

AURIX™ TC3xx

About this document

Scope and purpose

This User's Manual describes the Infineon AURIX™ TC3xx Platform family, a range of 32-bit multicore microcontrollers based on the Infineon TriCore™ Architecture.

This family document covers the superset functionality. It is supplemented by a separate device specific document "Appendix" that covers differences of a particular device to this family superset.

Table of Contents

	About this document	Preface-1
	Table of Contents	TOC-1
27	System Timer (STM)	27-1
27.1	Feature List	27-1
27.2	Overview	27-2
27.3	Functional Description	27-2
27.3.1	Compare Register Operation	27-4
27.3.2	Compare Match Interrupt Control	27-5
27.3.3	Using Multiple STMs	27-5
27.3.4	STM as Reset Trigger	27-5
27.4	Registers	27-6
27.4.1	Clock Control Register	27-7
27.4.2	Timer/Capture Registers	27-9
27.4.3	Compare Registers	27-13
27.4.4	Interrupt Registers	27-16
27.4.5	Interface Registers	27-19
27.5	IO Interfaces	27-23
27.6	Revision History	27-23
28	Generic Timer Module (GTM)	28-1
28.1	Feature List	28-2
28.1.1	Delta to AURIX	28-2
28.2	Overview	28-4
28.3	Generic Timer Module (GTM)	28-4
28.3.1	Overview	28-4
28.3.2	Document Structure	28-6
28.4	GTM Architecture	28-7
28.4.1	Overview	28-7
28.4.2	GTM Interfaces	28-13
28.4.2.1	GTM Generic Bus Interface (AEI)	28-13
28.4.2.2	GTM Multi-master and multitasking support	28-14
28.4.3	ARU Routing Concept	28-14
28.4.3.1	ARU Round Trip Time	28-16
28.4.3.2	ARU Blocking Mechanism	28-16
28.4.4	GTM Clock and Time Base Management (CTBM)	28-17
28.4.4.1	GTM Clock and time base management architecture	28-18
28.4.4.2	Cyclic Event Compare	28-19
28.4.5	GTM Interrupt Concept	28-20
28.4.5.1	Level interrupt mode	28-22
28.4.5.2	Pulse interrupt mode	28-23
28.4.5.3	Pulse-notify interrupt mode	28-25
28.4.5.4	Single-pulse interrupt mode	28-26
28.4.5.5	GTM Interrupt concentration method	28-27
28.4.6	GTM Software Debugger Support	28-27
28.4.7	GTM Programming conventions	28-28
28.4.8	GTM TOP-Level Configuration Register Overview	28-28
28.4.9	GTM TOP-Level Configuration Registers Description	28-30
28.4.9.1	Register GTM_REV	28-30

28.4.9.2	Register GTM_RST	28-31
28.4.9.3	Register GTM_CTRL	28-31
28.4.9.4	Register GTM_AEI_ADDR_XPT	28-32
28.4.9.5	Register GTM_AEI_STA_XPT	28-33
28.4.9.6	Register GTM_IRQ_NOTIFY	28-34
28.4.9.7	Register GTM_IRQ_EN	28-36
28.4.9.8	Register GTM_IRQ_FORCINT	28-37
28.4.9.9	Register GTM_IRQ_MODE	28-39
28.4.9.10	Register GTM_BRIDGE_MODE	28-39
28.4.9.11	Register GTM_BRIDGE_PTR1	28-41
28.4.9.12	Register GTM_BRIDGE_PTR2	28-42
28.4.9.13	Register GTM_MCS_AEM_DIS	28-43
28.4.9.14	Register GTM_EIRQ_EN	28-44
28.4.9.15	Register GTM_CLS_CLK_CFG	28-45
28.4.9.16	Register GTM_CFG	28-46
28.5	Advanced Routing Unit (ARU)	28-47
28.5.1	Overview	28-47
28.5.2	Special Data Sources	28-47
28.5.3	ARU Access via AEI	28-47
28.5.3.1	Default ARU Access	28-47
28.5.3.2	Debug Access	28-48
28.5.4	ARU dynamic routing	28-49
28.5.4.1	Dynamic routing - CPU controlled	28-49
28.5.4.1.1	Dynamic routing ring mode	28-50
28.5.4.2	Dynamic routing - ARU controlled	28-50
28.5.5	ARU Interrupt Signals	28-51
28.5.6	ARU Configuration Register Overview	28-52
28.5.7	ARU Configuration Register Description	28-53
28.5.7.1	Register ARU_ACCESS	28-53
28.5.7.2	Register ARU_DATA_H	28-54
28.5.7.3	Register ARU_DATA_L	28-55
28.5.7.4	Register ARU_DBG_ACCESS0	28-55
28.5.7.5	Register ARU_DBG_DATA0_H	28-57
28.5.7.6	Register ARU_DBG_DATA0_L	28-57
28.5.7.7	Register ARU_DBG_ACCESS1	28-58
28.5.7.8	Register ARU_DBG_DATA1_H	28-59
28.5.7.9	Register ARU_DBG_DATA1_L	28-60
28.5.7.10	Register ARU_IRQ_NOTIFY	28-60
28.5.7.11	Register ARU_IRQ_EN	28-61
28.5.7.12	Register ARU_IRQ_FORCINT	28-62
28.5.7.13	Register ARU_IRQ_MODE	28-63
28.5.7.14	Register ARU_CADDR_END	28-63
28.5.7.15	Register ARU_CADDR	28-64
28.5.7.16	Register ARU_CTRL	28-65
28.5.7.17	Register ARU_[z]_DYN_CTRL	28-66
28.5.7.18	Register ARU_[z]_DYN_RDADDR	28-66
28.5.7.19	Register ARU_[z]_DYN_ROUTE_LOW	28-67
28.5.7.20	Register ARU_[z]_DYN_ROUTE_HIGH	28-68
28.5.7.21	Register ARU_[z]_DYN_ROUTE_SR_LOW	28-68
28.5.7.22	Register ARU_[z]_DYN_ROUTE_SR_HIGH	28-69

28.6	Broadcast Module (BRC)	28-71
28.6.1	Overview	28-71
28.6.2	BRC Configuration	28-71
28.6.3	BRC Interrupt Signals	28-72
28.6.4	BRC Configuration Register Overview	28-72
28.6.5	BRC Configuration Register Description	28-74
28.6.5.1	Register BRC_SRC[z]_ADDR	28-74
28.6.5.2	Register BRC_SRC[z]_DEST	28-75
28.6.5.3	Register BRC_IRQ_NOTIFY	28-76
28.6.5.4	Register BRC_IRQ_EN	28-77
28.6.5.5	Register BRC_IRQ_FORCINT	28-78
28.6.5.6	Register BRC_IRQ_MODE	28-78
28.6.5.7	Register BRC_EIRQ_EN	28-79
28.6.5.8	Register BRC_RST	28-80
28.7	First In First Out Module (FIFO)	28-81
28.7.1	Overview	28-81
28.7.2	Operation Modes	28-81
28.7.2.1	FIFO Operation Mode	28-81
28.7.2.2	Ring Buffer Operation Mode	28-82
28.7.2.3	DMA Hysteresis Mode	28-82
28.7.3	FIFO Interrupt	28-82
28.7.4	FIFO Configuration Register Overview	28-83
28.7.5	FIFO Configuration Registers Description	28-84
28.7.5.1	Register FIFO[i]_CH[z]_CTRL	28-84
28.7.5.2	Register FIFO[i]_CH[z]_END_ADDR	28-85
28.7.5.3	Register FIFO[i]_CH[z]_START_ADDR	28-85
28.7.5.4	Register FIFO[i]_CH[z]_UPPER_WM	28-86
28.7.5.5	Register FIFO[i]_CH[z]_LOWER_WM	28-86
28.7.5.6	Register FIFO[i]_CH[z]_STATUS	28-87
28.7.5.7	Register FIFO[i]_CH[z]_FILL_LEVEL	28-88
28.7.5.8	Register FIFO[i]_CH[z]_WR_PTR	28-88
28.7.5.9	Register FIFO[i]_CH[z]_RD_PTR	28-89
28.7.5.10	Register FIFO[i]_CH[z]_IRQ_NOTIFY	28-90
28.7.5.11	Register FIFO[i]_CH[z]_IRQ_EN	28-91
28.7.5.12	Register FIFO[i]_CH[z]_IRQ_FORCINT	28-92
28.7.5.13	Register FIFO[i]_CH[z]_IRQ_MODE	28-93
28.7.5.14	Register FIFO[i]_CH[z]_EIRQ_EN	28-94
28.8	AEI to FIFO Data Interface (AFD)	28-95
28.8.1	Overview	28-95
28.8.2	AFD Register overview	28-95
28.8.3	AFD Register description	28-95
28.8.3.1	Register AFD[i]_CH[z]_BUF_ACC	28-95
28.9	FIFO to ARU Unit (F2A)	28-96
28.9.1	Overview	28-96
28.9.2	Transfer modes	28-96
28.9.3	Internal buffer mode	28-97
28.9.4	F2A Configuration Register Overview	28-98
28.9.5	F2A Configuration Register description	28-99
28.9.5.1	Register F2A[i]_ENABLE	28-99
28.9.5.2	Register F2A[i]_CH[z]_ARU_RD_FIFO	28-99

28.9.5.3	Register F2A[i]_CH[z]_STR_CFG	28-100
28.9.5.4	Register F2A[i]_CTRL	28-101
28.10	Clock Management Unit (CMU)	28-102
28.10.1	Overview	28-102
28.10.2	Global Clock Divider	28-104
28.10.3	Configurable Clock Generation sub-unit (CFGU)	28-104
28.10.4	Fixed Clock Generation (FXU)	28-105
28.10.5	External Generation Unit (EGU)	28-105
28.10.6	CMU Configuration Register Overview	28-106
28.10.7	CMU Configuration Register Description	28-107
28.10.7.1	Register CMU_CLK_EN	28-107
28.10.7.2	Register CMU_GCLK_NUM	28-108
28.10.7.3	Register CMU_GCLK_DEN	28-108
28.10.7.4	Register CMU_CLK_[z]_CTRL	28-109
28.10.7.5	Register CMU_ECLK_[z]_NUM	28-110
28.10.7.6	Register CMU_ECLK_[z]_DEN	28-110
28.10.7.7	Register CMU_FXCLK_CTRL	28-111
28.10.7.8	Register CMU_GLB_CTRL	28-112
28.10.7.9	Register CMU_CLK_CTRL	28-113
28.11	Cluster Configuration Module (CCM)	28-115
28.11.1	Overview	28-115
28.11.2	Address Range Protection	28-116
28.11.3	CCM Configuration Register Overview	28-118
28.11.4	CCM Configuration Register description	28-119
28.11.4.1	Register CCM[i]_PROT	28-119
28.11.4.2	Register CCM[i]_CFG	28-119
28.11.4.3	Register CCM[i]_CMU_CLK_CFG	28-121
28.11.4.4	Register CCM[i]_CMU_FXCLK_CFG	28-122
28.11.4.5	Register CCM[i]_AEIM_STA	28-122
28.11.4.6	Register CCM[i]_ARP[z]_CTRL	28-123
28.11.4.7	Register CCM[i]_ARP[z]_PROT	28-124
28.11.4.8	Register CCM[i]_HW_CONF	28-125
28.11.4.9	Register CCM[i]_TIM_AUX_IN_SRC	28-128
28.11.4.10	Register CCM[i]_EXT_CAP_EN	28-129
28.11.4.11	Register CCM[i]_TOM_OUT	28-130
28.11.4.12	Register CCM[i]_ATOM_OUT	28-130
28.12	Time Base Unit (TBU)	28-131
28.12.1	Overview	28-131
28.12.2	TBU Channels	28-133
28.12.2.1	Independent Modes	28-133
28.12.2.1.1	Free Running Counter Mode	28-133
28.12.2.1.2	Forward/Backward Counter Mode	28-133
28.12.2.2	Dependent Mode	28-133
28.12.2.2.1	Modulo Counter Mode	28-133
28.12.3	TBU Configuration Register Overview	28-134
28.12.4	TBU Register description	28-135
28.12.4.1	Register TBU_CHEN	28-135
28.12.4.2	Register TBU_CH0_CTRL	28-135
28.12.4.3	Register TBU_CH0_BASE	28-136
28.12.4.4	Register TBU_CH1_CTRL	28-137

28.12.4.5	Register TBU_CH2_CTRL	28-138
28.12.4.6	Register TBU_CH[y]_BASE	28-139
28.12.4.7	Register TBU_CH3_CTRL	28-140
28.12.4.8	Register TBU_CH3_BASE	28-140
28.12.4.9	Register TBU_CH3_BASE_MARK	28-141
28.12.4.10	Register TBU_CH3_BASE_CAPTURE	28-141
28.13	Timer Input Module (TIM)	28-143
28.13.1	Overview	28-143
28.13.1.1	Input source selection INPUTSRCx	28-145
28.13.1.2	Input observation	28-146
28.13.1.3	External capture source selection EXTCAPSRCx	28-146
28.13.2	TIM Filter Functionality (FLT)	28-147
28.13.2.1	Overview	28-147
28.13.2.2	TIM Filter Modes	28-149
28.13.2.2.1	Immediate Edge Propagation Mode	28-149
28.13.2.2.2	Individual De-glitch Time Mode (up/down counter)	28-151
28.13.2.2.3	Individual De-glitch Time Mode (hold counter)	28-152
28.13.2.2.4	Individual De-glitch Time Mode (reset counter)	28-152
28.13.2.2.5	Immediate Edge Propagation and Individual De-glitch Mode	28-153
28.13.2.3	TIM Filter re-configuration	28-154
28.13.3	Timeout Detection Unit (TDU)	28-154
28.13.3.1	Used parallel functions	28-155
28.13.3.2	Which of the available 8 bit resources are cascaded with a chosen SLICING	28-156
28.13.3.3	Architecture of the TDU Sub-unit	28-158
28.13.4	TIM Channel Architecture	28-160
28.13.4.1	Overview	28-160
28.13.4.2	TIM Channel Modes	28-162
28.13.4.2.1	TIM PWM Measurement Mode (TPWM)	28-163
28.13.4.2.2	TIM Pulse Integration Mode (TPIM)	28-164
28.13.4.2.3	TIM Input Event Mode (TIEM)	28-166
28.13.4.2.4	TIM Input Prescaler Mode (TIPM)	28-167
28.13.4.2.5	TIM Bit Compression Mode (TBCM)	28-167
28.13.4.2.6	TIM Gated Periodic Sampling Mode (TGPS)	28-169
28.13.4.2.7	TIM Serial Shift Mode (TSSM)	28-171
28.13.5	MAP Submodule Interface	28-175
28.13.5.1	Structure of map data	28-176
28.13.6	TIM Interrupt Signals	28-176
28.13.7	TIM Configuration Register Overview	28-176
28.13.8	TIM Configuration Registers Description	28-178
28.13.8.1	Register TIM[i]_CH[x]_CTRL	28-178
28.13.8.2	Register TIM[i]_CH[x]_FLT_RE	28-182
28.13.8.3	Register TIM[i]_CH[x]_FLT_FE	28-183
28.13.8.4	Register TIM[i]_CH[x]_GPR0	28-183
28.13.8.5	Register TIM[i]_CH[x]_GPR1	28-184
28.13.8.6	Register TIM[i]_CH[x]_CNT	28-185
28.13.8.7	Register TIM[i]_CH[x]_CNTS	28-185
28.13.8.8	Register TIM[i]_CH[x]_IRQ_NOTIFY	28-186
28.13.8.9	Register TIM[i]_CH[x]_IRQ_EN	28-187
28.13.8.10	Register TIM[i]_CH[x]_IRQ_FORCINT	28-188
28.13.8.11	Register TIM[i]_CH[x]_IRQ_MODE	28-189

28.13.8.12	Register TIM[i]_RST	28-189
28.13.8.13	Register TIM[i]_IN_SRC	28-190
28.13.8.14	Register TIM[i]_CH[x]_EIRQ_EN	28-191
28.13.8.15	Register TIM[i]_CH[x]_TUV	28-192
28.13.8.16	Register TIM[i]_CH[x]_TUC	28-193
28.13.8.17	Register TIM[i]_CH[x]_ECNT	28-194
28.13.8.18	Register TIM[i]_CH[x]_ECTRL	28-194
28.13.8.19	Register TIM[i]_INP_VAL	28-198
28.14	Timer Output Module (TOM)	28-200
28.14.1	Overview	28-200
28.14.2	TOM Global Channel Control (TGC0, TGC1)	28-202
28.14.2.1	Overview	28-202
28.14.2.2	TGC Sub-unit	28-202
28.14.3	TOM Channel	28-204
28.14.3.1	Duty cycle, Period and Clock Frequency Update Mechanisms	28-208
28.14.3.1.1	Synchronous Update Of Duty Cycle Only	28-209
28.14.3.1.2	Asynchronous Update Of Duty Cycle Only	28-209
28.14.3.2	Continuous Counting Up Mode	28-210
28.14.3.3	Continuous Counting Up-Down Mode	28-211
28.14.3.4	One-shot Counting Up Mode	28-213
28.14.3.5	One-shot Counting Up-Down Mode	28-215
28.14.3.6	Pulse Count Modulation Mode	28-216
28.14.3.7	Trigger Generation	28-218
28.14.4	TOM BLDC Support	28-218
28.14.5	TOM Gated Counter Mode	28-219
28.14.6	TOM Interrupt signals	28-220
28.14.7	TOM Configuration Register Overview	28-220
28.14.8	TOM Configuration Register Description	28-221
28.14.8.1	Register TOM[i]_TGC[y]_GLB_CTRL	28-221
28.14.8.2	Register TOM[i]_TGC[y]_ENDIS_CTRL	28-222
28.14.8.3	Register TOM[i]_TGC[y]_ENDIS_STAT	28-223
28.14.8.4	Register TOM[i]_TGC[y]_ACT_TB	28-224
28.14.8.5	Register TOM[i]_TGC[y]_OUTEN_CTRL	28-225
28.14.8.6	Register TOM[i]_TGC[y]_OUTEN_STAT	28-226
28.14.8.7	Register TOM[i]_TGC[y]_FUPD_CTRL	28-226
28.14.8.8	Register TOM[i]_TGC[y]_INT_TRIG	28-227
28.14.8.9	Register TOM[i]_CH[x]_CTRL	28-228
28.14.8.10	Register TOM[i]_CH[x]_CN0	28-232
28.14.8.11	Register TOM[i]_CH[x]_CM0	28-233
28.14.8.12	Register TOM[i]_CH[x]_SR0	28-233
28.14.8.13	Register TOM[i]_CH[x]_CM1	28-234
28.14.8.14	Register TOM[i]_CH[x]_SR1	28-234
28.14.8.15	Register TOM[i]_CH[x]_STAT	28-235
28.14.8.16	Register TOM[i]_CH[x]_IRQ_NOTIFY	28-235
28.14.8.17	Register TOM[i]_CH[x]_IRQ_EN	28-236
28.14.8.18	Register TOM[i]_CH[x]_IRQ_FORCINT	28-237
28.14.8.19	Register TOM[i]_CH[x]_IRQ_MODE	28-237
28.15	ARU-connected Timer Output Module (ATOM)	28-239
28.15.1	Overview	28-239
28.15.1.1	ATOM Global Control (AGC)	28-240

28.15.1.1.1	Overview	28-240
28.15.1.1.2	AGC Sub-unit	28-241
28.15.1.2	ATOM Channel Mode Overview	28-243
28.15.2	ATOM Channel Architecture	28-243
28.15.2.1	ARU Communication Interface	28-245
28.15.3	ATOM Channel Modes	28-246
28.15.3.1	ATOM Signal Output Mode Immediate (SOMI)	28-247
28.15.3.1.1	Register ATOM[i]_CH[x]_CTRL in SOMI mode	28-248
28.15.3.2	ATOM Signal Output Mode Compare (SOMC)	28-249
28.15.3.2.1	Overview	28-249
28.15.3.2.2	SOMC Mode under CPU control	28-250
28.15.3.2.3	SOMC Mode under ARU control	28-256
28.15.3.2.4	Register ATOM[i]_CH[x]_CTRL in SOMC mode	28-265
28.15.3.3	ATOM Signal Output Mode PWM (SOMP)	28-268
28.15.3.3.1	Continuous Counting Up Mode	28-269
28.15.3.3.2	Continuous Counting Up-Down Mode	28-271
28.15.3.3.3	ARU controlled update	28-272
28.15.3.3.4	CPU controlled update	28-273
28.15.3.3.5	One-shot Counting Up Mode	28-274
28.15.3.3.6	One-shot Counting Up-Down Mode	28-275
28.15.3.3.7	Pulse Count Modulation Mode	28-276
28.15.3.3.8	Trigger generation	28-278
28.15.3.3.9	Register ATOM[i]_CH[x]_CTRL in SOMP mode	28-279
28.15.3.4	ATOM Signal Output Mode Serial (SOMS)	28-282
28.15.3.4.1	SOMS mode with ARU_EN = 1 and OSM = 0, UPEN_CTRL[x] = 1	28-284
28.15.3.4.2	SOMS mode with ARU_EN = 1 and OSM = 1, UPEN_CTRL[x] = 1	28-284
28.15.3.4.3	SOMS mode with ARU_EN = 0 and OSM = 0, UPEN_CTRL[x] = 1	28-285
28.15.3.4.4	SOMS mode with ARU_EN = 0 and OSM = 1, UPEN_CTRL[x] = 1:	28-285
28.15.3.4.5	SOMS mode with double output	28-285
28.15.3.4.6	Interrupts in SOMS mode	28-285
28.15.3.4.7	Register ATOM[i]_CH[x]_CTRL in SOMS mode	28-286
28.15.3.5	ATOM Signal Output Mode Buffered Compare (SOMB)	28-288
28.15.3.5.1	Overview	28-288
28.15.3.5.2	SOMB under CPU control	28-290
28.15.3.5.3	SOMB under ARU control	28-290
28.15.3.5.4	Register ATOM[i]_CH[x]_CTRL in SOMB mode	28-293
28.15.4	ATOM Interrupt Signals	28-295
28.15.5	ATOM Register Overview	28-296
28.15.6	ATOM Register Description	28-297
28.15.6.1	Register ATOM[i]_AGC_GLB_CTRL	28-297
28.15.6.2	Register ATOM[i]_AGC_ENDIS_CTRL	28-298
28.15.6.3	Register ATOM[i]_AGC_ENDIS_STAT	28-299
28.15.6.4	Register ATOM[i]_AGC_ACT_TB	28-300
28.15.6.5	Register ATOM[i]_AGC_OUTEN_CTRL	28-301
28.15.6.6	Register ATOM[i]_AGC_OUTEN_STAT	28-301
28.15.6.7	Register ATOM[i]_AGC_FUPD_CTRL	28-302
28.15.6.8	Register ATOM[i]_AGC_INT_TRIG	28-303
28.15.6.9	Register ATOM[i]_CH[x]_CTRL	28-304
28.15.6.10	Register ATOM[i]_CH[x]_STAT	28-309
28.15.6.11	Register ATOM[i]_CH[x]_RDADDR	28-311

28.15.6.12	Register ATOM[i]_CH[x]_CN0	28-311
28.15.6.13	Register ATOM[i]_CH[x]_CM0	28-312
28.15.6.14	Register ATOM[i]_CH[x]_SR0	28-312
28.15.6.15	Register ATOM[i]_CH[x]_CM1	28-313
28.15.6.16	Register ATOM[i]_CH[x]_SR1	28-314
28.15.6.17	Register ATOM[i]_CH[x]_IRQ_NOTIFY	28-314
28.15.6.18	Register ATOM[i]_CH[x]_IRQ_EN	28-315
28.15.6.19	Register ATOM[i]_CH[x]_IRQ_FORCINT	28-316
28.15.6.20	Register ATOM[i]_CH[x]_IRQ_MODE	28-316
28.16	Dead Time Module (DTM)	28-318
28.16.1	Overview	28-318
28.16.2	DTM Channel	28-322
28.16.2.1	Standard dead time generation	28-323
28.16.2.2	Cross channel dead time	28-325
28.16.3	Phase Shift Control Unit	28-326
28.16.4	Multiple output signal combination	28-327
28.16.4.1	Combination of input signal TIM_CH_IN/AUX_IN with TOM/ATOM signal	28-327
28.16.4.2	Combination of multiple TOM/ATOM output signals	28-328
28.16.4.3	Pulse generation on edge	28-328
28.16.5	Synchronous update of channel control register 2	28-329
28.16.6	DTM output shut off	28-330
28.16.7	DTM connections on GTM top level	28-330
28.16.8	CDTM Configuration Register Overview	28-331
28.16.9	Configuration Register Description	28-332
28.16.9.1	Register CDTM[i]_DTM[j]_CTRL	28-332
28.16.9.2	Register CDTM[i]_DTM[j]_CH_CTRL1	28-334
28.16.9.3	Register CDTM[i]_DTM[j]_CH_CTRL2	28-337
28.16.9.4	Register CDTM[i]_DTM[j]_CH_CTRL2_SR	28-340
28.16.9.5	Register CDTM[i]_DTM[j]_CH_CTRL3	28-343
28.16.9.6	Register CDTM[i]_DTM[j]_PS_CTRL	28-345
28.16.9.7	Register CDTM[i]_DTM[j]_CH[z]_DTV	28-346
28.16.9.8	Register CDTM[i]_DTM[j]_CH_SR	28-347
28.17	Multi Channel Sequencer (MCS)	28-348
28.17.1	Overview	28-348
28.17.2	Architecture	28-348
28.17.3	Scheduling	28-351
28.17.3.1	Round Robin Scheduling	28-351
28.17.3.2	Accelerated Scheduling	28-352
28.17.3.3	Single Prioritization Scheduling	28-354
28.17.3.4	Multiple Prioritization Scheduling	28-355
28.17.4	Memory Organization	28-355
28.17.5	AEI Bus Master Interface	28-356
28.17.6	ADC Interface	28-357
28.17.6.1	Basic ADC Functions	28-357
28.17.7	Instruction Set	28-357
28.17.7.1	MOVL Instruction	28-364
28.17.7.2	MOV Instruction	28-364
28.17.7.3	MRD Instruction	28-364
28.17.7.4	MWR Instruction	28-364
28.17.7.5	MWRL Instruction	28-365

28.17.7.6	MRDI Instruction	28-365
28.17.7.7	MRDIO Instruction	28-365
28.17.7.8	MWRI Instruction	28-366
28.17.7.9	MWRIO Instruction	28-366
28.17.7.10	MWRIL Instruction	28-366
28.17.7.11	POP Instruction	28-367
28.17.7.12	PUSH Instruction	28-367
28.17.7.13	ARD Instruction	28-368
28.17.7.14	ARDI Instruction	28-368
28.17.7.15	AWR Instruction	28-369
28.17.7.16	AWRI Instruction	28-369
28.17.7.17	NARD Instruction	28-370
28.17.7.18	NARDI Instruction	28-370
28.17.7.19	BRD Instruction	28-371
28.17.7.20	BWR Instruction	28-371
28.17.7.21	BRDI Instruction	28-371
28.17.7.22	BWRI Instruction	28-372
28.17.7.23	ADDL Instruction	28-372
28.17.7.24	ADD Instruction	28-373
28.17.7.25	ADDC Instruction	28-373
28.17.7.26	SUBL Instruction	28-373
28.17.7.27	SUB Instruction	28-374
28.17.7.28	SUBC Instruction	28-374
28.17.7.29	NEG Instruction	28-375
28.17.7.30	ANDL Instruction	28-375
28.17.7.31	AND Instruction	28-375
28.17.7.32	ORL Instruction	28-375
28.17.7.33	OR Instruction	28-376
28.17.7.34	XORL Instruction	28-376
28.17.7.35	XOR Instruction	28-376
28.17.7.36	SHR Instruction	28-376
28.17.7.37	SHL Instruction	28-377
28.17.7.38	ASRU Instruction	28-377
28.17.7.39	ASRS Instruction	28-377
28.17.7.40	ASL Instruction	28-377
28.17.7.41	MULU Instruction	28-378
28.17.7.42	MULS Instruction	28-378
28.17.7.43	DIVU Instruction	28-379
28.17.7.44	DIVS Instruction	28-379
28.17.7.45	MINU Instruction	28-380
28.17.7.46	MINS Instruction	28-380
28.17.7.47	MAXU Instruction	28-380
28.17.7.48	MAXS Instruction	28-381
28.17.7.49	ATUL Instruction	28-381
28.17.7.50	ATU Instruction	28-381
28.17.7.51	ATSL Instruction	28-381
28.17.7.52	ATS Instruction	28-382
28.17.7.53	BTL Instruction	28-382
28.17.7.54	BT Instruction	28-382
28.17.7.55	SETB Instruction	28-383

28.17.7.56	CLRB Instruction	28-383
28.17.7.57	XCHB Instruction	28-383
28.17.7.58	JMP Instruction	28-383
28.17.7.59	JBS Instruction	28-384
28.17.7.60	JBC Instruction	28-384
28.17.7.61	CALL Instruction	28-384
28.17.7.62	RET Instruction	28-385
28.17.7.63	JMPI Instruction	28-385
28.17.7.64	JBSI Instruction	28-385
28.17.7.65	JBCI Instruction	28-386
28.17.7.66	CALLI Instruction	28-386
28.17.7.67	WURM Instruction	28-386
28.17.7.68	WURMX Instruction	28-387
28.17.7.69	WURCX Instruction	28-388
28.17.7.70	WUCE Instruction	28-388
28.17.7.71	NOP Instruction	28-389
28.17.8	MCS Internal Register Description	28-389
28.17.8.1	MCS Internal Register Overview	28-389
28.17.9	MCS Internal Register Description	28-391
28.17.9.1	Register R[y]	28-391
28.17.9.2	Register RS[y]	28-391
28.17.9.3	Register STA	28-392
28.17.9.4	Register ACB	28-395
28.17.9.5	Register CTRG	28-396
28.17.9.6	Register STRG	28-400
28.17.9.7	Register TBU_TS0	28-400
28.17.9.8	Register TBU_TS1	28-401
28.17.9.9	Register TBU_TS2	28-401
28.17.9.10	Register MHB	28-401
28.17.9.11	Register GMI0	28-402
28.17.9.12	Register GMI1	28-403
28.17.9.13	Register DSTA	28-405
28.17.9.14	Register DSTAX	28-406
28.17.10	MCS Configuration Register Overview	28-407
28.17.11	MCS Configuration Register Description	28-409
28.17.11.1	Register MCS[i]_CH[x]_CTRL	28-409
28.17.11.2	Register MCS[i]_CH[x]_PC	28-410
28.17.11.3	Register MCS[i]_CH[x]_R[y]	28-411
28.17.11.4	Register MCS[i]_CH[x]_ACB	28-411
28.17.11.5	Register MCS[i]_CH[x]_MHB	28-412
28.17.11.6	Register MCS[i]_CH[x]_IRQ_NOTIFY	28-413
28.17.11.7	Register MCS[i]_CH[x]_IRQ_EN	28-414
28.17.11.8	Register MCS[i]_CH[x]_IRQ_FORCINT	28-414
28.17.11.9	Register MCS[i]_CH[x]_IRQ_MODE	28-415
28.17.11.10	Register MCS[i]_CH[x]_EIRQ_EN	28-416
28.17.11.11	Register MCS[i]_CTRL_STAT	28-417
28.17.11.12	Register MCS[i]_REG_PROT	28-419
28.17.11.13	Register MCS[i]_CTRG	28-420
28.17.11.14	Register MCS[i]_STRG	28-421
28.17.11.15	Register MCS[i]_RESET	28-422

28.17.11.16	Register MCS[i]_CAT	28-423
28.17.11.17	Register MCS[i]_CWT	28-424
28.17.11.18	Register MCS[i]_ERR	28-425
28.18	Memory Configuration (MCFG)	28-427
28.18.1	Overview	28-427
28.18.2	MCFG Register Overview	28-429
28.18.3	MCFG Register Description	28-430
28.18.3.1	Register MCFG_CTRL	28-430
28.19	TIM0 Input Mapping Module (MAP)	28-431
28.19.1	Overview	28-431
28.19.2	TIM Signal Preprocessing (TSPP)	28-432
28.19.2.1	Bit Stream Combination	28-432
28.19.3	MAP Register overview	28-433
28.19.4	MAP Register description	28-434
28.19.4.1	Register MAP_CTRL	28-434
28.20	Digital PLL Module (DPLL)	28-436
28.20.1	Overview	28-436
28.20.2	Requirements and demarcation	28-436
28.20.3	Input signal courses	28-437
28.20.4	Block and interface description	28-438
28.20.4.1	Interface description of DPLL	28-439
28.20.5	DPLL Architecture	28-442
28.20.5.1	Purpose of the module	28-442
28.20.5.2	Explanation of the prediction methodology	28-443
28.20.5.3	Clock topology	28-443
28.20.5.4	Clock generation	28-443
28.20.5.5	Typical frequencies	28-443
28.20.5.6	Time stamps and systematic corrections	28-443
28.20.5.7	DPLL Architecture overview	28-444
28.20.5.8	DPLL Architecture description	28-445
28.20.5.9	Block diagrams of time stamp processing.	28-446
28.20.5.10	Register and RAM address overview	28-448
28.20.5.10.1	RAM Region 1	28-450
28.20.5.10.2	RAM Region 2	28-451
28.20.5.11	Software reset and DPLL deactivation	28-452
28.20.6	Prediction of the current increment duration	28-453
28.20.6.1	The use of increments in the past	28-453
28.20.6.2	Increment prediction in Normal Mode and for first PMSM forwards	28-453
28.20.6.2.1	Equations DPLL-1a to calculate TRIGGER time stamps	28-454
28.20.6.2.2	Equation DPLL-1b to calculate DT_T_ACT (nominal value)	28-454
28.20.6.2.3	Equation DPLL-1c to calculate RDT_T_ACT (nominal value)	28-455
28.20.6.2.4	Equation DPLL-2a1 to calculate QDT_T_ACT	28-455
28.20.6.2.5	Equation DPLL-3 to calculate the error of last prediction	28-455
28.20.6.2.6	Equation DPLL-4 to calculate the weighted average error	28-455
28.20.6.2.7	Equations DPLL-5 to calculate the current increment value	28-455
28.20.6.3	Increment prediction in Emergency Mode and for second PMSM forwards	28-456
28.20.6.3.1	Equations DPLL-6a to calculate STATE time stamps	28-456
28.20.6.3.2	Equation DPLL-6b to calculate DT_S_ACT (nominal value)	28-457
28.20.6.3.3	Equation DPLL-6c to calculate RDT_S_ACT (nominal value)	28-457
28.20.6.3.4	Equation DPLL-7a1 to calculate QDT_S_ACT	28-457

28.20.6.3.5	Equation DPLL-8 to calculate the error of last prediction	28-458
28.20.6.3.6	Equation DPLL-9 to calculate the weighted average error	28-458
28.20.6.3.7	Equations DPLL-10 to calculate the current increment (nominal value)	28-458
28.20.6.4	Increment prediction in Normal Mode and for first PMSM backwards	28-460
28.20.6.4.1	Equations DPLL-2a2 to calculate QDT_T_ACT backwards	28-460
28.20.6.4.2	Equation DPLL-3a to calculate of the error of last prediction	28-460
28.20.6.4.3	Equation DPLL-4 to calculate the weighted average error	28-460
28.20.6.4.4	Equation DPLL-5 to calculate the current increment value	28-460
28.20.6.5	Increment prediction in Emergency Mode and for second PMSM backwards	28-461
28.20.6.5.1	Equation DPLL-7a2 to calculate QDT_S_ACT backwards	28-461
28.20.6.5.2	Equation DPLL-8a to calculate the error of the last prediction	28-461
28.20.6.5.3	Equation DPLL-9 to calculate the weighted average error	28-461
28.20.6.5.4	Equations DPLL-10 to calculate the current increment value	28-461
28.20.7	Calculations for actions	28-462
28.20.7.1	Action calculations for TRIGGER forwards	28-463
28.20.7.1.1	Equation DPLL-11a1 to calculate the time prediction for an action	28-464
28.20.7.1.2	Equation DPLL-11a2 to calculate the time prediction for an action	28-464
28.20.7.1.3	Equation DPLL-11b to calculate the time prediction for an action	28-464
28.20.7.1.4	Equation DPLL-11c to calculate the time prediction for an action	28-464
28.20.7.1.5	Equation DPLL-12 to calculate the duration value until action	28-465
28.20.7.2	Action calculations for TRIGGER backwards	28-465
28.20.7.2.1	Equation DPLL-11a3 to calculate the time prediction for an action	28-465
28.20.7.2.2	Equation DPLL-11a4 to calculate the time prediction for an action	28-465
28.20.7.2.3	Equation DPLL-11b1 to calculate the time prediction for an action	28-465
28.20.7.2.4	Equation DPLL-11c1 to calculate the time prediction for an action	28-467
28.20.7.2.5	Equation DPLL-12 to calculate the duration value for an action	28-467
28.20.7.3	Action calculations for STATE forwards	28-467
28.20.7.3.1	Equation DPLL-13a1 to calculate the time prediction for an action	28-467
28.20.7.3.2	Equation DPLL-13a2 to calculate the time prediction for an action	28-467
28.20.7.3.3	Equation DPLL-13b to calculate the time prediction for an action	28-468
28.20.7.3.4	Equation DPLL-13c to calculate the time prediction for an action	28-468
28.20.7.3.5	Equation DPLL-14 to calculate the duration value for an action	28-468
28.20.7.4	Action calculations for STATE backwards	28-468
28.20.7.4.1	Equation DPLL-13a3 to calculate the time prediction for an action	28-469
28.20.7.4.2	Equation DPLL-13a4 to calculate the time prediction for an action	28-469
28.20.7.4.3	Equation DPLL-13b1 to calculate the time prediction for an action	28-469
28.20.7.4.4	Equation DPLL-13c1 to calculate the time prediction for an action	28-469
28.20.7.4.5	Equation DPLL-14 to calculate the duration value until action	28-470
28.20.7.5	Update of RAM in Normal and Emergency Mode	28-470
28.20.7.5.1	Equation DPLL-1a4 to update the time stamp values for TRIGGER	28-470
28.20.7.5.2	Equation DPLL-1a5-7 to extend the time stamp values for TRIGGER in forward direction .	28-470
28.20.7.5.3	Equations DPLL-1a5-7 for backward direction	28-471
28.20.7.5.4	Equations DPLL-1b1 and DPLL-1c1 to update the RAM after calculation	28-471
28.20.7.5.5	Equation DPLL-6a4 to update the time stamp values for STATE	28-471
28.20.7.5.6	Equations DPLL-6a5-7 to extend the time stamp values for STATE	28-472
28.20.7.5.7	Equations DPLL-6a5-7 for backward direction	28-472
28.20.7.5.8	Equations DPLL-6b1 and DPLL-6c2 to update the RAM after calculation	28-472
28.20.7.6	Time and position stamps for actions in Normal Mode	28-473
28.20.7.6.1	Equation DPLL-15 to calculate the action time stamp	28-473
28.20.7.6.2	Equations DPLL-17 to calculate the position stamp forwards	28-473

28.20.7.6.3	Equations DPLL-17 to calculate the position stamp backwards	28-474
28.20.7.7	The use of the RAM	28-475
28.20.7.8	Time and position stamps for actions in Emergency Mode	28-476
28.20.7.8.1	Equation DPLL-18 to calculate the action time stamp	28-476
28.20.7.8.2	Equations DPLL-20 to calculate the position stamp forwards	28-476
28.20.7.8.3	Equations DPLL-20 to calculate the position stamp backwards	28-478
28.20.8	Signal processing	28-479
28.20.8.1	Time stamp processing	28-479
28.20.8.2	Count and compare unit	28-479
28.20.8.3	Sub pulse generation for SMC=0	28-479
28.20.8.3.1	Adder for generation of SUB_INCx by the carry c_{out}	28-479
28.20.8.3.2	Equation DPLL-21 to calculate the number of pulses to be sent in normal mode using the automatic end mode condition	28-480
28.20.8.3.3	Equations DPLL-22-24 to calculate the number of pulses to be sent in emergency mode using the automatic end mode condition for SMC=0	28-480
28.20.8.3.4	Equation DPLL-25 to calculate ADD_IN in normal mode for SMC=0	28-481
28.20.8.3.5	Enabling of the compensated output for pulses	28-482
28.20.8.3.6	Equation DPLL-26 to calculate ADD_IN in emergency mode for SMC=0	28-482
28.20.8.4	Sub pulse generation for SMC=1	28-483
28.20.8.4.1	Necessity of two pulse generators	28-483
28.20.8.4.2	Equation DPLL-27 to calculate the number of pulses to be sent for the first device using the automatic end mode condition	28-483
28.20.8.4.3	Equation DPLL-28 to calculate the number of pulses to be sent for the second device using the automatic end mode condition	28-483
28.20.8.4.4	Equation DPLL-30 to calculate ADD_IN for the first device for SMC=1	28-484
28.20.8.4.5	Equation DPLL-31 to calculate ADD_IN for the second device for SMC=1	28-484
28.20.8.5	Calculation of the Accurate Position Values	28-485
28.20.8.6	Scheduling of the Calculation	28-486
28.20.8.6.1	Synchronization description	28-487
28.20.8.6.2	Operation for direction change in normal and emergency mode (SMC=0)	28-489
28.20.8.6.3	Operation for direction change for TRIGGER (SMC=1)	28-491
28.20.8.6.4	Operation for direction change for STATE (SMC=1)	28-492
28.20.8.6.5	DPLL reaction in the case of non plausible input signals	28-493
28.20.8.6.6	State description of the State Machine	28-494
28.20.9	DPLL Interrupt signals	28-502
28.20.10	MCS to DPLL interface	28-503
28.20.10.1	Architecture and organization	28-503
28.20.10.2	General functionality	28-504
28.20.10.3	MCS to DPLL Register overview	28-505
28.20.11	DPLL Register Memory overview	28-505
28.20.11.1	Available DPLL register overview	28-505
28.20.11.2	RAM Region 1a map description	28-507
28.20.11.3	RAM Region 1b map description	28-507
28.20.11.4	RAM Region 1c map description	28-509
28.20.11.5	Register Region EXT description	28-509
28.20.11.6	RAM Region 2 map description	28-510
28.20.12	DPLL Register and Memory description	28-511
28.20.12.1	Register DPLL_CTRL_0	28-511
28.20.12.2	Register DPLL_CTRL_1	28-514
28.20.12.3	Register DPLL_CTRL_2	28-520

28.20.12.4	Register DPLL_CTRL_3	28-521
28.20.12.5	Register DPLL_CTRL_4	28-522
28.20.12.6	Register DPLL_CTRL_5	28-523
28.20.12.7	Register DPLL_ACT_STA	28-524
28.20.12.8	Register DPLL_OSW	28-525
28.20.12.9	Register DPLL_AOSV_2	28-527
28.20.12.10	Register DPLL_APT	28-528
28.20.12.11	Register DPLL_APS	28-530
28.20.12.12	Register DPLL_APT_2C	28-531
28.20.12.13	Register DPLL_APS_1C3	28-532
28.20.12.14	Register DPLL_NUTC	28-533
28.20.12.15	Register DPLL_NUSC	28-535
28.20.12.16	Register DPLL_NTI_CNT	28-537
28.20.12.17	Register DPLL_IRQ_NOTIFY	28-538
28.20.12.18	Register DPLL_IRQ_EN	28-541
28.20.12.19	Register DPLL_IRQ_FORCINT	28-544
28.20.12.20	Register DPLL_IRQ_MODE	28-546
28.20.12.21	Register DPLL_EIRQ_EN	28-546
28.20.12.22	Register DPLL_INC_CNT1	28-549
28.20.12.23	Register DPLL_INC_CNT2	28-549
28.20.12.24	Register DPLL_APT_SYNC	28-550
28.20.12.25	Register DPLL_APS_SYNC	28-551
28.20.12.26	Register DPLL_TBU_TS0_T	28-553
28.20.12.27	Register DPLL_TBU_TS0_S	28-553
28.20.12.28	Register DPLL_ADD_IN_LD1	28-554
28.20.12.29	Register DPLL_ADD_IN_LD2	28-555
28.20.12.30	Register DPLL_STATUS	28-556
28.20.12.31	Register DPLL_ID_PMTR_[z]	28-562
28.20.12.32	Register DPLL_CTRL_0_SHADOW_TRIGGER	28-562
28.20.12.33	Register DPLL_CTRL_0_SHADOW_STATE	28-563
28.20.12.34	Register DPLL_CTRL_1_SHADOW_TRIGGER	28-564
28.20.12.35	Register DPLL_CTRL_1_SHADOW_STATE	28-565
28.20.12.36	Register DPLL_RAM_INI	28-566
28.20.12.37	Memory DPLL_TS_T	28-567
28.20.12.38	Memory DPLL_TS_T_OLD	28-567
28.20.12.39	Memory DPLL_FTV_T	28-568
28.20.12.40	Memory DPLL_TS_S	28-569
28.20.12.41	Memory DPLL_TS_S_OLD	28-569
28.20.12.42	Memory DPLL_FTV_S	28-570
28.20.12.43	Memory DPLL_THMI	28-571
28.20.12.44	Memory DPLL_THMA	28-572
28.20.12.45	Memory DPLL_THVAL	28-572
28.20.12.46	Memory DPLL_TOV	28-573
28.20.12.47	Memory DPLL_TOV_S	28-574
28.20.12.48	Memory DPLL_ADD_IN_CAL1	28-575
28.20.12.49	Memory DPLL_ADD_IN_CAL2	28-576
28.20.12.50	Memory DPLL_MPVAL1	28-577
28.20.12.51	Memory DPLL_MPVAL2	28-578
28.20.12.52	Memory DPLL_NMB_T_TAR	28-579
28.20.12.53	Memory DPLL_NMB_T_TAR_OLD	28-580

28.20.12.54	Memory DPLL_NMB_S_TAR	28-581
28.20.12.55	Memory DPLL_NMB_S_TAR_OLD	28-582
28.20.12.56	Memory DPLL_RCDT_TX	28-583
28.20.12.57	Memory DPLL_RCDT_SX	28-583
28.20.12.58	Memory DPLL_RCDT_TX_NOM	28-584
28.20.12.59	Memory DPLL_RCDT_SX_NOM	28-585
28.20.12.60	Memory DPLL_RDT_T_ACT	28-586
28.20.12.61	Memory DPLL_RDT_S_ACT	28-586
28.20.12.62	Memory DPLL_DT_T_ACT	28-587
28.20.12.63	Memory DPLL_DT_S_ACT	28-588
28.20.12.64	Memory DPLL_EDT_T	28-589
28.20.12.65	Memory DPLL_MEDT_T	28-589
28.20.12.66	Memory DPLL_EDT_S	28-590
28.20.12.67	Memory DPLL_MEDT_S	28-591
28.20.12.68	Memory DPLL_CDT_TX	28-592
28.20.12.69	Memory DPLL_CDT_SX	28-592
28.20.12.70	Memory DPLL_CDT_TX_NOM	28-593
28.20.12.71	Memory DPLL_CDT_SX_NOM	28-594
28.20.12.72	Memory DPLL_TLR	28-594
28.20.12.73	Memory DPLL_SLR	28-595
28.20.12.74	Memory DPLL_PDT_[z]	28-596
28.20.12.75	Memory DPLL_MLS1	28-597
28.20.12.76	Memory DPLL_MLS2	28-598
28.20.12.77	Memory DPLL_CNT_NUM_1	28-598
28.20.12.78	Memory DPLL_CNT_NUM_2	28-599
28.20.12.79	Memory DPLL_PVT	28-600
28.20.12.80	Memory DPLL_PSTC	28-601
28.20.12.81	Memory DPLL_PSSC	28-602
28.20.12.82	Memory DPLL_PSTM	28-602
28.20.12.83	Memory DPLL_PSTM_OLD	28-603
28.20.12.84	Memory DPLL_PSSM	28-604
28.20.12.85	Memory DPLL_PSSM_OLD	28-605
28.20.12.86	Memory DPLL_NMB_T	28-606
28.20.12.87	Memory DPLL_NMB_S	28-606
28.20.12.88	Memory DPLL_RDT_S[i]	28-607
28.20.12.89	Memory DPLL_TSF_S[i]	28-608
28.20.12.90	Memory DPLL_ADT_S[i]	28-609
28.20.12.91	Memory DPLL_DT_S[i]	28-610
28.20.12.92	Register DPLL_TSAC[z]	28-611
28.20.12.93	Register DPLL_PSAC[z]	28-611
28.20.12.94	Register DPLL_ACB_[z]	28-612
28.20.12.95	Register DPLL_CTRL_11	28-614
28.20.12.96	Register DPLL_THVAL2	28-622
28.20.12.97	Register DPLL_TIDEL	28-623
28.20.12.98	Register DPLL_SIDE_L	28-623
28.20.12.99	Register DPLL_CTN_MIN	28-624
28.20.12.100	Register DPLL_CTN_MAX	28-624
28.20.12.101	Register DPLL_CSN_MIN	28-625
28.20.12.102	Register DPLL_CSN_MAX	28-625
28.20.12.103	Register DPLL_STA	28-626

28.20.12.104	Register DPLL_INCF1_OFFSET	28-630
28.20.12.105	Register DPLL_INCF2_OFFSET	28-630
28.20.12.106	Register DPLL_DT_T_START	28-631
28.20.12.107	Register DPLL_DT_S_START	28-632
28.20.12.108	Register DPLL_STA_MASK	28-632
28.20.12.109	Register DPLL_STA_FLAG	28-633
28.20.12.110	Register DPLL_INC_CNT1_MASK	28-634
28.20.12.111	Register DPLL_INC_CNT2_MASK	28-635
28.20.12.112	Register DPLL_NUSC_EXT1	28-635
28.20.12.113	Register DPLL_NUSC_EXT2	28-636
28.20.12.114	Register DPLL_APS_EXT	28-637
28.20.12.115	Register DPLL_APS_1C3_EXT	28-639
28.20.12.116	Register DPLL_APS_SYNC_EXT	28-640
28.20.12.117	Register DPLL_CTRL_EXT	28-641
28.20.13	DPLL RAM Region 1a value description	28-643
28.20.13.1	Memory DPLL_PSA[i]	28-643
28.20.13.2	Memory DPLL_DLA[i]	28-643
28.20.13.3	Memory DPLL_NA[i]	28-644
28.20.13.4	Memory DPLL_DTA[i]	28-645
28.20.14	DPLL RAM Region 2 value description	28-646
28.20.14.1	Memory DPLL_RDT_T[i]	28-646
28.20.14.2	Memory DPLL_TSF_T[i]	28-647
28.20.14.3	Memory DPLL_ADT_T[i]	28-647
28.20.14.4	Memory DPLL_DT_T[i]	28-649
28.20.15	MCS to DPLL Register description	28-650
28.20.15.1	Register MCS2DPLL_DEB0	28-650
28.20.15.2	Register MCS2DPLL_DEB1	28-650
28.20.15.3	Register MCS2DPLL_DEB2	28-651
28.20.15.4	Register MCS2DPLL_DEB3	28-652
28.20.15.5	Register MCS2DPLL_DEB4	28-652
28.20.15.6	Register MCS2DPLL_DEB5	28-653
28.20.15.7	Register MCS2DPLL_DEB6	28-654
28.20.15.8	Register MCS2DPLL_DEB7	28-655
28.20.15.9	Register MCS2DPLL_DEB8	28-655
28.20.15.10	Register MCS2DPLL_DEB9	28-656
28.20.15.11	Register MCS2DPLL_DEB10	28-657
28.20.15.12	Register MCS2DPLL_DEB11	28-657
28.20.15.13	Register MCS2DPLL_DEB12	28-658
28.20.15.14	Register MCS2DPLL_DEB13	28-658
28.20.15.15	Register MCS2DPLL_DEB14	28-659
28.20.15.16	Register MCS2DPLL_DEB15	28-659
28.21	Sensor Pattern Evaluation (SPE)	28-661
28.21.1	Overview	28-661
28.21.2	SPE Submodule description	28-663
28.21.2.1	SPE Revolution detection	28-668
28.21.3	SPE Interrupt signals	28-668
28.21.4	SPE Register overview	28-668
28.21.5	SPE Register description	28-670
28.21.5.1	Register SPE[i]_CTRL_STAT	28-670
28.21.5.2	Register SPE[i]_PAT	28-671

28.21.5.3	Register SPE[i]_OUT_PAT[z]	28-672
28.21.5.4	Register SPE[i]_OUT_CTRL	28-673
28.21.5.5	Register SPE[i]_REV_CNT	28-674
28.21.5.6	Register SPE[i]_REV_CMP	28-674
28.21.5.7	Register SPE[i]_IRQ_NOTIFY	28-675
28.21.5.8	Register SPE[i]_IRQ_EN	28-676
28.21.5.9	Register SPE[i]_IRQ_FORCINT	28-677
28.21.5.10	Register SPE[i]_IRQ_MODE	28-678
28.21.5.11	Register SPE[i]_EIRQ_EN	28-678
28.21.5.12	Register SPE[i]_CTRL_STAT2	28-679
28.21.5.13	Register SPE[i]_CMD	28-680
28.22	Interrupt Concentrator Module (ICM)	28-681
28.22.1	Overview	28-681
28.22.2	Bundling	28-681
28.22.2.1	GTM Infrastructure Interrupt Bundling	28-681
28.22.2.2	DPLL Interrupt Bundling	28-681
28.22.2.3	TIM Interrupt Bundling	28-682
28.22.2.4	MCS Interrupt Bundling	28-682
28.22.2.5	TOM and ATOM Interrupt Bundling	28-682
28.22.2.6	Module Error Interrupt Bundling	28-683
28.22.2.7	FIFO Channel Error Interrupt Bundling	28-684
28.22.2.8	TIM Channel Error Interrupt Bundling	28-684
28.22.2.9	MCS Channel Error Interrupt Bundling	28-684
28.22.2.10	Error Interrupt Cluster Bundling	28-684
28.22.3	ICM Interrupt Signals	28-684
28.22.4	ICM Configuration Register Overview	28-687
28.22.5	ICM Configuration Register Description	28-689
28.22.5.1	Register ICM_IRQG_0	28-689
28.22.5.2	Register ICM_IRQG_1	28-690
28.22.5.3	Register ICM_IRQG_2	28-692
28.22.5.4	Register ICM_IRQG_3	28-694
28.22.5.5	Register ICM_IRQG_4	28-695
28.22.5.6	Register ICM_IRQG_5	28-696
28.22.5.7	Register ICM_IRQG_6	28-697
28.22.5.8	Register ICM_IRQG_7	28-698
28.22.5.9	Register ICM_IRQG_8	28-699
28.22.5.10	Register ICM_IRQG_9	28-700
28.22.5.11	Register ICM_IRQG_10	28-701
28.22.5.12	Register ICM_IRQG_11	28-702
28.22.5.13	Register ICM_IRQG_MEI	28-703
28.22.5.14	Register ICM_IRQG_CEI0	28-705
28.22.5.15	Register ICM_IRQG_CEI1	28-706
28.22.5.16	Register ICM_IRQG_CEI2	28-707
28.22.5.17	Register ICM_IRQG_CEI3	28-708
28.22.5.18	Register ICM_IRQG_CEI4	28-709
28.22.5.19	Register ICM_IRQG_MCS[i]_CI	28-710
28.22.5.20	Register ICM_IRQG_MCS[i]_CEI	28-710
28.22.5.21	Register ICM_IRQG_SPE_CI	28-711
28.22.5.22	Register ICM_IRQG_SPE_CEI	28-712
28.22.5.23	Register ICM_IRQG_PSM_0_CI	28-712

28.22.5.24	Register ICM_IRQG_PSM_0_CEI	28-713
28.22.5.25	Register ICM_IRQG_TOM_[k]_CI	28-714
28.22.5.26	Register ICM_IRQG_ATOM_[k]_CI	28-715
28.22.5.27	Register ICM_IRQG_CLS_[k]_MEI	28-716
28.23	Output Compare Unit (CMP)	28-718
28.23.1	Overview	28-718
28.23.2	Bitwise Compare Unit (BWC)	28-718
28.23.2.1	ABWC compare unit	28-719
28.23.2.2	TBWC compare unit	28-719
28.23.3	Configuration of the Compare Unit	28-719
28.23.4	Error Generator	28-720
28.23.5	CMP Interrupt Signal	28-720
28.23.6	CMP Configuration Register Overview	28-720
28.23.7	CMP Configuration Register Description	28-721
28.23.7.1	Register CMP_EN	28-721
28.23.7.2	Register CMP_IRQ_NOTIFY	28-721
28.23.7.3	Register CMP_IRQ_EN	28-722
28.23.7.4	Register CMP_IRQ_FORCINT	28-723
28.23.7.5	Register CMP_IRQ_MODE	28-723
28.23.7.6	Register CMP_EIRQ_EN	28-724
28.24	Monitor Unit (MON)	28-725
28.24.1	Overview	28-725
28.24.1.1	Realization without Activity Checker of the clock signals	28-725
28.24.2	Clock Monitoring	28-725
28.24.3	CMP error Monitoring	28-726
28.24.4	Checking the Characteristics of Signals by MCS	28-726
28.24.5	Checking ARU Cycle Time	28-726
28.24.6	MON Interrupt Signals	28-727
28.24.7	MON Register Overview	28-727
28.24.8	MON Configuration Register Description	28-728
28.24.8.1	Register MON_STATUS	28-728
28.24.8.2	Register MON_ACTIVITY_0	28-729
28.24.8.3	Register MON_ACTIVITY_1	28-729
28.24.8.4	Register MON_ACTIVITY_MCS[z]	28-730
28.25	GTM Implementation	28-731
28.25.1	AURIX TC3xx Family GTM Configuration	28-731
28.25.2	GTM Memories Address Map	28-734
28.25.3	GTM Interrupts	28-735
28.25.4	GTM Bridge	28-737
28.25.5	GTM Control Registers	28-738
28.25.6	Port Connections	28-744
28.25.6.1	GTM Outputs to Port Connections	28-744
28.25.6.1.1	GTM Outputs to Port Control Registers (TOUTSEL)	28-745
28.25.6.2	GPIO to GTM Connections	28-746
28.25.6.2.1	Port to GTM Connections (TIMnINSEL)	28-747
28.25.6.2.2	GPIO/EDSADC to DTM_AUX Connections	28-749
28.25.7	MSC Connections	28-750
28.25.7.1	GTM to MSC Control Registers	28-752
28.25.8	EDSADC Connections	28-756
28.25.8.1	EDSADC to GTM Connections	28-756

28.25.8.2	GTM to EDSADC Connections	28-757
28.25.9	EVADC Connections	28-759
28.25.10	GTM ADC Interface	28-760
28.25.11	SENT Connections	28-763
28.25.12	CAN / TTCAN Connection	28-764
28.25.13	LC DC/DC Connection	28-766
28.25.14	CCU6x Connections	28-766
28.25.15	PSI5 Connections	28-767
28.25.16	GTM Data Exchange Registers	28-770
28.25.17	SCU Connections	28-777
28.25.18	HSM Connections	28-777
28.25.19	GTM Debug Interface	28-778
28.25.19.1	GTM OCDS Interface	28-778
28.25.19.1.1	GTM Suspend and Single Stepping	28-778
28.25.19.1.2	OCDS Trigger Bus (OTGB) Interface	28-778
28.25.19.1.3	GTM Debug Registers	28-784
28.25.20	GTM Application constraints and limitations	28-792
28.25.21	ARU Write Address Overview	28-800
28.25.22	ARU Port Partitioning	28-801
28.25.23	ARU Read ID	28-802
28.25.24	MCS Master Interface Address Map	28-804
28.25.25	General remarks	28-847
28.26	Revision History	28-848
29	Capture/Compare Unit 6 (CCU6)	29-1
29.1	Feature List	29-1
29.2	Overview	29-2
29.2.1	Functional Overview	29-2
29.2.2	CCU6 Register Overview	29-4
29.3	Operating Timer T12	29-7
29.3.1	T12 Overview	29-8
29.3.2	T12 Counting Scheme	29-9
29.3.2.1	Clock Selection	29-9
29.3.2.2	Edge-Aligned / Center-Aligned Mode	29-10
29.3.2.3	Single-Shot Mode	29-11
29.3.3	T12 Compare Mode	29-12
29.3.3.1	Compare Channels	29-12
29.3.3.2	Channel State Bits	29-13
29.3.3.3	Hysteresis-Like Control Mode	29-17
29.3.4	Compare Mode Output Path	29-18
29.3.4.1	Dead-Time Generation	29-18
29.3.4.2	State Selection	29-20
29.3.4.3	Output Modulation and Level Selection	29-21
29.3.5	T12 Capture Modes	29-23
29.3.6	T12 Shadow Register Transfer	29-26
29.3.7	Timer T12 Operating Mode Selection	29-27
29.3.8	T12 related Registers	29-28
29.3.9	Capture/Compare Control Registers	29-32
29.4	Operating Timer T13	29-42
29.4.1	T13 Overview	29-42

29.4.2	T13 Counting Scheme	29-44
29.4.2.1	Clock Selection	29-44
29.4.2.2	T13 Counting	29-45
29.4.2.3	Single-Shot Mode	29-45
29.4.2.4	Synchronization to T12	29-46
29.4.3	T13 Compare Mode	29-47
29.4.4	Compare Mode Output Path	29-48
29.4.5	T13 Shadow Register Transfer	29-49
29.4.6	T13 related Registers	29-51
29.5	Synchronous Start Feature	29-54
29.6	Trap Handling	29-54
29.7	Multi-Channel Mode	29-56
29.8	Hall Sensor Mode	29-57
29.8.1	Hall Pattern Evaluation	29-58
29.8.2	Hall Pattern Compare Logic	29-59
29.8.3	Hall Mode Flags	29-60
29.8.4	Hall Mode for Brushless DC-Motor Control	29-61
29.9	Modulation Control Registers	29-64
29.10	Interrupt Handling	29-73
29.10.1	Interrupt Structure	29-73
29.10.2	Interrupt Registers	29-75
29.11	General Module Operation	29-83
29.11.1	Input Selection	29-83
29.11.2	Input Monitoring	29-83
29.11.3	OCDS Suspend	29-84
29.11.4	OCDS Trigger Bus (OTGB) Interface	29-86
29.11.5	General Registers	29-87
29.11.6	System Registers	29-97
29.12	Revision History	29-103
30	General Purpose Timer Unit (GPT12)	30-1
30.1	Feature List	30-1
30.2	Timer Block GPT1	30-2
30.2.1	GPT1 Core Timer T3 Control	30-3
30.2.2	GPT1 Core Timer T3 Operating Modes	30-4
30.2.3	GPT1 Auxiliary Timers T2/T4 Control	30-9
30.2.4	GPT1 Auxiliary Timers T2/T4 Operating Modes	30-9
30.2.5	GPT1 Clock Signal Control	30-19
30.2.6	GPT1 Registers	30-21
30.2.7	Encoding of Specific Bitfields of GPT1 Registers	30-28
30.3	Timer Block GPT2	30-30
30.3.1	GPT2 Core Timer T6 Control	30-31
30.3.2	GPT2 Core Timer T6 Operating Modes	30-33
30.3.3	GPT2 Auxiliary Timer T5 Control	30-35
30.3.4	GPT2 Auxiliary Timer T5 Operating Modes	30-35
30.3.5	GPT2 Register CAPREL Operating Modes	30-40
30.3.6	GPT2 Clock Signal Control	30-45
30.3.7	GPT2 Registers	30-47
30.3.8	Encoding of Specific Bitfields of GPT2 Registers	30-52
30.4	GPT12 Kernel Register Overview	30-53

30.5	General Module Operation	30-55
30.5.1	Input Selection	30-55
30.5.2	OCDS Suspend	30-55
30.5.3	Miscellaneous GPT12 Registers	30-55
30.5.4	BPI Registers	30-58
30.6	Implementation of the GPT12 Module	30-63
30.7	Revision History	30-65
31	Converter Control Block (CONVCTRL)	31-1
31.1	Configuration of the CONVCTRL	31-2
31.2	Phase Synchronizer (PhSync)	31-9
31.2.1	Introduction and Basic Structure	31-10
31.2.2	Operation of the PhSync	31-11
31.2.3	Generation of the Analog Clock Signal	31-12
31.2.4	Safety Measures	31-13
31.2.5	Configuration of the PhSync	31-16
31.3	Application Considerations	31-17
31.3.1	Clock Synchronization	31-17
31.3.2	Example Settings for Operation	31-18
31.3.3	Basic Initialization Sequence	31-19
31.3.4	Module Handling in Sleep Mode	31-19
31.4	Summary of Registers and Locations	31-20
31.5	Revision History	31-21
32	Enhanced Versatile Analog-to-Digital Converter (EVADC)	32-1
32.1	Feature List	32-2
32.2	Overview	32-3
32.3	Configuration of General Functions	32-9
32.3.1	Changing the Configuration	32-9
32.3.2	Register Access Notes	32-10
32.3.3	Module Identification	32-11
32.3.4	System Registers	32-12
32.3.5	General Clocking Scheme and Control	32-18
32.3.6	Register Access Control	32-21
32.4	Analog Module Activation and Control	32-24
32.4.1	Analog Converter Control	32-24
32.4.2	Analog Signal Buffering	32-24
32.4.3	Alternate Reference Selection	32-25
32.4.4	Calibration	32-25
32.4.5	Noise Reduction Methods	32-26
32.4.6	Analog Module Functions	32-27
32.5	Conversion Request Generation	32-29
32.5.1	Queued Source Operation	32-31
32.5.2	Triggers and Gate Signals	32-33
32.5.3	Extended Conversion Sequences through Concatenation	32-36
32.5.4	Queue Request Source Control Registers	32-38
32.6	Request Source Arbitration	32-51
32.6.1	Arbiter Operation and Configuration	32-52
32.6.2	Conversion Start Mode	32-55
32.7	Analog Input Channel Configuration	32-57
32.7.1	Channel Parameters	32-58

32.7.2	Alias Feature	32-64
32.7.3	Compare with Standard Conversions (Limit Checking)	32-66
32.8	Fast Compare Channel Operation	32-69
32.8.1	Peak-and-Hold Operation	32-72
32.8.2	Fast Compare Channel Control Registers	32-74
32.8.3	Boundary Definition	32-81
32.8.4	Boundary Flag Control	32-82
32.9	Conversion Timing	32-86
32.9.1	Start-Up Calibration Timing	32-86
32.9.2	Standard Converter Channels Timing	32-87
32.9.3	Fast Compare Channels Timing	32-87
32.9.4	Conversion Timing Configurations	32-88
32.10	Conversion Result Handling	32-89
32.10.1	Storage of Conversion Results	32-89
32.10.2	Data Alignment	32-98
32.10.3	Wait-for-Read Mode	32-98
32.10.4	Result FIFO Buffer	32-99
32.10.5	Data Modification	32-101
32.10.6	Result Event Generation	32-106
32.10.7	Hardware Data Interface	32-107
32.11	Synchronization of Conversions	32-108
32.11.1	Synchronized Conversions for Parallel Sampling	32-108
32.11.2	Equidistant Sampling	32-112
32.11.3	Synchronous Sampling	32-113
32.12	Safety Features	32-114
32.12.1	Pull-Down Diagnostics	32-114
32.12.2	Multiplexer Diagnostics	32-114
32.12.3	Converter Diagnostics	32-115
32.12.4	Broken Wire Detection	32-115
32.12.5	On-Chip Supervision Signals	32-117
32.12.6	Configuration of Test Functions	32-119
32.12.7	Automatic Execution of Test Sequences	32-122
32.13	External Multiplexer Control	32-124
32.14	Service Request Generation	32-129
32.14.1	Source Event Flag Registers, Group x	32-131
32.14.2	Channel Event Flag Registers, Group x	32-133
32.14.3	Result Event Flag Registers, Group x	32-137
32.14.4	Global Event Flag Registers	32-140
32.14.5	Software Activation of Service Requests, Group x	32-142
32.14.6	Service Requests for Fast Compare Channels	32-143
32.15	Application Considerations	32-144
32.15.1	Clock Synchronization	32-144
32.15.2	Calibration Recommendation	32-144
32.15.3	Examples for Operation	32-144
32.15.4	Basic Initialization Sequence	32-145
32.15.5	Module Handling in Sleep Mode	32-146
32.16	Electrical Models	32-147
32.17	Summary of Registers and Locations	32-151
32.18	Revision History	32-155

33	Enhanced Delta-Sigma Analog-to-Digital Converter (EDSADC)	33-1
33.1	Feature List	33-2
33.2	Overview	33-3
33.3	Configuration of General Functions	33-7
33.3.1	Changing the Configuration	33-7
33.3.2	Module Identification	33-7
33.3.3	System Registers	33-9
33.3.4	Register Access Control	33-14
33.3.5	Global Configuration Registers	33-16
33.4	Input Channel Configuration	33-19
33.4.1	Modulator Clock Generation	33-22
33.4.2	Input Data Selection	33-23
33.4.3	External Modulator	33-23
33.4.4	On-Chip Modulator	33-25
33.4.5	Input Path Control	33-27
33.4.6	Common Mode Voltage	33-34
33.4.7	Calibration Support	33-36
33.4.8	Correction for External Circuitry	33-39
33.5	Filter Chain	33-42
33.5.1	CIC Filter	33-44
33.5.2	Gain Correction	33-46
33.5.3	Overshoot Compensation	33-48
33.5.4	FIR Filters	33-50
33.5.5	Offset Compensation	33-52
33.5.6	Integrator Stage	33-55
33.5.7	Group Delay and Settling Time	33-61
33.5.8	Filter Configuration Options	33-63
33.6	Auxiliary Filter	33-67
33.7	Time-Stamp Support	33-69
33.8	Conversion Result Handling	33-71
33.8.1	Filtering and Post-Processing	33-71
33.8.2	Storage of Conversion Results	33-72
33.8.3	Result Service Request Generation and Read Sequencing	33-76
33.8.4	Hardware Data Interface	33-78
33.9	Limit Checking	33-79
33.10	Safety Features	33-82
33.11	Service Request Generation	33-83
33.12	Resolver Support	33-86
33.12.1	Resolver System Overview	33-86
33.12.2	Carrier Signal Generation	33-87
33.12.3	Return Signal Synchronization	33-90
33.13	Application Considerations	33-94
33.13.1	Clock Synchronization	33-94
33.13.2	Calibration Recommendation	33-94
33.13.3	Examples for Operation	33-94
33.13.4	Supported Operating Ranges	33-95
33.13.5	Basic Initialization Sequence	33-97
33.13.6	Module Handling in Sleep Mode	33-97
33.13.7	Overlap of CH9 and CH12	33-98
33.14	Summary of Registers and Locations	33-99

33.15	Revision History	33-102
34	Inter-Integrated Circuit (I2C)	34-1
34.1	Feature List	34-1
34.2	Overview	34-2
34.3	Functional Description	34-3
34.3.1	I2C Kernel Description	34-3
34.3.1.1	I2C Protocol	34-3
34.3.1.2	References	34-9
34.3.1.3	Functional restrictions	34-9
34.3.1.4	Clock and Timing Control	34-9
34.3.1.4.1	Baudrate Generation for Master Mode	34-9
34.3.1.4.2	Baudrate Generation for Slave Mode	34-11
34.3.1.4.3	I2C Timing Adjustment	34-12
34.3.1.5	I2C Kernel Control Logic	34-14
34.3.1.6	FIFO Operation	34-25
34.3.1.6.1	Data Transmission	34-26
34.3.1.6.2	Transmit Request Generation	34-27
34.3.1.6.3	Transmit Data Alignment	34-29
34.3.1.6.4	Data Reception	34-32
34.3.1.6.5	Receive Request Generation	34-32
34.3.1.6.6	Receive Data Alignment	34-34
34.3.1.6.7	Switching between Transmission and Reception	34-36
34.3.1.6.8	Switching between Reception and Transmission	34-37
34.3.1.7	Service Request Block Operation	34-37
34.3.1.7.1	Overview of Service Requests	34-37
34.3.1.7.2	Interrupt Service Request Structure	34-39
34.3.2	I2C Module Implementation	34-42
34.3.2.1	Interfaces of the I2C Module(s)	34-42
34.3.2.2	Module Clock Control	34-42
34.3.2.3	Bus Peripheral Interface Registers	34-45
34.3.2.4	Port and I/O Line Control	34-47
34.3.2.5	Interrupt Control	34-47
34.3.3	Module Integration	34-48
34.3.3.1	Integration Overview	34-48
34.3.3.2	BPI_SPB Module Registers Overview	34-48
34.3.3.2.1	BPI_SPB Module Registers	34-49
34.4	Registers	34-55
34.4.1	Global Module Control Registers	34-59
34.4.2	FIFO Registers	34-67
34.4.3	Basic Interrupt Registers	34-72
34.4.4	Error Interrupt Source Registers	34-77
34.4.5	Protocol Interrupt Source Registers	34-80
34.5	Safety Measures	34-83
34.6	IO Interfaces	34-83
34.7	Revision History	34-84
35	High Speed Serial Link (HSSL)	35-1
35.1	Feature List	35-1
35.2	Overview	35-3
35.2.1	Lower Communication Layers (HSCT, PLL, Pads)	35-3

35.3	Functional Description	35-5
35.3.1	HSSL Protocol Definition	35-5
35.3.1.1	List of Abbreviations, Acronyms, and Term Definitions	35-5
35.3.1.2	Frame Types	35-5
35.3.1.2.1	Frame and Payload Lengths	35-7
35.3.1.2.2	Data Types	35-8
35.3.1.2.3	Cyclic Redundancy Check Field - CRC	35-8
35.3.1.2.4	Header Structure	35-9
35.3.1.3	Single and Block Transfers	35-11
35.3.1.4	Streaming Interface	35-11
35.3.1.5	Sliding Window Protocol	35-11
35.3.1.6	Error Management	35-12
35.3.1.7	Shift Direction	35-14
35.3.2	HSSL Implementation	35-15
35.3.3	Overview	35-15
35.3.3.1	HSSL Module Operation	35-15
35.3.3.1.1	Frame Transmission Priorisation	35-17
35.3.3.1.2	Received Frame Management and Command Execution	35-18
35.3.3.2	HSSL Channel Architecture	35-20
35.3.3.3	Acknowledge Responses	35-22
35.3.3.4	Cross Dependencies Between the Frame Types	35-23
35.3.3.5	Command Timeout	35-25
35.3.3.5.1	Command Timeout Operation	35-25
35.3.3.6	Stream Timeout	35-26
35.3.3.6.1	Stream Timeout Operation	35-28
35.3.3.7	Data FIFOs of the Streaming Channel 2	35-30
35.3.4	Modes of Operation	35-31
35.3.5	Interrupts	35-33
35.3.6	Operating a Command Channel	35-33
35.3.6.1	Initiating a Single Write Command	35-33
35.3.6.2	Initiating a Single Read Command	35-34
35.3.6.3	Initiating a Single Trigger Command	35-34
35.3.6.4	DMA Operated Command Queues	35-34
35.3.6.5	Receiver Error Handling	35-34
35.3.6.5.1	Timeout Error	35-35
35.3.6.5.2	Transaction Tag Error	35-35
35.3.6.6	Global Error	35-35
35.3.7	Memory Block Transfer Modes of the Stream Channel	35-35
35.3.8	HSSL Reset	35-37
35.3.9	OCDS SRI / SPB Master Suspend	35-37
35.3.10	OCDS Trigger Sets	35-38
35.3.11	Access Protection	35-40
35.3.12	Multi-Slave Operation	35-43
35.3.12.1	Slave Tag and Slave Control	35-43
35.3.12.2	Slave Tag Frame Filter and Translator	35-44
35.3.12.3	Activating a Slave	35-44
35.3.12.4	Deactivating a Slave	35-45
35.3.12.5	MSCR HSSL to HSCT Connections	35-45
35.4	Registers	35-47
35.4.1	Global Registers	35-50

35.4.2	Channel.Flags Registers	35-52
35.4.3	Channel.Initiator Registers	35-64
35.4.4	Channel.Target Registers	35-67
35.4.5	Initiator Stream Registers	35-69
35.4.6	Target Stream Registers	35-71
35.4.7	Access Protection Registers	35-73
35.4.8	Security and Multi Slave Registers	35-75
35.4.9	BPI_FPI Module Registers	35-77
35.5	IO Interfaces	35-82
35.6	Revision History	35-82
35.7	High Speed Communication Tunnel (HSCT)	35-84
35.7.1	Feature List	35-84
35.7.2	Overview	35-85
35.7.3	Functional Description	35-85
35.7.3.1	Introduction	35-85
35.7.3.2	Physical Layer	35-86
35.7.3.2.1	RX / TX Data communication	35-87
35.7.3.2.2	Differential Signaling Principle Based on LVDS	35-88
35.7.3.2.3	Electrical Characteristics Based on LVDS for Reduced Link trace length	35-92
35.7.3.2.4	Data Rates	35-94
35.7.3.2.5	Correlator	35-97
35.7.3.2.6	Jitter Budget	35-98
35.7.3.3	Protocol Layer	35-102
35.7.3.3.1	Deframer	35-103
35.7.3.3.2	Framer	35-104
35.7.3.3.3	Interface Control	35-106
35.7.3.3.4	Power up sequence	35-111
35.7.3.4	Use Cases	35-112
35.7.3.4.1	HSCT point to point LVDS based communication	35-112
35.7.3.4.2	HSCT point to multi point LVDS based communication	35-112
35.7.3.5	Suspend, Sleep and Power-Off Behavior	35-113
35.7.3.5.1	OCDS Suspend	35-113
35.7.3.5.2	HSCT Protocol Sleep Mode	35-113
35.7.3.5.3	Disable Request (Power-Off)	35-113
35.7.3.6	References	35-114
35.7.4	Registers	35-114
35.7.4.1	Registers Definition	35-114
35.7.4.1.1	HSCT Kernel Register Definitions	35-115
35.7.4.1.2	BPI_FPI Module Registers (Single Kernel Configuration)	35-134
35.7.5	IO Interfaces	35-140
35.7.6	Revision History	35-140
36	Asynchronous/Synchronous Interface (ASCLIN)	36-1
36.1	Feature List	36-2
36.2	Overview	36-4
36.3	Functional Description	36-4
36.3.1	External Signals	36-5
36.3.2	User Interface	36-6
36.3.2.1	TxFIFO Overview	36-6
36.3.2.2	Using the TxFIFO	36-7

36.3.2.2.1	Standard ASC Mode	36-7
36.3.2.2.2	High Speed ASC Mode	36-9
36.3.2.2.3	LIN Mode	36-10
36.3.2.2.4	SPI Mode	36-10
36.3.2.3	TXFIFO Interrupt Generation	36-12
36.3.2.4	RxFIFO Overview	36-15
36.3.2.5	Using the RxFIFO	36-16
36.3.2.5.1	Standard ASC Mode	36-16
36.3.2.5.2	High Speed ASC Mode	36-18
36.3.2.5.3	LIN Mode	36-19
36.3.2.5.4	SPI Mode	36-20
36.3.2.6	RTS / CTS Handshaking	36-20
36.3.2.7	RXFIFO Interrupt Generation	36-21
36.3.3	Clock System	36-24
36.3.3.1	Baud Rate Generation	36-24
36.3.3.2	Bit Timing Properties	36-25
36.3.4	Data Frame Configuration	36-28
36.3.5	Miscellaneous Configuration	36-28
36.3.6	Synchronous Mode	36-28
36.3.6.1	Baud Rate and Clock Generation	36-28
36.3.6.2	Data Frame Configuration	36-29
36.3.6.3	Slave Selects Configuration	36-29
36.3.6.4	Miscellaneous Configuration	36-29
36.3.7	LIN Support	36-29
36.3.7.1	LIN Watchdog	36-31
36.3.7.1.1	LIN Break, Wake, Stuck Handling	36-32
36.3.7.1.2	LIN Header and Response Timers	36-33
36.3.7.2	LIN Master Sequences	36-35
36.3.7.3	LIN Slave Sequences	36-38
36.3.7.4	Using the ENI and HO Bits	36-39
36.3.7.5	LIN Error Recovery	36-39
36.3.7.6	LIN Sleep and LIN Wake-Up	36-40
36.3.8	Auto Baud Rate Detection	36-41
36.3.9	Collision Detection	36-42
36.3.10	LIN Protocol Control	36-43
36.3.11	Interrupts	36-45
36.3.12	Digital Glitch Filter	36-48
36.3.13	Suspend, Sleep and Power-Off Behavior	36-49
36.3.13.1	OCDS Suspend	36-49
36.3.13.2	Sleep Mode	36-49
36.3.13.3	Disable Request (Power-Off)	36-49
36.3.14	Reset Behavior	36-49
36.3.15	Implementation	36-50
36.3.15.1	BPI_FPI Module Registers	36-50
36.3.15.1.1	System Registers	36-50
36.3.16	On-Chip Connections	36-55
36.3.17	ASC at CAN Support	36-56
36.4	Registers	36-57
36.4.1	Kernel Registers	36-59
36.5	Use Cases	36-88

36.6	IO Interfaces	36-89
36.7	Revision History	36-91
37	Queued Synchronous Peripheral Interface (QSPI)	37-1
37.1	Feature List	37-2
37.2	Overview	37-3
37.2.1	Abstract Overview	37-4
37.2.2	External Signals	37-4
37.2.3	Operating Modes	37-6
37.2.4	Queue Support Overview	37-8
37.2.5	Architecture Overview	37-9
37.2.6	Three Wire Connection	37-10
37.3	Functional Description QSPI	37-10
37.3.1	Frequency Domains	37-11
37.3.2	Master Mode State Machine	37-12
37.3.2.1	Phases of one Communication Cycle	37-12
37.3.2.2	Configuration Extensions	37-18
37.3.2.3	Details of the Baud Rate and Phase Duration Control	37-19
37.3.2.4	Calculation of the Baud Rates and the Delays	37-21
37.3.2.5	State Diagram of Standard Communication Cycle	37-22
37.3.2.6	Expect Phase	37-25
37.3.2.7	External Slave Select Expansion	37-26
37.3.3	Slave Mode	37-27
37.3.3.1	Shift Clock Phase and Polarity in Slave Mode	37-29
37.3.3.2	Shift Clock Monitoring	37-29
37.3.3.2.1	Baud Rate Error Detection	37-31
37.3.3.2.2	Spike Detection	37-31
37.3.3.2.3	Shift Clock Monitor Flags	37-32
37.3.3.3	Parity	37-33
37.3.4	Operation Modes	37-34
37.3.4.1	OCDS Suspend	37-35
37.3.4.2	Sleep Mode	37-38
37.3.4.3	Disabling the QSPI	37-39
37.3.5	User Interface	37-40
37.3.5.1	Transmit and Receive FIFOs	37-41
37.3.5.1.1	Short Data Mode	37-44
37.3.5.1.2	Long Data Mode	37-46
37.3.5.1.3	Continuous Data Mode	37-48
37.3.5.1.4	Single Configuration - Multiple Frames Behavior	37-51
37.3.5.1.5	Big Endian Data Format	37-51
37.3.5.2	Loop-Back Mode	37-53
37.3.6	Interrupts	37-55
37.3.6.1	Slave Mode SLSI Interrupt	37-56
37.3.6.2	Interrupt Flags Behavior	37-56
37.3.6.3	TXFIFO Interrupt Generation	37-58
37.3.6.4	RXFIFO Interrupt Generation	37-62
37.3.7	Reset Behavior	37-65
37.3.8	QSPI Module Implementation	37-65
37.3.8.1	Interfaces of the QSPI Modules	37-65
37.3.8.2	On-Chip Connections	37-66

37.3.8.3	BPI_FPI Module Registers	37-66
37.3.8.4	Further QSPI Related External Registers	37-72
37.4	Functional Description HSIC	37-73
37.4.1	HSIC Implementation	37-75
37.5	Registers	37-76
37.5.1	Kernel Registers	37-76
37.5.1.1	Register Description	37-78
37.5.2	HSIC Registers	37-103
37.6	IO Interfaces	37-104
37.7	Revision History	37-106
38	Micro Second Channel (MSC)	38-1
38.1	Feature List	38-1
38.2	Overview	38-2
38.3	Functional Description	38-3
38.3.1	MSC Kernel Description	38-3
38.3.1.1	Downstream Channel	38-3
38.3.1.1.1	Frame Formats and Definitions	38-5
38.3.1.1.2	Shift Register Operation	38-11
38.3.1.1.3	External Signal Injection	38-13
38.3.1.1.4	Transmission Modes	38-14
38.3.1.1.5	Downstream Counter and Enable Signals	38-18
38.3.1.1.6	Baud Rate	38-19
38.3.1.1.7	Abort of Frames	38-19
38.3.1.2	Upstream Channel	38-19
38.3.1.2.1	Data Frames	38-21
38.3.1.2.2	Parity Checking	38-21
38.3.1.2.3	Data Reception	38-21
38.3.1.2.4	Baud Rate	38-24
38.3.1.2.5	Spike Filter	38-25
38.3.1.2.6	Upstream Timer	38-25
38.3.1.3	I/O Control	38-26
38.3.1.3.1	Downstream Channel Output Control	38-26
38.3.1.3.2	Upstream Channel	38-28
38.3.1.4	MSC Interrupts	38-29
38.3.1.4.1	Data Frame Interrupt	38-29
38.3.1.4.2	Command Frame Interrupt	38-30
38.3.1.4.3	Time Frame Finished Interrupt	38-30
38.3.1.4.4	Receive Data Interrupt	38-31
38.3.1.4.5	Interrupt Request Compressor	38-31
38.3.2	CX (Command Extension) Mode	38-33
38.3.3	ABRA (Asynchronous Baud Rate Adjustment Block)	38-34
38.3.3.1	Overview	38-34
38.3.3.2	Timing Issues	38-35
38.3.3.3	Adjusting the Passive Phase of a Frame	38-35
38.3.3.4	Jitter of the Downstream Frames	38-37
38.3.3.4.1	Jitter in Active Phase Clock Mode	38-37
38.3.3.4.2	Jitter in Continuous Clock Mode	38-38
38.3.3.5	Interrupt Position with the ABRA Block	38-39
38.3.3.6	Configuring the ABRA block	38-40

38.3.3.7	Implementation Issues	38-41
38.3.3.8	ABRA Disable, Sleep and Suspend Behavior	38-42
38.3.3.8.1	Disable and Sleep Behavior	38-42
38.3.3.8.2	OCDS Suspend Behavior	38-42
38.3.4	MSC Module Implementation	38-43
38.3.4.1	BPI_FPI Module Registers (Single Kernel Configuration)	38-43
38.3.4.1.1	System Registers	38-43
38.3.4.2	Interface Connections of the MSC Module	38-48
38.3.4.3	MSC Module-Related External Registers	38-49
38.3.4.4	Clock Control	38-49
38.3.4.4.1	Clock Control Without the ABRA Block	38-50
38.3.4.4.2	Clock Control when using the ABRA Block	38-51
38.3.4.4.3	Fractional Divider Register	38-53
38.3.4.5	Port Control	38-53
38.4	Registers	38-54
38.4.1	Module Identification Register	38-57
38.4.2	Status and Control Registers	38-58
38.4.3	Data Registers	38-77
38.4.4	Extension Registers	38-79
38.4.5	Asynchronous Block Registers	38-82
38.5	Use Cases	38-85
38.6	IO Interfaces	38-86
38.6.1	Port Emergency Stop Signal (from SCU)	38-87
38.6.2	Interrupt Service Requests	38-87
38.6.3	GTM Connections	38-87
38.7	Revision History	38-87
39	Single Edge Nibble Transmission (SENT)	39-1
39.1	Feature List	39-1
39.2	Overview	39-2
39.3	Functional Description	39-2
39.3.1	General Operation	39-2
39.3.1.1	Definitions	39-4
39.3.2	Standard SENT Operation	39-4
39.3.2.1	Frame Formats and Definitions	39-5
39.3.3	SPC Operation	39-10
39.3.3.1	Synchronous Transmission	39-10
39.3.3.2	Range Selection	39-11
39.3.3.3	ID Selection	39-12
39.3.3.4	Bidirectional Transmit Mode	39-12
39.3.3.5	SPC Timing	39-13
39.3.3.6	Abort of Frames	39-13
39.3.4	Baud Rate Generation	39-13
39.3.4.1	Operation outside the granted Standard Limits	39-15
39.3.5	Error Detection Capabilities	39-15
39.3.6	Support for Frequency Drift Analysis in Frames with Pause Pulse (FDFL)	39-15
39.3.7	Digital Glitch Filter	39-16
39.3.8	Interrupts	39-17
39.3.9	Interface Connections of the SENT Module	39-17
39.3.9.1	Trigger Inputs	39-18

39.3.10	Port Control	39-18
39.3.10.1	Input/Output Function Selection	39-19
39.4	Registers	39-20
39.4.1	Module Control	39-22
39.4.2	Channel Baud Rate Registers	39-25
39.4.3	Receiver Control and Status Registers	39-27
39.4.4	Input and Output Control	39-34
39.4.5	Receive Data Registers	39-37
39.4.6	SPC Control	39-40
39.4.7	Interrupt Control Registers	39-42
39.4.8	Bus Control Interface Registers	39-53
39.5	IO Interfaces	39-58
39.6	Revision History	39-61
40	CAN Interface (MCMCAN)	40-1
40.1	Feature List	40-2
40.1.1	Delta to AURIX	40-2
40.2	Overview	40-2
40.3	Functional Description	40-3
40.3.1	MCMCAN User Interface	40-3
40.3.1.1	MCMCAN Clockpaths	40-3
40.3.1.1.1	Module Clock Generation	40-6
40.3.1.2	Interrupt groups	40-6
40.3.1.2.1	Mapping of interrupts	40-6
40.3.1.2.2	Signalling interrupts of groups	40-9
40.3.1.2.3	Connections to Interrupt Router Inputs	40-9
40.3.1.3	Port, I/O Line Control and Interconnects	40-10
40.3.1.3.1	Input/Output Function Selection in Ports	40-10
40.3.1.3.2	Trigger inputs	40-14
40.3.1.3.3	External CAN Time Trigger Inputs	40-14
40.3.1.3.4	CAN Transmit Trigger Inputs	40-14
40.3.1.3.5	TT Capture Time Trigger Input	40-15
40.3.1.3.6	Signals to other modules	40-16
40.3.1.4	Connecting the module to the outside world	40-18
40.3.1.4.1	Module internal Loop-Back Mode	40-18
40.3.1.4.2	Module Loop Back Mode Out (B-step feature)	40-19
40.3.1.5	Fixing the address protection for the CAN nodes	40-19
40.3.1.6	Node Timing Functions	40-19
40.3.1.6.1	Automatic transferring of messages	40-22
40.3.1.7	Destructive Debug Entry	40-22
40.3.2	M_CAN Functional Description	40-23
40.3.2.1	Operating Modes	40-23
40.3.2.1.1	Software Initialization	40-23
40.3.2.1.2	Normal Operation	40-24
40.3.2.1.3	CAN FD Operation	40-24
40.3.2.1.4	Transmitter Delay Compensation	40-25
40.3.2.1.5	Restricted Operation Mode	40-27
40.3.2.1.6	Bus Monitoring Mode	40-27
40.3.2.1.7	Disabled Automatic Retransmission	40-28
40.3.2.1.8	Power Down (Sleep Mode)	40-28

40.3.2.1.9	Test Modes	40-29
40.3.2.1.10	Application Watchdog	40-30
40.3.2.2	Timestamp Generation	40-30
40.3.2.3	Timeout Counter	40-30
40.3.2.4	Rx Handling	40-30
40.3.2.4.1	Acceptance Filtering	40-31
40.3.2.4.2	Rx FIFOs	40-34
40.3.2.4.3	Dedicated Rx Buffers	40-36
40.3.2.5	Tx Handling	40-37
40.3.2.5.1	Transmit Pause	40-38
40.3.2.5.2	Dedicated Tx Buffers	40-38
40.3.2.5.3	Tx FIFO	40-39
40.3.2.5.4	Tx Queue	40-39
40.3.2.5.5	Mixed Dedicated Tx Buffers / Tx FIFO	40-40
40.3.2.5.6	Mixed Dedicated Tx Buffers / Tx Queue	40-40
40.3.2.5.7	Transmit Cancellation	40-41
40.3.2.5.8	Tx Event Handling	40-41
40.3.2.6	FIFO Acknowledge Handling	40-41
40.3.2.7	OCDS Suspend Behaviour Support	40-42
40.3.3	TTCAN Operation	40-43
40.3.3.1	Reference Message	40-43
40.3.3.1.1	Level 1	40-43
40.3.3.1.2	Level 2	40-44
40.3.3.1.3	Level 0	40-44
40.3.3.2	TTCAN Configuration	40-45
40.3.3.2.1	TTCAN Timing	40-45
40.3.3.2.2	Message Scheduling	40-46
40.3.3.2.3	Trigger Memory	40-48
40.3.3.2.4	TTCAN Schedule Initialization	40-51
40.3.3.3	TTCAN Gap Control	40-53
40.3.3.4	Stop Watch	40-53
40.3.3.5	Local Time, Cycle Time, Global Time, and External Clock Synchronization	40-54
40.3.3.6	TTCAN Error Level	40-56
40.3.3.7	TTCAN Message Handling	40-57
40.3.3.7.1	Reference Message	40-57
40.3.3.7.2	Message Reception	40-58
40.3.3.7.3	Message Transmission	40-59
40.3.3.8	TTCAN Interrupt and Error Handling	40-60
40.3.3.9	Level 0	40-61
40.3.3.9.1	Synchronizing	40-62
40.3.3.9.2	Handling of Error Levels	40-62
40.3.3.9.3	Master Slave Relation	40-63
40.3.3.10	Synchronization to external Time Schedule	40-63
40.4	Registers	40-64
40.4.1	MCMCAN RAM address space	40-64
40.4.2	MCMCAN register overview	40-65
40.4.3	General Configuration Registers	40-70
40.4.3.1	Global Module Registers	40-70
40.4.3.2	System Registers	40-76
40.4.3.3	Access Enable Registers ACCEN	40-78

40.4.3.4	Additional Access Enable Registers ACCENCTR and ACCENNODEi	40-78
40.4.3.5	Kernel Reset Registers	40-80
40.4.4	MCMCAN User Interface Registers	40-83
40.4.4.1	The Clock Control Register	40-83
40.4.4.2	Interrupt Grouping and Signalling Registers	40-83
40.4.4.3	Node Port Control Register	40-87
40.4.4.4	Time Trigger Control Register	40-88
40.4.4.5	Message RAM start address register	40-89
40.4.4.6	Message RAM end address register	40-89
40.4.4.7	NTCCR	40-90
40.4.4.8	CAN Node timers for pretended networking	40-91
40.4.4.9	Node Timer Receive Timerout Register	40-93
40.4.5	Registers within M_CAN	40-94
40.4.5.1	Standard Registers	40-95
40.4.6	Message RAM	40-159
40.4.6.1	Message RAM Configuration	40-159
40.4.6.2	Rx Buffer and FIFO Element	40-160
40.4.6.3	Tx Buffer Element	40-163
40.4.6.4	Tx Event FIFO Element	40-166
40.4.6.5	Standard Message ID Filter Element	40-168
40.4.6.6	Extended Message ID Filter Element	40-169
40.4.6.7	Trigger Memory Element	40-172
40.5	IO Interfaces	40-176
40.6	Glossary - Terms and Abbreviations	40-178
40.7	Revision History	40-179
41	FlexRay™ Protocol Controller (E-Ray)	41-1
41.1	Feature List	41-1
41.2	Overview	41-1
41.2.1	E-Ray Kernel Description	41-1
41.2.2	Block Diagram	41-3
41.3	Functional Description	41-6
41.3.1	Definitions	41-6
41.3.2	Communication Cycle	41-6
41.3.2.1	Static Segment	41-6
41.3.2.2	Dynamic Segment	41-7
41.3.2.3	Symbol Window	41-7
41.3.2.4	Network Idle Time (NIT)	41-7
41.3.2.5	Configuration of Network Idle Time (NIT) Start and Offset Correction Start	41-7
41.3.3	Communication Modes	41-8
41.3.4	Clock Synchronization	41-8
41.3.4.1	Global Time	41-8
41.3.4.2	Local Time	41-8
41.3.4.3	Synchronization Process	41-9
41.3.4.4	External Clock Synchronization	41-10
41.3.5	Error Handling	41-10
41.3.5.1	Clock Correction Failed Counter	41-12
41.3.5.2	Passive to Active Counter	41-12
41.3.5.3	HALT Command	41-12
41.3.5.4	FREEZE Command	41-12

41.3.6	Communication Controller States	41-13
41.3.6.1	Communication Controller State Diagram	41-13
41.3.6.2	DEFAULT_CONFIG State	41-15
41.3.6.2.1	CONFIG State	41-15
41.3.6.3	MONITOR_MODE	41-15
41.3.6.4	READY State	41-16
41.3.6.5	WAKEUP State	41-16
41.3.6.6	STARTUP State	41-20
41.3.6.7	Startup Time-outs	41-22
41.3.6.8	Path of leading Coldstart Node (initiating coldstart)	41-23
41.3.6.9	NORMAL_ACTIVE State	41-24
41.3.6.10	NORMAL_PASSIVE State	41-24
41.3.6.11	HALT State	41-26
41.3.7	Network Management	41-26
41.3.8	Filtering and Masking	41-26
41.3.8.1	Frame ID Filtering	41-27
41.3.8.2	Channel ID Filtering	41-27
41.3.8.3	Cycle Counter Filtering	41-28
41.3.8.4	FIFO Filtering	41-29
41.3.9	Transmit Process	41-29
41.3.9.1	Static Segment	41-29
41.3.9.2	Dynamic Segment	41-29
41.3.9.3	Transmit Buffers	41-30
41.3.9.4	Frame Transmission	41-31
41.3.9.5	NULL Frame Transmission	41-32
41.3.10	Receive Process	41-33
41.3.10.1	Frame Reception	41-33
41.3.10.2	NULL Frame reception	41-33
41.3.11	FIFO Function	41-33
41.3.11.1	Description	41-34
41.3.11.2	Configuration of the FIFO	41-35
41.3.11.3	Access to the FIFO	41-35
41.3.12	Message Handling	41-35
41.3.12.1	Host access to Message RAM	41-35
41.3.12.2	Data Transfers between IBF / OBF and Message RAM	41-40
41.3.12.3	Minimum f_{CLC_ERAY}	41-45
41.3.12.3.1	Minimum f_{CLC_ERAY} for various maximum payload length	41-46
41.3.12.3.2	Minimum f_{CLC_ERAY} for various minimum minislot length	41-48
41.3.12.3.3	Minimum f_{CLC_ERAY} for various amount of configured Message Buffers	41-48
41.3.12.3.4	Minimum f_{CLC_ERAY} for a typical configuration	41-48
41.3.12.4	FlexRay™ Protocol Controller access to Message RAM	41-48
41.3.13	Message RAM	41-49
41.3.13.1	Header Partition	41-51
41.3.13.2	Data Partition	41-53
41.3.13.3	ECC Check	41-54
41.3.14	Host Handling of Errors	41-56
41.3.14.1	Self-Healing	41-57
41.3.14.2	CLEAR_RAM Command	41-57
41.3.14.3	Temporary Unlocking of Header Section	41-57
41.3.15	Module Service Request	41-58

41.3.16	Restrictions	41-60
41.3.16.1	Message Buffers with the same Frame ID	41-60
41.3.16.2	Data Transfers between IBF / OBF and Message RAM	41-60
41.3.17	E-Ray Module Implementation	41-61
41.3.17.1	Interconnections of the E-Ray Module	41-61
41.3.17.2	Port Control and Connections	41-62
41.3.17.2.1	Input/Output Function Selection	41-62
41.3.17.3	On-Chip Connections	41-64
41.3.17.3.1	E-Ray Connections with IR	41-64
41.3.17.3.2	E-Ray Connections with SMU	41-64
41.3.17.3.3	E-Ray Connections with the External Request Unit of SCU	41-64
41.3.17.3.4	E-Ray Connections to GTM	41-65
41.3.17.3.5	E-Ray Connections with the External Clock Output of SCU	41-65
41.3.17.4	OCDS Trigger Bus (OTGB) Interface	41-65
41.3.17.5	OTGB E-Ray Registers	41-68
41.3.17.5.1	OCDS Trigger Bus (OTGB)	41-68
41.3.17.6	BPI_FPI Module Registers	41-69
41.3.17.7	Interrupt Registers	41-73
41.4	Registers	41-78
41.4.1	Register Map	41-78
41.4.2	E-Ray Kernel Registers	41-80
41.4.2.1	Customer Registers	41-86
41.4.2.2	Special Registers	41-91
41.4.2.3	Service Request Registers	41-99
41.4.2.4	Communication Controller Control Registers	41-125
41.4.2.5	Communication Controller Status Registers	41-145
41.4.2.6	Message Buffer Control Registers	41-161
41.4.2.7	Message Buffer Status Registers	41-166
41.4.2.8	Identification Registers	41-180
41.4.2.9	Input Buffer	41-181
41.4.2.10	Output Buffer	41-189
41.5	Destructive Debug	41-199
41.6	IO Interfaces	41-199
41.7	Revision History	41-201
42	Peripheral Sensor Interface (PSI5)	42-1
42.1	Feature List	42-2
42.2	Overview	42-2
42.3	Functional Description	42-3
42.3.1	General Operation	42-3
42.3.2	Definitions	42-4
42.3.3	PSI5 Operation	42-4
42.3.4	Frame Formats and Definitions	42-4
42.3.4.1	PSI5 V1.3 Frame	42-4
42.3.4.2	Extended PSI5 Frame (non standard)	42-5
42.3.4.3	Enhanced Serial Message ("Slow Channel")	42-5
42.3.4.4	Enhanced Serial Data Frame	42-6
42.3.5	Sync Pulses	42-7
42.3.5.1	Synchronous Transmission	42-7
42.3.5.2	ECU to Sensor Communication	42-7

42.3.6	Manchester Decoding	42-9
42.3.7	Bit Rate Generation	42-12
42.3.8	Digital Glitch Filter	42-14
42.3.9	Time Stamp Generation	42-15
42.3.10	Watch Dog Timer	42-16
42.3.11	Receive Data Memory	42-19
42.3.12	Sync Pulse Control	42-20
42.3.13	Channel Trigger	42-21
42.3.14	Send Control	42-23
42.3.15	Error Detection Capabilities	42-25
42.3.16	Interrupts	42-25
42.3.17	Trigger Outputs	42-26
42.4	Registers	42-26
42.4.1	Detailed Register Description	42-30
42.5	Safety Measures	42-93
42.6	IO Interfaces	42-94
42.7	Revision History	42-95
43	Peripheral Sensor Interface with Serial PHY Connection (PSI5-S)	43-1
43.1	Feature List	43-2
43.2	Overview	43-3
43.2.1	Definitions	43-4
43.3	Functional Description	43-4
43.3.1	PSI5 ECU to Sensor Operation	43-5
43.3.2	Frame Formats and Definitions	43-5
43.3.2.1	Communication between PSI5-S and PHY via UART	43-5
43.3.2.1.1	“Packet Frames” received from PHY	43-5
43.3.2.1.2	PSI5-S UART Frames transmitted to PHY	43-9
43.3.2.2	Communication between PHY and Sensor (PSI5 Standard)	43-9
43.3.2.2.1	PSI5 Standard Frame Format	43-9
43.3.2.2.2	PSI5 Extended Frame Format	43-10
43.3.2.2.3	Sync Pulses	43-10
43.3.3	Clock Generation	43-12
43.3.3.1	Overview on Clocks in the System	43-13
43.3.4	Time Stamp Generation	43-14
43.3.5	Watch Dog Timers	43-15
43.3.6	Send Data	43-18
43.3.6.1	Channel Trigger	43-18
43.3.6.2	Sync Pulse Control	43-20
43.3.6.3	Send Data Preparation	43-21
43.3.7	Message Generation	43-22
43.3.8	DMA Support	43-23
43.3.8.1	Single DMA, 8 dedicated DMAs	43-23
43.3.8.2	Two daisy chained DMAs	43-24
43.3.8.3	Interrupts for DMA support	43-29
43.3.9	Error Detection Capabilities	43-30
43.3.10	Special use of Channel 0	43-30
43.3.11	ASC Kernel Description	43-31
43.3.11.1	Overview	43-31
43.3.11.2	General Operation	43-33

43.3.11.3	Asynchronous Operation	43-34
43.3.11.3.1	Asynchronous Data Frames	43-34
43.3.11.3.2	Asynchronous Transmission	43-37
43.3.11.3.3	Asynchronous Reception	43-37
43.3.11.3.4	RXD/TXD Data Path Selection in Asynchronous Modes	43-38
43.3.11.4	Synchronous Operation	43-38
43.3.11.4.1	Synchronous Transmission	43-39
43.3.11.4.2	Synchronous Reception	43-39
43.3.11.4.3	Synchronous Timing	43-40
43.3.11.5	Baud Rate Generation	43-41
43.3.11.5.1	Baud Rates in Asynchronous Mode	43-42
43.3.11.5.2	Baud Rates in Synchronous Mode	43-45
43.3.11.6	Hardware Error Detection Capabilities	43-46
43.3.11.7	Interrupts	43-46
43.3.12	Interrupts	43-47
43.3.13	Trigger Outputs	43-48
43.4	Registers	43-48
43.4.1	Module Control	43-52
43.5	IO Interfaces	43-97
43.6	Revision History	43-98
44	Gigabit Ethernet MAC (GETH)	44-1
44.1	Feature List	44-2
44.1.1	Delta to AURIX™ TC2xx	44-2
44.2	Overview	44-3
44.2.1	Basic Structure Diagram	44-3
44.2.2	DWC_ether_qos General Product Description	44-3
44.2.3	DWC_ether_qos Interfaces	44-5
44.2.4	DWC_ether_qos Features	44-6
44.2.4.1	Standard Compliance	44-6
44.2.4.2	MAC Features	44-6
44.2.4.2.1	MAC Tx and Rx Common Features	44-6
44.2.4.2.2	MAC Tx Features	44-7
44.2.4.2.3	MAC Rx Features	44-7
44.2.4.3	Transaction Layer (MTL) Features	44-8
44.2.4.3.1	MTL Tx and Rx Common Features	44-8
44.2.4.3.2	MTL Tx Features	44-8
44.2.4.3.3	MTL Rx Features	44-9
44.2.4.4	DMA Block Features	44-9
44.2.4.5	AHB Interface Features	44-11
44.2.4.5.1	AHB Master Interface Features	44-11
44.2.4.5.2	AHB Slave Interface Features	44-11
44.2.4.6	Audio and Video Features	44-11
44.2.4.7	Generic Queuing Support	44-12
44.2.4.8	Monitor, Testing, and Debugging Features	44-12
44.3	Functional Description	44-12
44.3.1	Architecture	44-13
44.3.1.1	CSR Slave Interface	44-13
44.3.1.1.1	AHB Slave Interface	44-13
44.3.1.2	Application Master Interface	44-13

44.3.1.2.1	AHB Master Interface	44-13
44.3.1.3	DMA Controller	44-15
44.3.1.3.1	DMA Arbiter (EQOS-DMA and EQOS-AHB Configurations)	44-16
44.3.1.3.2	DMA Transmit Operation	44-17
44.3.1.3.3	DMA Receive Operation	44-23
44.3.1.3.4	Error Response to DMA	44-25
44.3.1.3.5	DMA Interrupts	44-26
44.3.1.4	MAC Transaction Layer	44-28
44.3.1.4.1	SPRAM Interface	44-28
44.3.1.5	MAC	44-30
44.3.1.5.1	MAC Transmission	44-30
44.3.1.5.2	MAC Reception	44-33
44.3.2	Processing Double VLAN	44-35
44.3.2.1	Introduction to Double VLAN Processing	44-35
44.3.2.2	Description to Double VLAN Processing	44-35
44.3.3	Source Address and VLAN Insertion, Replacement, or Deletion	44-37
44.3.3.1	Introduction to SA and VLAN Insertion, Replacement, or Deletion	44-37
44.3.3.2	Programming Source Address Insertion or Replacement	44-37
44.3.3.3	Programming VLAN Insertion, Replacement, or Deletion	44-37
44.3.4	Queue Channel Based VLAN Tag Insertion	44-39
44.3.4.1	Introduction to Queue/Channel Based VLAN Tag Insertion on Tx	44-39
44.3.4.2	Accessing Queue/Channel Specific VLAN Tag Registers	44-39
44.3.5	Managing Buffers and Memories	44-40
44.3.5.1	Introduction to Transmit and Receive FIFOs	44-40
44.3.5.2	Transmit and Receive FIFO-Related Registers	44-40
44.3.6	Using PHY Interface	44-41
44.3.6.1	Station Management Agent	44-41
44.3.6.1.1	Introduction to Station Management Agent	44-41
44.3.6.1.2	Functional Description of Station Management Agent	44-41
44.3.6.1.3	Preamble Suppression	44-44
44.3.6.1.4	Trailing Clocks and Back to Back transactions	44-44
44.3.6.1.5	Interrupt for MDIO transaction completion	44-44
44.3.6.2	Reduced Gigabit Media Independent Interface	44-44
44.3.6.2.1	Introduction to Reduced Gigabit Media Independent Interface (RGMII)	44-44
44.3.6.3	Reduced Media Independent Interface	44-45
44.3.6.3.1	Introduction to Reduced Media Independent Interface	44-45
44.3.7	Packet Filtering	44-46
44.3.7.1	Packet Filtering Sequence	44-46
44.3.7.2	Source Address or Destination Address Filtering	44-47
44.3.7.2.1	Introduction to Source or Destination Address Filtering	44-47
44.3.7.2.2	Programming Different Types of Address Filtering	44-47
44.3.7.3	VLAN Filtering	44-49
44.3.7.3.1	VLAN Tag Perfect Filtering	44-49
44.3.7.3.2	Introduction to VLAN Tag Hash Filtering	44-49
44.3.7.3.3	VLAN Tag Hash Filtering	44-49
44.3.7.4	Extended Rx VLAN Filtering and Routing	44-50
44.3.7.4.1	Introduction to Extended Receive VLAN Filtering	44-50
44.3.7.4.2	Comparison Modes	44-50
44.3.7.4.3	VLAN Filter Fail Packets Queue	44-51
44.3.7.4.4	Filter Status	44-51

44.3.7.4.5	Stripping	44-54
44.3.8	Using IEEE 1588 Timestamp Support	44-55
44.3.8.1	Using IEEE 1588 Timestamp Support	44-55
44.3.8.1.1	Introduction to IEEE 1588 Timestamp Support	44-55
44.3.8.1.2	Description of IEEE 1588 Timestamp Support	44-55
44.3.8.2	Using IEEE 1588 System Time Source	44-68
44.3.8.2.1	Introduction to IEEE 1588 Time Source	44-68
44.3.8.2.2	Description of IEEE 1588 Time Source	44-68
44.3.8.3	Using IEEE 1588 Higher Word Register	44-71
44.3.8.3.1	Introduction to IEEE 1588 Higher Word Register	44-71
44.3.8.4	Using Flexible Pulse-Per-Second Output	44-71
44.3.8.4.1	Introduction to Flexible Pulse-Per-Second Output	44-71
44.3.8.4.2	Description of Flexible Pulse-Per-Second Output	44-72
44.3.8.5	Using One-Step Timestamp Feature	44-74
44.3.8.5.1	MAC Transmit PTP Mode	44-74
44.3.8.6	One-Step Time Stamping for PTP Over UDP	44-77
44.3.8.6.1	Introduction to One-Step Timestamping for PTP Over UDP Feature	44-77
44.3.8.6.2	Checksum Update for One-Step Timestamping for PTP	44-77
44.3.8.7	Using IEEE 1588 Sub Nanoseconds Timestamp Support	44-78
44.3.8.7.1	Description of IEEE 1588 Sub Nanoseconds Timestamp Support	44-78
44.3.9	Multiple Channels and Queues Support	44-79
44.3.9.1	Block Diagram of DWC_ether_qos Multiple Channels and Queues	44-79
44.3.9.2	Multiple Queues and Channels Support in Transmit Path	44-79
44.3.9.2.1	Description of Fixed Priority Scheme in EQOS-AHB and EQOS-DMA	44-80
44.3.9.2.2	Description of Weighted Strict Priority in EQOS-AHB and EQOS-DMA	44-80
44.3.9.2.3	Description of Weighted Round Robing in EQOS-AHB and EQOS-DMA	44-80
44.3.9.3	Multiple Queues in Receive Path	44-81
44.3.9.3.1	Priority Scheme for Tx DMA and Rx DMA	44-81
44.3.9.4	Multiple Queues and Channels Support in EQOS-MTL	44-83
44.3.9.4.1	Queue Memory	44-83
44.3.9.5	Rx Queue to DMA Mapping	44-83
44.3.9.5.1	Static Mapping	44-83
44.3.9.5.2	Dynamic (Per Packet) Mapping	44-83
44.3.9.6	Selection of Tag Priorities Assigned to Tx and Rx Queues	44-84
44.3.9.7	Rx Side Routing from MAC to Queues	44-85
44.3.9.8	Rx Side Arbitration Between DMA and MTL	44-86
44.3.9.9	Tx Side Arbitration between DMA and MTL	44-86
44.3.9.10	Audio Video Bridging	44-86
44.3.9.10.1	Introduction to AV Feature	44-86
44.3.9.10.2	Transmit Path Functions	44-87
44.3.9.10.3	Receive Path Functions	44-88
44.3.9.10.4	Credit-Based Sharper Algorithm	44-88
44.3.9.10.5	Slot Number Function with Audio Video Bridging	44-90
44.3.9.11	Queue Modes	44-90
44.3.9.12	Programming Guidelines for Disabling Flow Control in AV Queues	44-91
44.3.9.13	Queue Priorities	44-92
44.3.10	Using TCP/IP Offloading Features	44-92
44.3.10.1	Using Transmit Checksum Offload Engine	44-92
44.3.10.1.1	Introduction to the Transmit Checksum Offload Engine	44-92
44.3.10.2	Description of the Transmit Checksum Offload Engine	44-92

44.3.10.2.1	IP Header Checksum Engine	44-93
44.3.10.2.2	TCP/UDP/ICMP Checksum Engine	44-93
44.3.10.3	Using Receive Checksum Offload Engine	44-95
44.3.10.3.1	Introduction to the Receive Checksum Offload Engine	44-95
44.3.10.3.2	Description of the Receive Checksum Offload Engine	44-95
44.3.11	Splitting Header on Receive	44-97
44.3.12	Implementing Low-Power Modes	44-98
44.3.12.1	Implementing Energy Efficient Ethernet	44-98
44.3.12.1.1	Introduction to Energy Efficient Ethernet (EEE)	44-98
44.3.12.1.2	Description of EEE	44-98
44.3.12.1.3	LPI Timers	44-101
44.3.12.1.4	LPI Interrupt	44-102
44.3.12.2	Implementing Power Management Through Magic Packet Detection	44-102
44.3.12.2.1	Power Management (PMT) Through Magic Packet Detection	44-102
44.3.12.3	Implementing Power Management Through Remote Wake-Up Packet Detection	44-104
44.3.12.3.1	Power Management (PMT) Through Remote Wake-Up Packet Detection	44-104
44.3.12.3.2	PMT Interrupt Signals	44-105
44.3.12.4	System Considerations During Power Down	44-106
44.3.13	Using MAC Management Counters	44-107
44.3.13.1	Introduction to MAC Management Counters	44-107
44.3.13.2	Address Assignments	44-107
44.3.14	Flow Control	44-108
44.3.14.1	Transmit Flow Control	44-108
44.3.14.1.1	Flow Control in Full-Duplex Mode	44-109
44.3.14.1.2	Flow Control in Half-Duplex Mode	44-109
44.3.14.2	Triggering Transmit Flow Control	44-110
44.3.14.3	Receive Flow Control	44-111
44.3.14.3.1	Description of Receive Flow Control	44-111
44.3.14.4	Enabling Receive Flow Control	44-112
44.3.15	Using Loopback Mode	44-113
44.3.15.1	Guidelines for Using Loopback Mode	44-113
44.3.15.2	Enabling Loopback Mode	44-113
44.3.16	Interrupts from the MAC	44-114
44.3.17	Descriptors	44-116
44.3.17.1	Overview of Descriptors	44-116
44.3.17.2	Descriptor Structure	44-116
44.3.17.3	Split Header Support	44-118
44.3.17.3.1	Descriptor Structure with Split Header Feature	44-118
44.3.17.4	Descriptor Endianness	44-120
44.3.17.5	Transmit Descriptor	44-120
44.3.17.5.1	Transmit Normal Descriptor (Read Format)	44-120
44.3.17.5.2	Transmit Normal Descriptor (Write-Back Format)	44-124
44.3.17.5.3	Transmit Context Descriptor	44-128
44.3.17.6	Receive Descriptor	44-131
44.3.17.6.1	Receive Normal Descriptor (Read Format)	44-132
44.3.17.6.2	Receive Normal Descriptor (Write-Back Format)	44-134
44.3.17.6.3	Receive Context Descriptor	44-140
44.3.18	Programming Sequences	44-143
44.3.18.1	Initializing DMA	44-143
44.3.18.2	Initializing MTL Registers	44-144

44.3.18.3	Initializing MAC	44-144
44.3.18.4	Performing Normal Receive and Transmit Operation	44-145
44.3.18.5	Stopping and Starting Transmission	44-145
44.3.18.6	Programming Guidelines for Switching to New Descriptor List in RxDMA	44-146
44.3.18.7	Programming Guidelines for Multi-Channel, Multi-Queuing	44-146
44.3.18.7.1	Programming Guidelines for Multi-Channel Multi-Queuing - Transmit	44-146
44.3.18.7.2	Programming Guidelines for Multi-Channel Multi-Queuing - Receive	44-146
44.3.18.8	Programming Guidelines for GMII Link State Transitions	44-147
44.3.18.8.1	Transmit and Receive Clocks Running when Link Down	44-147
44.3.18.8.2	Transmit and Receive Clocks Stopped when Link Down	44-148
44.3.18.9	Programming Guidelines for IEEE 1588 Timestamping	44-148
44.3.18.9.1	Initialization Guidelines for System Time Generation	44-148
44.3.18.9.2	Updating System Time in One Process	44-149
44.3.18.9.3	Updating System Time to Reduce System-Time Jitter	44-149
44.3.18.10	Programming Guidelines for AV Feature	44-150
44.3.18.10.1	Initializing the DMA	44-150
44.3.18.10.2	Enabling Slot Number Checking	44-151
44.3.18.10.3	Enabling Average Bits Per Slot Reporting	44-151
44.3.18.10.4	Disabling Transmit Flow Control for AV Enabled Queues	44-152
44.3.18.10.5	Disabling Receive Flow Control for AV Enabled Queues	44-152
44.3.18.11	Programming Guidelines for Energy Efficient Ethernet	44-152
44.3.18.11.1	Entering and Exiting the Tx LPI Mode	44-152
44.3.18.11.2	Gating Off the CSR Clock in the Rx LPI Mode	44-153
44.3.18.11.3	Gating Off the CSR Clock in the Tx LPI Mode	44-154
44.3.18.12	Programming Guidelines for Flexible Pulse-Per-Second Output	44-154
44.3.18.12.1	Generating Single Pulse on PPS	44-155
44.3.18.12.2	Generating Next Pulse on PPS	44-155
44.3.18.12.3	Generating a Pulse Train on PPS	44-155
44.3.18.12.4	Generating an Interrupt without Affecting the PPS	44-156
44.3.18.13	Programming Guidelines for Split Header on Receive	44-157
44.3.18.14	Programming Guidelines for VLAN filtering on Receive	44-158
44.3.18.15	Programming Guidelines for Extended VLAN Filtering and Routing on Receive	44-158
44.3.18.15.1	Programming Guidelines for Extended VLAN Filtering and Routing on Receive - Write ...	44-158
44.3.18.15.2	Programming Guidelines for Extended VLAN Filtering and Routing on Receive - Read ...	44-158
44.3.18.16	Programming sequence for Queue/Channel Based VLAN Inclusion Register	44-159
44.3.19	Definition of the PHY Interfaces MII, RMII and RGMII	44-159
44.4	Functional Specifications for Flexible Header Feature (FHE)	44-160
44.4.1	Overview of Feature	44-160
44.4.1.1	Transmit Path Features	44-160
44.4.1.2	Receive Path Features	44-161
44.4.2	Functional Description of the FHE Functionality	44-161
44.4.2.1	Transmit Checksum Offload Engine (TxCOE)	44-161
44.4.2.2	Transmit SA/VLAN Insertion/Replacement	44-161
44.4.2.3	PTP One_Step Processing	44-161
44.4.2.4	Transmit Pad Insertion	44-162
44.4.2.5	Transmit Packet Length implication	44-162
44.4.2.6	Receive Status	44-162
44.4.2.7	MAC Receiver functions and offloads	44-162
44.4.3	High Level Microarchitecture	44-162
44.4.3.1	Tx Side	44-163

44.4.3.2	Rx Side	44-163
44.4.4	DMA Descriptors / MTL Status	44-164
44.4.4.1	Receive Descriptor (DMA Configuration)	44-164
44.4.4.2	ARI Status (MTL Configuration)	44-165
44.4.5	Software Initialization and Guidelines	44-165
44.5	Registers	44-166
44.5.1	Register Description	44-166
44.5.1.1	GMAC Registers	44-179
44.6	IO Interfaces	44-413
44.7	Revision History	44-415
45	SRI External Bus Unit (EBU)	45-1
45.1	Feature List	45-1
45.2	Overview	45-1
45.3	Functional Description	45-2
45.3.1	References	45-2
45.3.2	Product Specific Core Customisation	45-2
45.3.3	Allocation of Unused Signals as GPIO	45-2
45.3.4	Memory Controller Structure	45-3
45.3.5	Memory Controller Read Architecture	45-4
45.3.6	Access Arbitration	45-4
45.3.6.1	Programming Sequence Locking	45-4
45.3.6.2	Access Enable	45-4
45.3.7	Clocking Strategy and Local Clock Generation	45-4
45.3.7.1	Clocking Modes	45-4
45.3.7.2	Standby Mode	45-6
45.3.7.3	External Bus Clock Generation	45-6
45.3.8	External Bus Arbitration	45-6
45.3.8.1	External Bus Modes	45-6
45.3.8.2	Arbitration Signals and Parameters	45-6
45.3.8.3	Arbitration Modes	45-8
45.3.8.3.1	No Bus Arbitration Mode	45-8
45.3.8.3.2	Sole Master Arbitration Mode	45-8
45.3.8.3.3	Arbiter Mode Arbitration Mode	45-8
45.3.8.3.4	“Participant Mode” Arbitration Mode	45-11
45.3.8.4	Switching Arbitration Modes	45-13
45.3.8.5	Arbitration Input Signal Sampling	45-13
45.3.8.6	Locking the External Bus	45-13
45.3.8.7	Interaction with Debug System	45-14
45.3.8.8	Arbitrating SDRAM control signals	45-14
45.3.9	Start-Up/Boot Process	45-14
45.3.9.1	Disabled (arbitration mode is “nobus”)	45-14
45.3.9.2	External Boot Mode	45-14
45.3.9.2.1	Configuration Word Fetch Process	45-15
45.3.9.2.2	Boot Configuration Value	45-17
45.3.10	Accessing the External Bus	45-18
45.3.10.1	External Memory Regions	45-18
45.3.10.2	Address Comparison	45-19
45.3.10.2.1	Operation Address Comparison	45-19
45.3.10.3	SRI Bus Width Translation	45-20

45.3.10.4	Address Alignment During Bus Accesses	45-20
45.3.10.5	SRI Data Buffering	45-20
45.3.10.6	Chip Select Control	45-21
45.3.10.7	Combined Chip Select (CSCOMB)	45-21
45.3.11	Connecting External Memories	45-21
45.3.11.1	Programmable Device Types	45-21
45.3.11.2	Support for Multiplexed Device Configurations	45-23
45.3.11.3	Support for Non-Multiplexed Device Configurations	45-23
45.3.12	Phases for Asynchronous and Synchronous Accesses	45-24
45.3.12.1	Address Phase (AP)	45-24
45.3.12.2	Address Hold Phase (AH)	45-25
45.3.12.3	Command Delay Phase (CD)	45-25
45.3.12.4	Command Phase (CP)	45-26
45.3.12.5	Data Hold Phase (DH)	45-26
45.3.12.5.1	Exceptional use of Data Hold	45-26
45.3.12.6	Burst Phase (BP)	45-26
45.3.12.7	Recovery Phase (RP)	45-27
45.3.13	Asynchronous Read/Write Accesses	45-28
45.3.13.1	Signal List	45-29
45.3.13.2	Standard Asynchronous Access Phases	45-29
45.3.13.3	Example Waveforms	45-30
45.3.13.4	Control of ADV & Other Signal Delays During Asynchronous Accesses	45-32
45.3.13.5	Programmable Parameters	45-33
45.3.13.6	Asynchronous Access Control	45-33
45.3.13.6.1	External Extension of the Command Phase by WAIT	45-34
45.3.13.7	Interfacing to Asynchronous Nand Flash Devices	45-36
45.3.13.7.1	NAND flash page mode	45-37
45.3.14	Synchronous Read/Write Accesses	45-41
45.3.14.1	Signals	45-42
45.3.14.2	Support for Burst FLASH device types	45-42
45.3.14.3	Typical Burst Flash Connection	45-43
45.3.14.4	Standard Access Phases	45-43
45.3.14.5	Example Waveforms	45-44
45.3.14.6	Burst Length Control	45-45
45.3.14.7	Burst Flash Clock	45-46
45.3.14.8	Control of ADV & Control Signal Delays During Synchronous Accesses	45-47
45.3.14.9	Burst Flash Clock Feedback	45-48
45.3.14.10	Asynchronous Address Phase	45-49
45.3.14.11	Critical Word First Read Accesses	45-49
45.3.14.12	Example Burst Flash Access Cycle	45-50
45.3.14.13	External Cycle Control via the $\overline{\text{WAIT}}$ Input	45-51
45.3.14.14	Flash Non-Array Access Support	45-52
45.3.14.15	Termination of a Burst Access	45-53
45.3.14.16	Burst Flash Device Programming Sequences	45-53
45.3.14.17	Cellular RAM	45-53
45.3.14.17.1	Synchronous Write Access	45-54
45.3.14.17.2	Fujitsu FCRAM Support (burst write with $\overline{\text{WR}}$ active during data phase)	45-56
45.3.14.18	Programmable Parameters	45-56
45.4	Registers	45-58
45.4.1	Clock Control Register, CLC	45-60

45.4.2	Configuration Register, MODCON	45-62
45.4.3	External Boot Configuration Control Register, EXTBOOT	45-64
45.4.4	Address Select Register, ADDRSELx (x=0-2)	45-66
45.4.5	Bus Read Configuration Register, BUSRCONx (x=0-2)	45-68
45.4.6	Bus Write Configuration Register, BUSWCONx (x=0-2)	45-71
45.4.7	Bus Read Access Parameter Register, BUSRAPx (x=0-2)	45-73
45.4.8	Bus Write Access Parameter Register, BUSWAPx (x=0-2)	45-75
45.4.9	SDRAM Control Register, SDRMCON	45-77
45.4.10	SDRAM Mode Register, SDRMOD	45-79
45.4.11	SDRAM Refresh Control Register, SDRMREF	45-81
45.4.12	SDRAM Status Register, SDRSTAT	45-83
45.4.13	Test/Control Configuration Register, USERCON	45-84
45.4.14	Access Enable Registers, ACCEN0 and ACCEN1	45-85
45.5	IO Interfaces	45-86
45.5.1	Bus State During Reset	45-86
45.6	Revision History	45-88
46	SD- and eMMC Interface (SDMMC)	46-1
46.1	Feature List	46-1
46.2	Functional Description	46-2
46.2.1	Architecture	46-3
46.2.1.1	System Description	46-3
46.2.1.2	Error Handling	46-5
46.2.1.3	OCDS Suspend	46-6
46.2.2	DWC_mshc Programming Sequences	46-7
46.2.2.1	Pin enabling	46-7
46.2.2.2	Programming Overview	46-7
46.2.2.3	Card Detection	46-8
46.2.2.4	Host Controller Setup Sequence	46-8
46.2.2.4.1	Host Controller Setup Sequence for an SD Interface	46-9
46.2.2.4.2	Host Controller Setup Sequence for an eMMC Device	46-10
46.2.2.5	Clock Control	46-10
46.2.2.5.1	Host Controller Clock Setup Sequence	46-11
46.2.2.5.2	Card Clock Supply and Stop Sequence	46-12
46.2.2.5.3	SD Clock Frequency Change Sequence	46-13
46.2.2.6	Card Interface Setup Sequence	46-13
46.2.2.6.1	SD Card Interface Setup Sequence	46-15
46.2.2.6.2	eMMC Card Interface Setup	46-16
46.2.2.7	Timeout Setting for an SD/eMMC Bus	46-17
46.2.2.8	Abort Transaction	46-17
46.2.2.8.1	Abort Command Sequence	46-17
46.2.2.8.2	Asynchronous Abort	46-18
46.2.2.8.3	Synchronous Abort	46-19
46.2.2.9	SD/SDIO Transaction Mode	46-20
46.2.2.9.1	SD Card Initialization and Identification	46-21
46.2.2.9.2	Changing SD Bus Width	46-23
46.2.2.9.3	SD Bus Power Control	46-24
46.2.2.9.4	Issuing CMD Without Data Transfer	46-25
46.2.2.9.5	Issuing CMD with Data Transfer (Not Using DMA/PIO)	46-26
46.2.2.9.6	Issuing CMD with Data Transfer (Using SDMA)	46-28

46.2.2.9.7	Issuing CMD with Data Transfer (Using ADMA2)	46-29
46.2.2.9.8	Issuing CMD with Data Transfer (Using ADMA3)	46-31
46.2.2.9.9	SD Changing Bus Speed Mode	46-32
46.2.2.9.10	SDIO Card Interrupt	46-32
46.2.2.10	eMMC Transaction Mode	46-33
46.2.2.10.1	Initializing and Identifying an eMMC Device	46-34
46.2.2.10.2	Issue CMD without Data Transfer for an eMMC Device	46-35
46.2.2.10.3	Issue CMD with Data Transfer for an eMMC Device	46-35
46.2.2.10.4	Switch to Various Speed Modes in an eMMC Device	46-35
46.2.2.10.5	Changing the Data Bus Width for an eMMC Device	46-36
46.2.2.11	Boot and Abort Programming Sequences for eMMC	46-36
46.2.2.11.1	Preparing for a Boot	46-37
46.2.2.11.2	Initiating a Mandatory Boot in Non-DMA Mode	46-38
46.2.2.11.3	Initiating a Mandatory Boot in SDMA Mode	46-39
46.2.2.11.4	Initiating a Mandatory Boot in ADMA2 Mode	46-40
46.2.2.11.5	Abort Mandatory Boot	46-41
46.2.2.11.6	Initiating Alternate Boot	46-42
46.2.2.11.7	Alternate Boot	46-43
46.2.2.12	Error Recovery in SD/eMMC Mode	46-44
46.3	Registers	46-46
46.4	IO Interfaces	46-118
46.5	Revision History	46-119
47	Hardware Security Module (HSM)	47-1
48	Input Output Monitor (IOM)	48-1
48.1	Feature List	48-1
48.2	Overview	48-1
48.3	Functional Description	48-2
48.3.1	Interfaces	48-2
48.3.2	Kernel Description	48-2
48.3.3	Filter & Prescaler Channel (FPC) Description	48-3
48.3.4	EXOR Combiner Description	48-8
48.3.5	Logic Analyzer Module (LAM) Description	48-8
48.3.6	Event Combiner Module (ECM) Description	48-11
48.3.7	Configuration Sequence	48-12
48.3.8	Example Monitor/Safety Measures	48-13
48.3.8.1	Example 1 - Pulse or duty cycle too short	48-14
48.3.8.2	Example 2 - Pulse or duty cycle too long	48-15
48.3.8.3	Example 3 - Period too short	48-16
48.3.8.4	Example 4 - Period too long	48-17
48.3.8.5	Example 5 - Diagnosis of Command and Feedback - acceptable propagation window and/or signal consistency check	48-18
48.3.8.6	Example 6 - Diagnosis of Set-up and Hold times	48-19
48.4	Registers	48-21
48.4.1	IOM Identification Register (IOM_ID)	48-23
48.4.2	Filter & Prescaler Channel (FPC) Registers	48-24
48.4.3	GTM Input Related Registers	48-27
48.4.4	Logic Analyzer Module (LAM) Registers	48-28
48.4.5	Event Combiner Module (ECM) Registers	48-33
48.4.6	System Registers	48-39

48.5	IO Interfaces	48-43
48.6	Revision History	48-43
49	8-Bit Standby Controller (SCR)	49-1
49.1	Features of the SCR	49-2
49.2	Revision History	49-3
49.3	XC800 CPU	49-4
49.3.1	SFRs of the CPU	49-4
49.3.1.1	Stack Pointer (SP, D4 _H)	49-4
49.3.1.2	Data Pointer (DPTR, D5-6 _H)	49-4
49.3.1.3	Accumulator (ACC, E0 _H)	49-4
49.3.1.4	B Register (DA _H)	49-4
49.3.1.5	Program Status Word (PSW, D0 _H)	49-5
49.3.1.6	Extended Operation Register (EO, D7 _H)	49-6
49.3.1.7	Power Control Register (PCON, D9 _H)	49-7
49.3.1.8	Interrupt Registers	49-8
49.3.2	SFRs of The Core Peripherals	49-8
49.3.2.1	Timer Registers	49-8
49.3.2.2	UART Registers	49-8
49.3.3	Instruction Timing	49-8
49.3.4	XRAM Addressing Modes	49-13
49.3.4.1	Access to XRAM Using the DPTR (16-bit addressing Mode)	49-13
49.3.4.2	Access to XRAM Using the Register R0/R1 (8-bit addressing Mode)	49-13
49.3.5	Revision History	49-15
49.4	Memory Organization	49-16
49.4.1	Program Memory	49-17
49.4.2	Data Memory	49-17
49.4.2.1	Internal Data Memory	49-17
49.4.2.2	External Data Memory	49-17
49.4.3	Special Function Registers	49-18
49.4.3.1	Address Extension by Mapping	49-18
49.4.3.2	System Control Register 0	49-20
49.4.3.3	Address Extension by Paging	49-21
49.4.3.4	Page Register	49-23
49.4.3.5	Bit-Addressing	49-23
49.4.3.6	Bit Protection Scheme	49-24
49.4.4	Memory Control Unit	49-25
49.4.4.1	Memory Protection Unit	49-25
49.4.5	Arbiter	49-26
49.4.5.1	Arbiter Logic	49-26
49.4.6	Revision History	49-27
49.5	SCR Firmware	49-28
49.5.1	Overview	49-28
49.5.1.1	BootROM location	49-28
49.5.1.2	Boot Mode Option	49-28
49.5.2	OCDS Mode	49-29
49.5.2.1	Features	49-29
49.5.2.2	OCDS Basic Understanding	49-29
49.5.2.2.1	Introduction of the XC800 Core Debug mode	49-29
49.5.2.2.2	Minimum hardware and overhead are added	49-29

49.5.2.2.3	Implementation of OCDS with the debug mode of XC800 Core	49-29
49.5.2.3	OCDS Monitor Firmware	49-29
49.5.2.3.1	OCDS mode entry	49-30
49.5.2.3.2	Communication between the Debugger and Monitor	49-31
49.5.2.3.3	Activate the Monitor ROM	49-36
49.5.2.3.4	Exit the Monitor ROM to return to user mode	49-39
49.5.2.3.5	Single step execution	49-39
49.5.2.3.6	Software breakpoint implementation	49-39
49.5.2.4	Important information for Debugger	49-39
49.5.2.4.1	Specific Infineon DAP instruction to configure DUT	49-39
49.5.2.4.2	Initial entry to the monitor mode	49-39
49.5.2.4.3	Implementation of the debugger	49-40
49.5.2.4.4	Calculation of the return address upon a break event	49-40
49.5.2.4.5	Limitation of the monitor mode	49-40
49.5.2.4.6	Exit sequence of the monitor mode	49-40
49.5.2.4.7	An example of a Debugging session	49-40
49.5.2.4.8	Detailed description of Monitor Program State Machine	49-41
49.5.3	Revision History	49-49
49.6	Special Function Register (SFR) Block	49-50
49.6.1	Registers in the SFR Block	49-51
49.6.2	Revision History	49-55
49.7	System Control Unit (SCU)	49-56
49.7.1	Clock System and Control	49-56
49.7.1.1	CCU Register	49-58
49.7.1.2	Module Suspend Control	49-60
49.7.2	Reset Control	49-60
49.7.2.1	Types of Reset	49-61
49.7.2.1.1	LVD Reset (Undervoltage Reset)	49-62
49.7.2.1.2	Main Reset (External Reset)	49-62
49.7.2.1.3	Generated Resets	49-62
49.7.2.2	Module Reset Behavior	49-64
49.7.2.3	Reset Register Description	49-65
49.7.3	Boot and Startup	49-68
49.7.3.1	Boot ROM Operating Mode	49-68
49.7.3.1.1	User Mode 0	49-68
49.7.3.1.2	User Mode 1	49-69
49.7.3.1.3	OCDS Mode with SCR DAP/SPD pin	49-69
49.7.3.1.4	OCDS Mode with SOC DAP/SPD pin	49-69
49.7.4	Power Management	49-69
49.7.4.1	Overview	49-69
49.7.4.2	Functional Description	49-70
49.7.4.2.1	Idle Mode	49-70
49.7.4.2.2	Peripheral Management	49-70
49.7.4.3	Exit Standby Mode via SCR	49-70
49.7.4.4	Register Description	49-71
49.7.4.4.1	Peripheral Management Register	49-74
49.7.5	Miscellaneous Control	49-75
49.7.5.1	Bit Protection Register	49-75
49.7.6	Revision History	49-77
49.8	Watchdog Timer (WDT)	49-78

49.8.1	Overview	49-78
49.8.2	System Information	49-79
49.8.2.1	Reset Effects	49-79
49.8.2.2	Clocking Configuration	49-79
49.8.2.3	Interrupt Events and Assignment	49-79
49.8.2.4	Module Suspend Control	49-79
49.8.3	Functional Description	49-80
49.8.4	Registers Description	49-83
49.8.4.1	Watchdog Timer Registers	49-83
49.8.5	Revision History	49-87
49.9	Interrupt System	49-88
49.9.1	Interrupt Sources	49-88
49.9.1.1	Interrupt Source and Vector	49-93
49.9.1.2	Interrupt Source and Priority	49-94
49.9.2	Interrupt Structure	49-94
49.9.2.1	Interrupt Structure 1	49-95
49.9.2.2	Interrupt Structure 2	49-95
49.9.3	Interrupt Handling	49-98
49.9.4	Interrupt Response Time	49-99
49.9.5	Interrupt from/to TriCore CPUx	49-101
49.9.6	Registers Description	49-101
49.9.6.1	Interrupt Node Enable Registers	49-102
49.9.6.2	External Interrupt Control Registers	49-106
49.9.6.3	Interrupt Flag Registers	49-115
49.9.6.4	Interrupt Priority Registers	49-122
49.9.7	Interrupt Events Related Registers	49-125
49.9.7.1	Interrupt Event Enable Control	49-125
49.9.7.2	Interrupt Data Exchange Registers	49-126
49.9.8	Interrupt Flag Overview	49-127
49.9.9	Revision History	49-129
49.10	General Purpose I/O Ports and Peripheral I/O Lines (Ports)	49-130
49.10.1	Basic Port Operation	49-131
49.10.2	Port Register Overview	49-133
49.10.2.1	Port Paging Register	49-134
49.10.2.2	Port Input/Output Control Registers	49-136
49.10.2.3	Pad Driver Mode Register	49-138
49.10.2.4	Pin Function Decision Control Register	49-142
49.10.2.5	Port Output Register	49-143
49.10.2.6	Port Output Modification Set Register	49-144
49.10.2.7	Port Output Modification Clear Register	49-145
49.10.2.8	Port Output Modification Toggle Register	49-146
49.10.2.9	Port Input Register	49-147
49.10.3	SCR Functions in Port SCR_P00 (P33L)	49-148
49.10.3.1	SCR Port SCR_P00 Configuration	49-148
49.10.3.2	Port SCR_P00 Function Table	49-148
49.10.3.3	Port SCR_P00 Registers	49-153
49.10.4	SCR Functions in Port SCR_P01 (P34.1 and P33H)	49-154
49.10.4.1	SCR Port SCR_P01 Configuration	49-154
49.10.4.2	Port SCR_P01 Function Table	49-154
49.10.4.3	Port SCR_P01 Registers	49-159

49.10.5	Additional Port Pins Available as Input	49-160
49.10.6	General Port Control	49-161
49.10.6.1	Input Pin Function Selection	49-162
49.10.7	Revision History	49-168
49.11	Real-Time Clock (RTC)	49-169
49.11.1	Overview	49-169
49.11.2	System Information	49-169
49.11.2.1	Interrupt Events and Assignment	49-169
49.11.2.2	Module Suspend Control	49-169
49.11.3	Clock Source	49-169
49.11.4	Real Time Clock Operation	49-170
49.11.4.1	Periodic Wake-up Mode	49-170
49.11.4.2	RTC Access Delays and Restrictions	49-172
49.11.5	Power Saving Mode Option	49-172
49.11.6	RTC Interrupt Request	49-172
49.11.7	Real-Time Clock Register	49-173
49.11.7.1	Register Mapping	49-173
49.11.7.2	Register Description	49-174
49.11.8	Revision History	49-178
49.12	Timer 0 and Timer 1	49-179
49.12.1	Overview	49-179
49.12.2	System Information	49-179
49.12.2.1	Pinning	49-179
49.12.2.2	Clocking Configuration	49-181
49.12.2.3	Interrupt Events and Assignment	49-181
49.12.3	Basic Timer Operations	49-182
49.12.4	Timer Modes	49-182
49.12.4.1	Mode 0	49-184
49.12.4.2	Mode 1	49-185
49.12.4.3	Mode 2	49-186
49.12.4.4	Mode 3	49-187
49.12.5	T0/T1 Interrupt Flags and Requests	49-188
49.12.6	Register Map	49-189
49.12.7	Register Description	49-190
49.12.8	Revision History	49-196
49.13	T2CCU Module	49-197
49.13.1	Overview	49-197
49.13.2	Timer 2	49-199
49.13.2.1	Basic Timer 2 Operations	49-199
49.13.2.1.1	Timer 2 Start/Stop and Count Control	49-199
49.13.2.1.2	Count Clock Options	49-200
49.13.2.2	Timer 2 Operating Modes	49-200
49.13.2.2.1	Reload Mode of Timer 2	49-200
49.13.2.2.2	Capture Mode of Timer 2	49-202
49.13.2.3	Timer 2 Interrupt Requests	49-203
49.13.2.3.1	Timer Overflow Interrupt Request	49-203
49.13.2.3.2	Timer External Interrupt Request	49-204
49.13.2.4	Input Selection for Timer 2	49-205
49.13.2.5	Timer 2 Register Map	49-207
49.13.2.6	Register Description	49-207

49.13.2.6.1	Mode Register	49-207
49.13.2.6.2	Control Register	49-208
49.13.2.6.3	Timer 2 Reload/Capture Register	49-210
49.13.2.6.4	Timer 2 Count Register	49-211
49.13.3	Capture/Compare Timer of T2CCU	49-213
49.13.3.1	CCT Timer Basic Operation	49-213
49.13.3.2	Software-Triggered CCT Timer Overflow	49-214
49.13.3.3	Synchronized Start of Timer 2 and CCT Timer	49-214
49.13.3.4	Cascading Timer 2 and CCT Timer for Flexible Count Rate	49-214
49.13.3.5	CCT Overflow Flag and Interrupt Request	49-215
49.13.4	Capture/Compare Unit (CCU) of the T2CCU	49-216
49.13.4.1	Capture/Compare Operation	49-217
49.13.4.2	Compare Operation	49-217
49.13.4.2.1	Compare Mode 0 (without dead-time control)	49-219
49.13.4.2.2	Compare Mode 0 with Dead-Time Control	49-222
49.13.4.2.3	Compare Mode 1	49-225
49.13.4.2.4	Concurrent Compare Mode	49-226
49.13.4.2.5	Using Interrupts in Combination with the Compare Function	49-229
49.13.4.3	Capture Function	49-229
49.13.4.3.1	Capture Mode 0	49-230
49.13.4.3.2	Capture Mode 1	49-230
49.13.4.3.3	Configuring the External Capture Input	49-230
49.13.4.4	CCU Interrupt and I/O Connections	49-232
49.13.4.4.1	Capture/Compare Channel 0	49-232
49.13.4.4.2	Capture/Compare Channel 1	49-233
49.13.4.4.3	Capture/Compare Channel 2	49-234
49.13.4.4.4	Capture/Compare Channel 3	49-235
49.13.4.4.5	Compare Channel 4	49-236
49.13.4.4.6	Compare Channel 5	49-237
49.13.5	T2CCU Registers	49-238
49.13.5.1	T2CCU Page Register	49-240
49.13.5.2	T2CCU Registers Description	49-241
49.13.6	T2CCU Clocking Configuration	49-255
49.13.7	Implementation Details of T2CCU	49-256
49.13.7.1	Interfaces of the T2CCU	49-256
49.13.7.1.1	Interrupt Events and Assignment	49-257
49.13.7.1.2	Module Suspend Control	49-258
49.13.8	Revision History	49-259
49.14	Universal Asynchronous Receiver/Transmitter (UART)	49-260
49.14.1	Overview	49-260
49.14.2	UART Modes	49-260
49.14.2.1	Mode 0, 8-Bit Shift Register, Fixed Baudrate	49-260
49.14.2.2	Mode 1, 8-Bit UART, Variable Baudrate	49-261
49.14.2.3	Mode 2, 9-Bit UART, Fixed Baudrate	49-263
49.14.2.4	Mode 3, 9-Bit UART, Variable Baudrate	49-263
49.14.3	Multiprocessor Communication	49-264
49.14.4	Baudrate Generation	49-265
49.14.4.1	Fixed Clock	49-265
49.14.4.2	UART Baudrate Generator	49-265
49.14.5	UART Interrupt Requests	49-267

49.14.6	LIN Support in UART	49-268
49.14.6.1	LIN Protocol	49-268
49.14.6.2	LIN Header Transmission	49-269
49.14.6.3	Automatic Synchronization to the Host	49-270
49.14.6.4	Initialization of Break/Synch Field Detection Logic	49-270
49.14.6.5	Break Detection	49-270
49.14.6.6	Baudrate Range Selection	49-270
49.14.6.7	LIN Baudrate Detection	49-272
49.14.6.8	LIN Interrupt Requests	49-272
49.14.7	UART Connections to GPIO	49-274
49.14.8	Register Description	49-275
49.14.8.1	UART Registers	49-276
49.14.8.2	Baudrate Generator Control and Status Registers	49-279
49.14.8.3	Baudrate Generator Timer/Reload Registers	49-282
49.14.9	Revision History	49-284
49.15	Synchronous Serial Channel	49-285
49.15.1	Overview	49-285
49.15.2	General Operation	49-286
49.15.2.1	Operating Mode Selection	49-286
49.15.2.2	Full-Duplex Operation	49-288
49.15.2.3	Half-Duplex Operation	49-290
49.15.2.4	Loop Back Mode	49-291
49.15.2.5	Continuous Transfers (Master Mode only)	49-291
49.15.2.6	Baud-Rate Generation	49-292
49.15.2.7	Error Detection Mechanisms	49-293
49.15.3	SSC Interrupts	49-294
49.15.4	SSC Connections to GPIO	49-296
49.15.5	Register Description	49-297
49.15.5.1	Configuration Register	49-298
49.15.5.2	Baud-Rate Timer Reload Register	49-303
49.15.5.3	Transmit Buffer Register	49-304
49.15.5.4	Receive Buffer Register	49-304
49.15.6	Revision History	49-306
49.16	ADC Comparator Unit (ADCOMP)	49-307
49.16.1	Features	49-307
49.16.2	Overview	49-307
49.16.3	ADC Comparator Operation	49-308
49.16.4	ADCOMP Interrupt Request	49-309
49.16.5	ADCOMP Connections to GPIO	49-309
49.16.6	ADCOMP Registers	49-310
49.16.6.1	ADCOMP Registers Description	49-311
49.16.7	Revision History	49-313
49.17	Wake-Up CAN (WCAN) Filter	49-314
49.17.1	Definitions and Abbreviations	49-314
49.17.2	Wake-Up CAN Filter Implementation	49-314
49.17.2.1	Overview	49-314
49.17.2.2	WCAN Filter Features	49-316
49.17.2.3	Introduction	49-317
49.17.2.3.1	Feature Overview	49-317
49.17.2.4	WCAN Module Control Registers	49-318

49.17.2.5	WCAN Initialization Sequence	49-326
49.17.2.6	Wake-Up Frame Configuration and Detection	49-326
49.17.2.6.1	Configuration of Wake-Up Frame Filter	49-326
49.17.2.6.2	Detection of Wake-Up Frame Filter	49-327
49.17.2.7	CAN Message Timeout	49-329
49.17.2.8	Error Counter	49-330
49.17.3	WUP Detection	49-332
49.17.4	CAN Functional Description	49-334
49.17.4.1	CAN Node Control	49-334
49.17.4.1.1	Baud Rate Prescaler	49-334
49.17.4.1.2	Receive Input Filter	49-334
49.17.4.1.3	Bit Timing	49-334
49.17.4.1.4	Network Propagation Delays	49-337
49.17.4.1.5	CAN FD Tolerance	49-339
49.17.4.2	WCAN Kernel Registers	49-340
49.17.4.2.1	Register Address Map	49-340
49.17.4.2.2	CAN Node Registers	49-342
49.17.4.2.3	Message Object Registers	49-348
49.17.4.3	Miscellaneous Register	49-354
49.17.4.3.1	Paging Register	49-354
49.17.5	WCAN Module Implementation	49-356
49.17.5.1	Wake-Up CAN Module Registers	49-356
49.17.5.2	Port and Interrupt Control	49-359
49.17.5.2.1	Input/Output Function Selection in Ports	49-359
49.17.5.2.2	Interrupt Control	49-360
49.17.6	Revision History	49-361
49.18	Debug System	49-362
49.18.1	Overview	49-362
49.18.1.1	Features	49-362
49.18.1.2	Components of the Debug System	49-362
49.18.1.2.1	Debug Interface	49-362
49.18.1.2.2	Monitor Program	49-362
49.18.1.2.3	On-Chip Debug System Unit (OCDS)	49-362
49.18.2	Product Specific Information	49-362
49.18.2.1	Pinning	49-363
49.18.2.2	Clocking Configuration	49-363
49.18.2.3	JTAG ID	49-364
49.18.3	Revision History	49-365
49.19	Device Access Port (DAP2)	49-366
49.19.1	Revision History	49-368
49.20	Single Pin DAP (SPD)	49-369
49.20.1	Revision History	49-370
Revision history		RevisionHistory-1