User Manual for Complex Architectures

FUNCTIONAL SAFETY SIS
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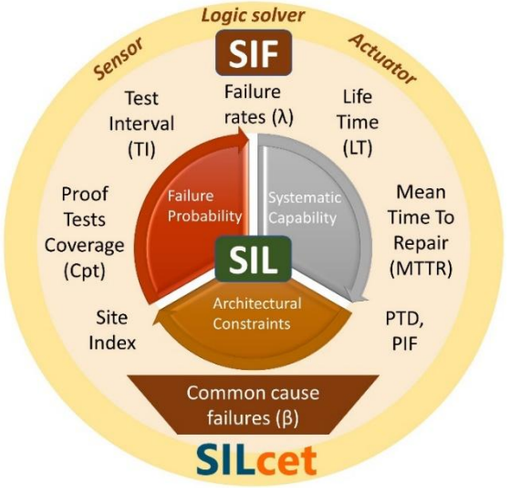
SILcet 7.1

Enertria



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INTRODUCTION

This document is a supplement to the SILcet Manual to explain several examples of how to calculate PFDavg and MTTFS values for complex architectures.

SILcet 6.1 or later must be used.
In this version the configuration and calculation is performed on the "SIL" sheet (it is no longer necessary to use the "CF" sheet of previous versions).

In column H the following options are used for Complex Architectures:

- ❑ **SEN_VOTING** (for complex sensor subsystem architectures).
- ❑ **ACT_VOTING** (for complex actuator subsystem architectures).
- ❑ **1oo1 Rates** (for calculating Failure Rates from PFDavg and MTTFS values).

Note: If you have a SILcet Pro Plus license you can request a SILcet Excel file with the examples in this document and additional examples (info@safetyandsis.com)

SUB-SIF HANDLING FOR COMPLEX ARCHITECTURES

Sub-SIF Handling – Simple cases

SILcet

In SILcet each SIF contains 12 rows that can be used for any component. For example:

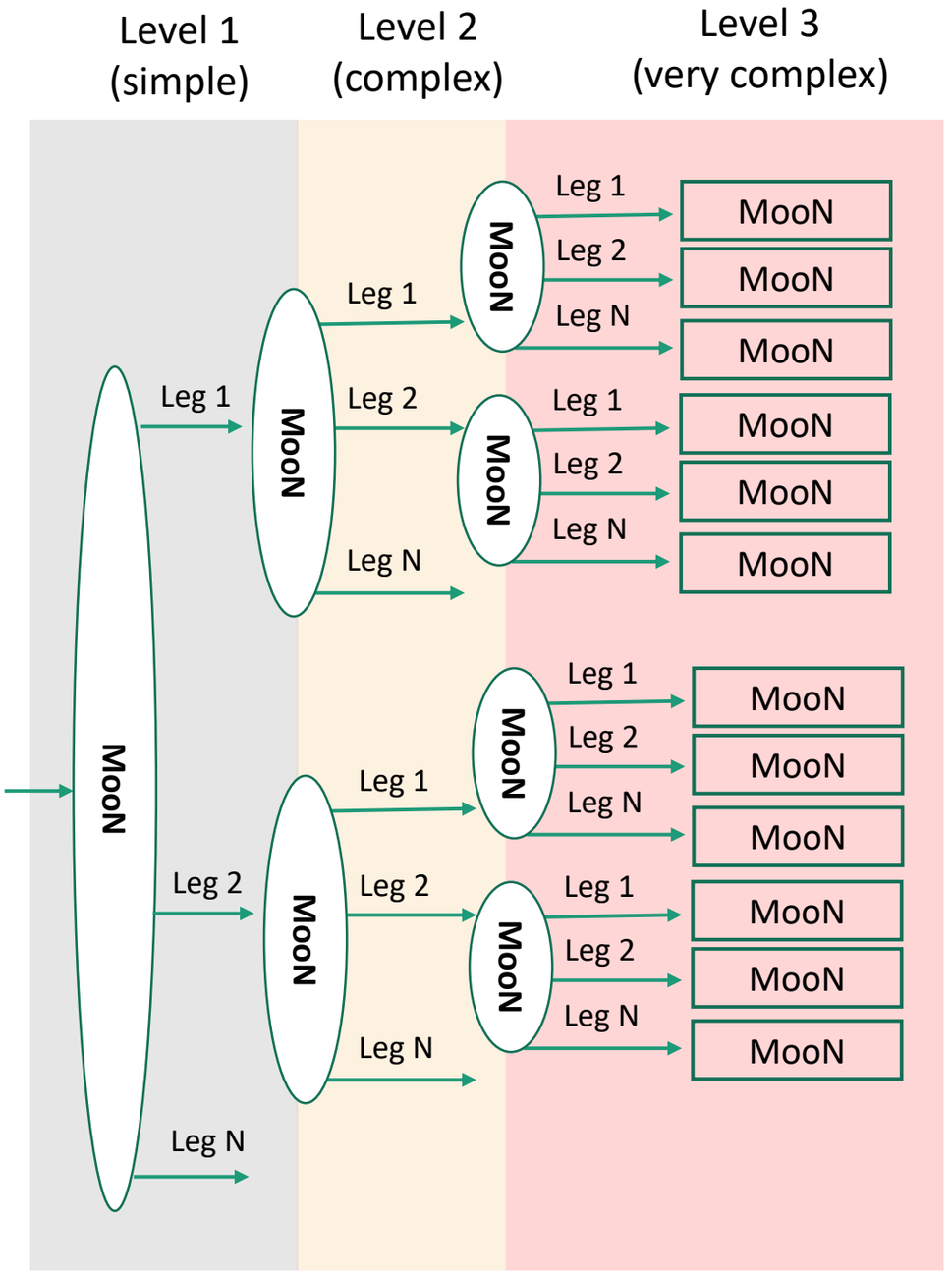
Select	Select		SD	SU	DD	DU	Type	SC	Cpt	TI (y)	LT (y)	β	$MTTR_{DD}$	Startup	Select	PFDavg	SIL (pfd)
sensor		PT-1	144	0	963	90	2	2	74%	1	15		48	24	1oo1	1,85E-03	2
sen_part	GenericPT	transmitter	115	0	820	45	2	2							--		
sen_part	Plugging-	process connecti	0	0	0	0	1								--		
sen_part	HIC2025	splitter	29	0	143	45	1	2							--		
logicsolver	2AI-2DO	ESD-1	11804	133	3920	247	2	3	99%	4	15	2%	48	24	1oo2D	1,70E-04	3
															--		
actuator		XV-16	0	916	0	829	1	3	73%	1	15	10%	48	24	1oo2	1,95E-03	2
act_part	Ball-C/FS	valve	0	0	0	442	1	3							--		
act_part	ACT-VL/A	actuator	0	286	0	199	1	3							--		
act_part	SOL-327/	solenoid	0	516	0	188	1	3							--		
act_part	Driver-KF	isolator	0	114	0	0	1	3							--		
															--		
		SENSOR >	ProTrip	T.Fault	Ch.Trip			SIL-2								3,97E-03	SIL-2
na	na	PLC diagn. ON	HH	U.R.	No											Achieved SIL=	SIL-2

In some cases we need more rows, for example if in the final element we have a 2oo2 or 1oo2 architecture. In these cases we will use a Sub-SIF to calculate the final element, and in the Main SIF we will introduce the calculated values of PFDavg and MTTFS.

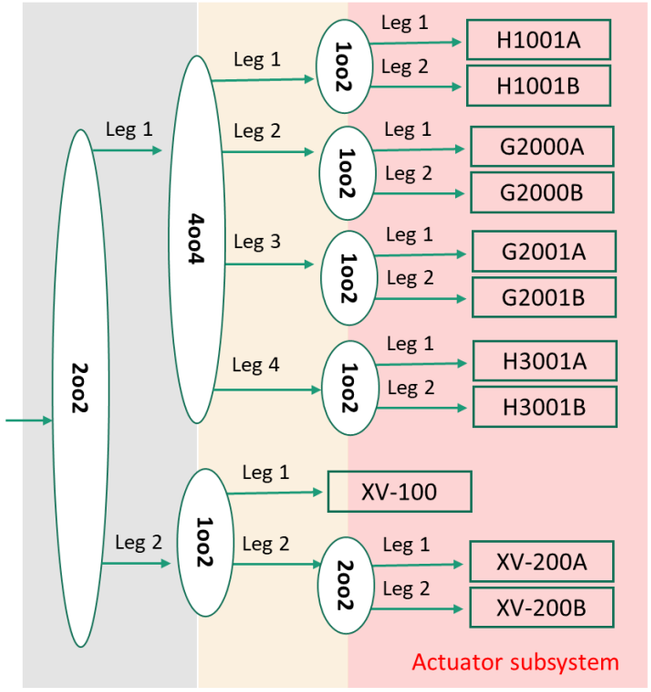
Note: see example 2 of this document.

Sub-SIF Handling – Complex cases (I)

In some cases it is not possible to calculate PFD/MTTFS directly due to the complexity of the architecture. These are architectures with 3 levels or more as shown in the image on the right.



Example 3



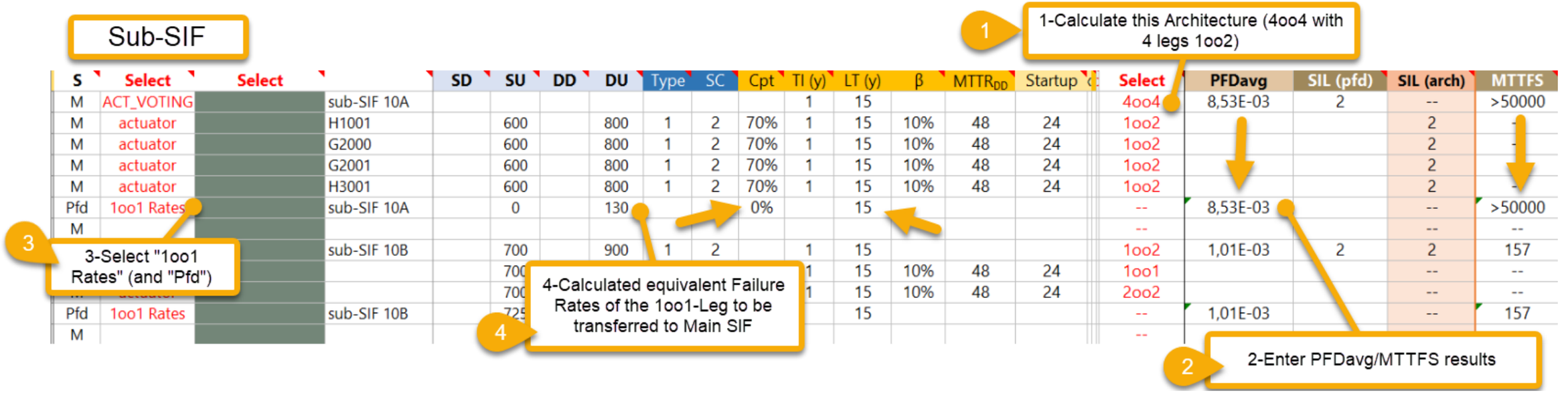
Sub-SIF Handling (Sub-SIF) – Complex cases (II)

In these cases it is necessary to use a Sub-SIF to model a part of the Main SIF (for example a very complex actuator subsystem architecture).

In the Sub-SIF we first calculate PFD/MTTFS with its parameters Cpt (coverage of proof tests), TI, LT, Beta and Failure rates.

We use the PFD/MTTFS results to calculate the equivalent failure rates of a 1oo1 architecture that we use in the Main-SIF.
To correctly transfer the 1oo1-Leg it is necessary to:

- Use the same LT (Life Time) in the Sub-SIF and Main SIF (for example, 15 years).
- Calculate the equivalent failure rates of the 1oo1-Leg with Cpt=0% (because the proof testing is already included in the PFDavg of the Sub-SIF and there is no further coverage you can claim, the proof test coverage of the Sub-SIF portion in the Main-SIF has to be 0%. Because of this, the proof test interval (TI) has no impact on the result of the calculation).



S	Select	Select		SD	SU	DD	DU	Type	SC	Cpt	TI (y)	LT (y)	β	$MTTR_{DD}$	Startup	Select	PFDavg	SIL (pfd)	SIL (arch)	MTTFS
M	ACT_VOTING		sub-SIF 10A								1	15				4oo4	8,53E-03	2	--	>50000
M	actuator		H1001		600		800	1	2	70%	1	15	10%	48	24	1oo2			2	
M	actuator		G2000		600		800	1	2	70%	1	15	10%	48	24	1oo2			2	
M	actuator		G2001		600		800	1	2	70%	1	15	10%	48	24	1oo2			2	
M	actuator		H3001		600		800	1	2	70%	1	15	10%	48	24	1oo2			2	
Pfd	1oo1 Rates		sub-SIF 10A		0		130			0%		15				--	8,53E-03		--	>50000
M																--			--	--
			sub-SIF 10B		700		900	1	2		1	15				1oo2	1,01E-03	2	2	157
					700						1	15	10%	48	24	1oo1			--	--
					700						1	15	10%	48	24	2oo2			--	--
Pfd	1oo1 Rates		sub-SIF 10B		725							15				--	1,01E-03		--	157
M																--				

Sub-SIF Handling (Main SIF) – Complex cases (III)

In the Main SIF we introduce the sub SIF as shown in the image below.

Main SIF

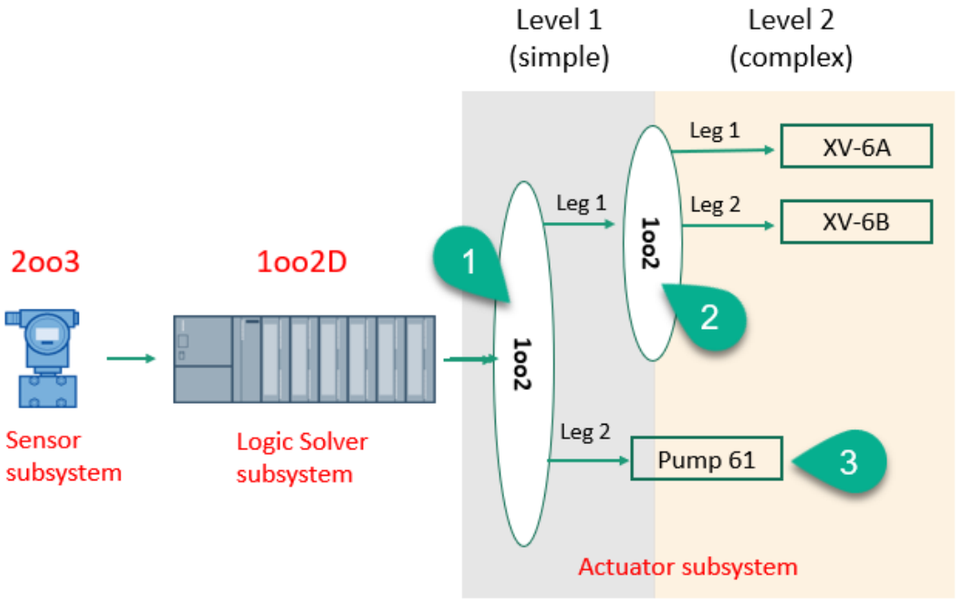
S	Select	Select		SD	SU	DD	DU	Type	SC	Cpt	TI (y)	LT (y)	β	$MTTR_{DD}$	Startup	Select	PFDavg	SIL (pfd)	SIL (arch)	MTTFS
Db	sensor	PT3150	PT-10	29	94	250	41	2	3	90%	1	15	5%	48	24	1oo2	2,17E-05	4	3	476
M																--			--	--
Db	logicsolver	2AI-13DO	ESD-02	15035	191	5589	387	2	3	99%	4	25	2%	48	24	1oo2D	3,05E-04	3	3	144
M																--			--	--
M	ACT_VOTING										1	15				2oo2	9,54E-03	2	--	>50000
M	actuator		sub-SIF 10A	0	0	0	130	1	2	0%		15				1oo1				--
M	actuator		sub-SIF 10B	0	725	0	15	1	2	0%		15				1oo1				--
M																--				--
M																--				--
M																--			--	--
M																--			--	--
M																--			--	--
Print1			SENSOR						SIL-2								9,87E-03	SIL-2	SIL-2	110,3
0	na	na	PLC diagn. ON	HH	U.R.	No											Achieved SIL=	SIL-2		

Equivalent Failure Rates of 1oo1-Leg

1oo1-Leg of Sub-SIF 10A

EXAMPLE 1 – Simple Case

EXAMPLE 1
How to calculate in SILcet



Select "ACT_VOTING" to allow a second level of architectures

Select	Select		SD	SU	DD	DU	Type	SC	Cpt	TI (y)	LT (y)	β	$MTTR_{DD}$	Startup	Select	PFDavg	SIL (pfd)	SIL (arch)	MTTFS
sensor		PT-6	279	94	0	87	2	3	94%	1	15	5%	48	24	2oo3	5,25E-05	4	2	3.866
sen_part	PT3150	transmitter	279	94	0	41	2	3							--			--	--
sen_part	PT1199-H	seal	0	0	0	46	1	3							--			--	--
logicsolver	3AI-3DO	SIS-01	11991	137	4025	253	2	3	99%				48		1oo2D	1,75E-04	3	3	199
ACT_VOTING		GROUP VOTING								1	15				1oo2	5,62E-06	4	--	41
actuator		XV-6A/B	0	916	0	829	1	3	73%	1	15	10%	48	24	1oo2			2	--
act_part	Ball-C/FS	valve	0	0	0	442	1	3							--			--	--
act_part	ACT-VL/A	actuator	0	286	0	199	1	3							--			--	--
act_part	SOL-327/	solenoid	0	516	0	188	1	3							--			--	--
act_part	Driver-KF	interface	0	114	0	0	1	3							--			--	--
actuator		Pump-61	0	1050	0	606	1	2	95%	1	15		48	24	1oo1			2	--
																		--	--
		SENSOR >	ProTrip	T.Fault	Ch.Trip			SIL-2								2,33E-04	SIL-3	SIL-2	33,6
		PLC diagn. ON	HH	--	Yes											Achieved SIL=		SIL-2	

Actuator Subsystem

XV-6A/B

Pump

1

2

3

EXAMPLE 1
Architectural Constraints

Select the Route in the "ACT_VOTING" row or in the rows of the 2 Legs. In general it is best to do this in the Legs of the architecture. Note: if it is done in "ACT_VOTING" then it is necessary to enter the overall Failure Rates (can be done in several ways: a)The maximum value of the Legs; b)The arithmetic or geometric mean).

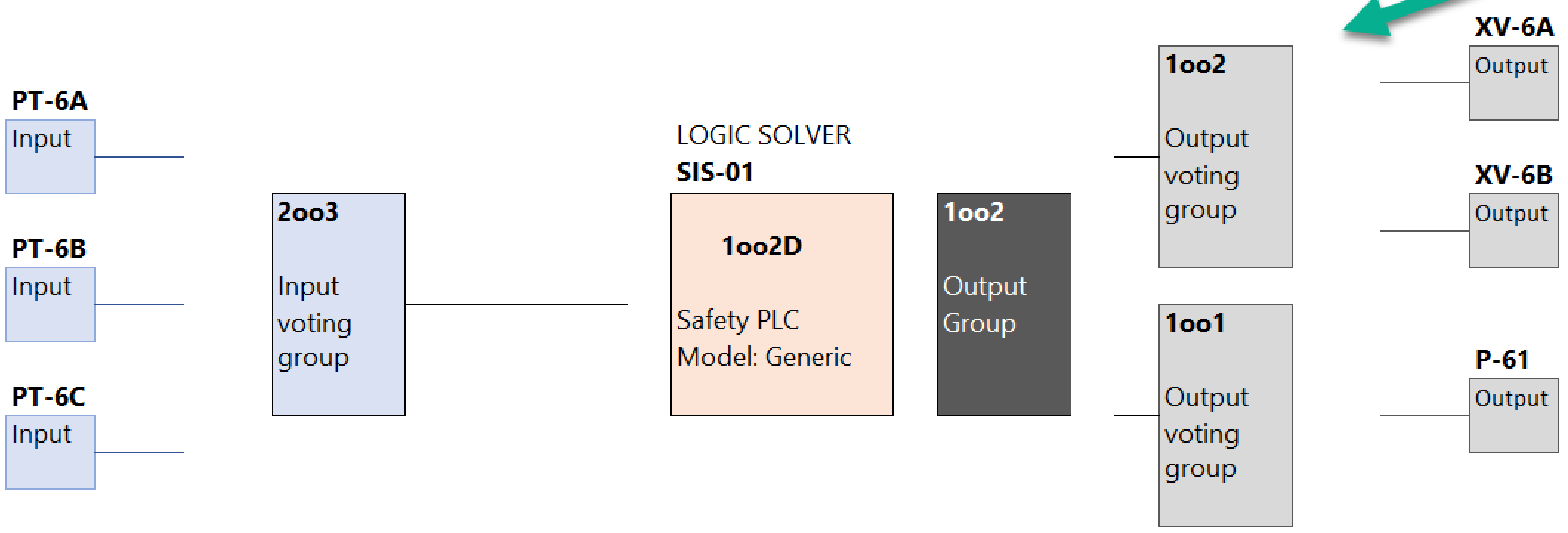
Select	Select		SD	SU	DD	DU	Type	SC	Select	PFDavg	SIL (pfd)	HFT	SFF/DC man	SFF	SIL (arch)	MTTFS	Route	value
sensor		PT-6	279	94	0	87	2	3	2oo3	5,25E-05	4	1		81,1%	2	866	Route 1H	SFF
sen_part	PT3150	transmitter	279	94	0	41	2	3	--			--		--	--	-		
sen_part	PT1199-H	seal	0	0	0	46	1	3	--							--		
logicsolver	3AI-3DO	SIS-01	11991	137	4025	253	2	3	1oo2D	1,75E-04	3	1		98,5%	3	199	Route 1H	SFF
ACT_VOTING		GROUP VOTING							1oo2	5,62E-06	4	1		--	--	41		
actuator		XV-6A/B	0	916	0	829	1	3	1oo2			1		52,5%	2	--	Route 1H	SFF
act_part	Ball-C/FS	valve	0	0	0	442	1	3	--			--		--	--	--		
act_part	ACT-VL/A	actuator	0	286	0	199	1	3	--			--		--	--	--		
act_part	SOL-327/	solenoid	0	516	0	188	1	3	--			--		--	--	--		
act_part	Driver-KF	interface	0	114	0	0	1	3	--			--		--	--	--		
actuator		Pump-61	0	1050	0	606	1	2	1oo1			0		63,4%	2	--	Route 1H	SFF
									--			--		--	--	--		
		SENSOR >	ProTrip	T.Fault	Ch.Trip			SIL-2		2,33E-04	SIL-3	1H	<Route		SIL-2	33,6		
na	na	PLC diagn. ON	HH	--	Yes					Achieved SIL=		SIL-2						

EXAMPLE 1

How to configure the Logic Diagram

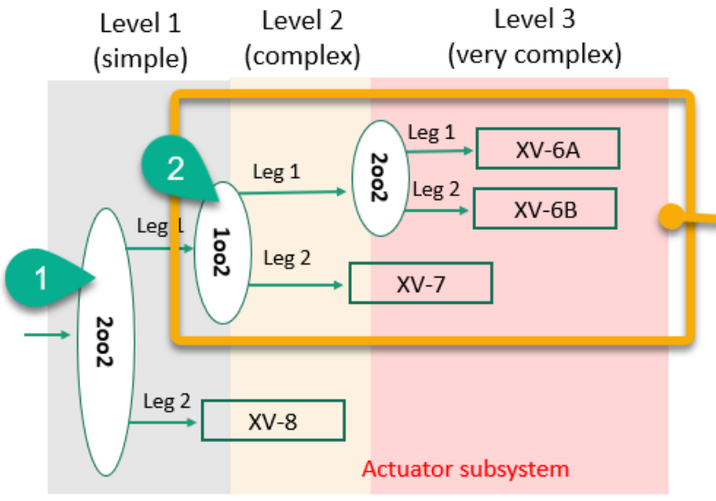
SILcet

1	SIF tag =	Example 1				Achieved>	SIL-2	4283	Example 1							Only for Logic Diagrams			Description
																On	Tags "One by one"		
S	Select	Select		SD	SU	DD	DU	Type	SC	Cpt	TI (y)	LT (y)	β	$MTTR_{DD}$	Startup	Arch	Sensor	Actuator	Select
M	sensor		PT-6	279	94	0	87	2	3	94%	1	15	5%	48	24		PT-6A	XV-6A	2oo3
Db	sen_part	PT3150	transmitter	279	94	0	41	2	3								PT-6B	XV-6B	--
Db	sen_part	PT1199-H	seal	0	0	0	46	1	3								PT-6C	P-61	--
Db	logicsolver	3AI-3DO	SIS-01	11991	137	4025	253	2	3	99%	4	15	2%	48	24				1oo2D
M	ACT_VOTING		GROUP VOTING								1	15							1oo2
M	actuator		XV-6A/B	0	916	0	829	1	3	73%	1	15	10%	48	24	1oo2			1oo2
Db	act_part	Ball-C/FS	valve	0	0	0	442	1	3										--
Db	act_part	ACT-VL/A	actuator	0	286	0	199	1	3										--
Db	act_part	SOL-327/	solenoid	0	516	0	188	1	3										--
Db	act_part	Driver-KF	interface	0	114	0	0	1	3										--
M	actuator		Pump-61	0	1050	0	606	1	2	95%	1	15		48	24	1oo2			1oo1
M																			--
Print1			SENSOR >	ProTrip	T.Fault	Ch.Trip			SIL-2										
0	na	na	PLC diagn. ON	HH	--	Yes										On			
			info			Target>	SIL-1	20											



EXAMPLE 2 – Simple Case with Sub-SIF

EXAMPLE 2
How to calculate in SILcet



Sub-SIF is calculated in another SIF. In column G of Main SIF select "Pfd" and enter PFD & MTTFS values of sub-SIF.

Level 1 architecture is 2oo2, therefore all Legs can be entered directly in the Main SIF.

Select	Select		SD	SU	DD	DU	Type	SC	Cpt	TI (y)	LT (y)	β	$MTTR_{DD}$	Startup	Select	PFDavg	SIL (pfd)	SIL (arch)	MTTFS
sensor		PT-6	279	94	0	87	2	3	94%	1	15	5%	48	24	2oo3	5,25E-05	4	2	3.866
sen_part	PT3150	transmitter	279	94	0	41	2	3							--			--	--
sen_part	PT1199-H	seal	0	0	0	46	1	3							--			--	--
logicsolver	3AI-4DO	SIS-01	12130	138	4082	256	2	3	99%	4	15	2%	48	24	1oo2D	1,78E-04	3	3	197
															--			--	
actuator		sub-SIF					1	3							1oo2	5,88E-04	3	2	120
															--			--	--
actuator		XV-8	0	1026	0	1417	1	3	69%	1	15		48	24	1oo1	3,31E-02	1	1	111
act_part	BTC/FS-c	valve	0	0	0	740	1	3							--			--	--
act_part	ACT-657/	actuator	0	396	0	489	1	3							--			--	--
act_part	SOL-327/	solenoid	0	516	0	188	1	3							--			--	--
act_part	Driver-KF	interface	0	114	0	0	1	3							--			--	--
		SENSOR >	ProTrip	T.Fault	Ch.Trip			SIL-3								3,39E-02	SIL-1	SIL-1	44,1
		PLC diagn. ON	HH	--	Yes											Achieved SIL=		SIL-1	

Main SIF

Select	Select		SD	SU	DD	DU	Type	SC	Cpt	TI (y)	LT (y)	β	$MTTR_{DD}$	St	Select	PFDavg	SIL (pfd)	SIL (arch)	MTTFS
ACT_VOTING		2oo2 OR 1oo1								1	15				1oo2	5,88E-04	3	--	120
actuator		XV-6A/B	0	916	0	829	1	3	73%	1	15	10%	48	24	2oo2			1	--
act_part	Ball-C/FS	valve	0	0	0	442	1	3							--			--	--
act_part	ACT-VL/A	actuator	0	286	0	199	1	3							--			--	--
act_part	SOL-327/	solenoid	0	516	0	188	1	3							--			--	--
act_part	Driver-KF	interface	0	114	0	0	1	3							--			--	--
actuator		XV-7	0	916	0	829	1	3	73%	1	15		48	24	1oo1			1	--
act_part	Ball-C/FS	valve	0	0	0	442	1	3							--			--	--
act_part	ACT-VL/A	actuator	0	286	0	199	1	3							--			--	--
act_part	SOL-327/	solenoid	0	516	0	188	1	3							--			--	--
act_part	Driver-KF	interface	0	114	0	0	1	3							--			--	--
															--			--	--

Sub-SIF

EXAMPLE 2
Architectural Constraints

SILcet

S	Select	Select		SD	SU	DD	DU	Type	SC	Select	PFDavg	SIL (pfd)	HFT	SFF/DC man	SFF	SIL (arch)	MTTFS	Route	value
M	sensor		PT-6	279	94	0	87	2	3	2oo3	5,25E-05	4	1		81,1%	2	3.866	Route 1H	SFF
Db	sen_part	PT3150	transmitter	279	94	0	41	2	3	--			--		--	--	--		
Db	sen_part	PT1199-H	seal	0	0	0	46	1	3	--			--		--	--	--		
Db	logicsolver	3AI-4DO	SIS-01	12130	138	4082	256	2	3	1oo2D	1,78E-04	3	1		98,5%	3	197	Route 1H	SFF
M										--			--		--	--	--		
Pfd	actuator		sub-SIF					1	3	1oo2	5,88E-04	3	1	52,5%	52,5%	2	120	Route 1H	SF
Db										--			--		--	--	--		
M	actuator		XV-8	0	1026	0	1417	1	3	1oo1	3,31E-02	1	0		42,0%	1	111	Route 1H	SF
Db	act_part	BTC/FS-c	valve	0	0	0	740	1	3	--			--		--	--	--		
Db	act_part	ACT-657/	actuator	0	396	0	489	1	3	--			--		--	--	--		
Db	act_part	SOL-327/	solenoid	0	516	0	188	1	3	--			--		--	--	--		
Db	act_part	Driver-KF	interface	0	114	0	0	1	3	--			--		--	--	--		
Print1			SENSOR >	ProTrip	T.Fault	Ch.Trip			SIL-3		3,39E-02	SIL-1	1H	<Route		SIL-1	44,1		
0	na	na	PLC diagn. ON	HH	--	Yes					Achieved SIL=	SIL-1							

Main SIF

S	Select	Select		SD	SU	DD	DU	Type	SC	Select	PFDavg	SIL (pfd)	HFT	SFF/DC man	SFF	SIL (arch)	MTTFS	Route	value
M	ACT_VOTING		2oo2 OR 1oo1							1oo2	5,88E-04	3	1		--	--	120		
M	actuator		XV-6A/B	0	916	0	829	1	3	2oo2			0		52,5%	1	--	Route 1H	
Db	act_part	Ball-C/FS	valve	0	0	0	442	1	3	--			--		--	--	--		
Db	act_part	ACT-VL/A	actuator	0	286	0	199	1	3	--			--		--	--	--		
Db	act_part	SOL-327/	solenoid	0	516	0	188	1	3	--			--		--	--	--		
Db	act_part	Driver-KF	interface	0	114	0	0	1	3	--			--		--	--	--		
M	actuator		XV-7	0	916	0	829	1	3	1oo1			0		52,5%	1	--	Route 1H	
Db	act_part	Ball-C/FS	valve	0	0	0	442	1	3	--			--		--	--	--		
Db	act_part	ACT-VL/A	actuator	0	286	0	199	1	3	--			--		--	--	--		
Db	act_part	SOL-327/	solenoid	0	516	0	188	1	3	--			--		--	--	--		
Db	act_part	Driver-KF	interface	0	114	0	0	1	3	--			--		--	--	--		
M										--			--		--	--	--		

Sub-SIF

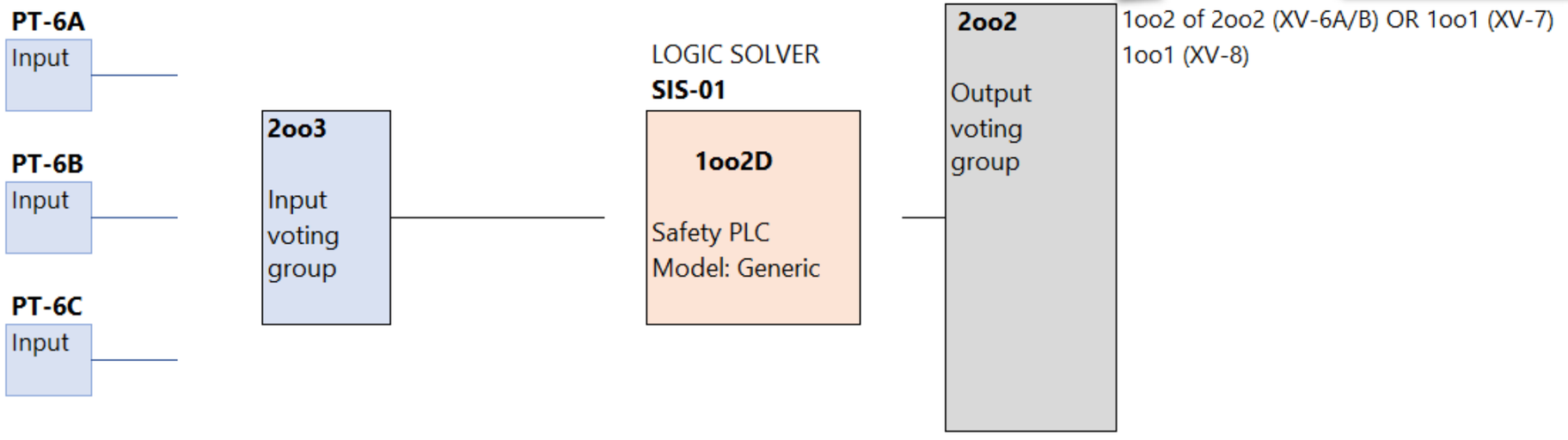
EXAMPLE 2
How to configure the Logic Diagram

SILcet

2	SIF tag =	Example 2 (Main SIF)						Achieved>	SIL-1	30	Example 2 (Main SIF)							Description
S	Select	Select		SD	SU	DD	DU	Type	SC	Cpt	TI (y)	LT (y)	β	$MTTR_{DD}$	Startup	Arch	Sensor	Actuator	Select
M	sensor		PT-6	279	94	0	87	2	3	94%	1	15	5%	48	24		PT-6A	1oo2 of 2oo2 (XV-6A/B) OR	2oo3
Db	sen_part	PT3150	transmitter	279	94	0	41	2	3								PT-6B	1oo1 (XV-8)	--
Db	sen_part	PT1199-H	seal	0	0	0	46	1	3								PT-6C		--
Db	logicsolver	3AI-4DO	SIS-01	12130	138	4082	256	2	3	99%	4	15	2%	48	24				1oo2D
M																			--
Pfd	actuator		sub-SIF					1	3							g 2oo2			1oo2
Db																			--
M	actuator		XV-8	0	1026	0	1417	1	3	69%	1	15		48	24	g 2oo2			1oo1
Db	act_part	BTC/FS-c	valve	0	0	0	740	1	3										--
Db	act_part	ACT-657/	actuator	0	396	0	489	1	3										--
Db	act_part	SOL-327/	solenoid	0	516	0	188	1	3										--
Db	act_part	Driver-KF	interface	0	114	0	0	1	3										--
Print1			SENSOR >	ProTrip	T.Fault	Ch.Trip			SIL-3										
0	na	na	PLC diagn. ON	HH	--	Yes										On			

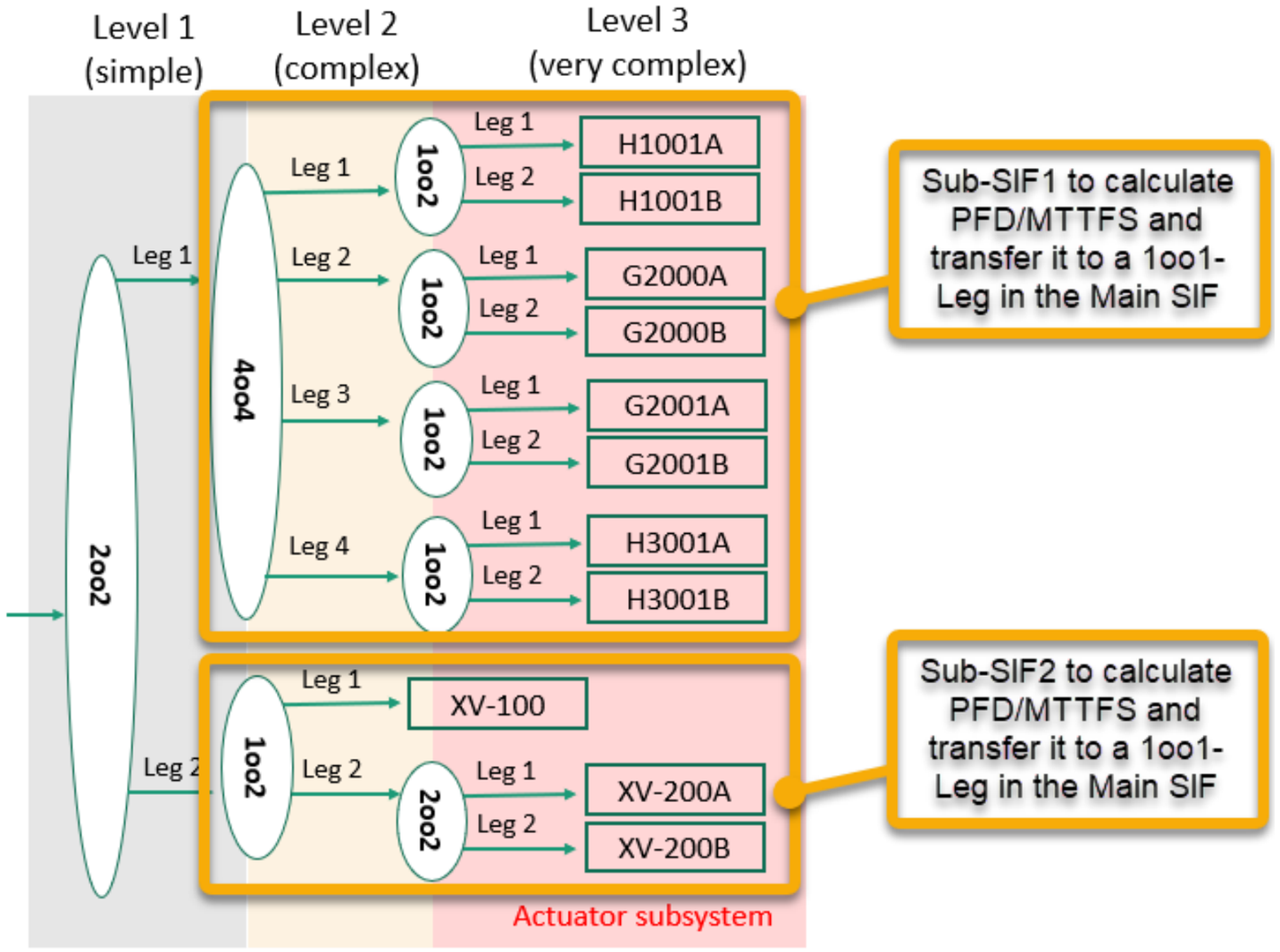
Only for Logic Diagrams		
On	Tags "One by one"	
Arch	Sensor	Actuator
	PT-6A	1oo2 of 2oo2 (XV-6A/B) OR
	PT-6B	1oo1 (XV-8)
	PT-6C	
g 2oo2		
g 2oo2		
On		

Use "General Symbol" (g MooN)

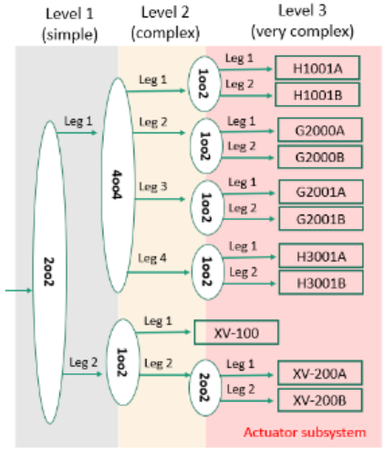


EXAMPLE 3 – Complex Case with Sub-SIF

EXAMPLE 3
SIF Architecture for Final Element



EXAMPLE 3
How to calculate in SILcet



S	Select	Select		SD	SU	DD	DU	Type	SC	Cpt	TI (y)	LT (y)	β	$MTTR_{DD}$	Startup	Select	PFDavg	SIL (pfd)	SIL (arch)	MTTFS
Db	sensor	PT3150	PT-10	29	94	250	41	2	3	90%	1	15	5%	48	24	1oo2	2,17E-05	4	3	476
M																--			--	--
Db	logicsolver	2AI-13DO	ESD-02	15035	191	5589	387	2	3	99%	4	25	2%	48	24	1oo2D	3,05E-04	3	3	144
M																--			--	--
M	ACT_VOTING										1	15				2oo2	9,54E-03	2	--	>50000
M	actuator		sub-SIF 10A	0	0	0	130	1	2	0%		15				1oo1			2	--
M	actuator		sub-SIF 10B	0	725	0	15	1	2	0%		15				1oo1			2	--
M																--			--	--
M																--			--	--
M																--			--	--
M																--			--	--
M																--			--	--
Print1			SENSOR >	ProTrip	T.Fault	Ch.Trip			SIL-2								9,87E-03	SIL-2	SIL-2	110,3
0	na	na	PLC diagn. ON	HH	U.R.	No											Achieved SIL=		SIL-2	

Sub-SIF1

Sub-SIF2

Main SIF

Use "ACT_VOTING" to calculate PFD/MTTFS of 4oo4 Architecture

Use "1oo1 Rates" to calculate the equivalent Rates with 1oo1 architecture.

S	Select	Select		SD	SU	DD	DU	Type	SC	Cpt	TI (y)	LT (y)	β	$MTTR_{DD}$	Startup	Select	PFDavg	SIL (pfd)	SIL (arch)	MTTFS
M	ACT_VOTING		sub-SIF 10A								1	15				4oo4	8,53E-03	2	--	>50000
M	actuator		H1001		600		800	1	2	70%	1	15	10%	48	24	1oo2			2	--
M	actuator		G2000		600		800	1	2	70%	1	15	10%	48	24	1oo2	Sub-SIF1		2	--
M	actuator		G2001		600		800	1	2	70%	1	15	10%	48	24	1oo2			2	--
M	actuator		H3001		600		800	1	2	70%	1	15	10%	48	24	1oo2			2	--
Pfd	1oo1 Rates		sub-SIF 10A		0		130			0%		15				--	8,53E-03		--	>50000
M																--			--	--
M	ACT_VOTING		sub-SIF 10B		700		900	1	2		1	15				1oo2	1,01E-03	2	2	157
M	actuator				700		900	1	2	65%	1	15	10%	48	24	1oo1	Sub-SIF2		--	--
M	actuator				700		900	1	2	70%	1	15	10%	48	24	2oo2			--	--
Pfd	1oo1 Rates		sub-SIF 10B		725		15			0%		15				--	1,01E-03		--	157
M																--			--	--

EXAMPLE 3
Architectural Constraints

-Sub-SIF 10A: SIL (arch.)=2, therefore enter 60% in the Main SIF to get SIL (arch.) = 2.
-Sub-SIF 10B: Enter Route in the row of “ACT_VOTING” and enter overall failure rates. SIL (arch.)=2, therefore enter 60% in the Main SIF to get SIL (arch.) = 2.

SILcet

S	Select	Select		SD	SU	DD	DU	Type	SC	Select	PFDavg	SIL (pfd)	HFT	SFF/DC man	SFF	SIL (arch)	MTTFS	Route	value
Db	sensor	PT3150	PT-10	29	94	250	41	2	3	1oo2	2,17E-05	4	1		90,1%	3	476	Route 1H	SFF
M										--			--		--	--	--		
Db	logicsolver	2AI-13DO	ESD-02	15035	191	5589	387	2	3	1oo2D	3,05E-04	3	1		98,2%	3	144	Route 1H	SFF
M										--			--		--	--	--		
M	ACT_VOTING									2oo2	9,54E-03	2	0		--	--	>50000		
M	actuator		sub-SIF 10A	0	0	0	130	1	2	1oo1			0	60,0%	60,0%	2	--	Route 1H	SFF
M	actuator		sub-SIF 10B	0	725	0	15	1	2	1oo1			0	60,0%	60,0%	2	--	Route 1H	
M										--			--		--	--	--		
M										--			--		--	--	--		
M																--	--		
M										--						--	--		
M										--						--	--		
Print1			SENSOR >	ProTrip	T.Fault	Ch.Trip			SIL-2		9,87E-03	SIL-2	1H	<Route		SIL-2	110,3		
0	na	na	PLC diagn. ON	HH	U.R.	No					Achieved SIL=	SIL-2							
			info				Target>	SIL-1	20										
5	SIF tag =	Sub-SIF of Example 3					Achieved>	SIL-1	52	Description >	Note: the modelling of the Main SIF is not directly possible due to the complex architecture. The Sub-SIF main task is to transfer a portion of the Main SIF to a 1oo1-Leg in the Main SIF.							Arch. Constraints	
								Ok										Select Route	Calculated value
S	Select	Select		SD	SU	DD	DU	Type	SC	Select	PFDavg	SIL (pfd)	HFT	SFF/DC man	SFF	SIL (arch)	MTTFS		
M	ACT_VOTING		sub-SIF 10A							4oo4	8,53E-03	2	0		--	--	>50000		
M	actuator		H1001		600		800	1	2	1oo2			1		42,9%	2	--	Route 1H	SFF
M	actuator		G2000		600		800	1	2	1oo2			1		42,9%	2	--	Route 1H	SFF
M	actuator		G2001		600		800	1	2	1oo2			1		42,9%	2	--	Route 1H	SFF
M	actuator		H3001		600		800	1	2	1oo2			1		42,9%	2	--	Route 1H	SFF
Pfd	1oo1 Rates		sub-SIF 10A		0		130			--	8,53E-03		--		--	--	>50000		
M										--			--		--	--	--		
M	ACT_VOTING		sub-SIF 10B		700		900	1	2	1oo2	1,01E-03	2	1		43,8%	2	157	Route 1H	
M	actuator				700		900	1	2	1oo1			0		--	--	--		
M	actuator				700		900	1	2	2oo2			0		--	--	--		
Pfd	1oo1 Rates		sub-SIF 10B		725		15				1,01E-03		--		--	--	157		
M													--		--	--	--		

Main SIF

Enter 60% manually to force SIL (arch.)=2

Sub-SIF

EXAMPLE 3
How to configure the Logic Diagram

SILcet

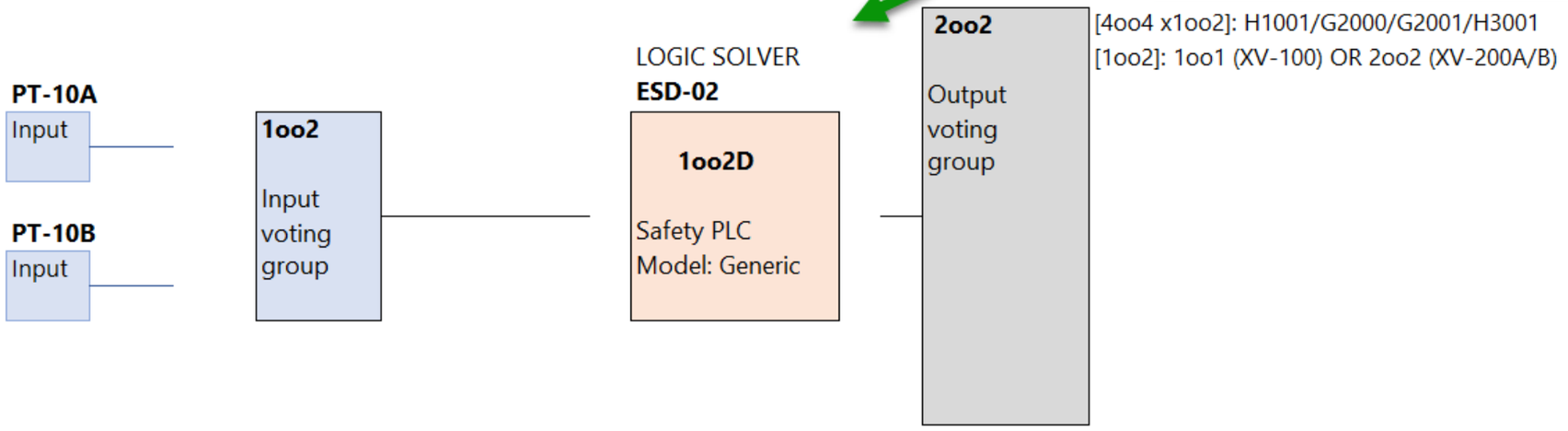
4	SIF tag =	Example 3 (Main SIF)													Achieved>	SIL-2	101	Example 3 (Main SIF)
															Ok			
S	Select	Select		SD	SU	DD	DU	Type	SC	Cpt	TI (y)	LT (y)	β	$MTTR_{DD}$	Startup			
Db	sensor	PT3150	PT-10	29	94	250	41	2	3	90%	1	15	5%	48	24			
M																		
Db	logicsolver	2AI-13DO	ESD-02	15035	191	5589	387	2	3	99%	4	25	2%	48	24			
M																		
M	ACT_VOTING										1	15						
M	actuator		sub-SIF 10A	0	0	0	130	1	2	0%		15						
M	actuator		sub-SIF 10B	0	725	0	15	1	2	0%		15						
M																		
M																		
M																		
M																		
M																		
Print1			SENSOR >	ProTrip	T.Fault	Ch.Trip			SIL-2									
0	na	na	PLC diagn. ON	HH	U.R.	No												

Only for Logic Diagrams		
On	Tags "One by one"	
Arch	Sensor	Actuator
	PT-10A	[4oo4 x1oo2]: H1001/G2000/G2001/H3001
	PT-10B	[1oo2]: 1oo1 (XV-100) OR 2oo2 (XV-200A/B)
g 2oo2		
g 2oo2		
On		

Description >

Select
1oo2
--
1oo2D
--
2oo2
1oo1
1oo1
--
--
--
--
--

Use "General Symbol" (g MooN)



EXAMPLE with common cause failure

Use of common cause failures

When using the "SEN_VOTING" or "ACT_VOTING" options, a common beta factor can be introduced in the calculation instead of using a beta factor for each Leg. The following image shows how to do it (comparison of 2 ways to calculate it).

S	Select	Select		SD	SU	DD	DU	Type	SC	Cpt	TI (y)	LT (y)	β	$MTTR_{DD}$	Startup	STR	x F	Select	PFDavg	SIL (pfd)
M	sensor				200		200			90%	1	15	5%	48	24			1oo2	1,08E-04	3
M																		--		
M																		--		
M	SEN_VOTING				200		200			90%	1	15	5%		24			1oo2	1,08E-04	3
M	sensor				200		200			90%	1	15		48	24			1oo1		
M	sensor				200		200			90%	1	15		48	24			1oo1		
M																		--		
M																		--		
M																		--		
M																		--		
M																		--		
M																		--		
Print1			SENSOR >	ProTrip	T.Fault	Ch.Trip			--										2,16E-04	SIL-3
0	na	na	not used	--	--	--													Achieved SIL=	SIL-0