

CONTENTS

Acknowledgements	<i>iii</i>
List of symbols	<i>iv</i>
Abbreviations and acnonyms used in the text.....	<i>viii</i>
1. Introduction	1
2. Semiconductor detectors.....	5
2.1. Materials for semiconductor detectors	6
2.2. Reverse bias p-n junction	8
2.3. Charge generation in detector.....	13
2.4. Charge transport	15
2.5. Ramo theory and signal formation	19
2.6. Detector geometry	21
2.7. Important detector parameters.....	23
3. Architecture of front-end electronics	27
3.1. Types of amplifiers.....	29
3.2. Charge sensitive amplifier.....	31
3.2.1. Ideal charge sensitive amplifier	31
3.2.2. Realistic charge sensitive amplifier	33
3.2.3. Examples of core amplifier architectures.....	37
3.2.4. Feedback configuration.....	40
3.2.5. Test injection circuit	42
3.3. Shaper.....	43
3.3.1. Signal shaping.....	44
3.3.2. Noise analysis	56
3.4. Noise optimization of CSA input transistor	62
3.4.1. Strong inversion region.....	63
3.4.2. Moderate and weak inversion regions	66
3.5. Aspect of fast signal processing	70
3.5.1. Pulse pile-ups at CSA output	71
3.5.2. Pole-zero cancellation circuit.....	72
3.5.3. Base line restorer	75
3.6. Further signal processing.....	80
3.6.1. Discriminators.....	83
3.6.2. Peak Detector Derandomizer	86
4. Important aspect of multichannel low noise mixed-mode integrated circuits.....	89
4.1. Noise modeling in MOS transistors	91
4.1.1. Channel thermal noise.....	91
4.1.2. Flicker noise.....	94
4.1.3. Short channel effects.....	96

4.2. Cross-talk in mixed mode circuits.....	98
4.2.1. Generation, transmission and reception of switching noise.....	98
4.2.2. Reducing the noise generation.....	102
4.2.3. Increasing the immunity of analog part.....	103
4.2.4. Isolation techniques.....	103
4.2.5. Summary of crosstalk reduction techniques.....	106
4.3. Random matching and offsets.....	107
4.3.1. Mismatch parameters of MOS transistors.....	109
4.3.2. Transistor matching in various processes.....	112
4.3.3. Current matching in MOS transistors.....	114
4.3.4. Random matching in circuits.....	115
4.3.5. Layout rules for good matching.....	116
4.3.6. Matching on multichip modules.....	118
4.3.7. Mismatch simulation using Monte Carlo analysis.....	119
5. Radiation damage in silicon detectors and readout electronics.....	121
5.1. Total dose effects.....	122
5.1.1. Displacement damage.....	122
5.1.2. Ionization effects.....	123
5.2. Single event effects.....	127
5.3. Radiation tolerant design of readout electronics.....	128
6. Examples of multichannel counting IC for X-ray applications.....	131
6.1. Requirements for multichannel counting systems.....	132
6.2. ASIC for strip detectors.....	135
6.3. Solutions for pad detectors and small array of pixel detectors.....	141
6.4. Solutions for pixel detectors.....	148
7. References.....	173