



НВП Радій  
RPC Radiy

Project:

Radiy FPGA-based Safety Controller (FSC)

## **FSC Application Function Block Library User Reference Manual (AFBL RM)**

**D11.5**

Kirovograd, Ukraine

2018



## Contents

<b>1</b>	<b>Introduction.....</b>	<b>6</b>
1.1	Scope and Purpose of this Document .....	6
1.2	The RadICS AFBL.....	7
1.3	Certification to IEC 61508 SIL 3 .....	7
1.4	Applicability and Version Information .....	7
1.5	References.....	8
1.6	Product Documents Referenced by this User Manual.....	9
1.7	Definitions and Acronyms.....	9
1.8	Safety Notes.....	11
<b>2</b>	<b>Overview of the FSC.....</b>	<b>12</b>
2.1	Brief Description of the RadICS FSC .....	12
2.2	FSC Hardware.....	12
2.3	Levels of FSC Operation .....	13
2.4	Modes of FSC Operation.....	14
<b>3</b>	<b>UAL Design .....</b>	<b>18</b>
3.1	Logic Schemas.....	18
3.2	Application Logic Design Constraints .....	19
3.3	AFB and UAL Defensive Design .....	21
3.4	Initialization.....	23
3.4.1	Function Block Initialization .....	23
3.4.2	UAL Initialization .....	24
3.5	Function Block Parameters .....	25
<b>4</b>	<b>Data Formats in RadICS .....</b>	<b>28</b>
4.1	Data types and Initialization .....	28
4.2	Floating Point (Analog) Data .....	28
4.3	Signed Integer (Analog) Data.....	31
4.4	Discrete (Boolean) Data .....	33
<b>5</b>	<b>I/O Hardware/Software Interface.....</b>	<b>34</b>
5.1	Connecting UAL and I/O .....	34
5.2	Analog Inputs .....	35
5.2.1	AI Signal Ports – Signal Properties Set Using RPCT .....	35
5.2.2	AI Signal Ports – Operation and Signal Validity .....	36
5.2.3	Engineering Units (EU) Conversion .....	37
5.2.4	Detection of Field Device Failure .....	38
5.3	Analog Outputs.....	40
5.3.1	AO Signal Ports – Signal Properties Set Using RPCT .....	40
5.3.2	AO Signal Ports – Operation and Signal Validity .....	41
5.3.3	Engineering Units (EU) Conversion for AOs .....	42
5.4	Discrete Inputs .....	43
5.4.1	DI Signal Ports – Operation and Signal Validity.....	43
5.5	Discrete Outputs.....	44
5.6	Analog Inputs for (neutron) Flux Measure .....	45
<b>6</b>	<b>Platform-UAL Interface.....</b>	<b>46</b>
6.1	Logic Module Platform Interface Controller (PIC) .....	46
<b>7</b>	<b>Nomenclature for AFB Specifications.....</b>	<b>48</b>
<b>8</b>	<b>AFB Specification Sheets .....</b>	<b>50</b>
8.1	COMPARISON BLOCKS .....	51
8.1.1	CMPC_FP_EQ .....	51
8.1.2	CMPC_FP_GR .....	53
8.1.3	CMPC_FP_LS .....	55
8.1.4	CMPC_FP_NE.....	57

8.1.5	CMPC_SI_EQ.....	59
8.1.6	CMPC_SI_GR .....	60
8.1.7	CMPC_SI_LS .....	62
8.1.8	CMPC_SI_NE.....	64
8.1.9	CMP_FP_EQ.....	65
8.1.10	CMP_FP_GR.....	67
8.1.11	CMP_FP_LS.....	69
8.1.12	CMP_FP_NE.....	71
8.1.13	CMP_SI_EQ.....	73
8.1.14	CMP_SI_GR.....	74
8.1.15	CMP_SI_LS.....	76
8.1.16	CMP_SI_NE.....	78
8.1.17	CMP_DH_FP_EQ.....	79
8.1.18	CMP_DH_FP_GR.....	81
8.1.19	CMP_DH_FP_LS.....	83
8.1.20	CMP_DH_FP_NE.....	85
8.2	COUNTER BLOCKS .....	87
8.2.1	CNT_UP .....	87
8.2.2	CNT_DN .....	88
8.3	DAMPER BLOCKS .....	89
8.3.1	DAMPC_FP .....	89
8.3.2	DAMPC_SI .....	92
8.3.3	DAMP_FP .....	94
8.3.4	DAMP_SI .....	97
8.4	DELAY BLOCKS .....	99
8.4.1	TCTC_OFF .....	99
8.4.2	TCTC_ON .....	101
8.4.3	TCTC_FILTER.....	103
8.4.4	TCTC_VIBR.....	105
8.4.5	TCTC_RSV.....	107
8.4.6	TCT_OFF .....	109
8.4.7	TCT_ON .....	111
8.4.8	TCT_FILTER .....	113
8.4.9	TCT_VIBR .....	115
8.4.10	TCT_RSV .....	117
8.5	FLIP-FLOP BLOCKS.....	119
8.5.1	FF_RS .....	119
8.5.2	FF_SR .....	120
8.5.3	FF_D_FRONT .....	121
8.5.4	FF_D_DECAY .....	122
8.5.5	FF_T_FRONT .....	123
8.5.6	FF_T_DECAY .....	124
8.5.7	LATCH BLOCKS .....	125
8.6	LIMIT BLOCKS.....	133
8.6.1	DB1_FP .....	133
8.6.2	DB1_SI .....	135
8.6.3	DB2_FP .....	137
8.6.4	DB2_SI .....	139
8.6.5	LIM_FP .....	141
8.6.6	LIM_SI .....	145
8.6.7	MEDIAN_FP .....	149
8.6.8	MEDIAN_SI .....	151

8.7	LOGIC BLOCKS.....	153
8.7.1	AND .....	153
8.7.2	OR .....	155
8.7.3	XOR .....	157
8.7.4	NOT .....	159
8.7.5	VOTER .....	160
8.7.6	COD.....	164
8.7.7	DEC .....	168
8.7.8	SWITCH_FP.....	172
8.7.9	SWITCH_SI .....	173
8.7.10	SIMLOCK .....	175
8.7.11	MISMATCH_FP .....	177
8.7.12	MISMATCH_SI .....	179
8.7.13	MISMATCH_R_FP .....	181
8.7.14	MISMATCH_R_SI.....	184
8.8	MATH BLOCKS.....	186
8.8.1	ADD_FP .....	186
8.8.2	ADD_SI.....	188
8.8.3	SUB_FP.....	190
8.8.4	SUB_SI.....	192
8.8.5	MUL_FP .....	194
8.8.6	MUL_SI.....	196
8.8.7	DIV_FP .....	198
8.8.8	DIV_SI .....	200
8.8.9	SQRT_FP .....	202
8.8.10	ABS_FP .....	204
8.8.11	ABS_SI .....	205
8.8.12	SIN_FP .....	206
8.8.13	COS_FP .....	207
8.8.14	LOG_FP .....	208
8.8.15	EXP_FP .....	210
8.8.16	INV_FP .....	212
8.8.17	POLY .....	214
8.8.18	SCALE_FP_FP .....	216
8.8.19	SCALE_FP_SI .....	219
8.8.20	SCALE_SI_FP .....	222
8.8.21	SCALE_SI_SI .....	225
8.8.22	INTEGRATORC.....	228
8.8.23	INTEGRATOR .....	231
8.8.24	DERIVC .....	235
8.8.25	DERIV.....	238
9	Product Forum .....	244
10	Revision History .....	245