

Contents

1 INTRODUCTION.....	17
1.1 Reactive Systems.....	17
1.2 The Synchronous Approach.....	19
1.3 Objective and Content of this Thesis	21
2 INTRODUCTION TO STATECHARTS	25
2.1 States and Transitions	25
2.2 Hierarchy and Structure.....	26
2.2.1 Depth.....	27
2.2.2 Orthogonality and Broadcast-Communication	27
2.3 Syntax of Statecharts	29
2.4 The Execution Model	32
2.4.1 Status.....	33
2.4.2 A Step	34
2.4.3 A Super-Step.....	36
2.4.4 Example	38
2.5 Statemate Models.....	39
2.5.1 Activity-Charts and Statecharts	39
2.5.2 Time Models.....	42
3 RELATED WORK.....	45
3.1 Timing Analysis.....	45

3.2 Schedulability Analysis	47
3.2.1 Response Time Analysis	51
3.2.2 Analysis of Multiprocessor and Distributed Systems.....	54
3.3 Verification Using Tests	55
3.4 Compilation of Statecharts Models	56
3.5 Code Optimization Techniques	57
4 STARC.....	61
4.1 Introduction.....	61
4.2 Structure of STARC.....	62
4.3 Advantages of STARC.....	64
5 CODE GENERATION	67
5.1 Introduction.....	67
5.2 Structure of the Generated System.....	69
5.2.1 Interrupt Routines	70
5.2.2 Structure of the Generated Tasks	71
5.3 Translation of the Language Elements	74
5.3.1 States and Transitions	74
5.3.2 Time Related Events and Actions	74
5.3.3 Priorities Between Transitions.....	76
5.4 Optimizations.....	77
5.4.1 Reducing Memory Load	77
5.4.1.1 Optimizations concerning variables and data types	78
5.4.1.2 Minimizing Double Buffering	78
5.4.2 Improving the Execution Time.....	85
6 WCET/WCNIS ANALYSIS	89
6.1 Introduction.....	89
6.2 Definitions	91
6.3 The WCET Analysis Steps	92

6.3.1	Generation of an Annotated CFG	92
6.3.1.1	Low Level Timing Analysis	93
6.3.1.2	Generation and Timing Analysis of Code Blocks.....	94
6.3.1.3	Example for High- and Low-Level Analysis	95
6.3.2	Determination of All Stable States	96
6.3.3	Extraction of the Longest Executable Paths	96
6.4	WCNIS Analysis	99
7	SCHEDULABILITY ANALYSIS	101
7.1	Introduction.....	101
7.2	Schedulability analysis at the specification level	104
8	EXPERIMENTAL RESULTS	111
8.1	Worst Case Number of Iteration Steps Analysis.....	111
8.2	Worst Case Execution Times Analysis	112
8.3	Code Generation	113
9	SUMMARY AND FUTURE WORK	115
	BIBLIOGRAPHY	119
	APPENDIX A	129
	APPENDIX B	139