM 8-bit microcontroller type ST62C65CB6
- Linear Technology 12-bit A/D converter type LTC1298IN8
- Fairchild 2k CMOS EEPROM type FM93C56EN
- Microchip Technology 8-bit CMOS microcontroller type PIC16-F84
- Intel 16-bit CMOS microcontroller type 80C196KC
- Dallas 64k CMOS RAM type DS1225Y
- Standard Microsystems 8-bit CMOS LAN controller type COM20020IP
- Wafer Scale Integration CMOS programmable peripheral type PSD301-B

5.2 Detailed Test Results

A table giving details of all the irradiation test runs carried out on the sample components is given in Appendix F at the end of this report. In this table the test runs are not listed in the order in which they were actually carried out, but are ordered by Item No., Item Serial No. and LET_{eff}. Individual test sheets showing electrical conditions and results for each Item No. are included in Appendix G.

6 CONCLUSIONS

On the basis of the testing performed on the supplied samples it is possible to conclude that eleven of the tested part types have an SEL LET threshold >73 MeV cm²/mg and therefore the parts meet the MSL project requirement of 36 MeV cm²/mg.
The following nine part types, listed in descending order of resistance to SEL, had a threshold below the minimum limit required for the MSL project. Further assessment of the use of the same basic part types in the MSL project is therefore recommended.

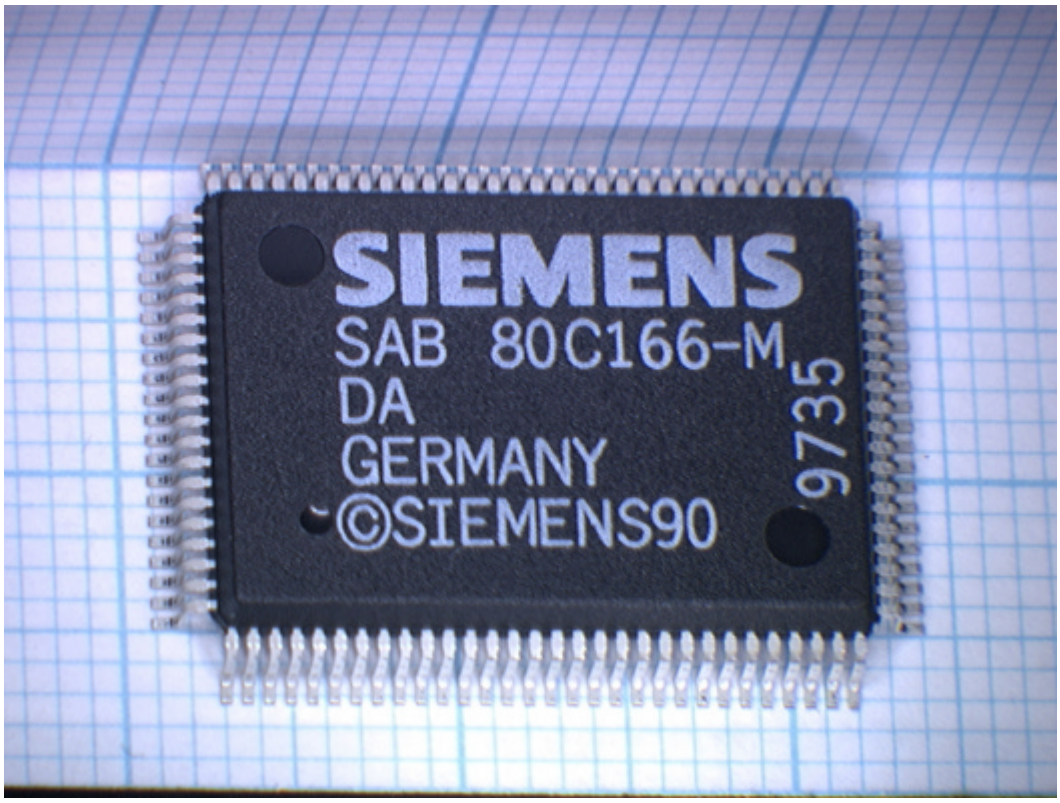
- Dallas 64k CMOS RAM type DS1225Y
  SEL occurred at 34.0 MeV cm²/mg but not at 14.1 Mev cm²/mg
- Wafer Scale Integration CMOS programmable peripheral type PSD301-B
  SEL occurred at 28.2 MeV cm²/mg but not at 19.9 Mev cm²/mg
- Intel 16-bit CMOS microcontroller type 80C196KC
  SEL occurred at 19.9 MeV cm²/mg but not at 14.1 Mev cm²/mg
- Infineon 16-bit CMOS microcontroller type SAB80C166M
  SEL occurred at 14.1 MeV cm²/mg but not at 9.1 Mev cm²/mg
- STM 8-bit microcontroller type ST62C65CB6
  SEL occurred at 14.1 MeV cm²/mg but not at 9.1 Mev cm²/mg
- Fairchild 2k CMOS EEPROM type FM93C56EN
  SEL occurred at 14.1 MeV cm²/mg but not at 9.1 Mev cm²/mg
- Microchip Technology 8-bit CMOS microcontroller type PIC16-F84-04
  SEL occurred at 14.1 MeV cm²/mg but not at 9.1 Mev cm²/mg
- Standard Microsystems 8-bit CMOS LAN controller type COM20020IP
  SEL occurred at 14.1 MeV cm²/mg but not at 9.1 Mev cm²/mg
- Linear Technology 12-bit A/D converter type LTC1298IN8
  SEL occurred at 9.1 MeV cm²/mg but not at 5.9 Mev cm²/mg

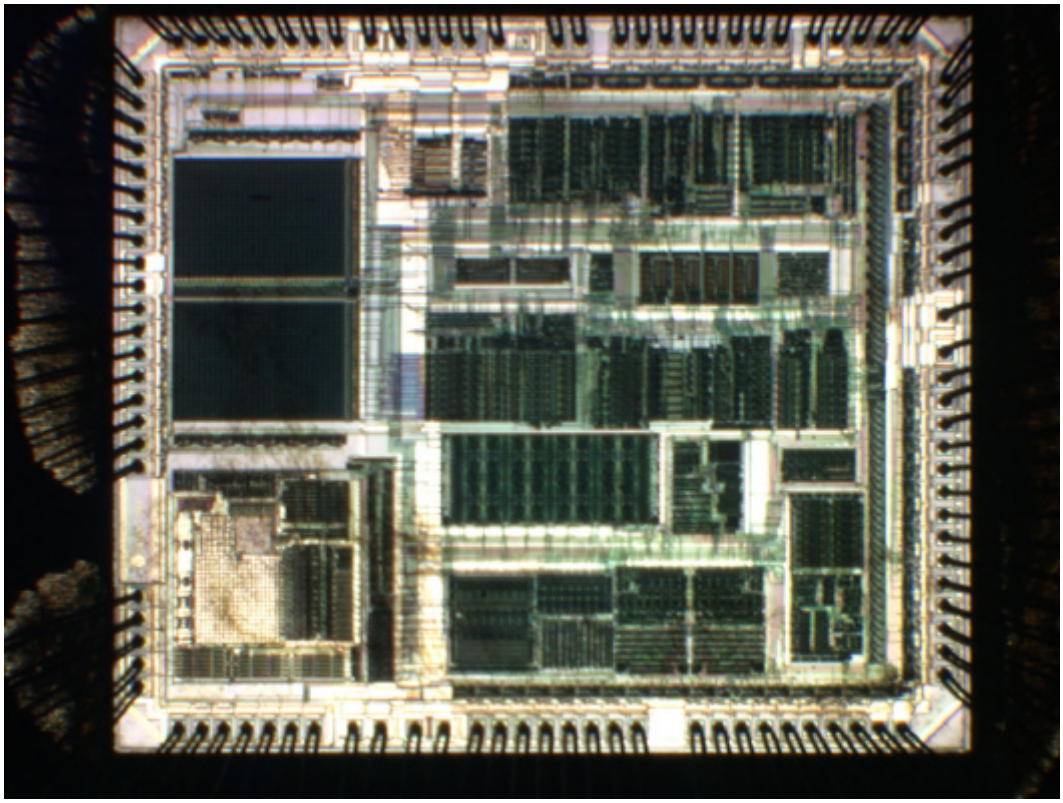
The Dallas 64k CMOS RAM was not tested at any LET_{eff} levels between 14.1 MeV cm²/mg and 34.0 MeV cm²/mg because it displayed anomalous behaviour. Latch-up occurred when the parts were initially tested at 34.0 MeV cm²/mg and testing was then performed using the next lighter ion and zero tilt to give an LET_{eff} of 14.1 MeV cm²/mg. At this level it was found that the supply current slowly increased to about 150 mA which prevented any reliable detection of latch-up. This effect might be related to malfunctioning of the internal power regulating chip which is included in the package.

As the estimated total radiation dose seen by all the test samples was extremely low (with a maximum of 2.48 krad) it was not considered sufficient to allow any meaningful assessment of total radiation dose effects.

APPENDIX A – TEST COMPONENT PHOTOGRAPHS

Item No. 1 – SAB80C166M





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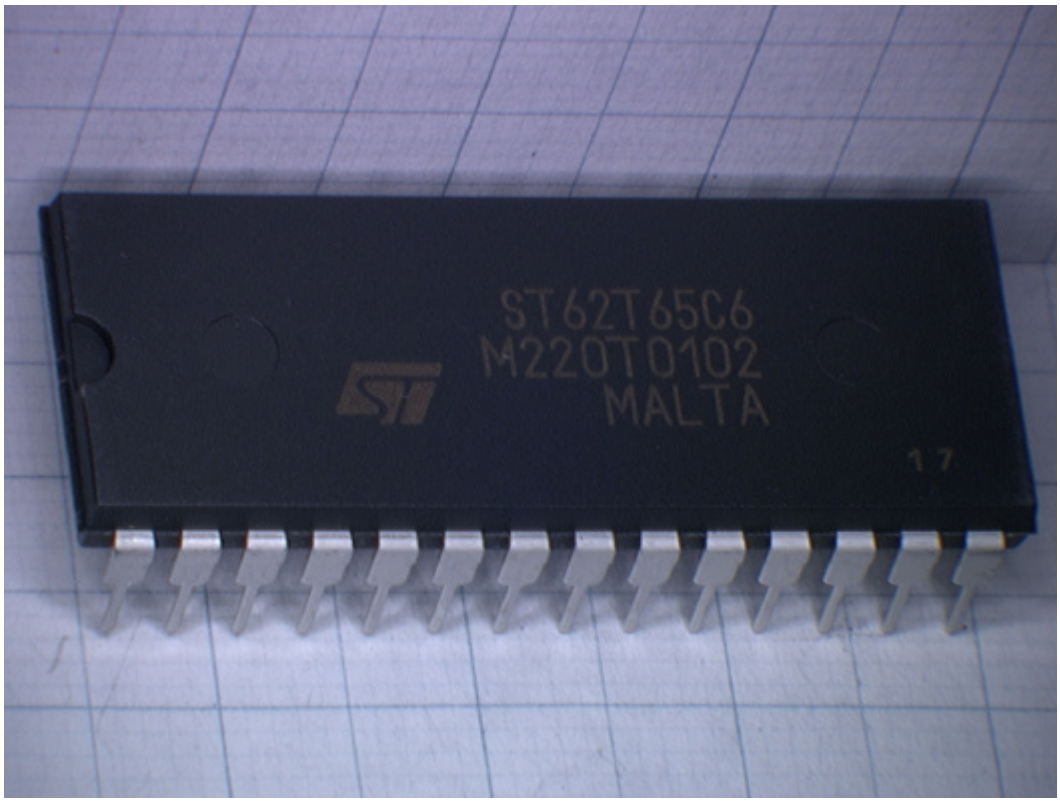

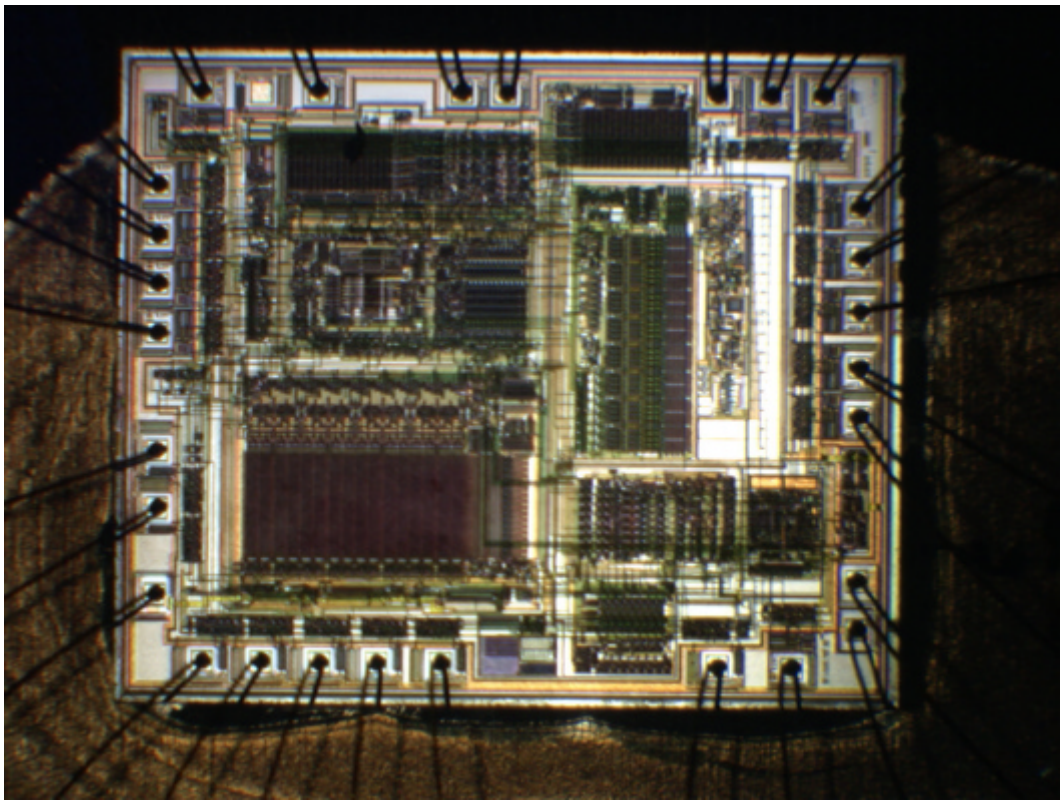

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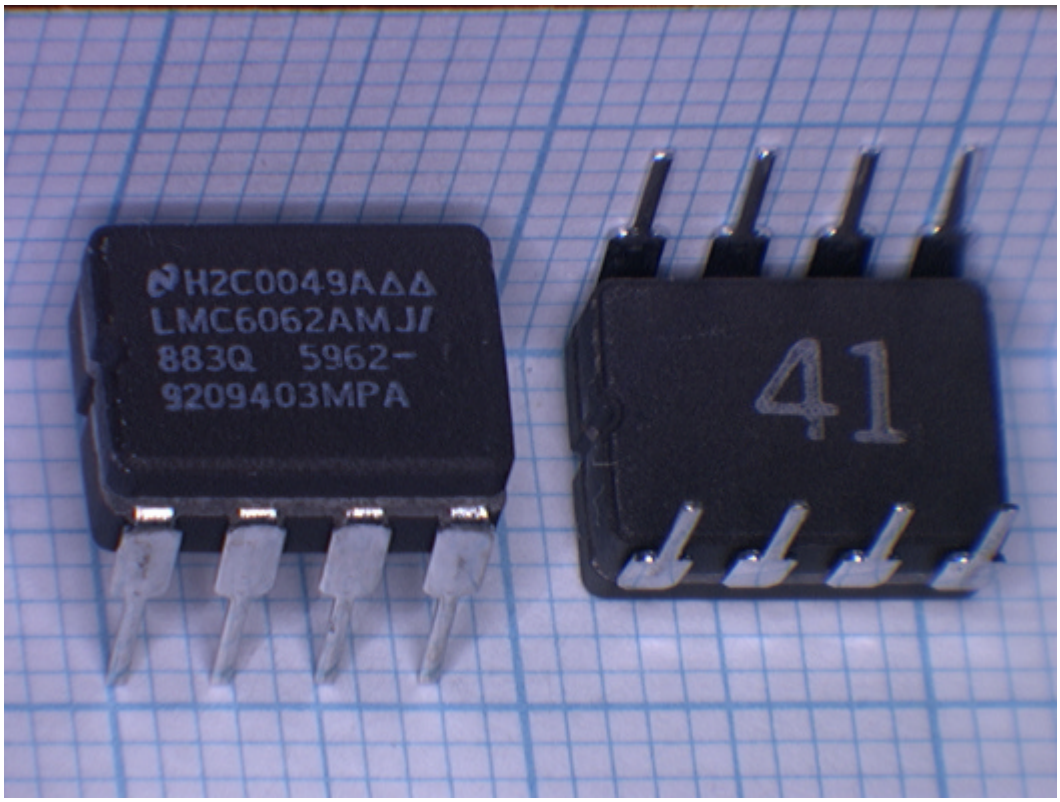
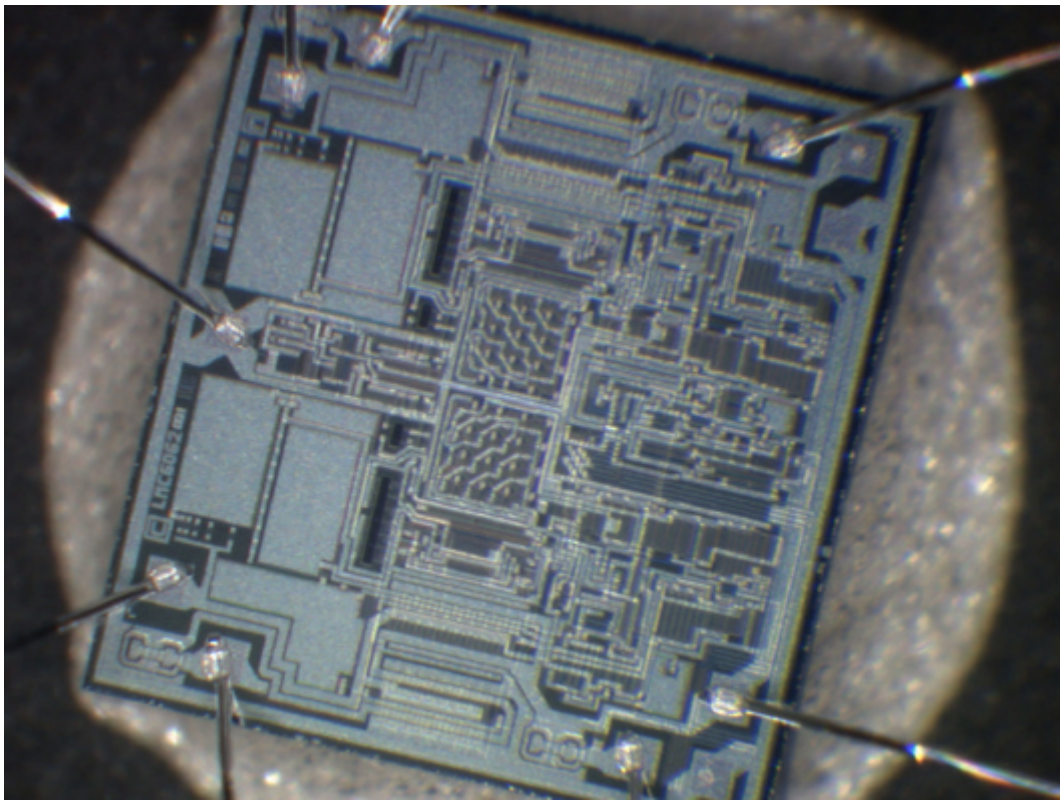
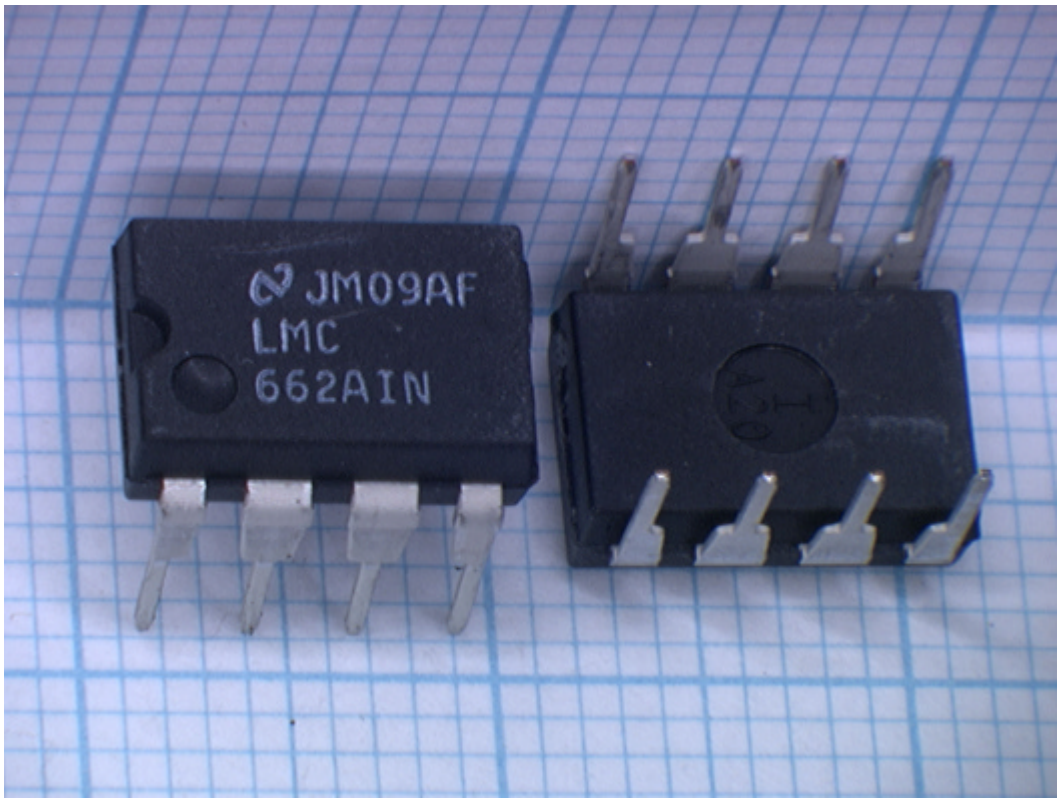
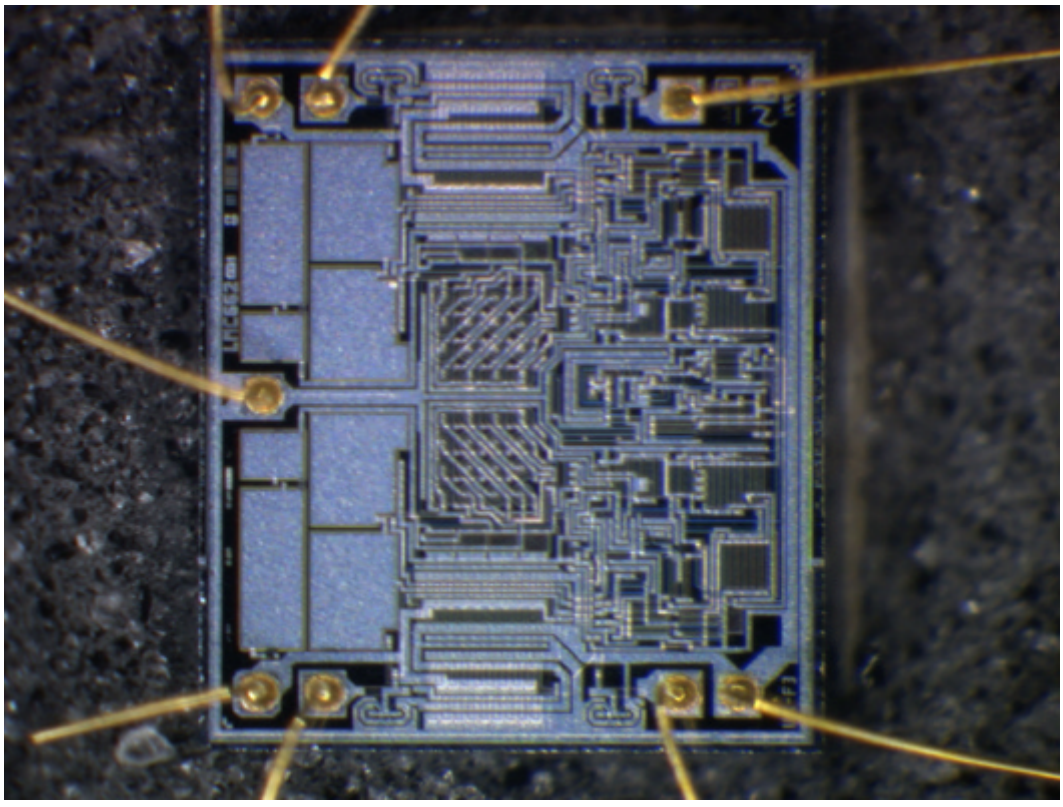


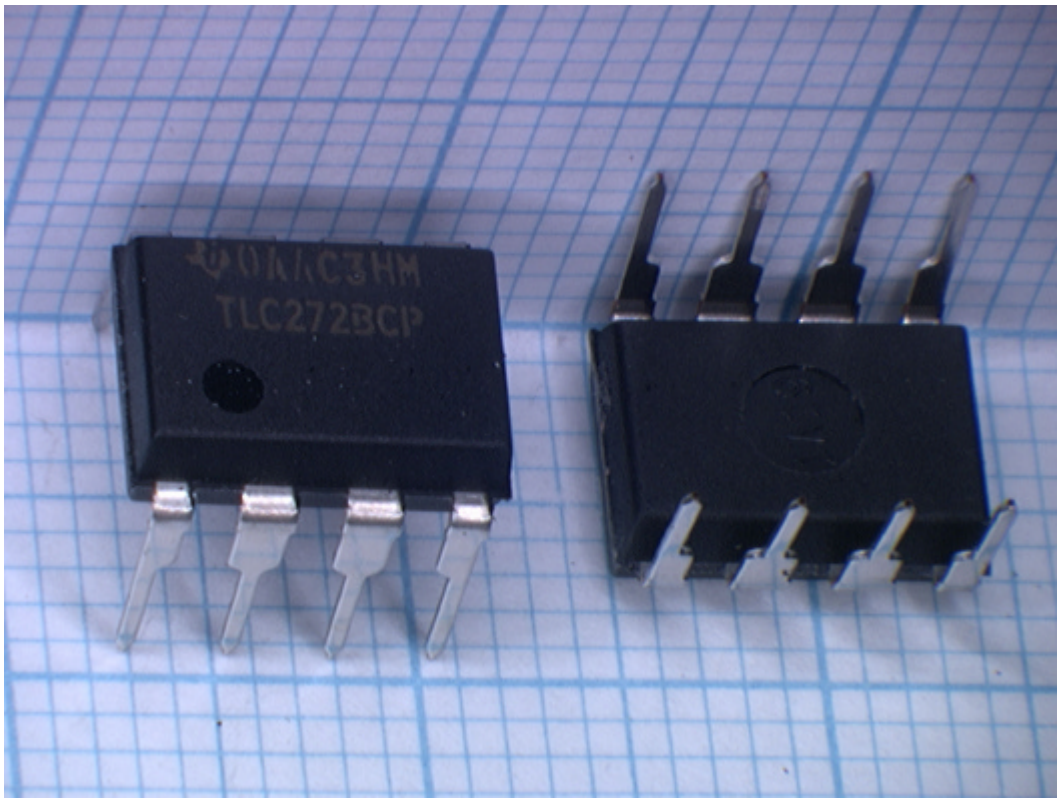


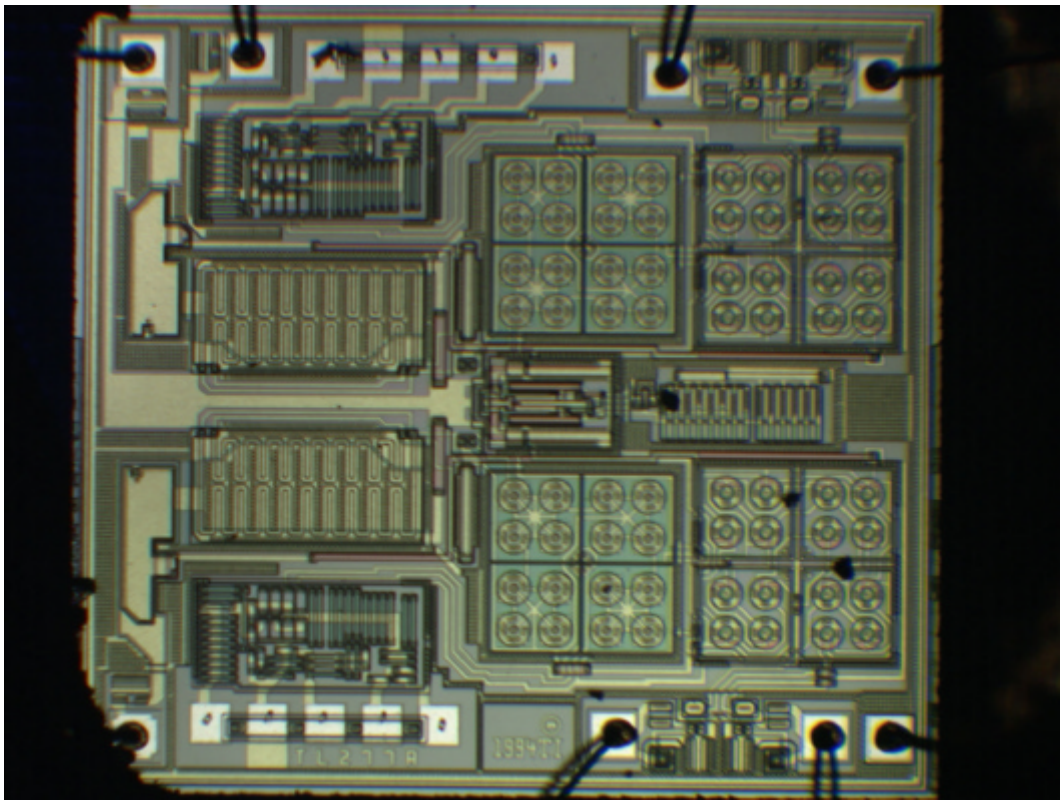
Item No. 4 – LMC662AIN



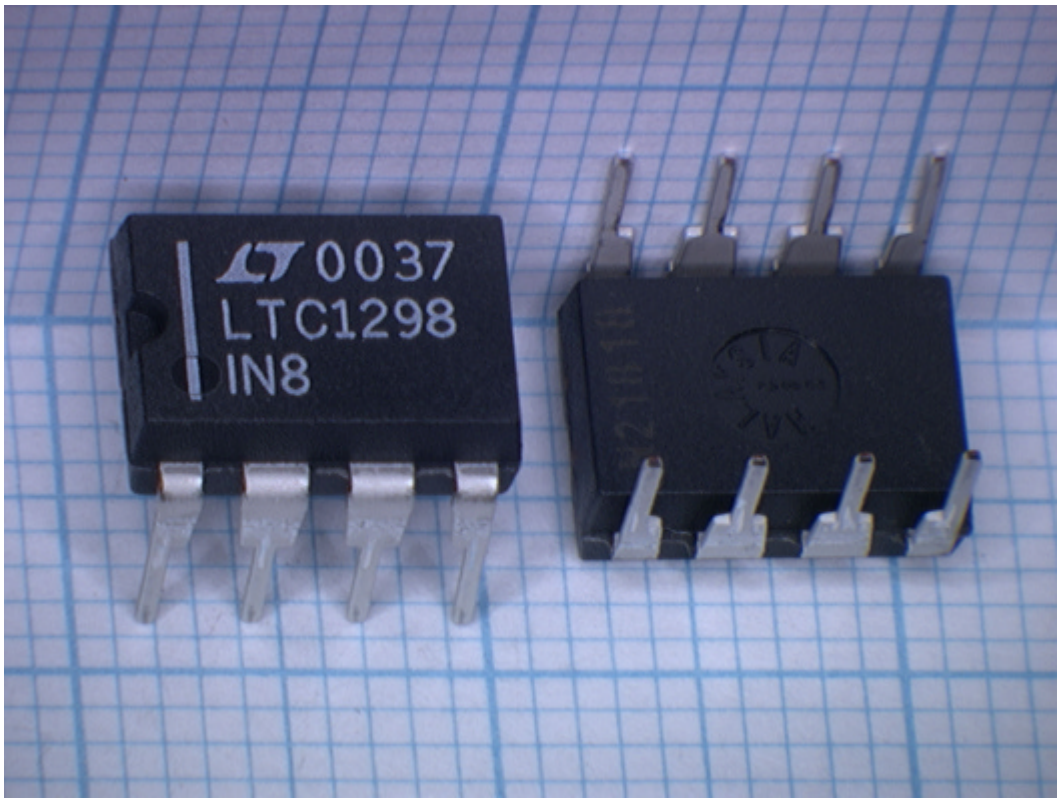


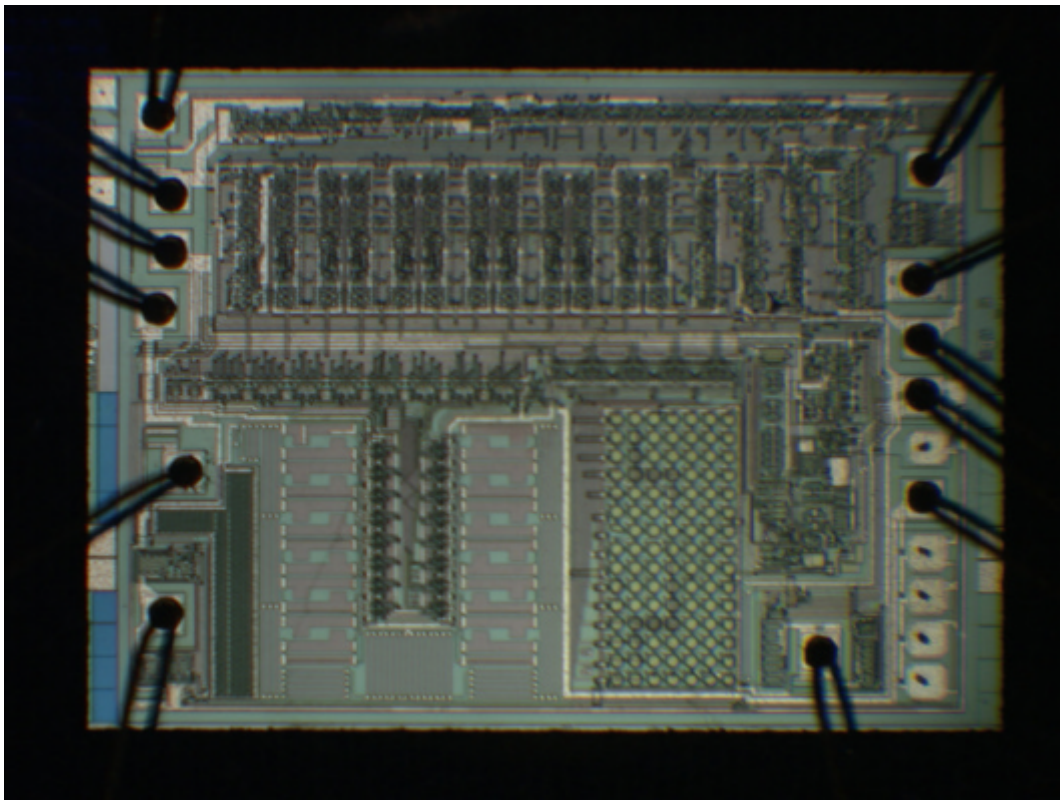
Item No. 5 – TLC272BCP



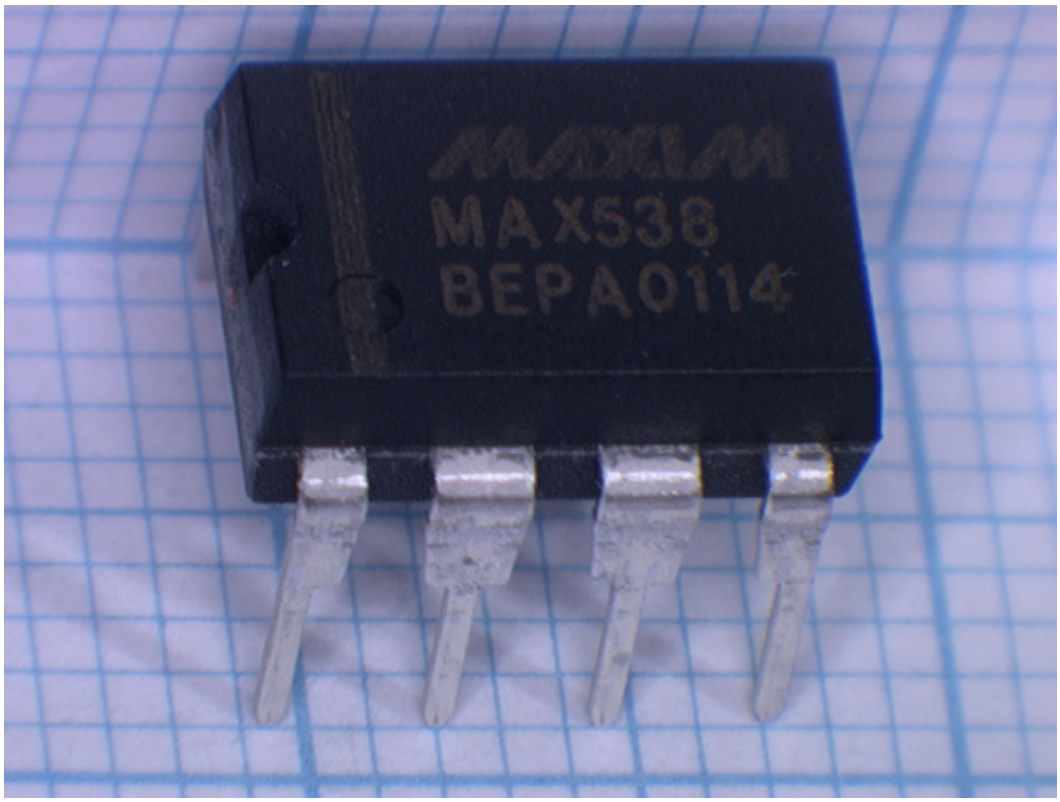


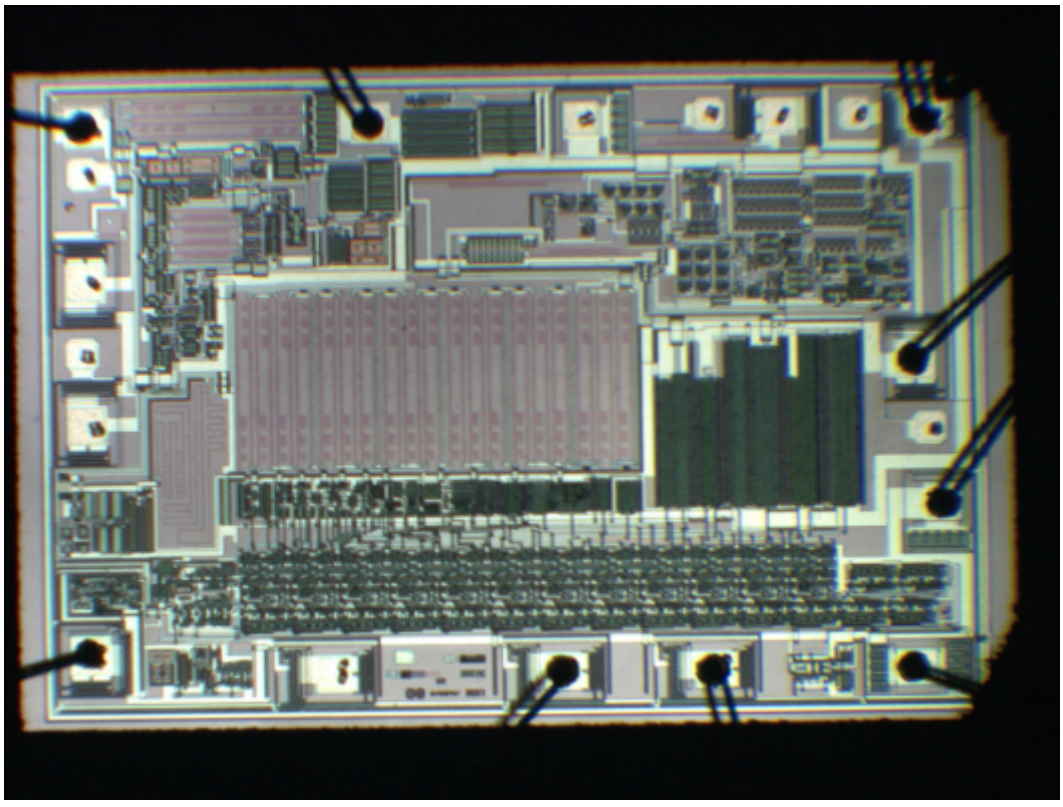
Item No. 6 – LT1298IN8



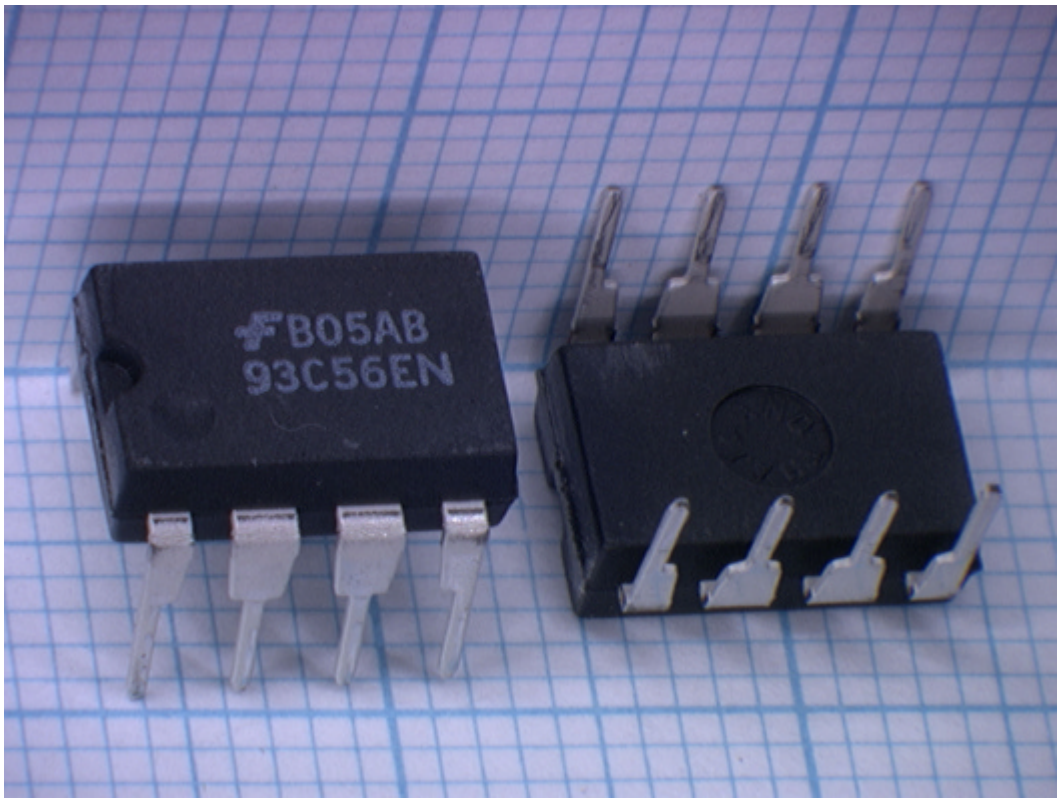


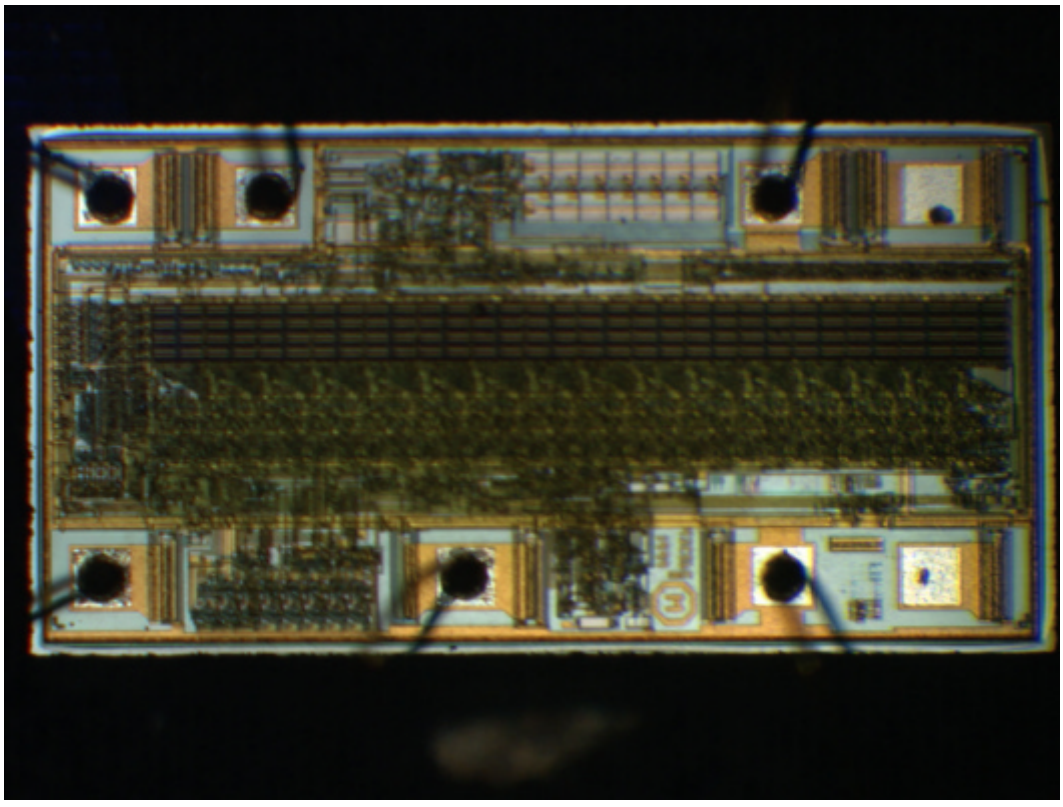
Item No. 7 – MAX538BEPA



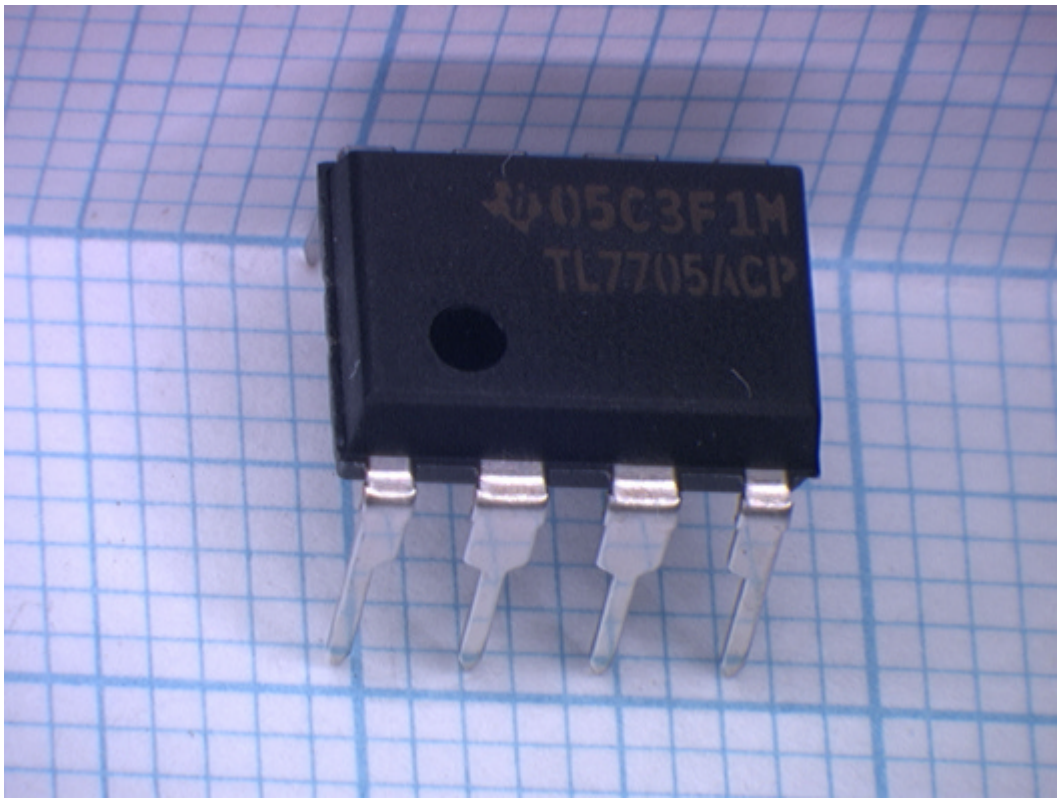


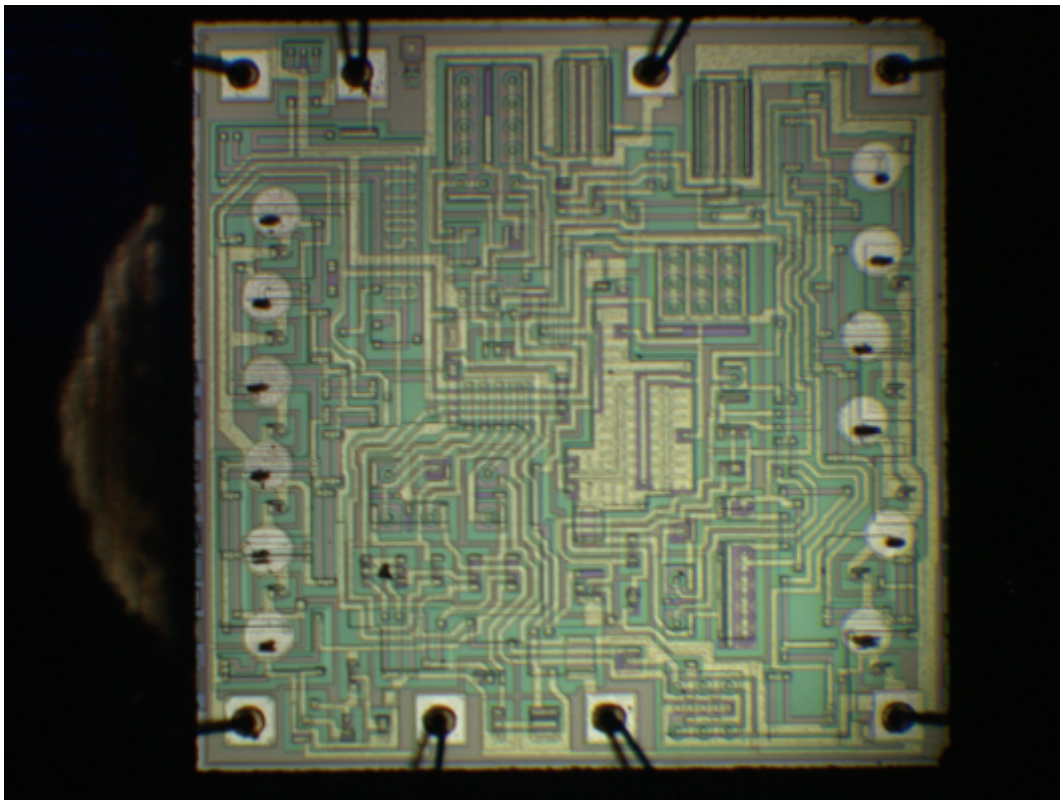
Item No. 8 – FM93C56EN



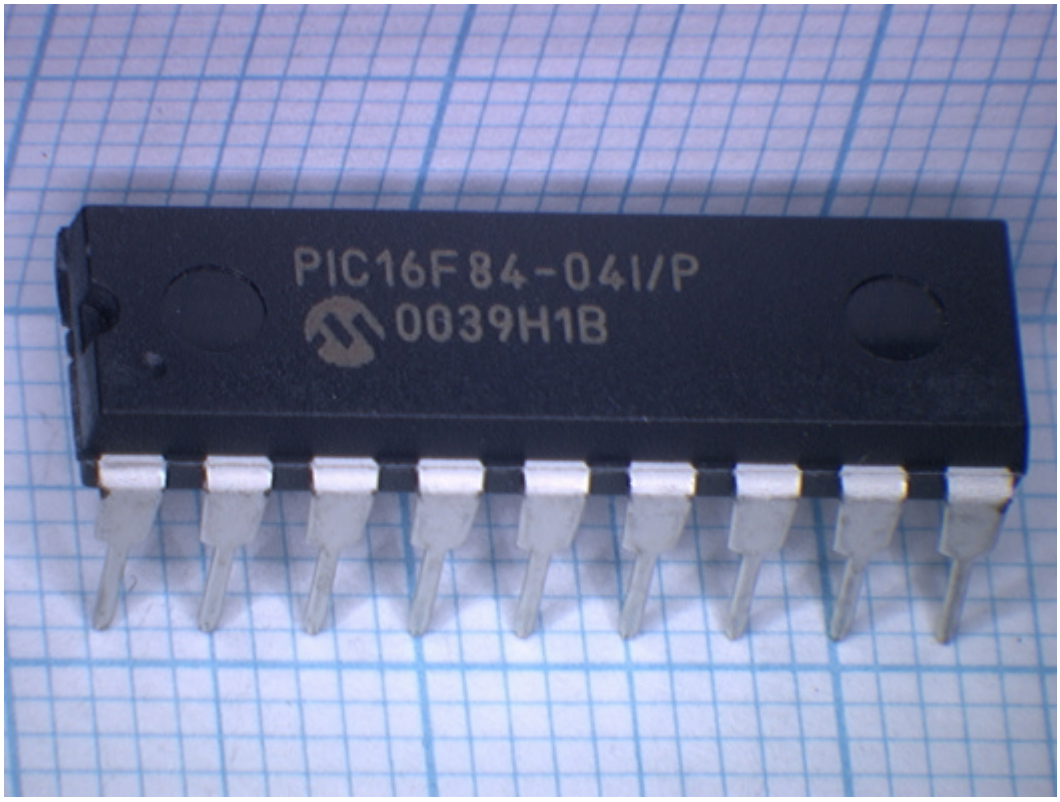


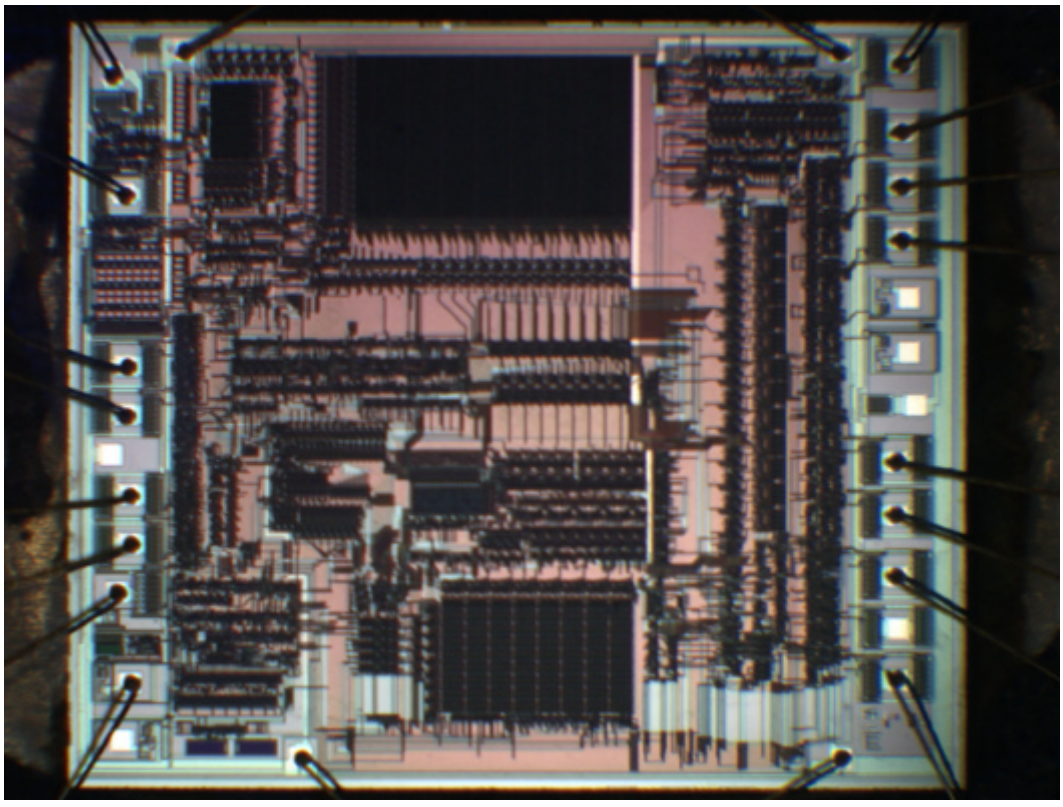
Item No. 9 – TL7705ACP



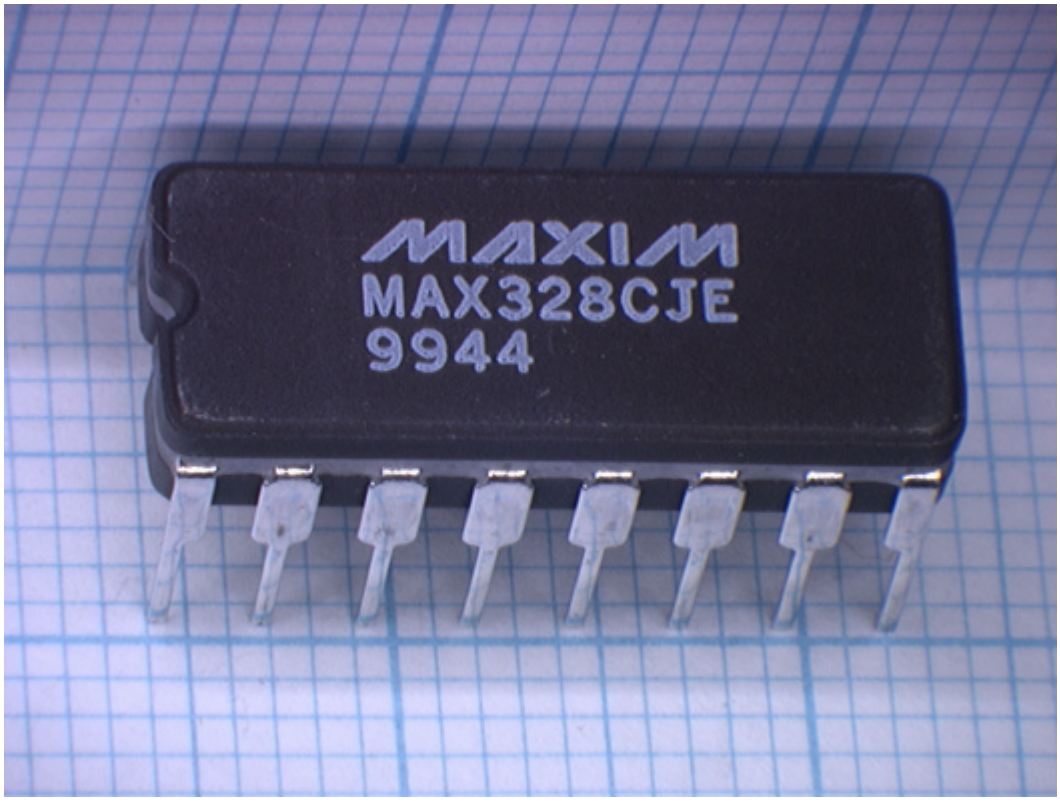


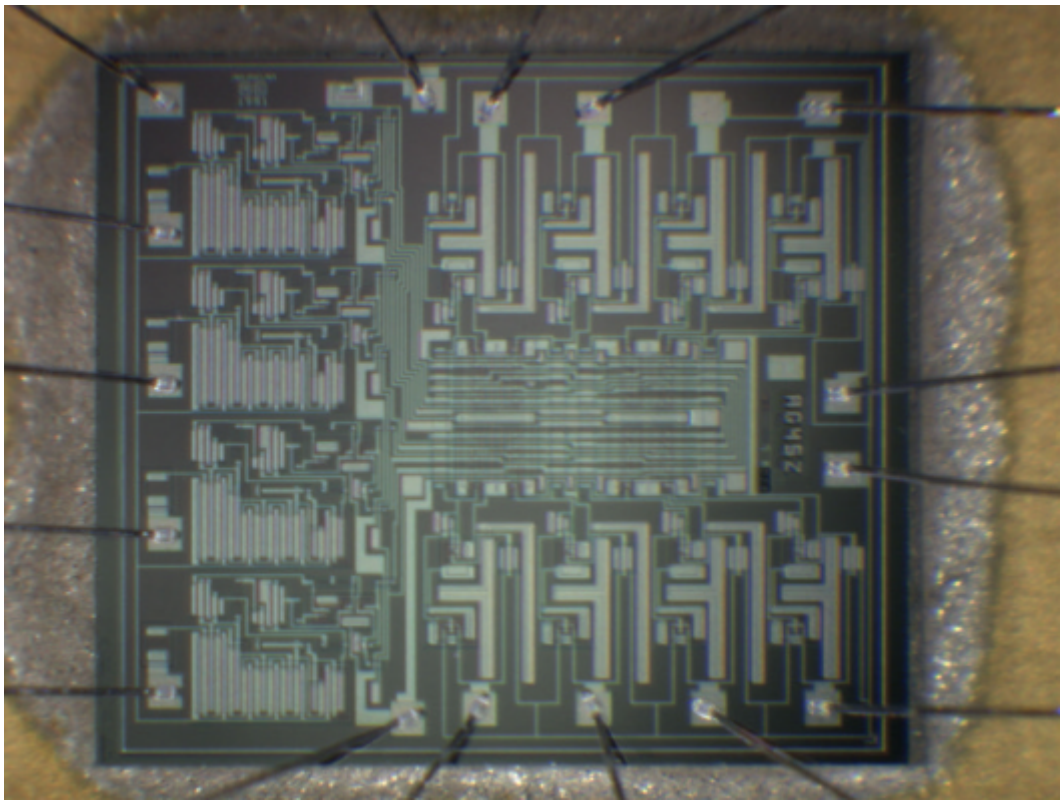
Item No. 10 – PIC16-F84-04I/P



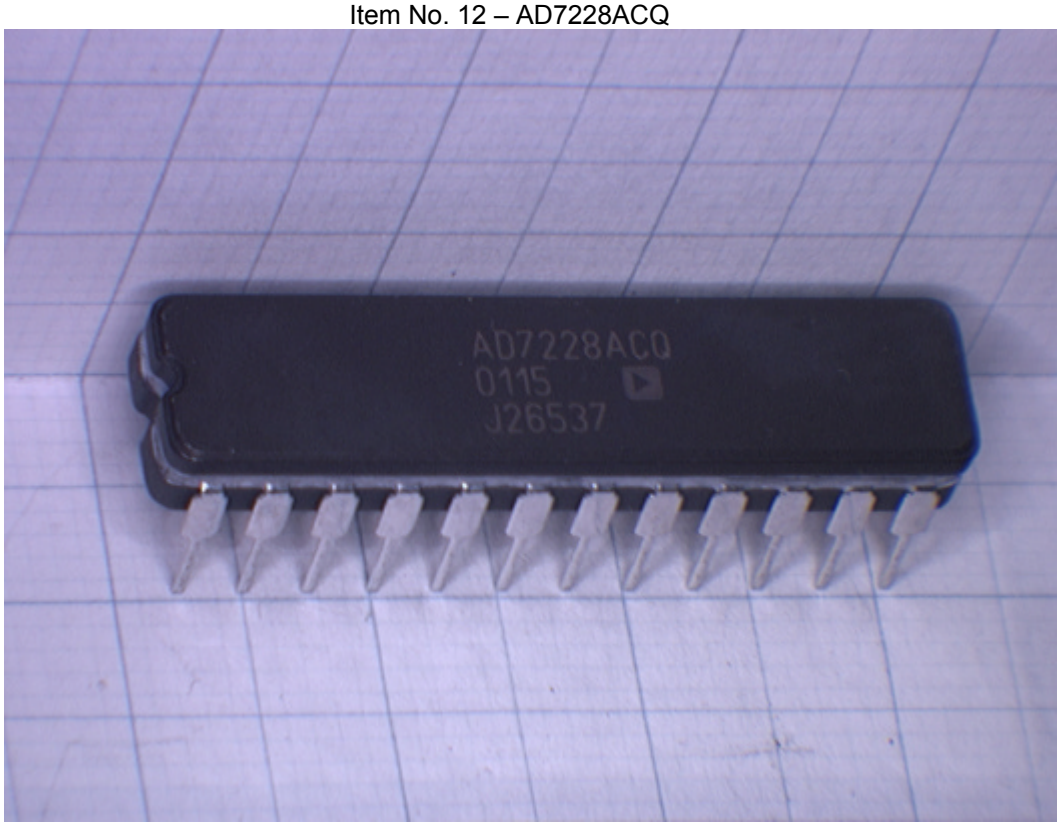


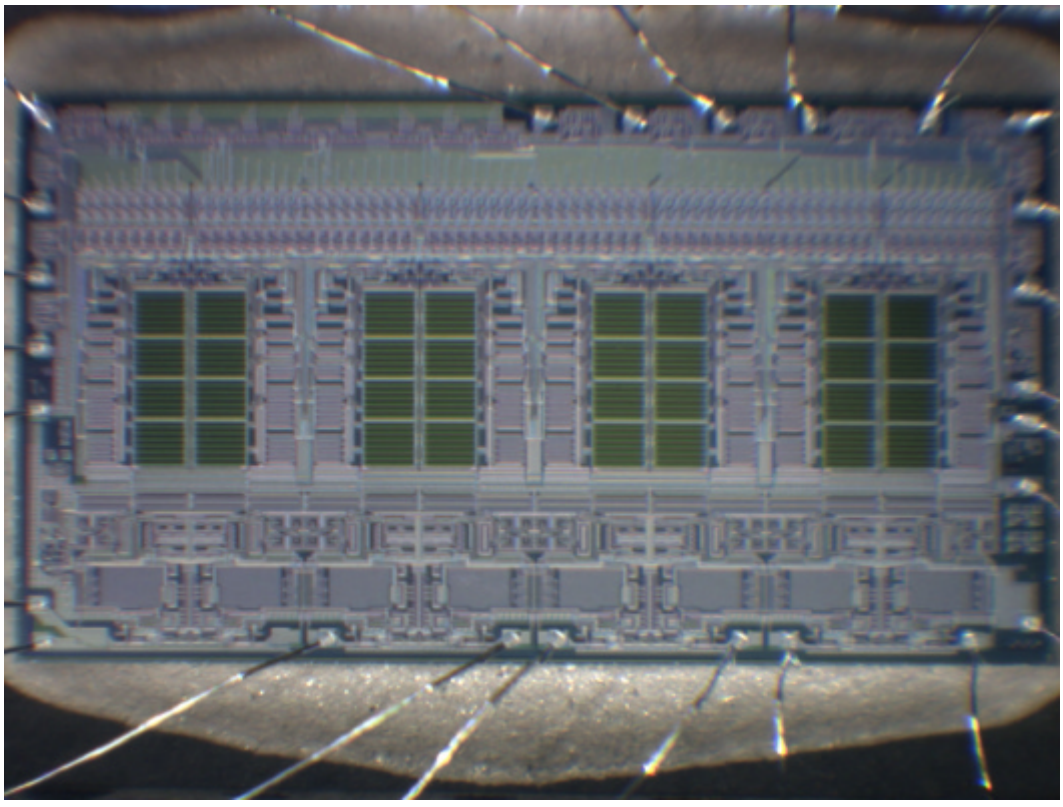
Item No. 11 – MAX328CJE



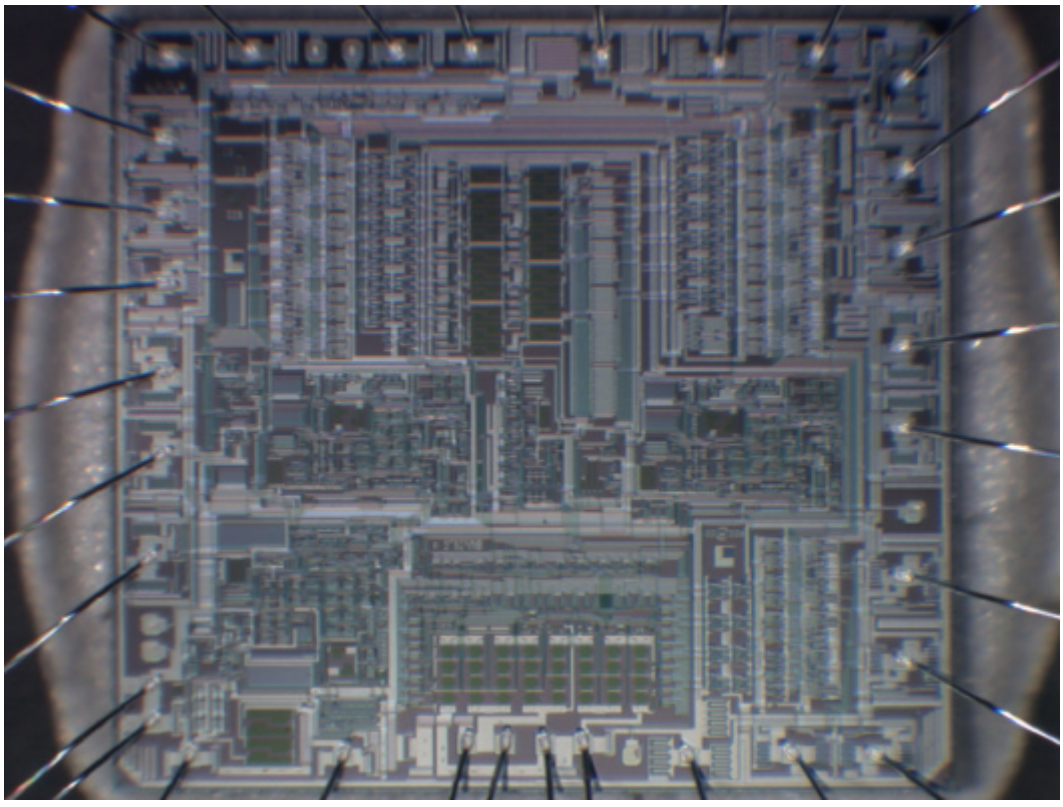


Item No. 12 – AD7228ACQ

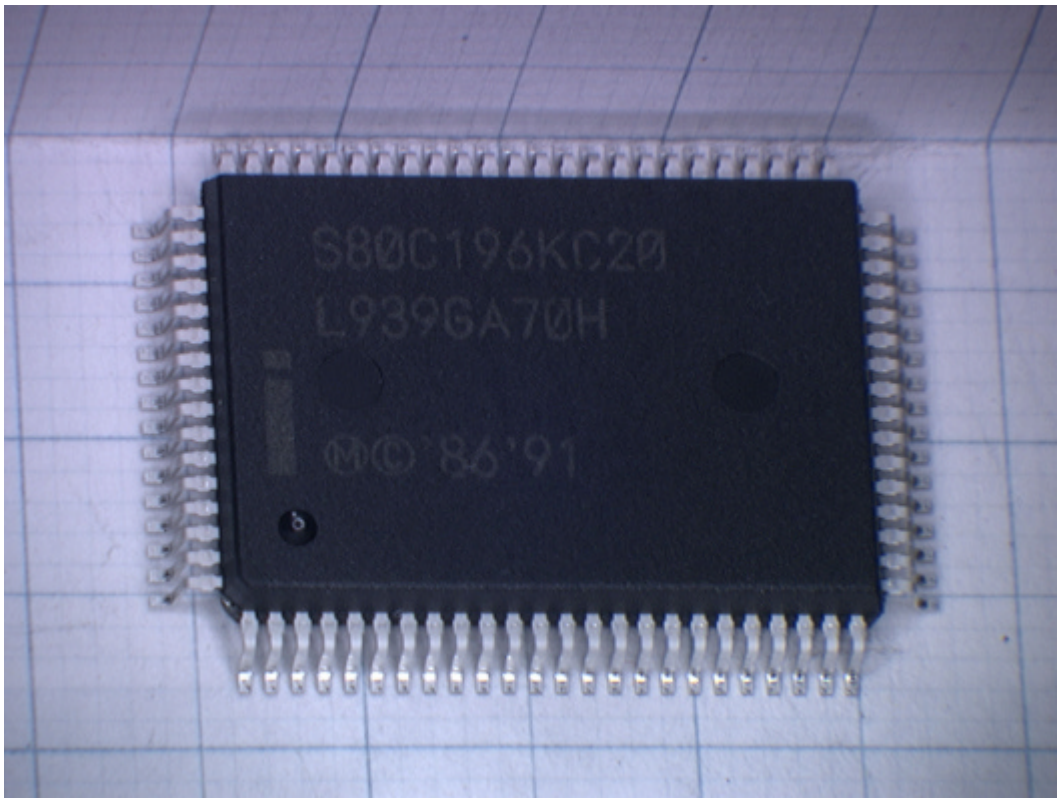


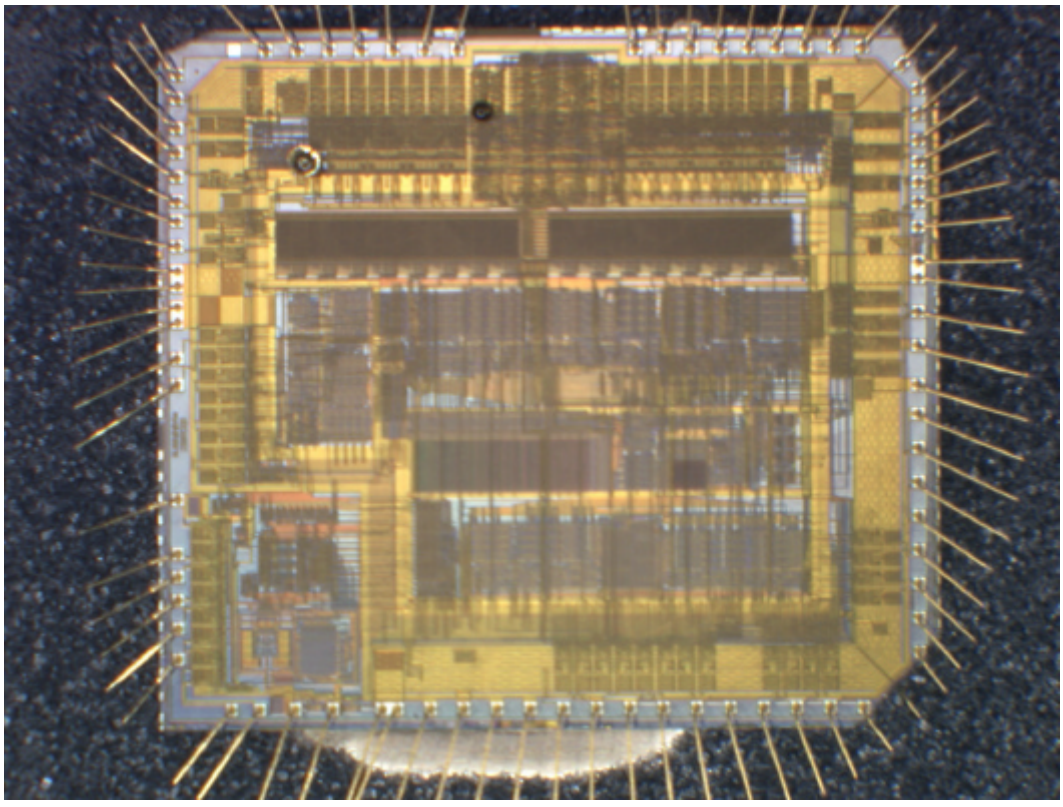


Item No. 13 – AD7846AQ

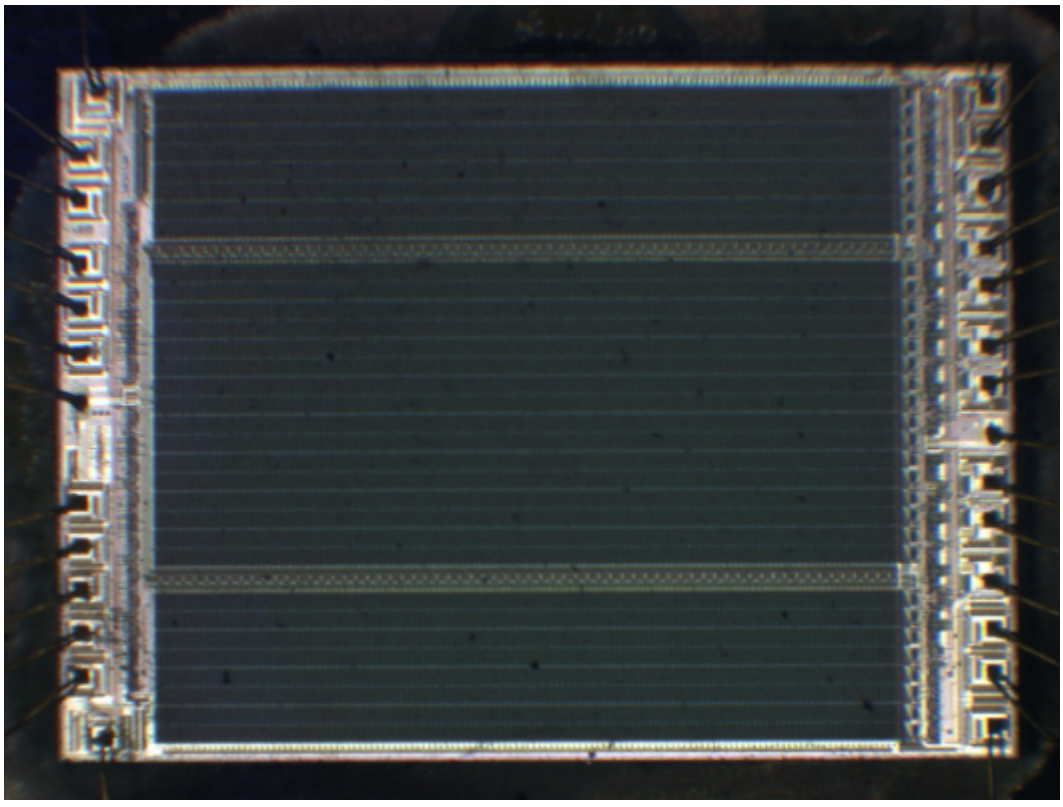


Item No. 14 – 80C196KC-20

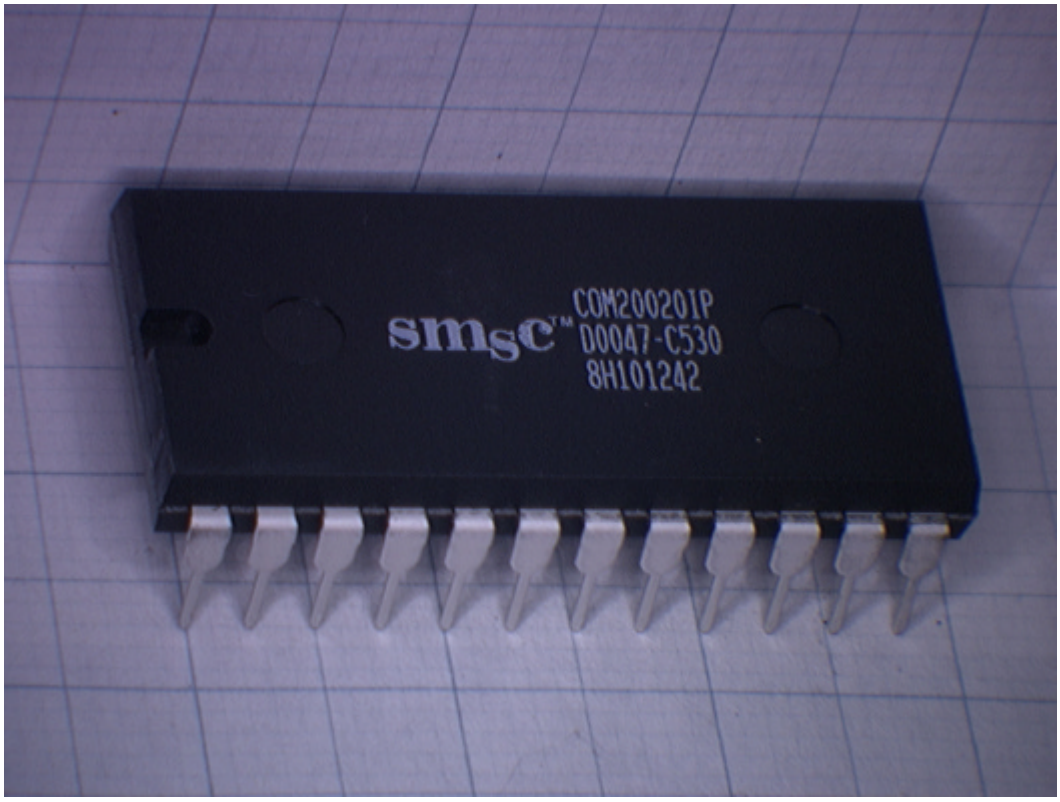


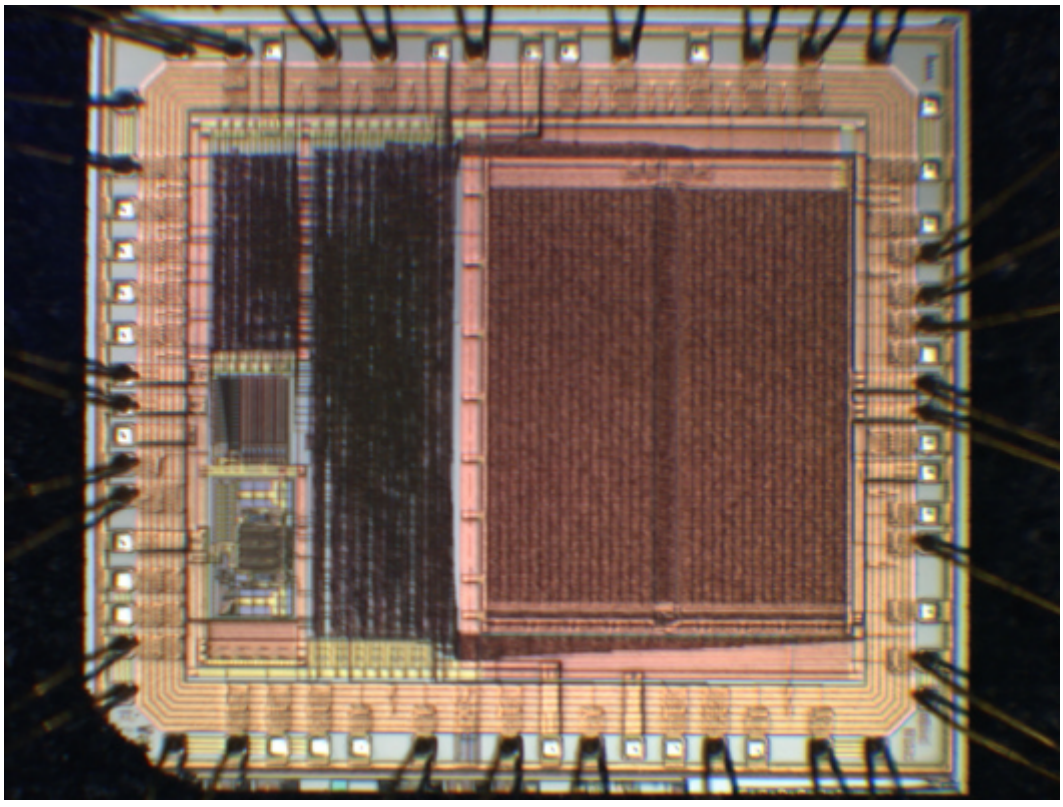


Item No. 15 – DS1225Y-200

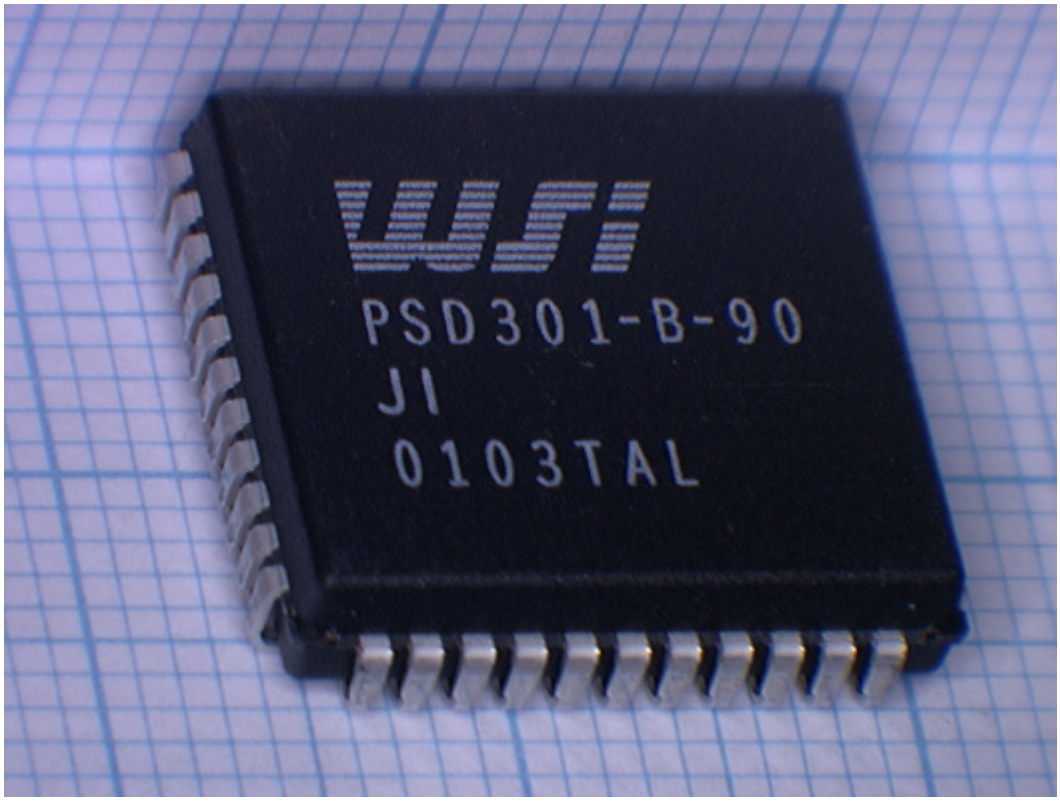


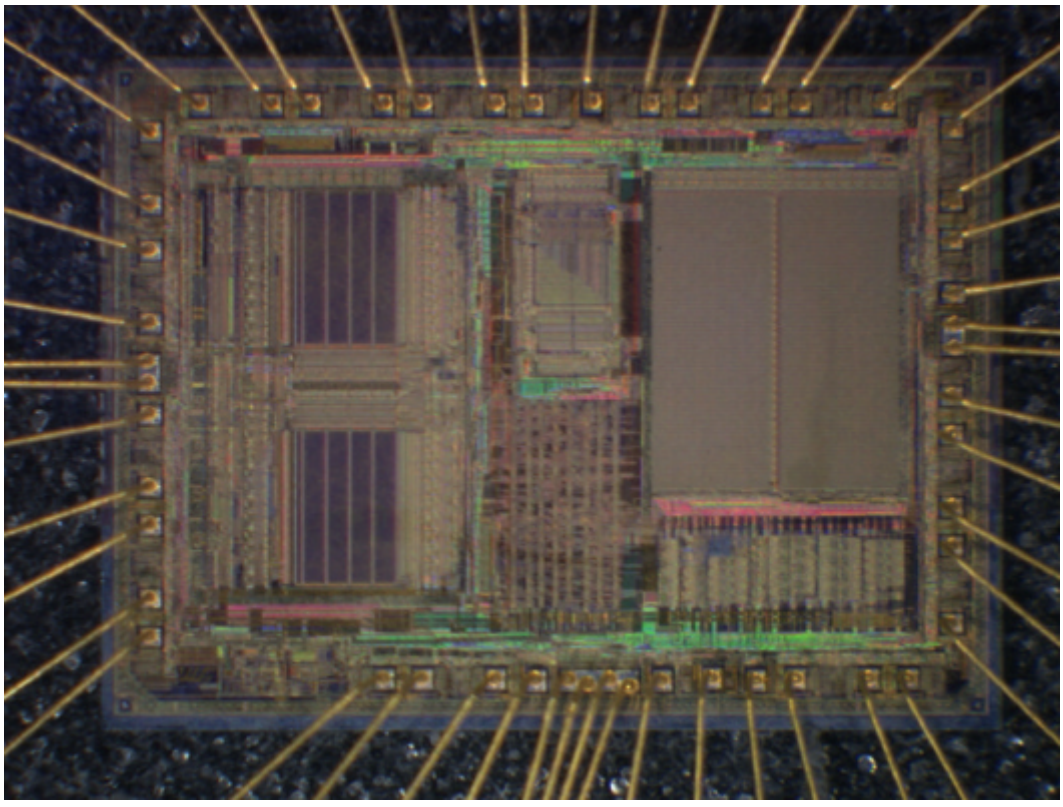
Item No. 16 – COM20020IP



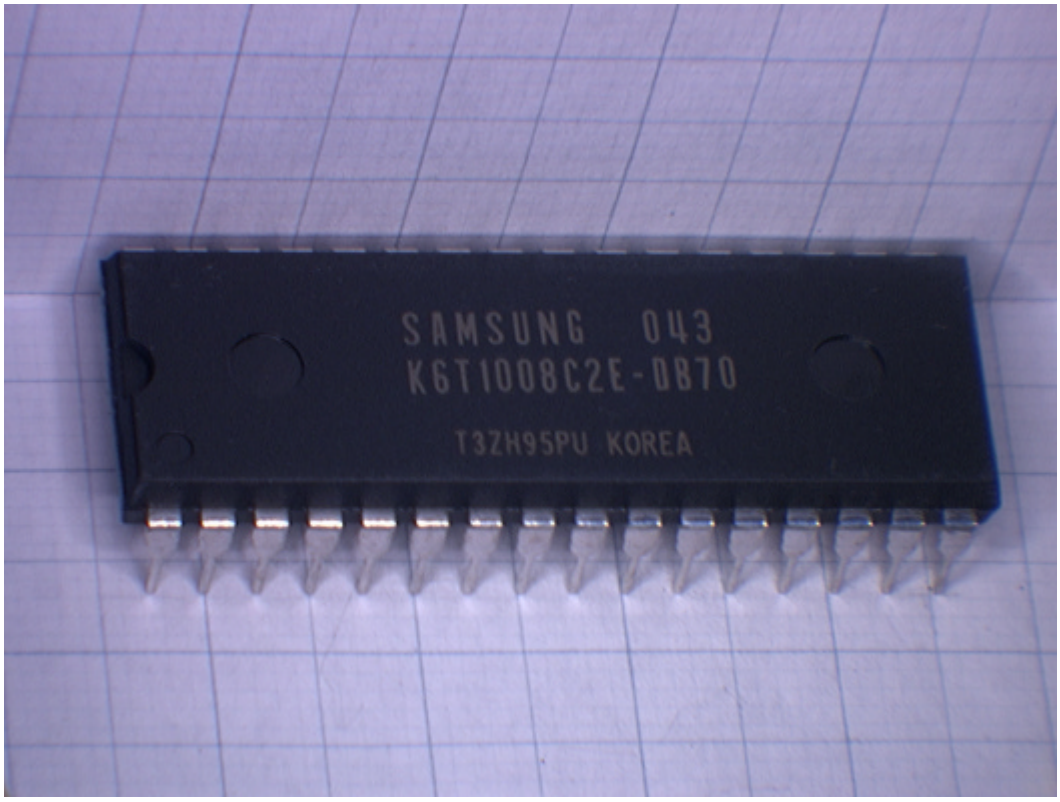


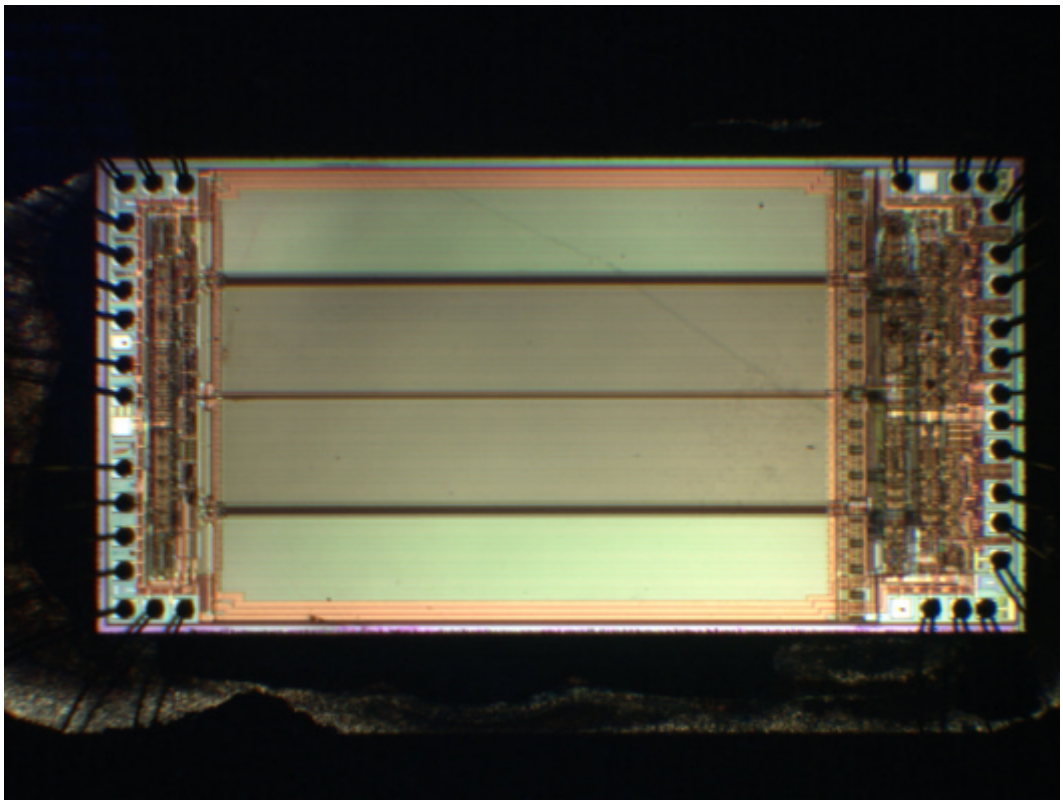
Item No. 17 – PSD301-B-90JI



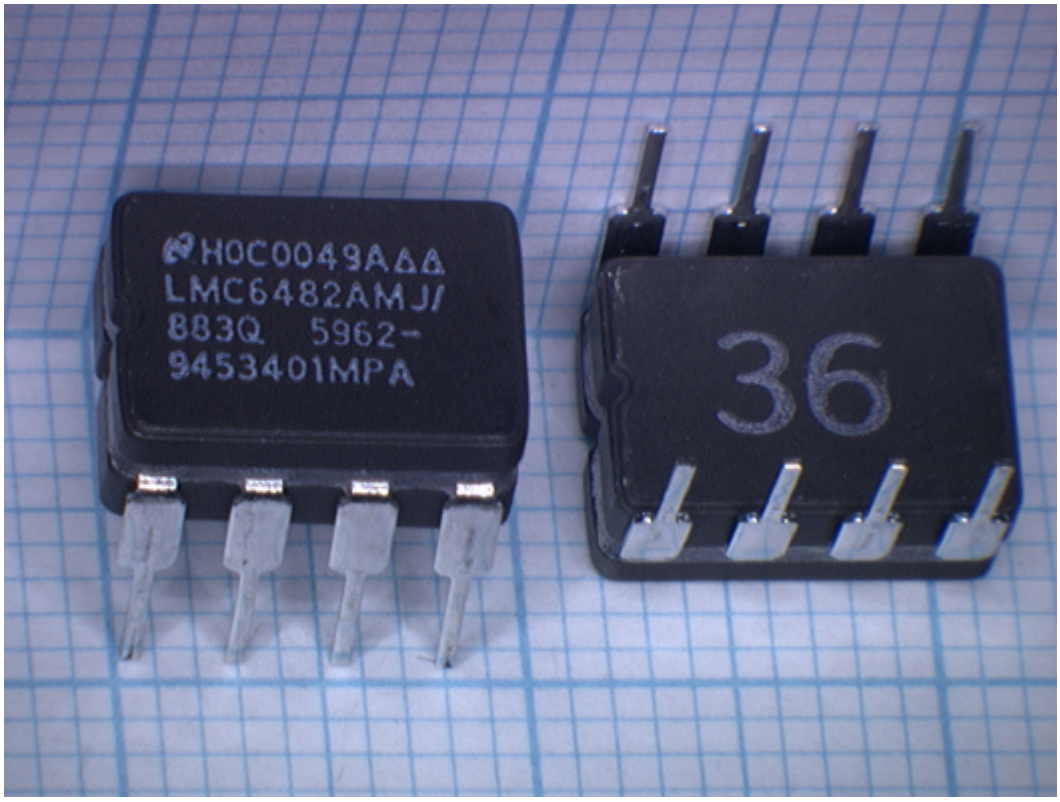


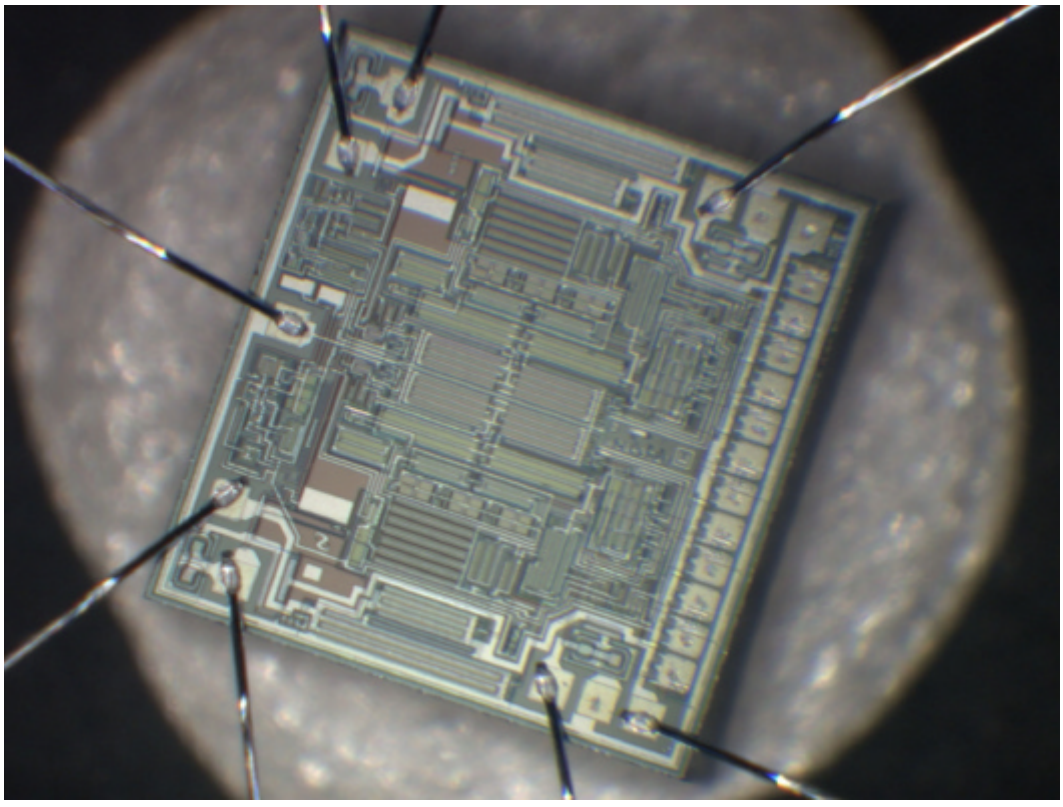
Item No. 18 – K6T1008C2E-DB70



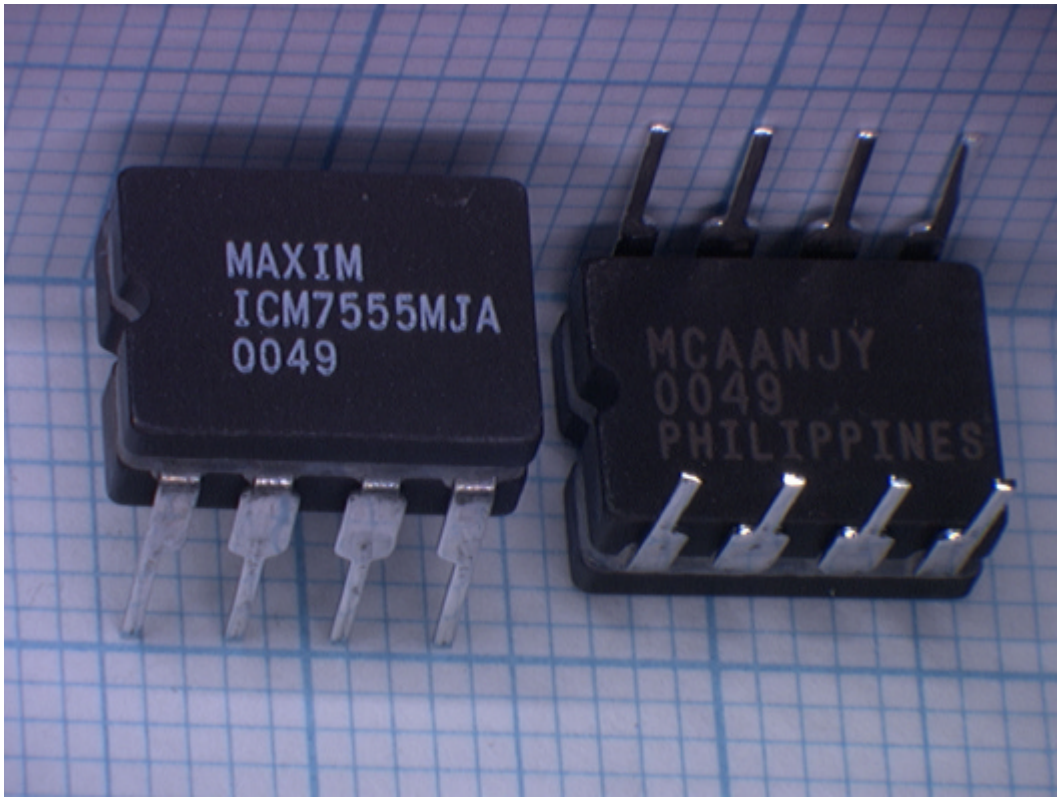


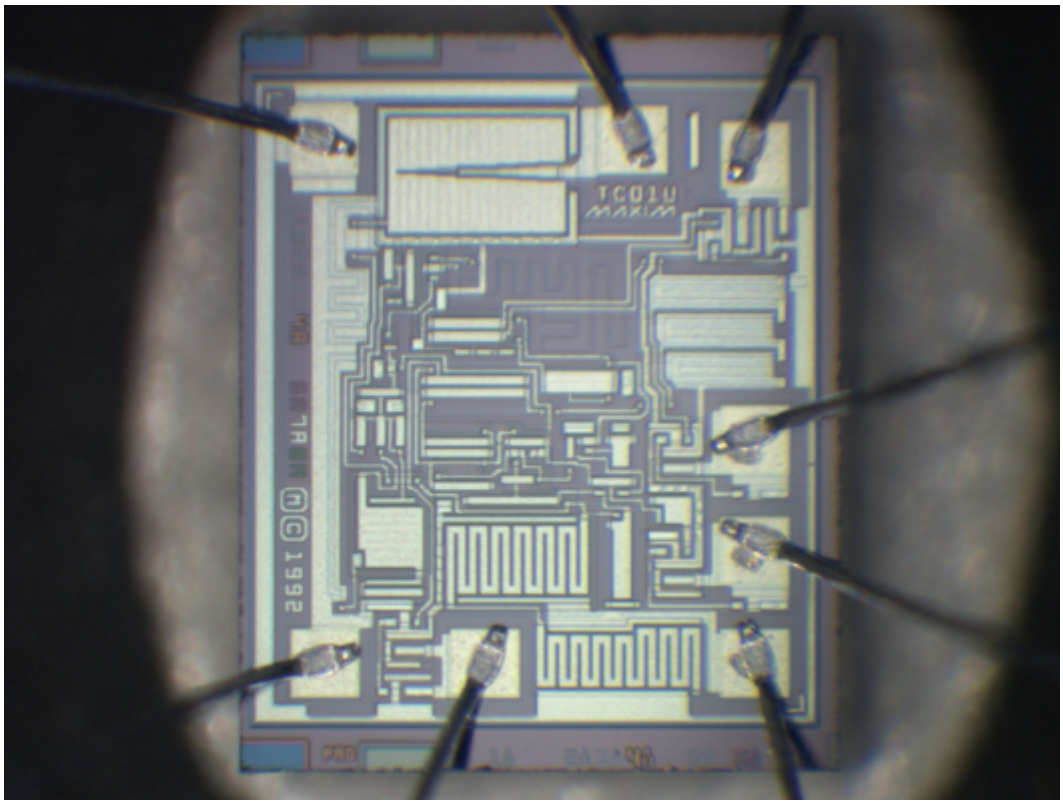
Item No. 19 – LMC6482AMJ/883





Item No. 20 – ICM7555MJA



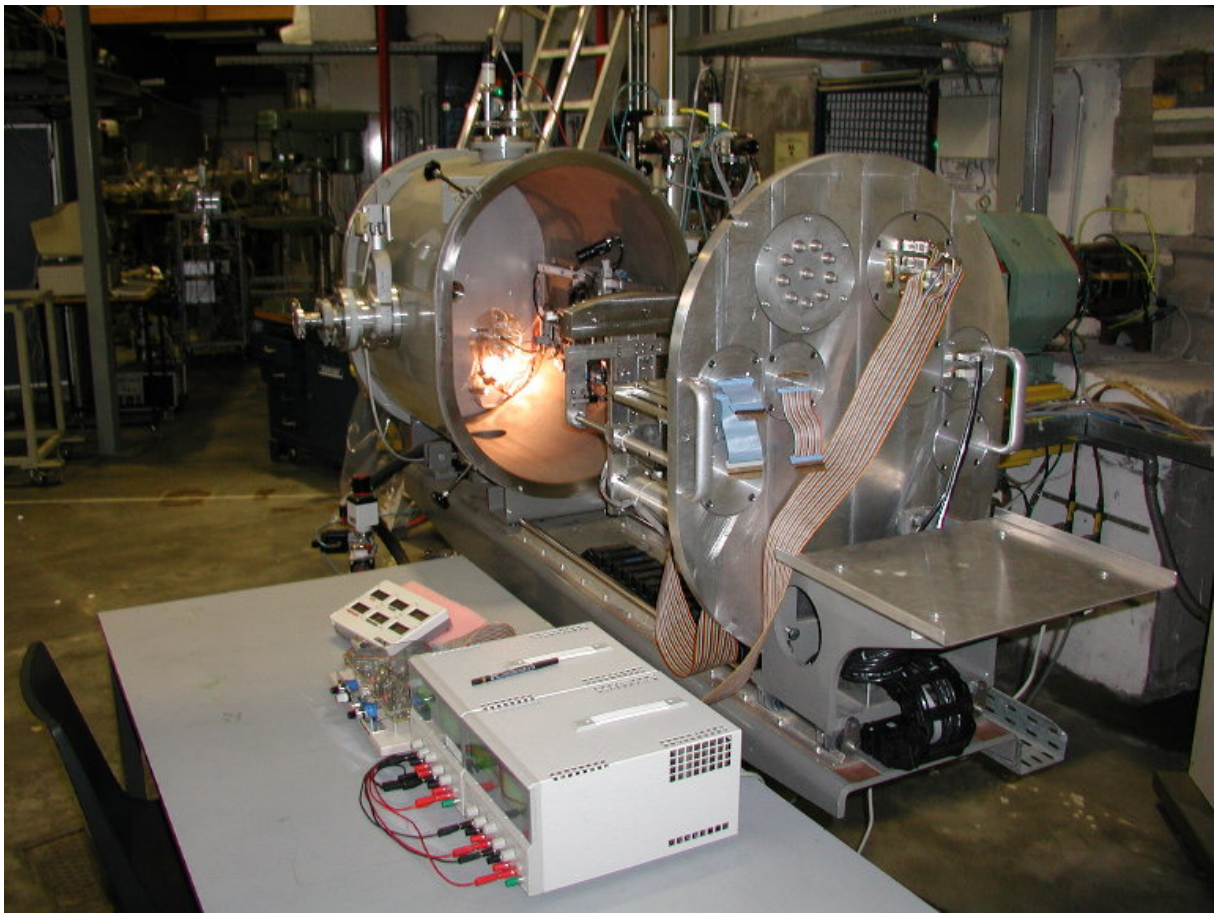


APPENDIX B – MARKING ON EACH COMPONENT

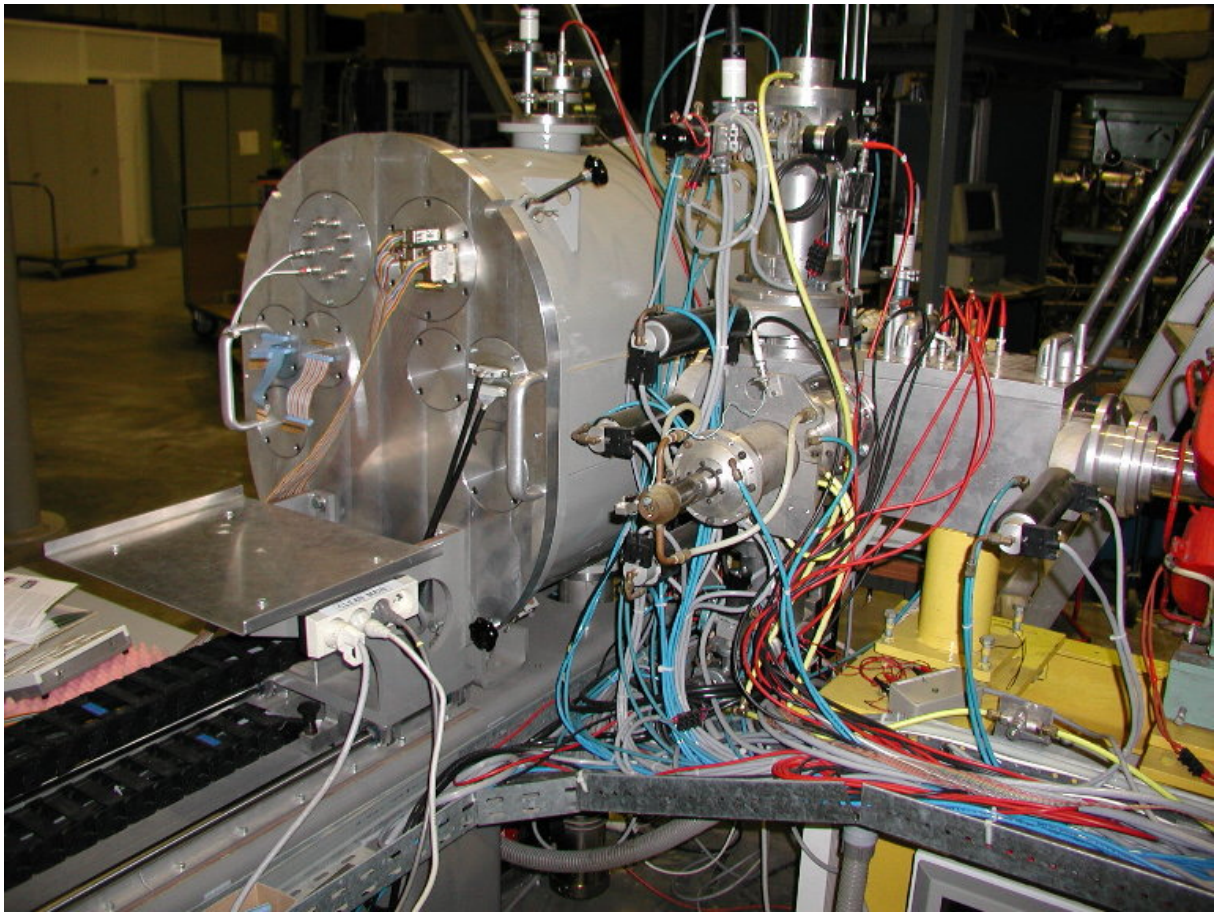
Item No.	Manufacturer	Top View	Bottom View
1	Infineon	SIEMENS SAB 80C166-M DA GERMANY 9735 SIEMENS90	RA718279S01 735KOB
2	STMicroelectronics	ST62T65C6 M220T0102 MALTA	
3	National semiconductor	H2C0049A LMC6062AMJ/883Q 5962-9209403MPA	41
4	National Semiconductor	JM09AF LMC662AIN	
5	Texas Instruments	OAAC3HM TLC272BCP	
6	Linear Technology	0037 LTC1298IN8	
7	Maxim	MAXIM MAX538 BEPA 0114	SXMBNAD 0114
8	Fairchild	B05AB 93C56EN	
9	Texas instruments	05C3F1M TL7705ACP	
10	Microchip Technology	PIC16F84-04I/P 0039H1C (x3) 0039H1B (x7)	
11	Maxim	MAXIM MAX328CJE 9944 (x25) 9849 (x25)	MRSANIB (x25) 9944 (x25) MRSAXRE (x25) 9849 (x25) PHILIPPINES

12	Analog Devices	AD7228ACQ 0115 J26537	C756666 C PHILIPPINES
13	Analog Devices	AD7846AQ 0047 J26564	C67965 C PHILIPPINES
14	Intel	S80C196KC20 L939GA70H ‘86’91	
15	Dallas	DALLAS DS1225Y-200 NONVOLATILE SRAM 0052S 300855 PHILIPPINES	DS1218 0042D1 411AB
16	Standard microsystems	COM20020IP D0047-C530 8H101242	TAIWAN ASE 8H101242
17	Wafer Scale Integration	PSD301-B-90 JI 0103TAL	
18	Samsung	SAMSUNG 043 K6T1008C2E-DB70 T3ZH95PE KOREA (x3) T3ZH95PU KOREA (x7)	
19	National Semiconductor	HOC0049A LMC6482AMJ/883Q 5962-9453401MPA	36
20	Maxim	MAXIM ICM7555MJA 0049	MCAANJY 0049 PHILIPPINES

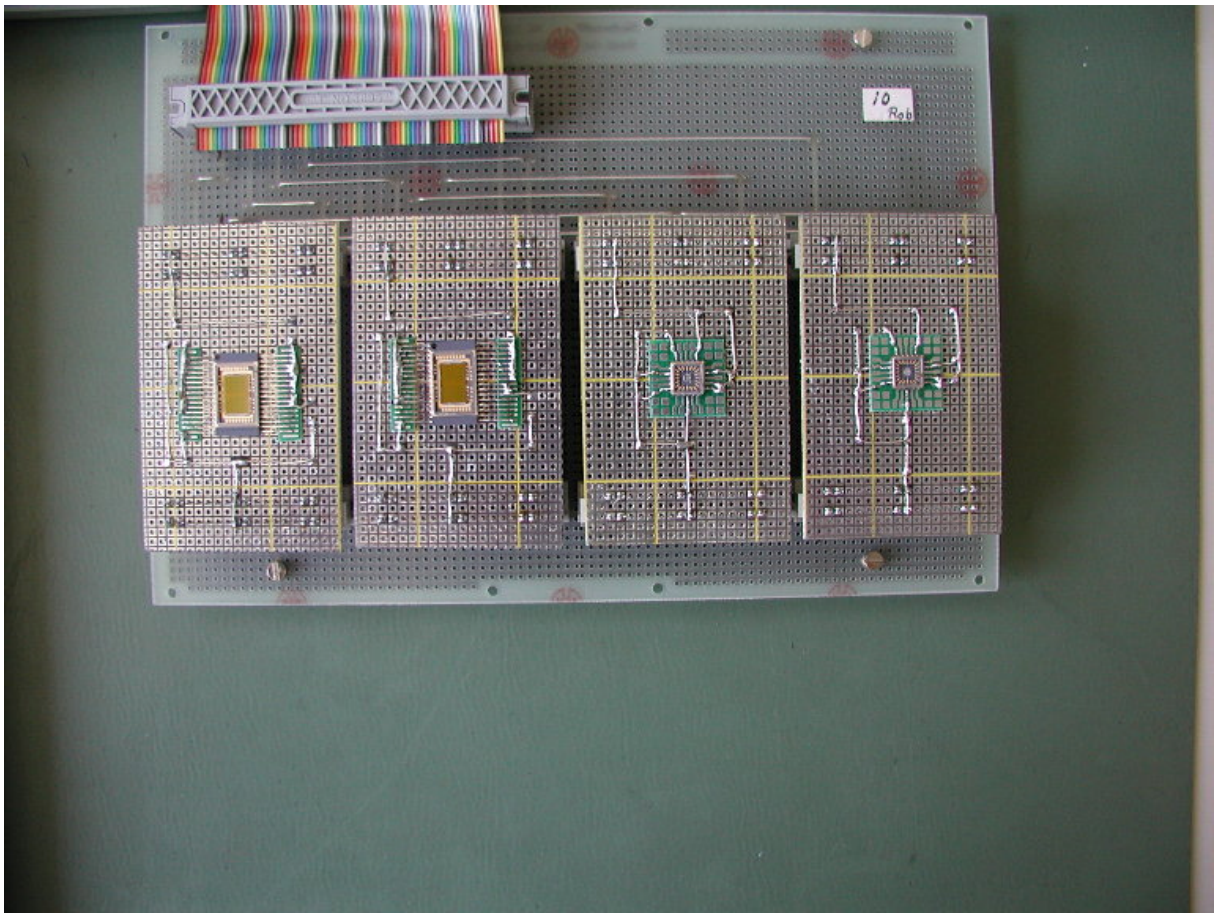
APPENDIX C – TEST HARDWARE PHOTOGRAPHS



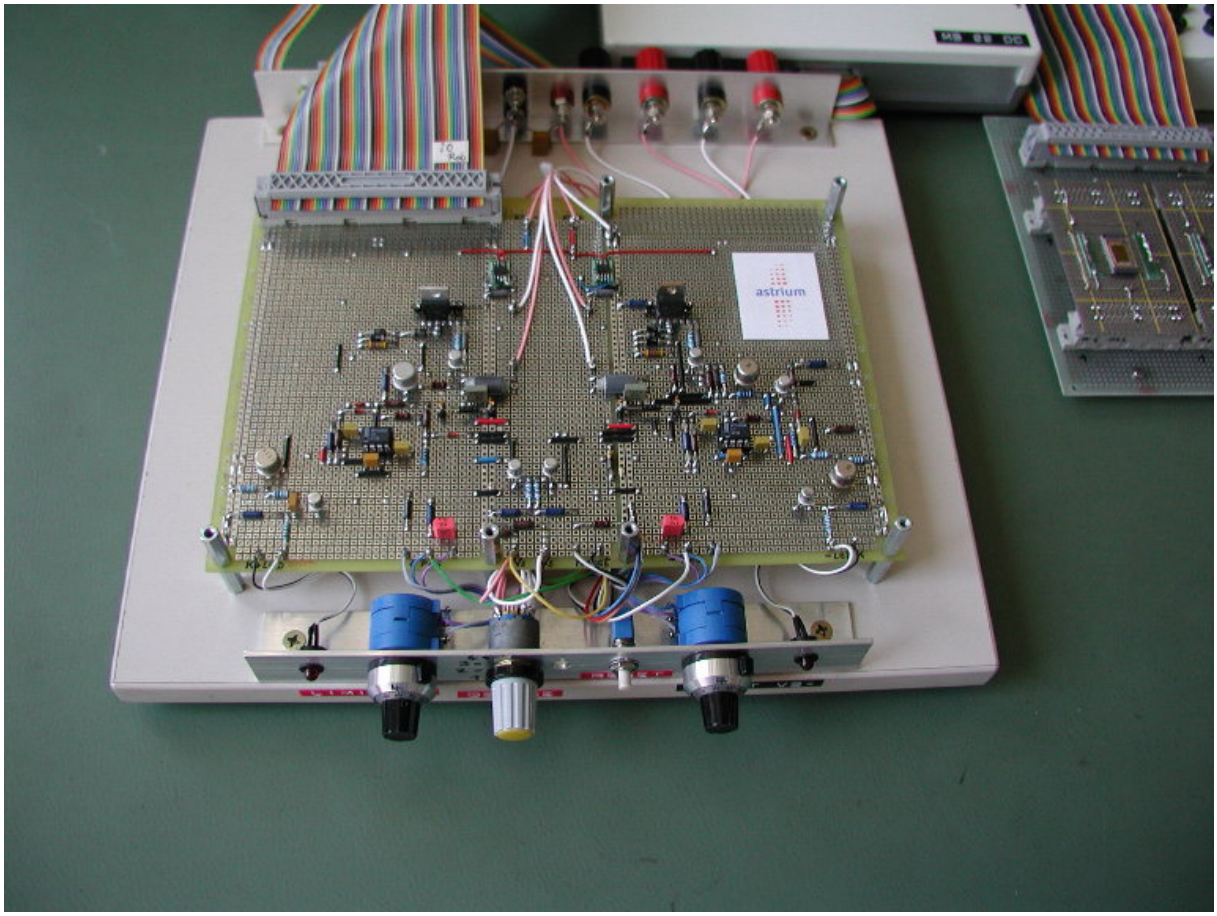
Photograph 1 – Open irradiation chamber with mother and daughter boards mounted inside open door, and biasing and monitoring circuitry on table in foreground



Photograph 2 – Closed irradiation chamber during test run showing where heavy ion beam enters chamber on the right

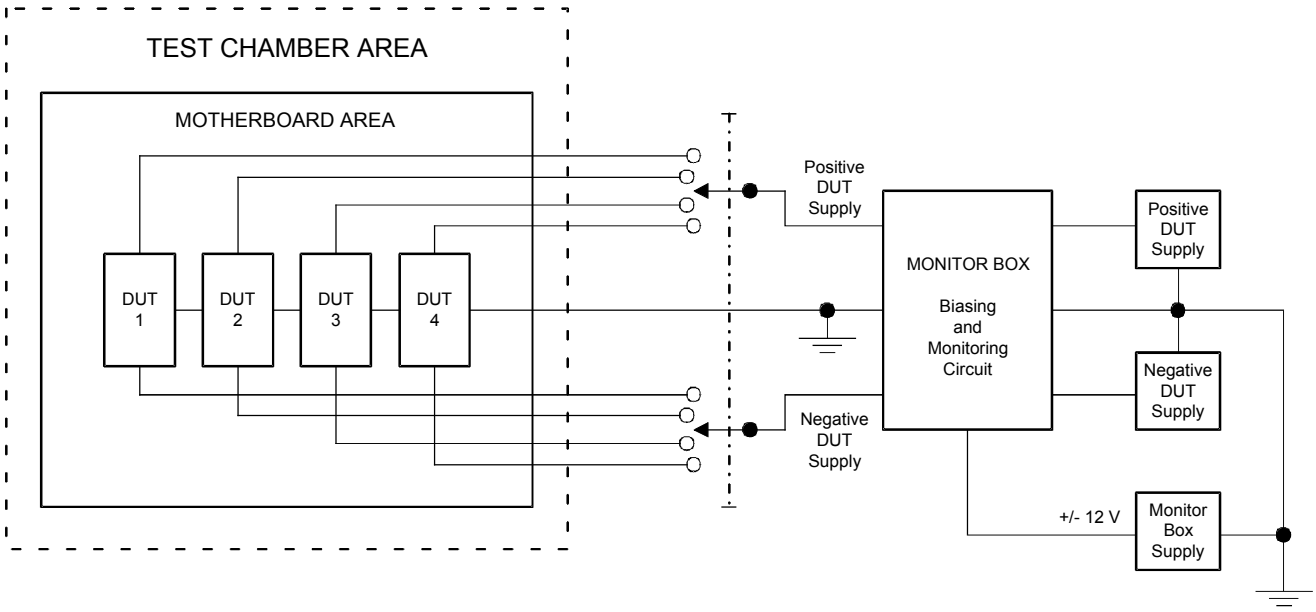


Photograph 3 – Mother board and four daughter boards with mounted components before being placed in the irradiation chamber



Photograph 4 – Monitoring and biasing circuit (power supplies not shown)

Appendix D – General test schematic



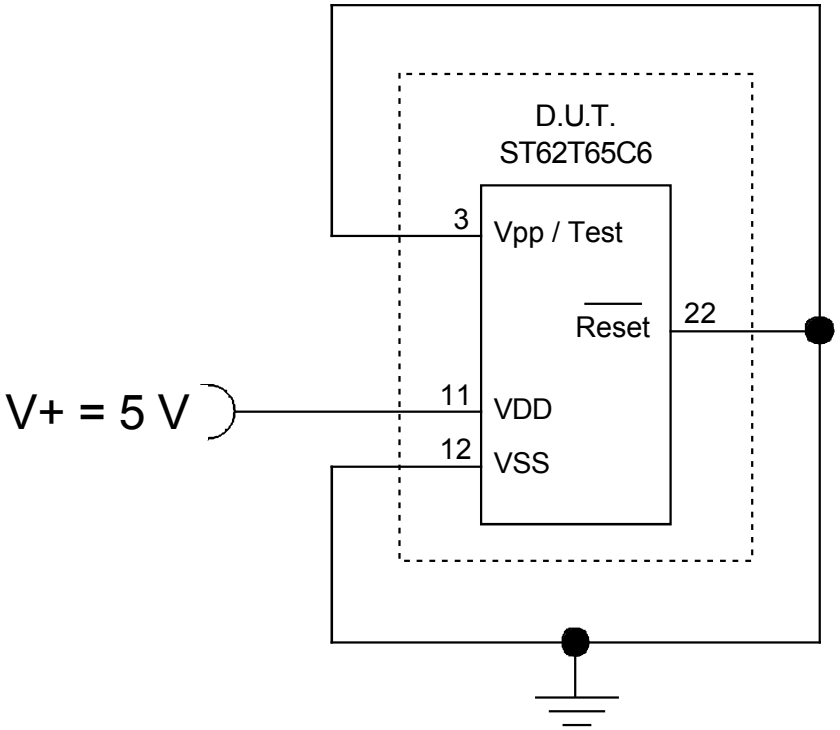
APPENDIX E – PART TYPE SPECIFIC SCHEMATICS

- Item No.: 1
- Component Type: SAB80C166M
- Component Package: 100-pin plastic flatpack (MQFP)
- Irradiation Bias Conditions:
  The connection to each pin on the test components was as shown below

+5V	Ground	Open
7	6	1-5
18	21-24	8-17
38	27	19-20
61	29	25-26
79	39	28
93	48-60	30-37
	78	40-47
	94	62-77
		80-92
		95-100

- Bias Options:
  None
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of Supply Current

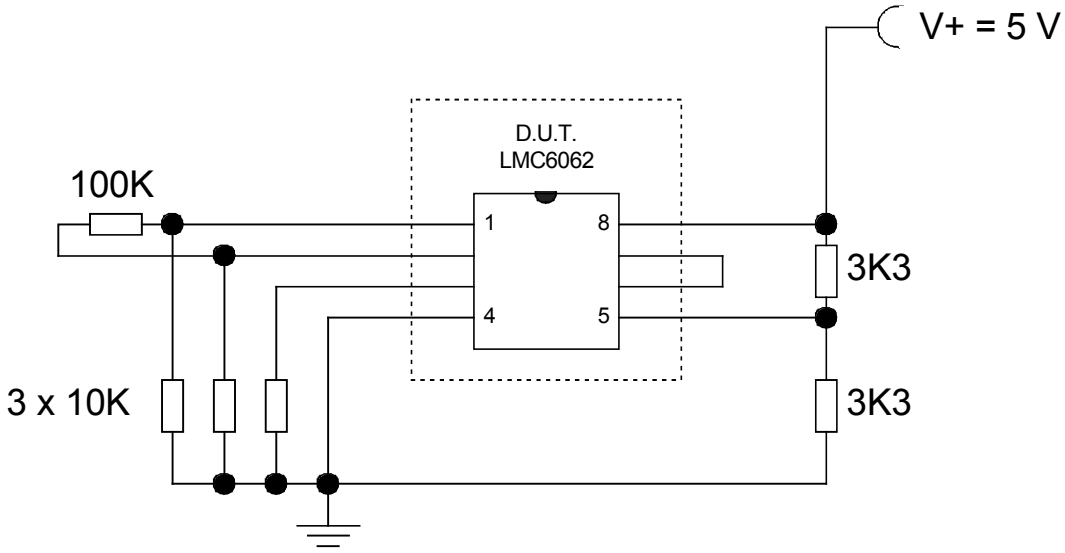
- Item No.: 2
- Component Type: ST62T65CB6
- Component Package: 28-pin plastic DIP
- Irradiation Bias Conditions:



pins not shown are not connected

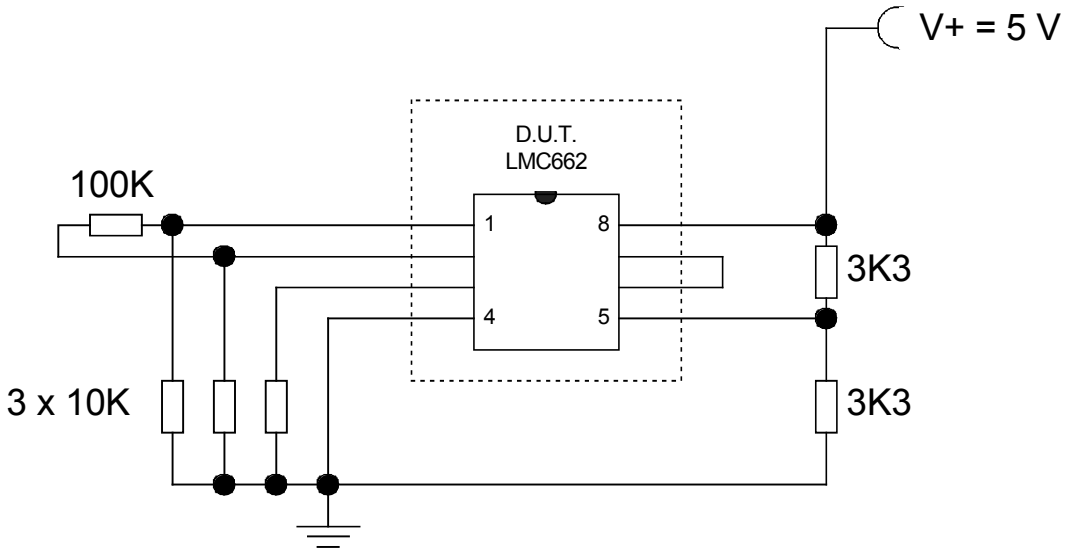
- Bias Options:
  None
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of Supply Current

- Item No.: 3
- Component Type: LMC6062/883
- Component Package: 8-pin ceramic DIP
- Irradiation Bias Conditions:



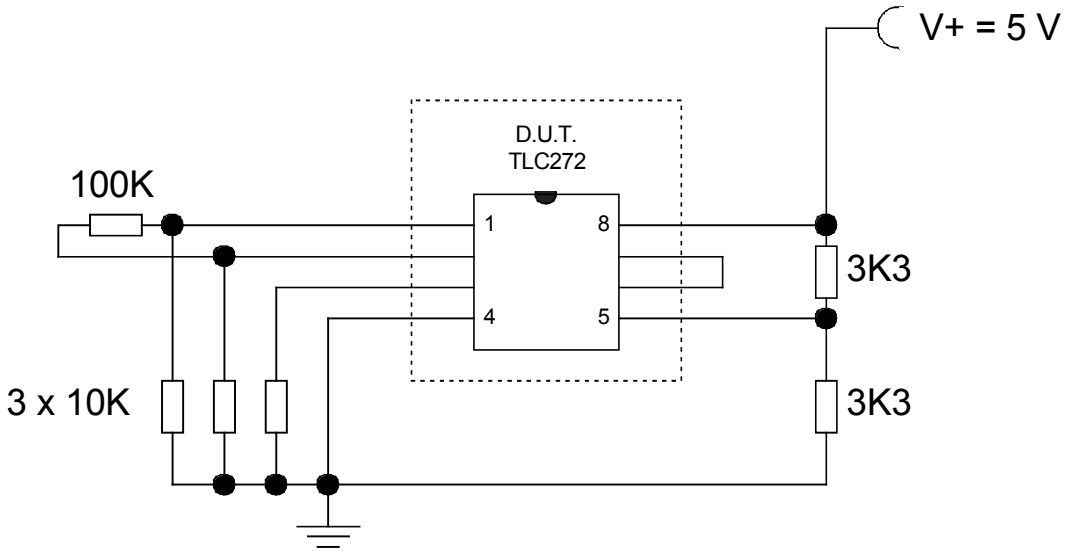
- Bias Options:
  Testing could be repeated with another supply voltage, e.g. 15V
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply current
  Measurement of output voltage

- Item No.: 4
- Component Type: LMC662AIN
- Component Package: 8-pin plastic DIP
- Irradiation Bias Conditions:



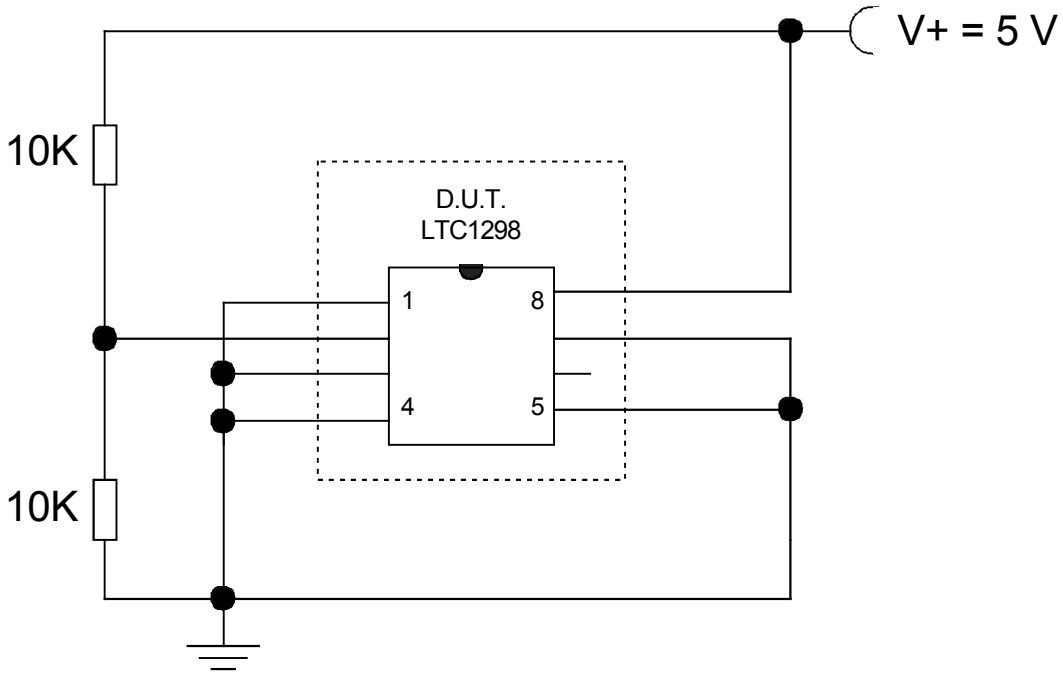
- Bias Options:
  Testing could be repeated at another supply voltage, e.g. 15V
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply current
  Measurement of output voltage

- Item No.: 5
- Component Type: TLC272BCP
- Component Package: 8-pin plastic DIP
- Irradiation Bias Conditions:



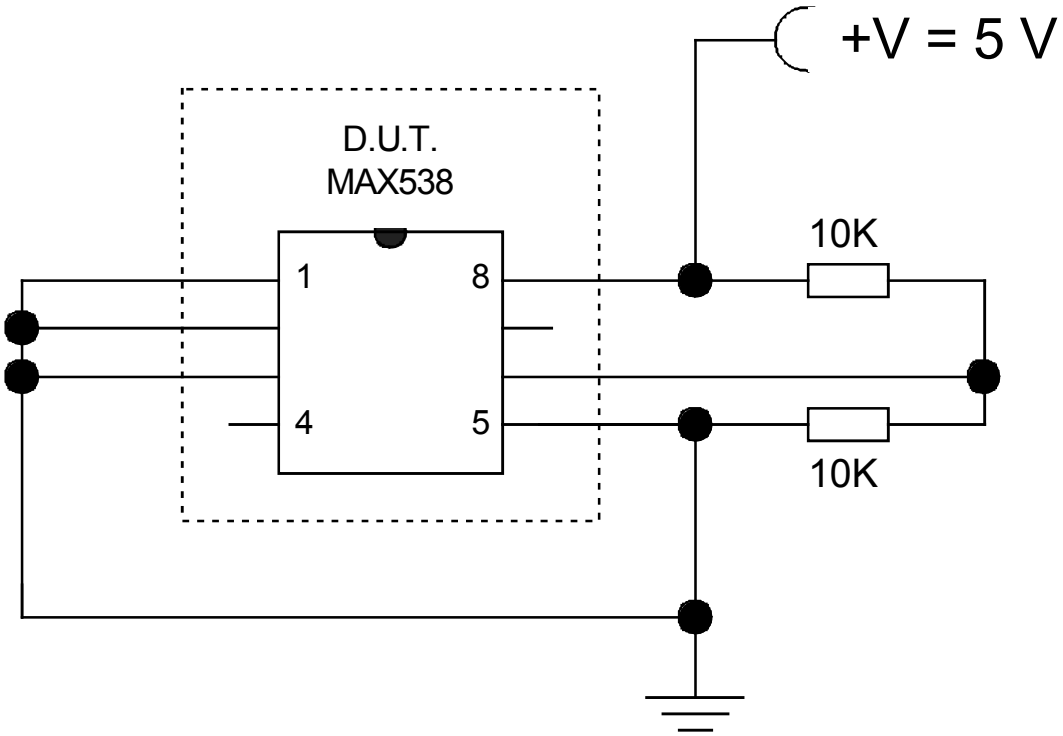
- Bias Options:
  Testing could be repeated with another supply voltage, e.g. 15V
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply current
  Measurement of output current

- Item No.: 6
- Component Type: LT1298IN8
- Component Package: 8-pin plastic DIP
- Irradiation Bias Conditions:



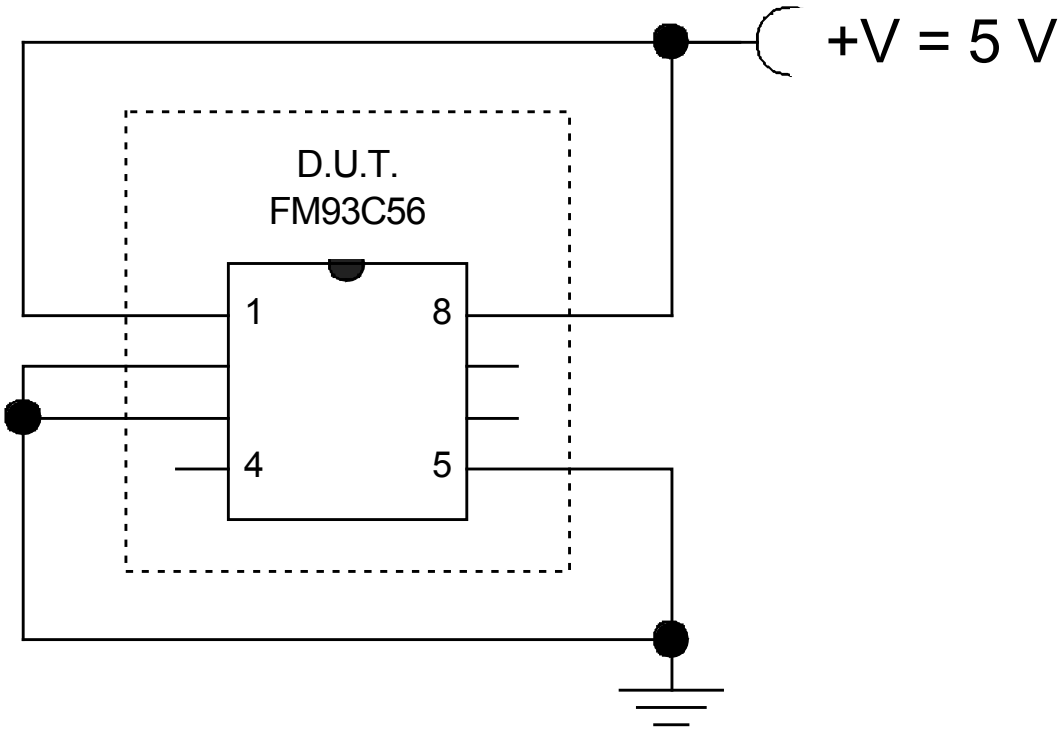
- Bias Options:
  None
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply current
  Measurement of output voltage

- Item No.: 7
- Component Type: MAX538BEPA
- Component Package: 14-pin plastic DIP
- Irradiation Bias Conditions:



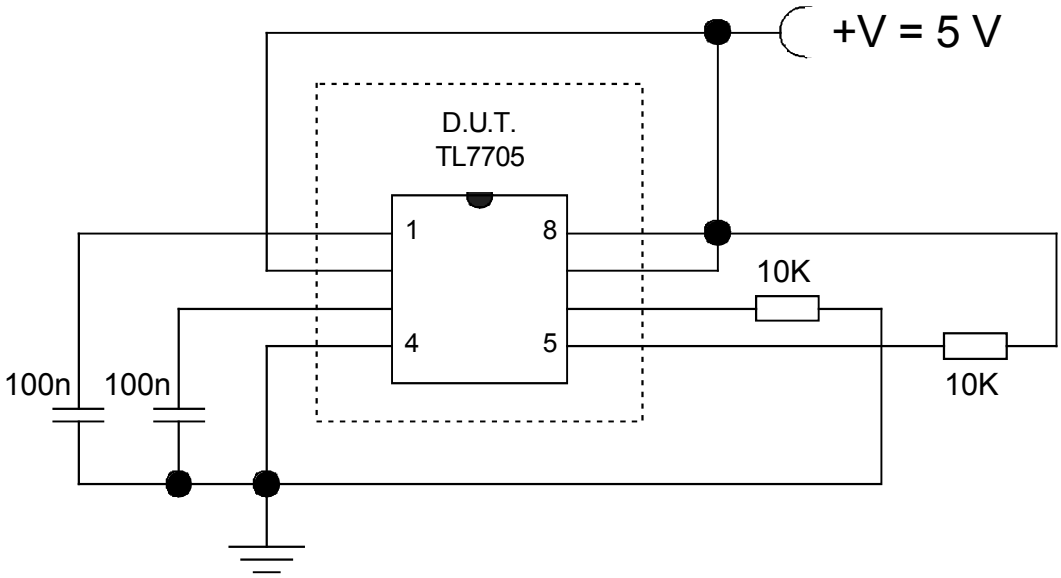
- Bias Options:
  None
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply current
  Measurement of output voltage

- Item No.: 8
- Component Type: FM93C56EN
- Component Package: 8-pin plastic DIP
- Irradiation Bias Conditions:



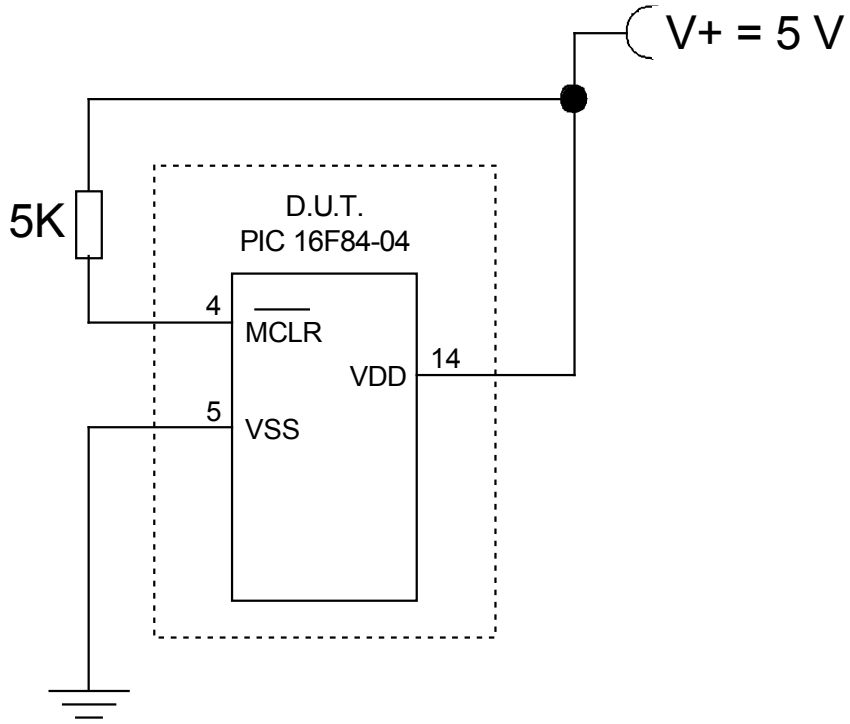
- Bias Options:
  None
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply current
  Measurement of output voltage

- Item No.: 9
- Component Type: TL7705ACP
- Component Package: 8-pin plastic DIP
- Irradiation Bias Conditions:



- Bias Options:
  None
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply current
  Measurement of output (REF) voltage

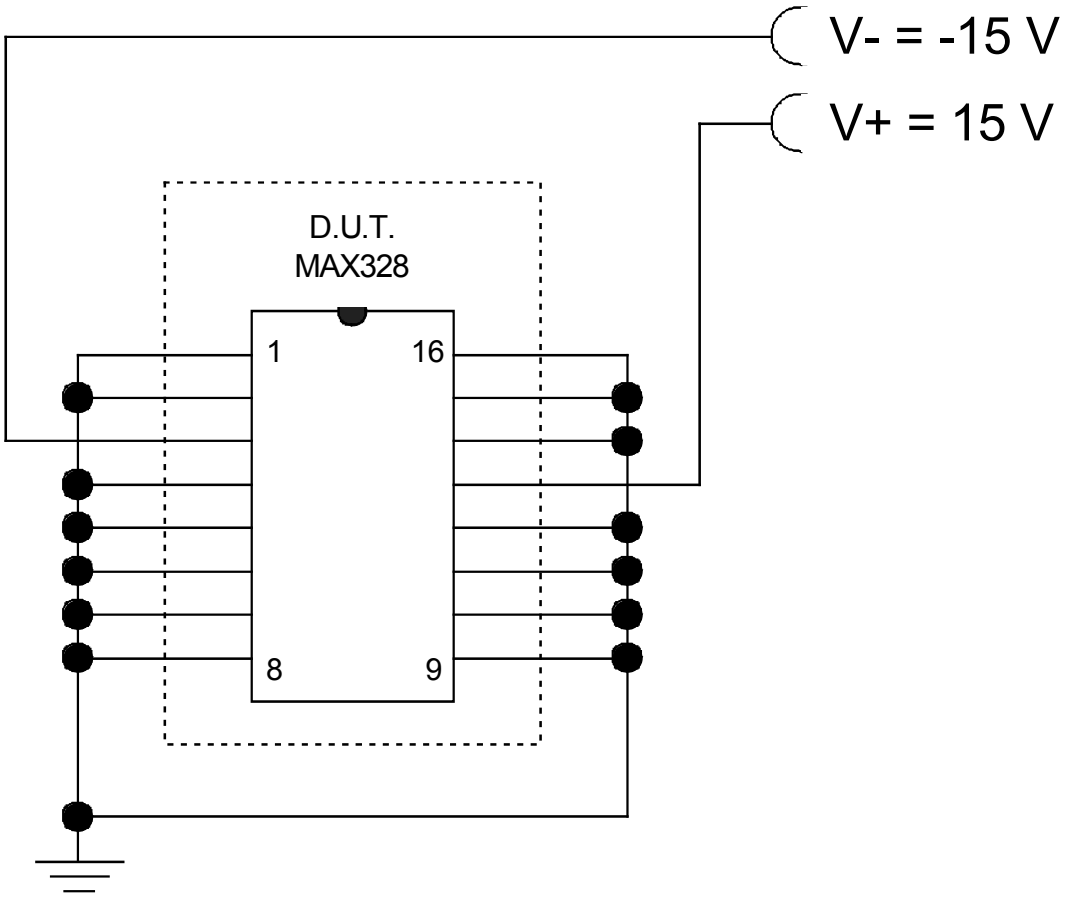
- Item No.: 10
- Component Type: PIC16-F84-04I/P
- Component Package: 18-pin plastic DIP
- Irradiation Bias Conditions:



pins not shown are not connected

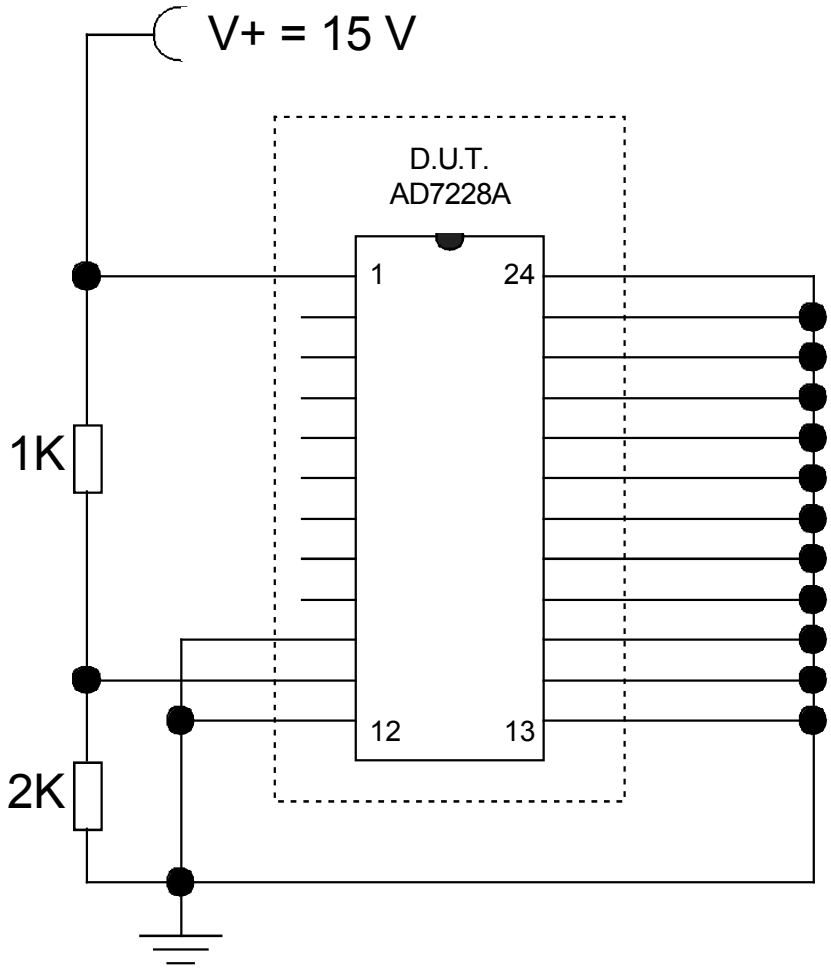
- Bias Options:
  None
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply current

- Item No.: 11
- Component Type: MAX328CJE
- Component Package: 16-pin ceramic DIP
- Irradiation Bias Conditions:



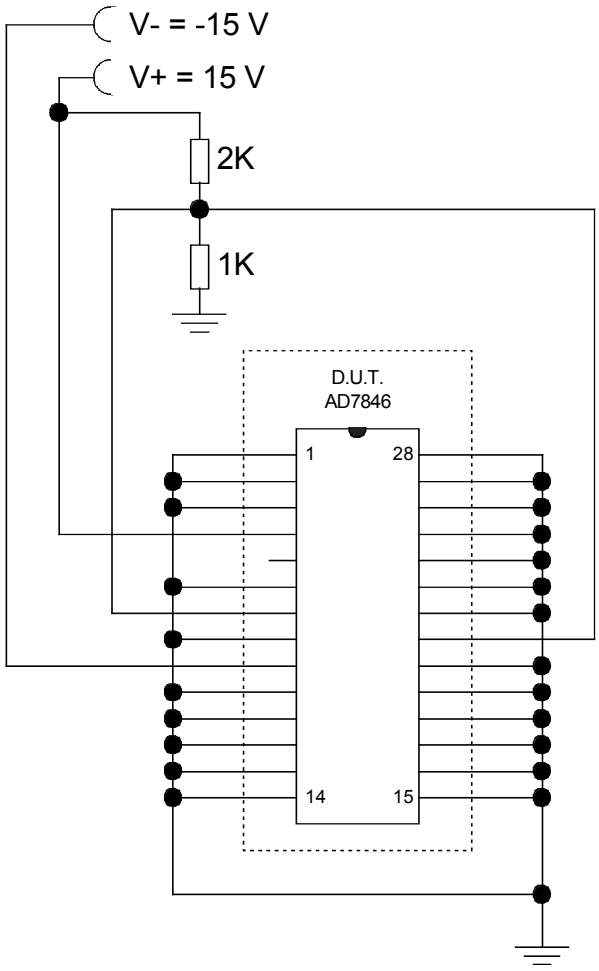
- Bias Options:
  Testing could be repeated with another supply voltage, e.g. ±10V
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply currents

- Item No.: 12
- Component Type: AD7228ACQ
- Component Package: 24-pin ceramic DIP
- Irradiation Bias Conditions:



- Bias Options:
  None
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply current
  (Possible measurement of output current)

- Item No.: 13
- Component Type: AD7846AQ
- Component Package: 28-pin ceramic DIP
- Irradiation Bias Conditions:



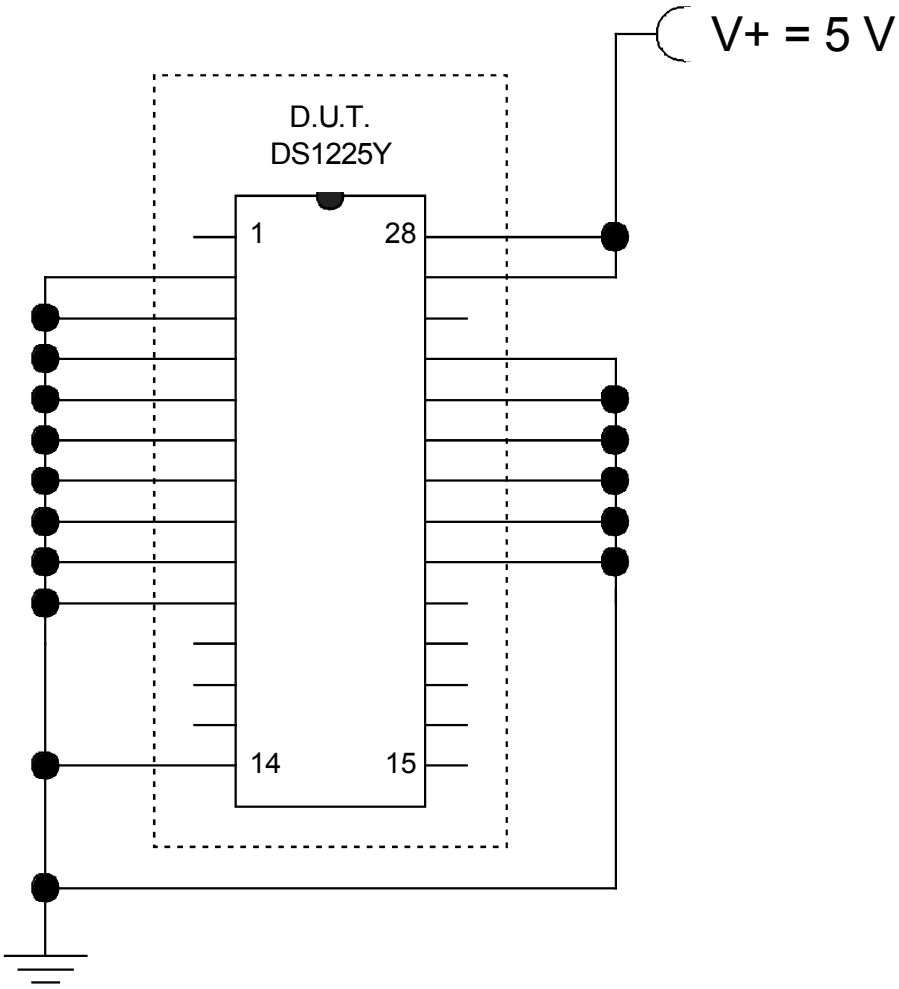
- Bias Options:
  None
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply current
  (Possible measurement of output voltage)

- Item No.: 14
- Component Type: 80C196KC-20
- Component Package: 80-pin plastic flatpack
- Irradiation Bias Conditions:
  The connection to each pin on the test components was as shown below

+5V	Ground	Open
12-14	6	1-5
26	10-11	7-9
29	16-25	15
52	27	28
75	30	31-32
	33	34-41
	42	43-50
	51	53
	54-55	56-61
	62-63	64-74
	79	76-78
		80

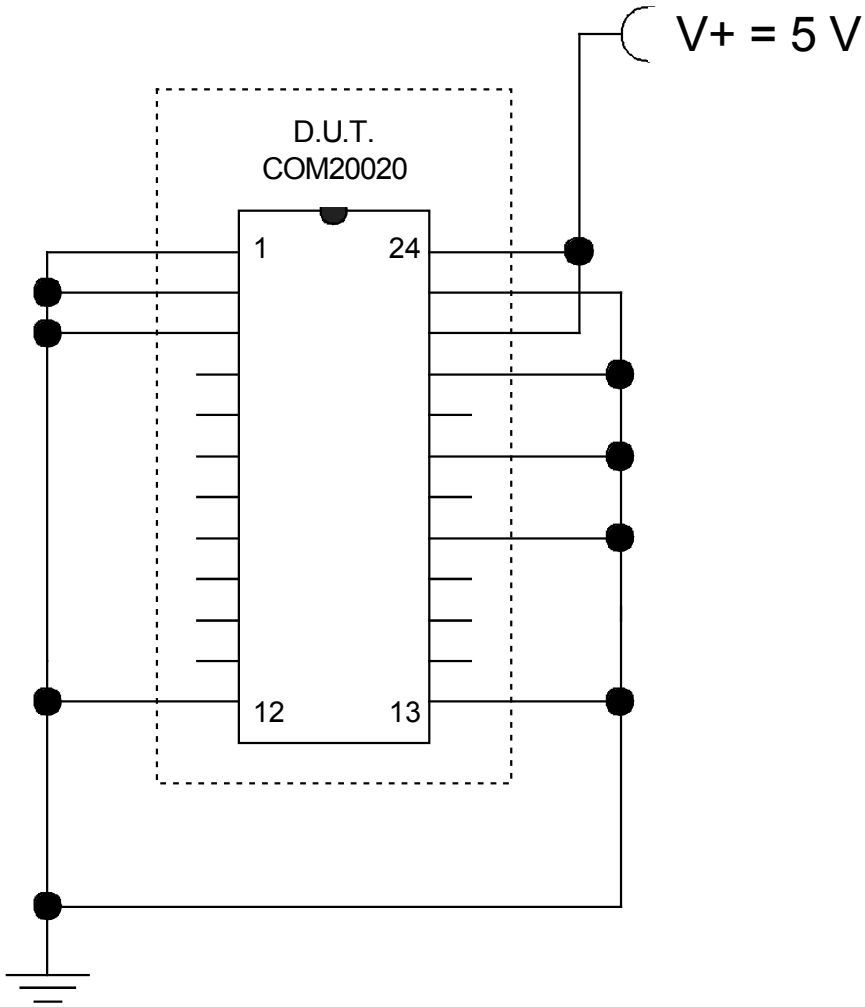
- Bias Options:
  None
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of Supply Current

- Item No.: 15
- Component Type: DS1225Y-200
- Component Package: 28-pin plastic DIP
- Irradiation Bias Conditions:



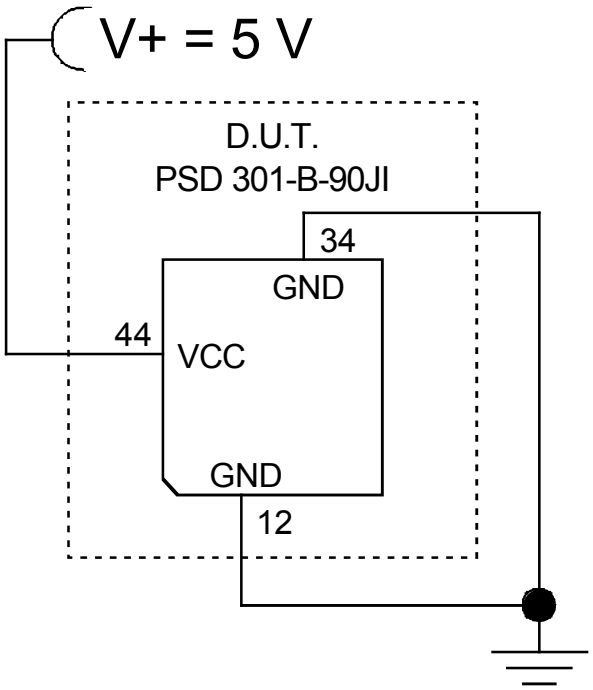
- Bias Conditions:
  Read mode operation
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply current

- Item No.: 16
- Component Type: COM20020IP
- Component Package: 28-pin plastic DIP
- Irradiation Bias Conditions:



- Bias Options:
  None
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply current

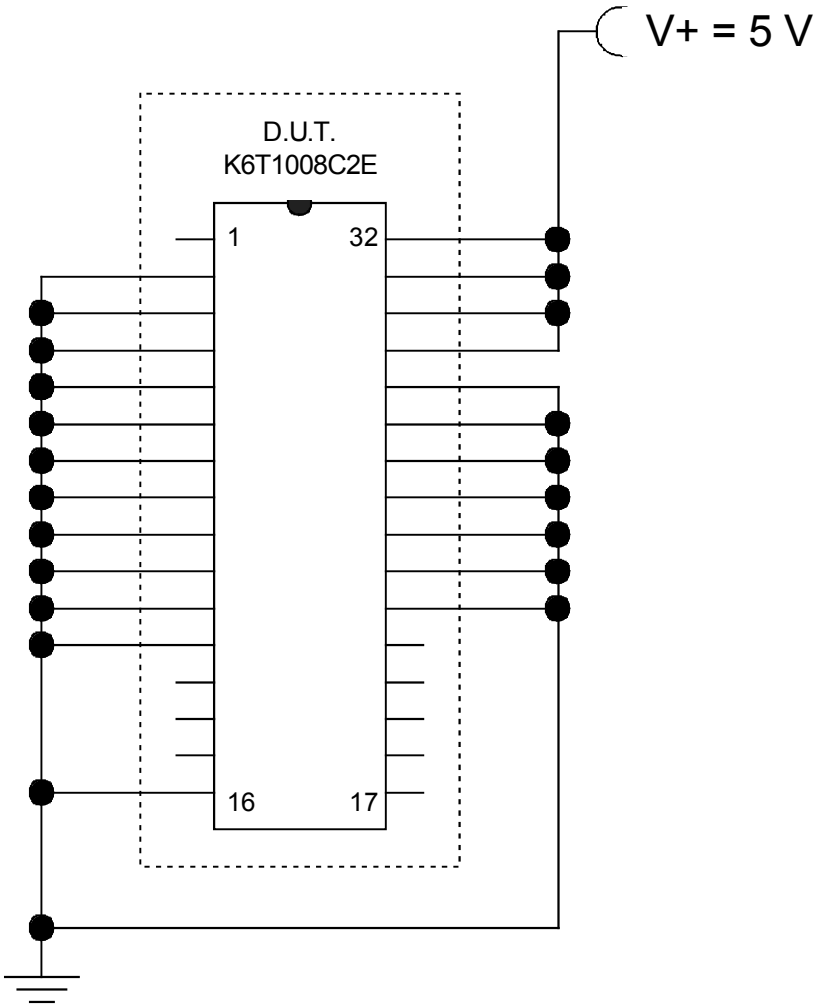
- Item No.: 17
- Component Type: PSD301-B-90JI
- Component Package: 44-pin plastic chip carrier
- Irradiation Bias Conditions:



pins not shown are not connected

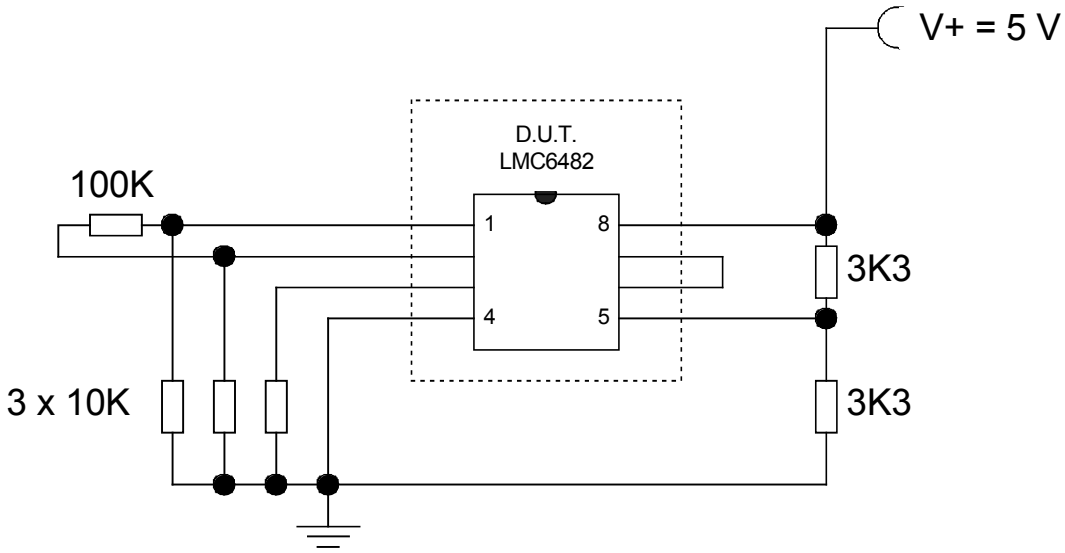
- Bias Options:
  None
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of Supply Current

- Item No.: 18
- Component Type: K6T1008C2E-DB70
- Component Package: 32-pin plastic DIP
- Irradiation Bias Conditions:



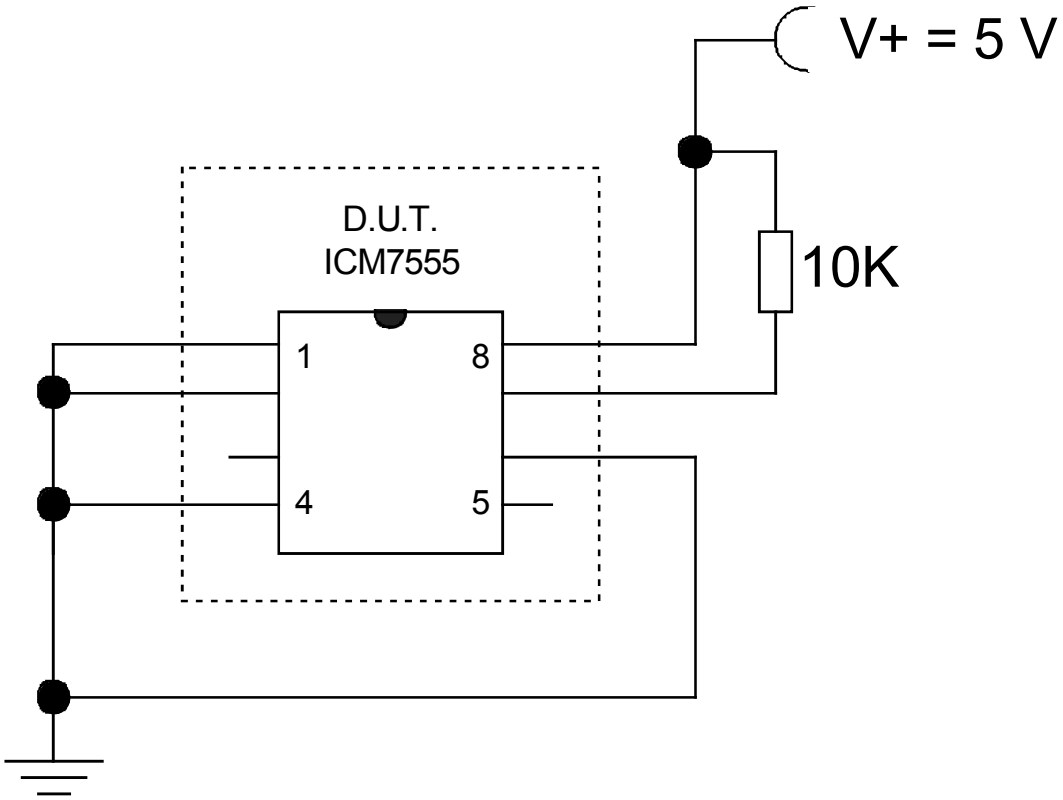
- Bias Conditions:
  Read mode operation
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply current

- Item No.: 19
- Component Type: LMC6482AMJ/883
- Component Package: 8-pin ceramic DIP
- Irradiation Bias Conditions:



- Bias Options:
  Testing could be repeated with another supply voltage, e.g. 15V
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply current
  Measurement of output voltage

- Item No.: 20
- Component Type: ICM7555MJA
- Component Package: 8-pin ceramic DIP
- Irradiation Bias Conditions:



- Bias Options:
  Testing could be repeated with another supply voltage, e.g. 15V
- Electrical Tests Before and After Opening and Prior to Irradiation:
  Measurement of supply current
  Measurement of output voltages

APPENDIX F – DETAILS OF ALL IRRADIATION TEST RUNS

MSL SEL TEST RUN DATA												
ITEM (#)	ITEM (S/N)	ION	TILT [°]	LETeff [MeV cm²/mg]	TEST RUN	TEST DATE	TEST START	Test Time (sec)	FLUENCE [cm²]	DOSE (rad)	SEL (P/F)	COMMENTS
1	011	Ne	0	5.85	137	20/09/01	7:00	109	1000000	94	P	
1	011	Ne	50	9.10	141	20/09/01	7:12	174	1000000	146	P	
1	011	Ar	0	14.1	092	19/09/01	11:54	1	28305	6	F	Latch-up !!!
1	011	Ar	0	14.1	093	19/09/01	11:55	6	78303	18	F	Latch-up !!!
1	011	Kr	0	34.0	065	19/09/01	9:55	1		0	F	Latch-up !!!
1	011	Kr	0	34.0	066	19/09/01	9:57	1		0	F	Latch-up !!!
1	012	Ne	0	5.85	138	20/09/01	7:03	110	1000000	94	P	
1	012	Ne	50	9.10	142	20/09/01	7:16	176	1000000	146	P	
1	012	Ar	0	14.1	094	19/09/01	11:56	2	104196	24	F	Latch-up !!!
1	012	Ar	0	14.1	095	19/09/01	11:58	1	21570	5	F	Latch-up !!!
1	012	Kr	0	34.0	067	19/09/01	9:59	1		0	F	Latch-up !!!
1	012	Kr	0	34.0	068	19/09/01	10:00	1		0	F	Latch-up !!!
2	021	Ne	0	5.85	139	20/09/01	7:06	104	1000000	94	P	
2	021	Ne	50	9.10	143	20/09/01	7:20	179	1000000	146	P	
2	021	Ar	0	14.1	098	19/09/01	12:30	2	104824	24	F	Latch-up !!!
2	021	Ar	0	14.1	099	19/09/01	12:31	5	65955	15	F	Latch-up !!!
2	021	Kr	0	34.0	057	19/09/01	7:01	1	20763	11	F	Latch-up !!!
2	021	Kr	0	34.0	058	19/09/01	7:02	1	22958	12	F	Latch-up !!!
2	022	Ne	0	5.85	140	20/09/01	7:09	110	1000000	94	P	
2	022	Ne	50	9.10	144	20/09/01	7:24	182	1000000	146	P	
2	022	Ar	0	14.1	100	19/09/01	12:32	12	196468	44	F	Latch-up !!!
2	022	Ar	0	14.1	101	19/09/01	12:33	1	24428	6	F	Latch-up !!!
2	022	Kr	0	34.0	059	19/09/01	7:03	1	80089	44	F	Latch-up !!!
2	022	Kr	0	34.0	060	19/09/01	7:04	1	20309	11	F	Latch-up !!!
3	031	Kr	0	34.0	001	19/09/01	1:53	100	1000000	544	P	
3	031	Kr	45	48.1	005	19/09/01	2:04	159	1000000	770	P	
3	031	Xe	40	73.0	145	20/09/01	8:18	203	1000000	1168	P	
3	032	Kr	0	34.0	002	19/09/01	1:55	101	1000000	544	P	
3	032	Kr	45	48.1	006	19/09/01	2:07	160	1000000	770	P	
3	032	Xe	40	73.0	146	20/09/01	8:22	154	1000000	1168	P	
4	041	Kr	0	34.0	003	19/09/01	1:58	102	1000000	544	P	
4	041	Kr	45	48.1	007	19/09/01	2:10	170	1000000	770	P	
4	041	Xe	40	73.0	147	20/09/01	8:25	181	1000000	1168	P	
4	042	Kr	0	34.0	004	19/09/01	2:01	106	1000000	544	P	
4	042	Kr	45	48.1	008	19/09/01	2:14	180	1000000	770	P	
4	042	Xe	40	73.0	148	20/09/01	8:29	152	1000000	1168	P	
5	051	Kr	0	34.0	009	19/09/01	2:42	179	1000000	544	P	
5	051	Kr	45	48.1	013	19/09/01	2:54	107	1000000	770	P	
5	051	Xe	40	73.0	149	20/09/01	8:45	134	1000000	1168	P	
5	052	Kr	0	34.0	010	19/09/01	2:46	103	1000000	544	P	
5	052	Kr	45	48.1	014	19/09/01	2:57	127	1000000	770	P	
5	052	Xe	40	73.0	150	20/09/01	8:48	130	1000000	1168	P	
6	061	Ne	0	5.85	126	20/09/01	6:19	107	1000000	94	P	
6	061	Ne	50	9.10	131	20/09/01	6:33	6	42184	6	F	Latch-up !!!
6	061	Ne	50	9.10	132	20/09/01	6:34	4	30753	4	F	Latch-up !!!
6	061	Ar	0	14.1	106	20/09/01	5:02	2	29386	7	F	Latch-up !!!
6	061	Ar	0	14.1	107	20/09/01	5:03	1	17816	4	F	Latch-up !!!
6	061	Kr	0	34.0	017	19/09/01	3:30	3		0	F	Latch-up !!!
6	061	Kr	0	34.0	018	19/09/01	3:32	1		0	F	Latch-up !!!
6	062	Ne	0	5.85	127	20/09/01	6:21	87	810262	76	F	Latch-up !!! (noise?)
6	062	Ne	0	5.85	128	20/09/01	6:24	109	1000000	94	P	
6	062	Ne	50	9.10	133	20/09/01	6:35	15	96510	14	F	Latch-up !!!
6	062	Ne	50	9.10	134	20/09/01	6:36	7	47233	7	F	Latch-up !!!
6	062	Ar	0	14.1	108	20/09/01	5:03	1	16566	4	F	Latch-up !!!
6	062	Ar	0	14.1	109	20/09/01	5:04	1	20533	5	F	Latch-up !!!
6	062	Kr	0	34.0	019	19/09/01	3:35	1		0	F	Latch-up !!!
6	062	Kr	0	34.0	020	19/09/01	3:37	1		0	F	Latch-up !!!

7	071	Kr	0	34.0	021	19/09/01	3:38	136	1000000	544	P	
7	071	Kr	45	48.1	023	19/09/01	3:45	177	1000000	770	P	
7	071	Xe	40	73.0	153	20/09/01	9:08	109	1000000	1168	P	
7	073	Kr	0	34.0	022	19/09/01	3:41	156	1000000	544	P	
7	073	Kr	45	48.1	024	19/09/01	3:49	150	1000000	770	P	
7	073	Xe	40	73.0	154	20/09/01	9:11	109	1000000	1168	P	
8	081	Ne	0	5.85	129	20/09/01	6:26	110	1000000	94	P	
8	081	Ne	50	9.10	135	20/09/01	6:37	171	1000000	146	P	
8	081	Ar	0	14.1	110	20/09/01	5:05	28	284253	64	**F**	**Latch-up !!!**
8	081	Ar	0	14.1	111	20/09/01	5:06	40	404757	91	**F**	**Latch-up !!!**
8	081	Kr	0	34.0	025	19/09/01	4:10	3		0	**F**	**Latch-up !!!**
8	081	Kr	0	34.0	026	19/09/01	4:11	1		0	**F**	**Latch-up !!!**
8	082	Ne	0	5.85	130	20/09/01	6:29	111	1000000	94	P	
8	082	Ne	50	9.10	136	20/09/01	6:40	164	1000000	146	P	
8	082	Ar	0	14.1	112	20/09/01	5:07	30	302997	68	**F**	**Latch-up !!!**
8	082	Ar	0	14.1	113	20/09/01	5:08	7	79391	18	**F**	**Latch-up !!!**
8	082	Kr	0	34.0	027	19/09/01	4:14	1		0	**F**	**Latch-up !!!**
8	082	Kr	0	34.0	028	19/09/01	4:15	1		0	**F**	**Latch-up !!!**
9	091	Kr	0	34.0	029	19/09/01	4:17	149	1000000	544	P	
9	091	Kr	45	48.1	031	19/09/01	4:23	202	1000000	770	P	
9	091	Xe	40	73.0	155	20/09/01	9:14	109	1000000	1168	P	
9	092	Kr	0	34.0	030	19/09/01	4:20	146	1000000	544	P	
9	092	Kr	45	48.1	032	19/09/01	4:27	163	1000000	770	P	
9	092	Xe	40	73.0	156	20/09/01	9:17	112	1000000	1168	P	
10	101	Ne	0	5.85	118	20/09/01	5:42	103	1000000	94	P	
10	101	Ne	50	9.10	122	20/09/01	5:53	155	1000000	146	P	
10	101	Ar	0	14.1	114	20/09/01	5:21	2	31787	7	**F**	**Latch-up !!!**
10	101	Ar	0	14.1	115	20/09/01	5:22	1	19276	4	**F**	**Latch-up !!!**
10	101	Kr	0	34.0	035	19/09/01	4:54	1	14022	8	**F**	**Latch-up !!!**
10	101	Kr	0	34.0	036	19/09/01	4:55	1	13545	7	**F**	**Latch-up !!!**
10	103	Ne	0	5.85	119	20/09/01	5:44	103	1000000	94	P	
10	103	Ne	50	9.10	123	20/09/01	5:56	164	1000000	146	P	
10	103	Ar	0	14.1	116	20/09/01	5:23	1	22929	5	**F**	**Latch-up !!!**
10	103	Ar	0	14.1	117	20/09/01	5:24	1	20836	5	**F**	**Latch-up !!!**
10	103	Kr	0	34.0	037	19/09/01	4:56	1	11630	6	**F**	**Latch-up !!!**
10	103	Kr	0	34.0	038	19/09/01	4:58	1	56982	31	**F**	**Latch-up !!!**
11	111	Kr	0	34.0	041	19/09/01	5:45	121	1000000	544	P	
11	111	Kr	45	48.1	045	19/09/01	5:57	215	1000000	770	P	
11	111	Xe	40	73.0	163	20/09/01	10:24	163	1000000	1168	P	
11	112	Kr	0	34.0	042	19/09/01	5:48	124	1000000	544	P	
11	112	Kr	45	48.1	046	19/09/01	6:02	198	1000000	770	P	
11	112	Xe	40	73.0	164	20/09/01	10:27	148	1000000	1168	P	
12	121	Kr	0	34.0	061	19/09/01	7:05	127	1000000	544	P	
12	121	Kr	45	48.1	063	19/09/01	7:12	323	1000000	770	P	
12	121	Xe	40	73.0	161	20/09/01	10:03	158	1000000	1168	P	
12	122	Kr	0	34.0	062	19/09/01	7:08	131	1000000	544	P	
12	122	Kr	45	48.1	064	19/09/01	7:19	211	1000000	770	P	
12	122	Xe	40	73.0	162	20/09/01	10:07	166	1000000	1168	P	
13	131	Kr	0	34.0	043	19/09/01	5:51	133	1000000	544	P	
13	131	Kr	45	48.1	047	19/09/01	6:06	136	1000000	770	P	
13	131	Xe	40	73.0	165	20/09/01	10:31	167	1000000	1168	P	
13	132	Kr	0	34.0	044	19/09/01	5:54	139	1000000	544	P	
13	132	Kr	45	48.1	048	19/09/01	6:09	146	1000000	770	P	
13	132	Xe	40	73.0	166	20/09/01	10:35	156	1000000	1168	P	
14	141	Ar	0	14.1	081	19/09/01	10:59	150	1000000	226	P	
14	141	Ar	45	19.9	085	19/09/01	11:17	76	480894	153	**F**	**Latch-up !!!**
14	141	Kr	0	34.0	073	19/09/01	10:20	10	67564	37	**F**	**Latch-up !!!**
14	141	Kr	0	34.0	074	19/09/01	10:21	8	51591	28	**F**	**Latch-up !!!**
14	142	Ar	0	14.1	082	19/09/01	11:07	150	1000000	226	P	
14	142	Ar	45	19.9	086	19/09/01	11:20	38	258113	82	**F**	**Latch-up !!!**
14	142	Kr	0	34.0	075	19/09/01	10:23	4	27467	15	**F**	**Latch-up !!!**
14	142	Kr	0	34.0	076	19/09/01	10:24	1	15657	9	**F**	**Latch-up !!!**

15	151	Ar	0	14.1	096	19/09/01	12:00	100	1000000	226	P	ICC increase (150 mA)!
15	151	Kr	0	34.0	069	19/09/01	10:01	1		0	**F**	**Latch-up !!!**
15	151	Kr	0	34.0	070	19/09/01	10:02	1		0	**F**	**Latch-up !!!**
15	152	Ar	0	14.1	097	19/09/01	12:03	100	1000000	226	P	ICC increase (150 mA)!
15	152	Kr	0	34.0	071	19/09/01	10:03	1		0	**F**	**Latch-up !!!**
15	152	Kr	0	34.0	072	19/09/01	10:04	1		0	**F**	**Latch-up !!!**
16	161	Ne	0	5.85	120	20/09/01	5:46	103	1000000	94	P	
16	161	Ne	50	9.10	124	20/09/01	6:00	165	1000000	146	P	
16	161	Ar	0	14.1	102	19/09/01	12:35	1	17277	4	**F**	**Latch-up !!!**
16	161	Ar	0	14.1	103	19/09/01	12:36	1	14333	3	**F**	**Latch-up !!!**
16	161	Kr	0	34.0	049	19/09/01	6:29	1	19769	11	**F**	**Latch-up !!!**
16	161	Kr	0	34.0	050	19/09/01	6:30	1	18532	10	**F**	**Latch-up !!!**
16	162	Ne	0	5.85	121	20/09/01	5:49	103	1000000	94	P	
16	162	Ne	50	9.10	125	20/09/01	6:03	165	1000000	146	P	
16	162	Ar	0	14.1	104	19/09/01	12:37	1	15507	3	**F**	**Latch-up !!!**
16	162	Ar	0	14.1	105	19/09/01	12:38	1	16681	4	**F**	**Latch-up !!!**
16	162	Kr	0	34.0	051	19/09/01	6:32	1	62549	34	**F**	**Latch-up !!!**
16	162	Kr	0	34.0	052	19/09/01	6:33	1	15247	8	**F**	**Latch-up !!!**
17	171	Ar	0	14.1	083	19/09/01	11:11	129	1000000	226	P	
17	171	Ar	45	19.9	087	19/09/01	11:23	160	1000000	318	P	
17	171	Ar	60	28.2	090	19/09/01	11:33	371	618987	279	**F**	**Latch-up !!!**
17	171	Kr	0	34.0	077	19/09/01	10:26	35	197866	108	**F**	**Latch-up !!!**
17	171	Kr	0	34.0	078	19/09/01	10:28	12	70571	38	**F**	**Latch-up !!!**
17	172	Ar	0	14.1	084	19/09/01	11:14	113	1000000	226	P	
17	172	Ar	45	19.9	088	19/09/01	11:27	19	132739	42	**F**	**Latch-up !!! (noise?)**
17	172	Ar	45	19.9	089	19/09/01	11:29	159	1000000	318	P	
17	172	Ar	60	28.2	091	19/09/01	11:37	51	243714	110	**F**	**Latch-up !!!**
17	172	Kr	0	34.0	079	19/09/01	10:29	27	147332	80	**F**	**Latch-up !!!**
17	172	Kr	0	34.0	080	19/09/01	10:30	22	155310	84	**F**	**Latch-up !!!**
18	181	Kr	0	34.0	053	19/09/01	6:34	160	1000000	544	P	
18	181	Kr	45	48.1	055	19/09/01	6:42	183	1000000	770	P	
18	181	Xe	40	73.0	157	20/09/01	9:36	129	1000000	1168	P	
18	182	Kr	0	34.0	054	19/09/01	6:37	159	1000000	544	P	
18	182	Kr	45	48.1	056	19/09/01	6:45	134	1000000	770	P	
18	182	Xe	40	73.0	158	20/09/01	9:39	136	1000000	1168	P	
19	191	Kr	0	34.0	011	19/09/01	2:49	84	1000000	544	P	
19	191	Kr	45	48.1	015	19/09/01	3:00	140	1000000	770	P	
19	191	Xe	40	73.0	151	20/09/01	8:52	142	1000000	1168	P	
19	192	Kr	0	34.0	012	19/09/01	2:51	73	1000000	544	P	
19	192	Kr	45	48.1	016	19/09/01	3:03	146	1000000	770	P	
19	192	Xe	40	73.0	152	20/09/01	8:55	136	1000000	1168	P	
20	201	Kr	0	34.0	033	19/09/01	4:47	152	1000000	544	P	
20	201	Kr	45	48.1	039	19/09/01	5:02	189	1000000	770	P	
20	201	Xe	40	73.0	159	20/09/01	9:42	141	1000000	1168	P	
20	202	Kr	0	34.0	034	19/09/01	4:50	161	1000000	544	P	
20	202	Kr	45	48.1	040	19/09/01	5:06	159	1000000	770	P	
20	202	Xe	40	73.0	160	20/09/01	9:45	139	1000000	1168	P	

APPENDIX G – INDIVIDUAL TEST SHEETS FOR EACH ITEM NUMBER

Note that S/N XX3 is the control for all component types except Items No. 7 and 10

MSL SEL TEST RECORD FOR ITEM 1
(SAB80C166M)

TEST DETAILS		S/N: 011		S/N: 012		S/N: 013		BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	ICC (A)		ICC (A)		ICC (A)		CONDITION (see below)	
Test **before** opening		*)		*)		*)		A	
Test **after** opening		17,5 mA		17,2 mA		**44,4 mA **)**		A	S/N 013 unstable measurement.
Test **before** irradiation		38,6 mA		25,8 mA				A	
065	34.0								S/N 011 tested, **latch-up !!!**
066	34.0								S/N 011 tested, **latch-up !!!**
067	34.0								S/N 012 tested, **latch-up !!!**
068	34.0								S/N 012 tested, **latch-up !!!**
092	14.1								S/N 011 tested, **latch-up !!!**
093	14.1								S/N 011 tested, **latch-up !!!**
094	14.1								S/N 012 tested, **latch-up !!!**
095	14.1								S/N 012 tested, **latch-up !!!**
137	5.9								S/N 011 tested, no latch-up
138	5.9								S/N 012 tested, no latch-up
141	9.1								S/N 011 tested, no latch-up
142	9.1								S/N 012 tested, no latch-up

Additional Comments : *) Parts not tested before opening because no test socket was available.
**) Measurement unstable. Do not use for SEL testing.

Bias condition A : Test Board #01; VDD = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 2
(ST62T65C6)

TEST DETAILS		S/N: 021		S/N: 022		S/N: 023		BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	IDD (A)		IDD (A)		IDD (A)		CONDITION (see below)	
Test **before** opening		*)		*)		*)		A	Vergleichsbt. IDD=1,41mA
Test **after** opening		1,39 mA		1,37 mA		1,36 mA		A	
Test **before** irradiation		1,27 mA		1,28 mA				A	
057	34.0								S/N 021 tested, **latch-up !!!**
058	34.0								S/N 021 tested, **latch-up !!!**
059	34.0								S/N 022 tested, **latch-up !!!**
060	34.0								S/N 022 tested, **latch-up !!!**
098	14.1								S/N 021 tested, **latch-up !!!**
099	14.1								S/N 021 tested, **latch-up !!!**
100	14.1								S/N 022 tested, **latch-up !!!**
101	14.1								S/N 022 tested, **latch-up !!!**
139	5.9								S/N 021 tested, no latch-up
140	5.9								S/N 022 tested, no latch-up
143	9.1								S/N 021 tested, no latch-up
144	9.1								S/N 022 tested, no latch-up

Additional Comments : *) Parts not tested before opening because no test socket was available.

Bias condition A : Test Board #02; VDD = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 3
(LMC6062)

TEST DETAILS		S/N: 031			S/N: 032			S/N: 033			BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	VOUT1 (V)	VOUT2 (V)	ISUP+ (A)	VOUT1 (V)	VOUT2 (V)	ISUP+ (A)	VOUT1 (V)	VOUT2 (V)	ISUP+ (A)	CONDITION (see below)	
Test **before** opening		1,48 mV	2,46 V	766 uA	1,05 mV	2,46 V	779 uA	0,81 mV	2,45 V	770 uA	A	
Test **after** opening		4,70 mV	2,46 V	766 uA	0,95 mV	2,45 V	782 uA	0,70 mV	2,47 V	776 uA	A	
Test **before** irradiation		1,40 mV	2,48 V	767 uA	0,90 mV	2,48 V	791 uA				A	
001	34.0											S/N 031 tested, no latch-up
002	34.0											S/N 032 tested, no latch-up
005	48.1											S/N 031 tested, no latch-up
006	48.1											S/N 032 tested, no latch-up
145	73.0											S/N 031 tested, no latch-up
146	73.0											S/N 032 tested, no latch-up

Additional Comments : VOUT1 = pin 1 and VOUT2 = pin 7.

Bias condition A : Test Board #03, 04, 05, 19; VSUP+ = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 4
(LMC662AIM)

TEST DETAILS		S/N: 041			S/N: 042			S/N: 043			BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	VOUT1 (V)	VOUT2 (V)	ISUP+ (A)	VOUT1 (V)	VOUT2 (V)	ISUP+ (A)	VOUT1 (V)	VOUT2 (V)	ISUP+ (A)	CONDITION (see below)	
Test **before** opening		1,63 mV	2,46 V	1,40 mA	3,80 mV	2,46 V	1,40 mA	1,78 mV	2,46 V	1,41 mA	A	
Test **after** opening		0,50 mV	2,49 V	1,44 mA	3,69 mV	2,51 V	1,47 mA	3,82 mV	2,50 V	1,47 mA	A	
Test **before** irradiation		0,30 mV	2,44 V	1,42 mA	3,70 mV	2,44 V	1,43 mA				A	
003	34.0											S/N 041 tested, no latch-up
004	34.0											S/N 042 tested, no latch-up
007	48.1											S/N 041 tested, no latch-up
008	48.1											S/N 042 tested, no latch-up
147	73.0											S/N 041 tested, no latch-up
148	73.0											S/N 042 tested, no latch-up

Additional Comments : VOUT1 = pin 1 and VOUT2 = pin 7.

Bias condition A : Test Board #03, 04, 05, 19; VSUP+ = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 5
(TLC272BCD)

TEST DETAILS		S/N: 051			S/N: 052			S/N: 053			BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	VOUT1 (V)	VOUT2 (V)	ISUP+ (A)	VOUT1 (V)	VOUT2 (V)	ISUP+ (A)	VOUT1 (V)	VOUT2 (V)	ISUP+ (A)	CONDITION (see below)	
Test **before** opening		0,91 mV	2,47 V	1,35 mA	1,04 mV	2,46 V	1,37 mA	0,96 mV	2,46 V	1,38 mA	A	
Test **after** opening		1,34 mV	2,49 V	1,40 mA	2,33 mV	2,50 V	1,41 mA	2,76 mV	2,50 V	1,44 mA	A	
Test **before** irradiation		1,30 mV	2,45 V	1,38 mA	2,30 mV	2,44 V	1,39 mA				A	
009	34.0											S/N 051 tested, no latch-up
010	34.0											S/N 052 tested, no latch-up
013	48.1											S/N 051 tested, no latch-up
014	48.1											S/N 052 tested, no latch-up
149	73.0											S/N 051 tested, no latch-up
150	73.0											S/N 052 tested, no latch-up

Additional Comments : VOUT1 = pin 1 and VOUT2 = pin 7.

Bias condition A : Test Board #03, 04, 05, 19; VSUP+ = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 6
(LTC1298IN8)

TEST DETAILS		S/N: 061		S/N: 062		S/N: 063		BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	ICC (A)		ICC (A)		ICC (A)		CONDITION (see below)	
Test **before** opening		206 uA		206 uA		206 uA		A	
Test **after** opening		205 uA		208 uA		*)		A	
Test **before** irradiation		206 uA		206 uA				A	
017	34.0								S/N 061 tested, **latch-up !!!**
018	34.0								S/N 061 tested, **latch-up !!!**
019	34.0								S/N 062 tested, **latch-up !!!**
020	34.0								S/N 062 tested, **latch-up !!!**
106	14.1								S/N 061 tested, **latch-up !!!**
107	14.1								S/N 061 tested, **latch-up !!!**
108	14.1								S/N 062 tested, **latch-up !!!**
109	14.1								S/N 062 tested, **latch-up !!!**
126	5.9								S/N 061 tested, no latch-up
127	5.9								S/N 062 tested, **latch-up !!! (noise)?**
128	5.9								S/N 062 tested, no latch-up
131	9.1								S/N 061 tested, **latch-up !!!**
132	9.1								S/N 061 tested, **latch-up !!!**
133	9.1								S/N 062 tested, **latch-up !!!**
134	9.1								S/N 062 tested, **latch-up !!!**

Additional Comments : *) Part type damaged during opening.
SN 061 draw high current after latch-up (about 150 mA). After about 1 min. the current came back to normal level.

Bias condition A : Test Board #06; VCC = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 7 (MAX538)									
TEST DETAILS		S/N: 071		S/N: 072		S/N: 073		BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	ICC (A)		ICC (A)		ICC (A)		CONDITION (see below)	
Test **before** opening		242 uA		248 uA		244 uA		A	
Test **after** opening		241 uA		**594 uA *)**		243 uA		A	
Test **before** irradiation		244 uA				241 uA		A	
021	34.0								S/N 071 tested, no latch-up
022	34.0								S/N 073 tested, no latch-up
023	48.1								S/N 071 tested, no latch-up
024	48.1								S/N 073 tested, no latch-up
153	73.0								S/N 071 tested, no latch-up
154	73.0								S/N 073 tested, no latch-up

Additional Comments : *) Part drifted after opening. Use S/N 071 and 073 for SEL testing.

Bias condition A : Test Board #07; VCC = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 8 (93C56EN)									
TEST DETAILS		S/N: 081		S/N: 082		S/N: 083		BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	IDD (A)		IDD (A)		IDD (A)		CONDITION (see below)	
Test **before** opening		136 uA		140 uA		142 uA		A	
Test **after** opening		139 uA		144 uA		145 uA		A	
Test **before** irradiation		138 uA		143 uA				A	
025	34.00								S/N 081 tested, **latch-up !!!**
026	34.00								S/N 081 tested, **latch-up !!!**
027	34.00								S/N 082 tested, **latch-up !!!**
028	34.00								S/N 082 tested, **latch-up !!!**
110	14.1								S/N 081 tested, **latch-up !!!**
111	14.1								S/N 081 tested, **latch-up !!!**
112	14.1								S/N 082 tested, **latch-up !!!**
113	14.1								S/N 082 tested, **latch-up !!!**
129	5.9								S/N 081 tested, no latch-up
130	5.9								S/N 082 tested, no latch-up
135	9.1								S/N 081 tested, no latch-up
136	9.1								S/N 082 tested, no latch-up

Additional Comments :

Bias condition A : Test Board #08; VDD = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 9 (TL7705ACP)										
TEST DETAILS		S/N: 091		S/N: 092		S/N: 093		BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	IDD (A)		IDD (A)		IDD (A)		CONDITION (see below)	
Test **before** opening		1,63 mA		1,59 mA		1,59 mA		A	
Test **after** opening		1,55 mA		1,56 mA		1,59 mA		A	
Test **before** irradiation		1,56 mA		1,57 mA				A	
029	34.0								S/N 091 tested, no latch-up
030	34.0								S/N 092 tested, no latch-up
031	48.1								S/N 091 tested, no latch-up
032	48.1								S/N 092 tested, no latch-up
155	73.0								S/N 091 tested, no latch-up
156	73.0								S/N 092 tested, no latch-up

Additional Comments :

Bias condition A : Test Board #09; VDD = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 10 (PIC16F84-04)									
TEST DETAILS		S/N: 101		S/N: 102		S/N: 103		BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	ICC (A)		ICC (A)		ICC (A)		CONDITION (see below)	
Test **before** opening		175 uA		181 uA		177 uA		A	Vergleichsbt. ICC = 177,8 uA
Test **after** opening		176 uA		180 uA		177 uA		A	
Test **before** irradiation		173 uA		**188 uA *)**		175 uA		A	
035	34.0								S/N 101 tested, **latch-up !!!**
036	34.0								S/N 101 tested, **latch-up !!!**
037	34.0								S/N 103 tested, **latch-up !!!**
038	34.0								S/N 103 tested, **latch-up !!!**
114	14.1								S/N 101 tested, **latch-up !!!**
115	14.1								S/N 101 tested, **latch-up !!!**
116	14.1								S/N 103 tested, **latch-up !!!**
117	14.1								S/N 103 tested, **latch-up !!!**
118	5.9								S/N 101 tested, no latch-up
119	5.9								S/N 103 tested, no latch-up
122	9.1								S/N 101 tested, no latch-up
123	9.1								S/N 103 tested, no latch-up

Additional Comments : *) Part drifting (unstable). Use S/N 101 and 103 for SEL testing.

Bias condition A : Test Board #10; VSUP = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 11 (MAX328CWE)										
TEST DETAILS		S/N: 111		S/N: 112		S/N: 113		BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	IS+ (A)	IS- (A)	IS+ (A)	IS- (A)	IS+ (A)	IS- (A)	CONDITION (see below)	
Test **before** opening		< 0,0 uA	< 0,0 uA	< 0,0 uA	< 0,0 uA	< 0,0 uA	< 0,0 uA	A	
Test **after** opening		< 0,0 uA	< 0,0 uA	< 0,0 uA	< 0,0 uA	< 0,0 uA	< 0,0 uA	A	
Test **before** irradiation		< 0,0 uA	< 0,0 uA	< 0,0 uA	< 0,0 uA			A	
041	34.0								S/N 111 tested, no latch-up
042	34.0								S/N 112 tested, no latch-up
045	48.1								S/N 111 tested, no latch-up
046	48.1								S/N 112 tested, no latch-up
163	73.0								S/N 111 tested, no latch-up
164	73.0								S/N 112 tested, no latch-up

Additional Comments :

Bias condition A : Test Board #11; V+ = 15V, V- = -15V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 12 (AD7228ACQ)								
TEST DETAILS		S/N: 121		S/N: 122		S/N: 123	BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	IDD (A)		IDD (A)		IDD (A)	CONDITION (see below)	
Test **before** opening		14,93 mA		14,52 mA		14,43 mA	A	
Test **after** opening		14,72 mA		14,41 mA		14,37 mA	A	
Test **before** irradiation		15,0 mA		14,6 mA			A	
061	34.0							S/N 121 tested, no latch-up
062	34.0							S/N 122 tested, no latch-up
063	48.1							S/N 121 tested, no latch-up
064	48.1							S/N 122 tested, no latch-up
161	73.0							S/N 121 tested, no latch-up
162	73.0							S/N 122 tested, no latch-up

Additional Comments :

Bias condition A : Test Board #12; VDD = 15V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 13
(AD7846AQ)

TEST DETAILS		S/N: 131		S/N: 132		S/N: 133		BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	IDD (A)	ISS (A)	IDD (A)	ISS (A)	IDD (A)	ISS (A)	CONDITION (see below)	
Test **before** opening		6,99 mA	1,91 mA	7,03 mA	1,95 mA	7,08 mA	2,01 mA	A	
Test **after** opening		7,00 mA	1,92 mA	7,05 mA	1,95 mA	7,10 mA	2,01 mA	A	
Test **before** irradiation		6,96 mA	1,92 mA	6,99 mA	1,96 mA			A	
043	34.0								S/N 131 tested, no latch-up
044	34.0								S/N 132 tested, no latch-up
047	48.1								S/N 131 tested, no latch-up
048	48.1								S/N 132 tested, no latch-up
165	73.0								S/N 131 tested, no latch-up
166	73.0								S/N 132 tested, no latch-up

Additional Comments : VCC = 5V which is provided by a voltage divider

Bias condition A : Test Board #13; VDD = 15V, VSS = -15V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 14
(80C196KC)

TEST DETAILS		S/N: 141		S/N: 142		S/N: 143		BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	ICC (A)		ICC (A)		ICC (A)		CONDITION (see below)	
Test **before** opening		*)		*)				A	Only two parts prepared for testing
Test **after** opening		3,03 mA		2,93 mA				A	
Test **before** irradiation		3,01 mA		2,89 mA				A	
073	34.0								S/N141 tested, **latch-up !!!**
074	34.0								S/N141 tested, **latch-up !!!**
075	34.0								S/N142 tested, **latch-up !!!**
076	34.0								S/N142 tested, **latch-up !!!**
081	14.1								S/N 141 tested, no latch-up
082	14.1								S/N 142 tested, no latch-up
085	19.9								S/N141 tested, **latch-up !!!**
086	19.9								S/N142 tested, **latch-up !!!**

Additional Comments : *) Parts not tested before opening because no test socket was available.

Bias condition A : Test Board #14; VCC = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 15
(DS1225Y)

TEST DETAILS		S/N: 151		S/N: 152		S/N: 153		BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	ICC (A)		ICC (A)		ICC (A)		CONDITION (see below)	
Test **before** opening		1,92 mA		2,02 mA		1,94 mA		A	
Test **after** opening		1,90 mA		1,99 mA		1,95 mA		A	
Test **before** irradiation		1,92 mA		2,01 mA				A	
069	34.0								S/N 151 tested, **latch-up !!!**
070	34.0								S/N 151 tested, **latch-up !!!**
071	34.0								S/N 152 tested, **latch-up !!!**
072	34.0								S/N 152 tested, **latch-up !!!**
096	14.1								S/N 151 tested, no latch-up ***)**
097	14.1								S/N 152 tested, no latch-up ***)**

Additional Comments : *) ICC increased slowly to about 150 mA during irradiation without triggering the latch-up monitoring. The effect might be related to the internal power regulating chip ?

Bias condition A : Test Board #15; VCC = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 16
(COM20020IP)

TEST DETAILS		S/N: 161		S/N: 162		S/N: 163		BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	IDD (A)		IDD (A)		IDD (A)		CONDITION (see below)	
Test **before** opening		455 uA		456 uA		460 uA		A	
Test **after** opening		452 uA		451 uA		457 uA		A	
Test **before** irradiation		459 uA		456 uA				A	
049	34.0								S/N 161 tested, **latch-up !!!**
050	34.0								S/N 161 tested, **latch-up !!!**
051	34.0								S/N 162 tested, **latch-up !!!**
052	34.0								S/N 162 tested, **latch-up !!!**
102	14.1								S/N 161 tested, **latch-up !!!**
103	14.1								S/N 161 tested, **latch-up !!!**
104	14.1								S/N 162 tested, **latch-up !!!**
105	14.1								S/N 162 tested, **latch-up !!!**
120	5.9								S/N 161 tested, no latch-up
121	5.9								S/N 162 tested, no latch-up
124	9.1								S/N 161 tested, no latch-up
125	9.1								S/N 162 tested, no latch-up

Additional Comments :

Bias condition A : Test Board #16; VCC = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 17 (PSD301-B)									
TEST DETAILS		S/N: 171		S/N: 172		S/N: 173		BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	ICC (A)		ICC (A)		ICC (A)		CONDITION (see below)	
Test **before** opening		*)		*)				A	Only two parts prepared for testing
Test **after** opening		5,69 uA		5,81 uA				A	
Test **before** irradiation		4,82 uA		4,89 uA				A	
077	34.0								S/N171 tested, **latch-up !!!**
078	34.0								S/N171 tested, **latch-up !!!**
079	34.0								S/N172 tested, **latch-up !!!**
080	34.0								S/N172 tested, **latch-up !!!**
083	14.1								S/N 171 tested, no latch-up
084	14.1								S/N 172 tested, no latch-up
087	19.9								S/N 171 tested, no latch-up
088	19.9								S/N172 tested, **latch-up !!! (noise)**
089	19.9								S/N 172 tested, no latch-up
090	28.2								S/N171 tested, **latch-up !!!**
091	28.2								S/N172 tested, **latch-up !!!**

Additional Comments : *) Parts not tested before opening because no test socket was available.

Bias condition A : Test Board #17; VCC = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 18 (K6T1008C2E)									
TEST DETAILS		S/N: 181		S/N: 182		S/N: 183		BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	ICC (A)		ICC (A)		ICC (A)		CONDITION (see below)	
Test **before** opening		49,04 uA		47,88 uA		48,46 uA		A	
Test **after** opening		48,83 uA		49,63 uA		49,20 uA		A	
Test **before** irradiation		49,44 uA		49,25 uA				A	
053	34.0								S/N 181 tested, no latch-up
054	34.0								S/N 182 tested, no latch-up
055	48.1								S/N 181 tested, no latch-up
056	48.1								S/N 182 tested, no latch-up
157	73.0								S/N 181 tested, no latch-up
158	73.0								S/N 182 tested, no latch-up

Additional Comments :

Bias condition A : Test Board #18; VCC = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 19
(LMC6482LIM)

TEST DETAILS		S/N: 191			S/N: 192			S/N: 193			BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	VOUT1 (V)	VOUT2 (V)	ISUP+ (A)	VOUT1 (V)	VOUT2 (V)	ISUP+ (A)	VOUT1 (V)	VOUT2 (V)	ISUP+ (A)	CONDITION (see below)	
Test **before** opening		8,09 mV	2,46 V	1,49 mA	8,86 mV	2,46 V	1,50 mA	8,42 mV	2,46 V	1,46 mA	A	
Test **after** opening		8,04 mV	2,42 V	1,48 mA	8,82 mV	2,42 V	1,49 mA	8,36 mV	2,43 V	1,45 mA	A	
Test **before** irradiation		7,70 mV	2,44 V	1,48 mA	8,40 mV	2,44 V	1,49 mA				A	
011	34.0											S/N 191 tested, no latch-up
012	34.0											S/N 192 tested, no latch-up
015	48.1											S/N 191 tested, no latch-up
016	48.1											S/N 192 tested, no latch-up
151	73.0											S/N 191 tested, no latch-up
151	73.0											S/N 192 tested, no latch-up

Additional Comments : VOUT1 = pin 1 and VOUT2 = pin 7.

Bias condition A : Test Board #03, 04, 05, 19; VSUP+ = 5V
Bias condition B :

MSL SEL TEST RECORD FOR ITEM 20
(ICM7555MJA)

TEST DETAILS		S/N: 201		S/N: 202		S/N: 203		BIAS	COMMENTS
TEST RUN	LETeff (MeV cm²/mg)	ISUP (A)	Vdis (V)	ISUP (A)	Vdis (V)	ISUP (A)	Vdis (V)	CONDITION (see below)	
Test **before** opening		446 uA	10,6 mV	447 uA	10,8 mV	451 uA	10,3 mV	A	
Test **after** opening		442 uA	10,4 mV	443 uA	10,7 mV	447 uA	10,3 mV	A	
Test **before** irradiation		447 uA	10,2 mV	447 uA	10,6 mV			A	
033	34.0								S/N 201 tested, no latch-up
034	34.0								S/N 202 tested, no latch-up
039	48.1								S/N 201 tested, no latch-up
040	48.1								S/N 202 tested, no latch-up
159	73.0								S/N 201 tested, no latch-up
160	73.0								S/N 202 tested, no latch-up

Additional Comments : Vdis = pin 7

Bias condition A : Test Board #20; V+ = 5V
Bias condition B :