



Dietmar Post, APR/ADVP, FAT and Training ArcelorMittal Dąbrowa Górnicza, September 2017, Ladenburg

DCS800

Quasi 24-pulse project

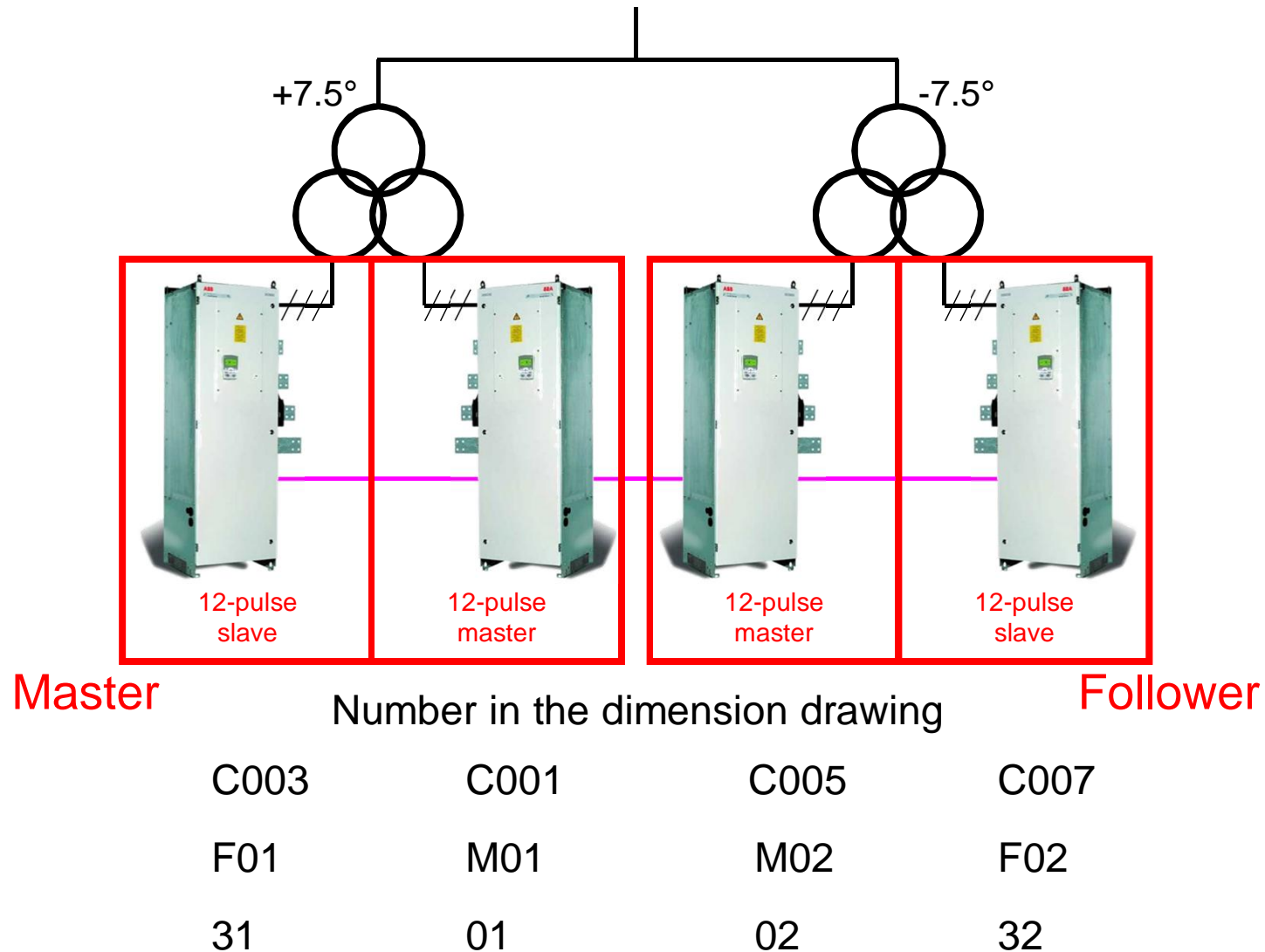
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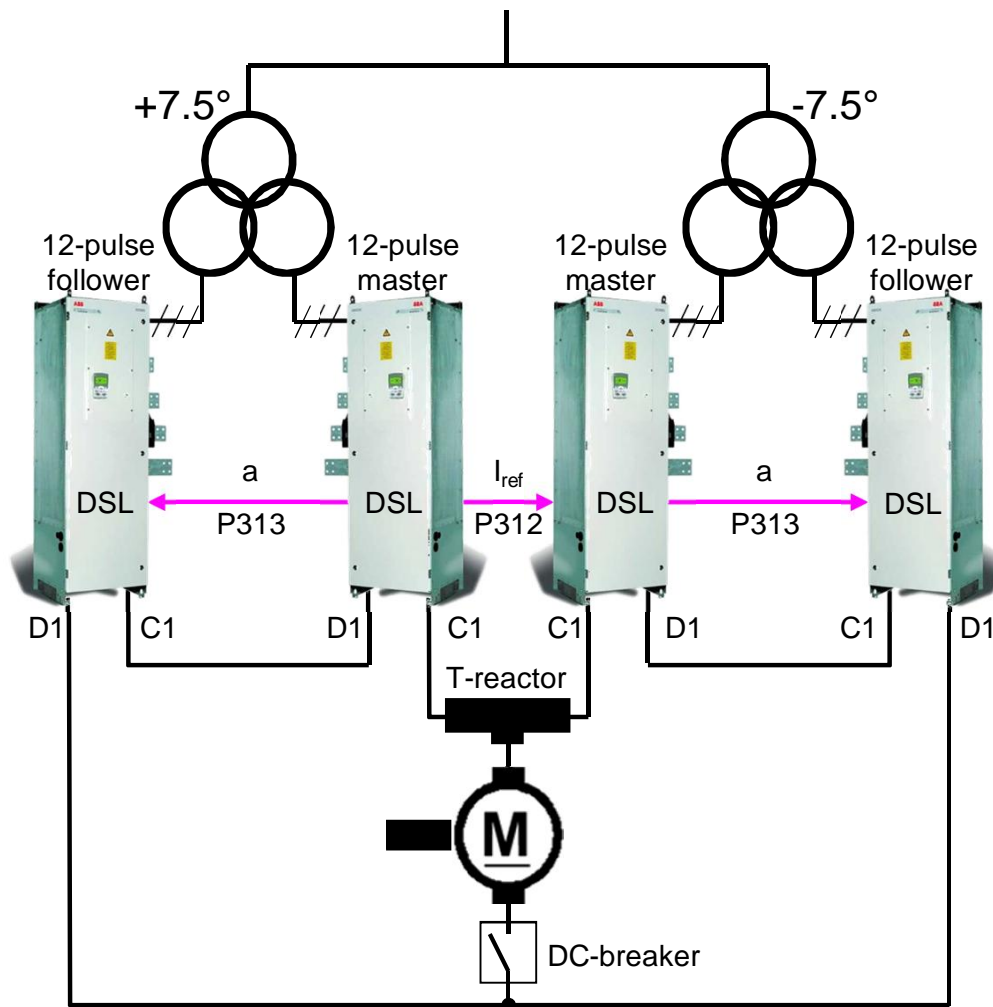
- § 24-pulse basics and naming conventions
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24-pulse basics

Naming conventions



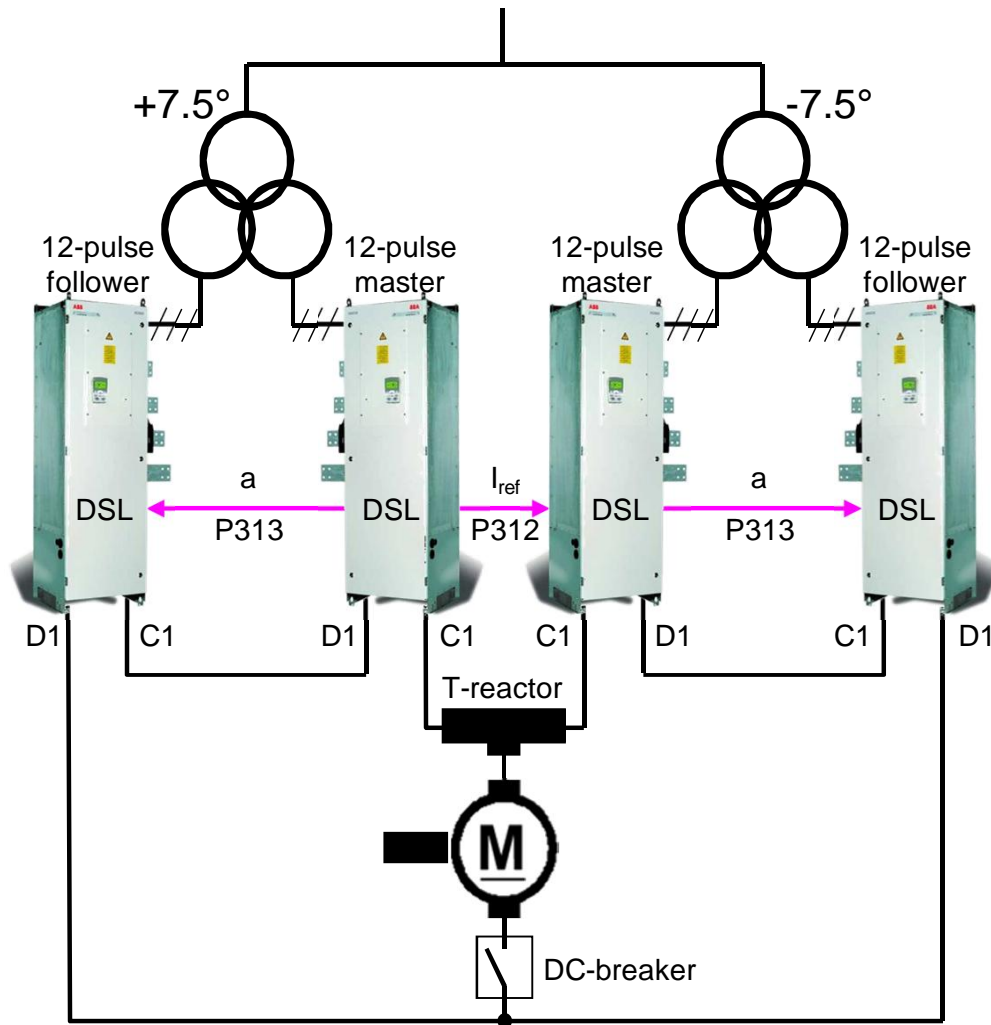
Parallel / serial using two 12-pulse systems (1)



- § Inductance of the only T-reactor leads to fastest current controller and thus to best control performance
- § 2-Q configuration is controlled by standard firmware
- § 2-Q configuration with field reversal is controlled by standard firmware
- § 4-Q configuration needs an additional application program to control the proper current direction change
- § For all configurations a fault and alarm supervision is recommended

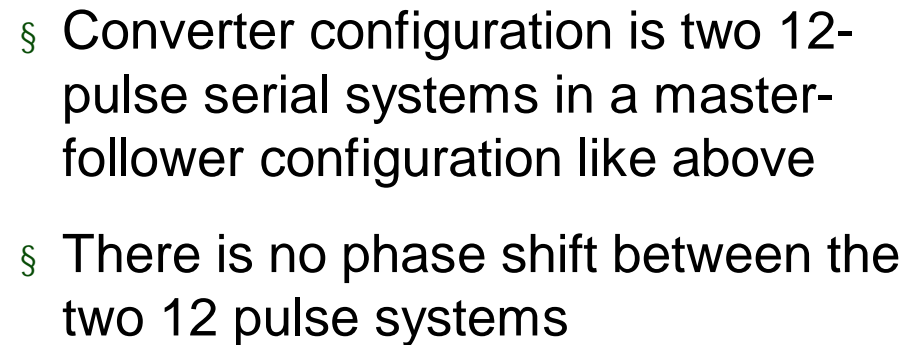
24-pulse basics

Parallel / serial using two 12-pulse systems (2)



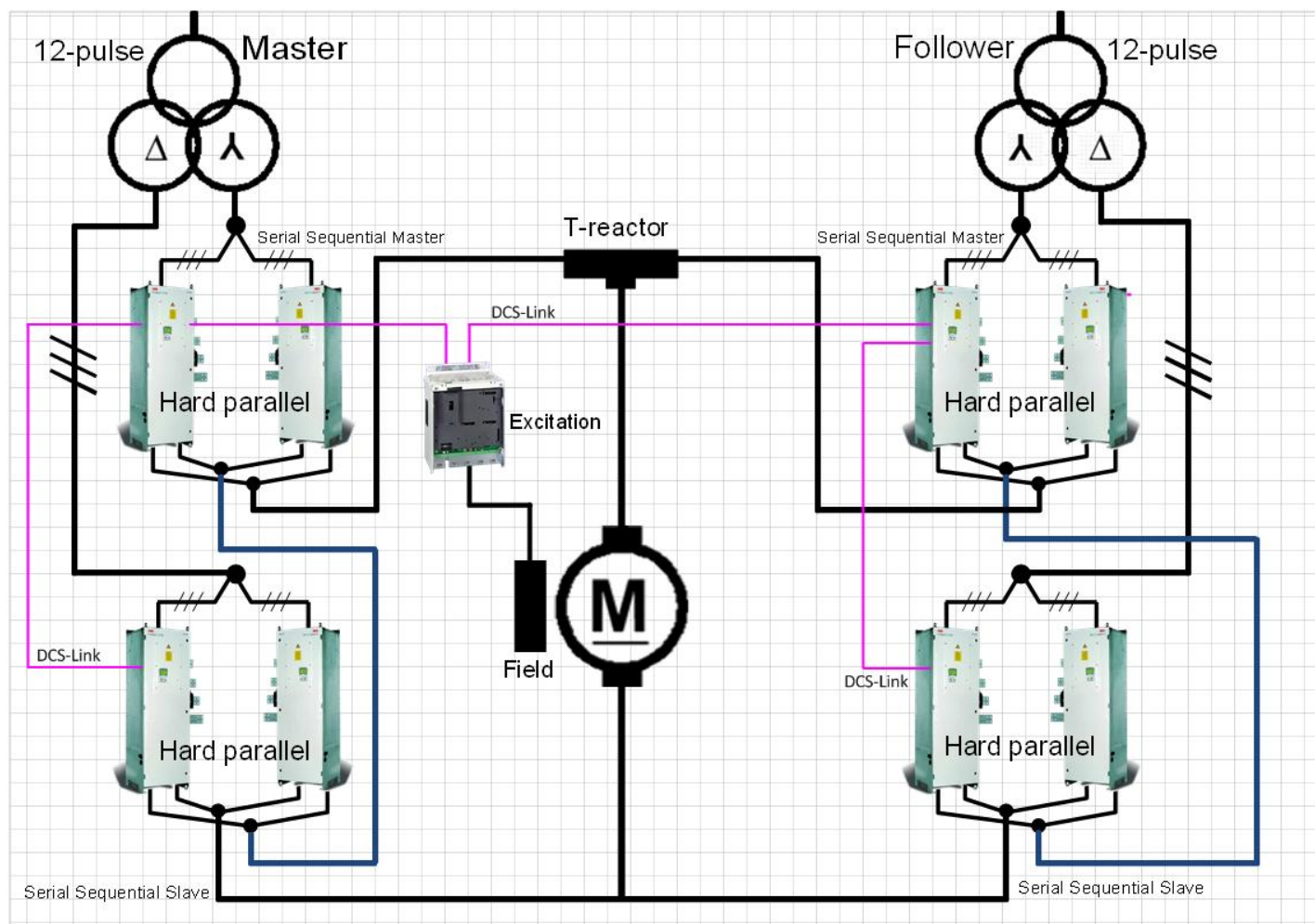
- § Converter configuration is two 12-pulse serial systems in a master-follower configuration
- § The 12-pulse masters send their firing angles - *ArmAlpha* (3.13) - to their 12-pulse slaves
- § The master of the master-follower configuration controls the follower by sending the current reference - *CurRefUsed* (3.12) - to the external current reference - *CurRefExt* (43.03) - of the follower

Quasi 24-pulse (parallel/serial) using two 12-pulse systems without $\pm 7,5^\circ$ phase shift



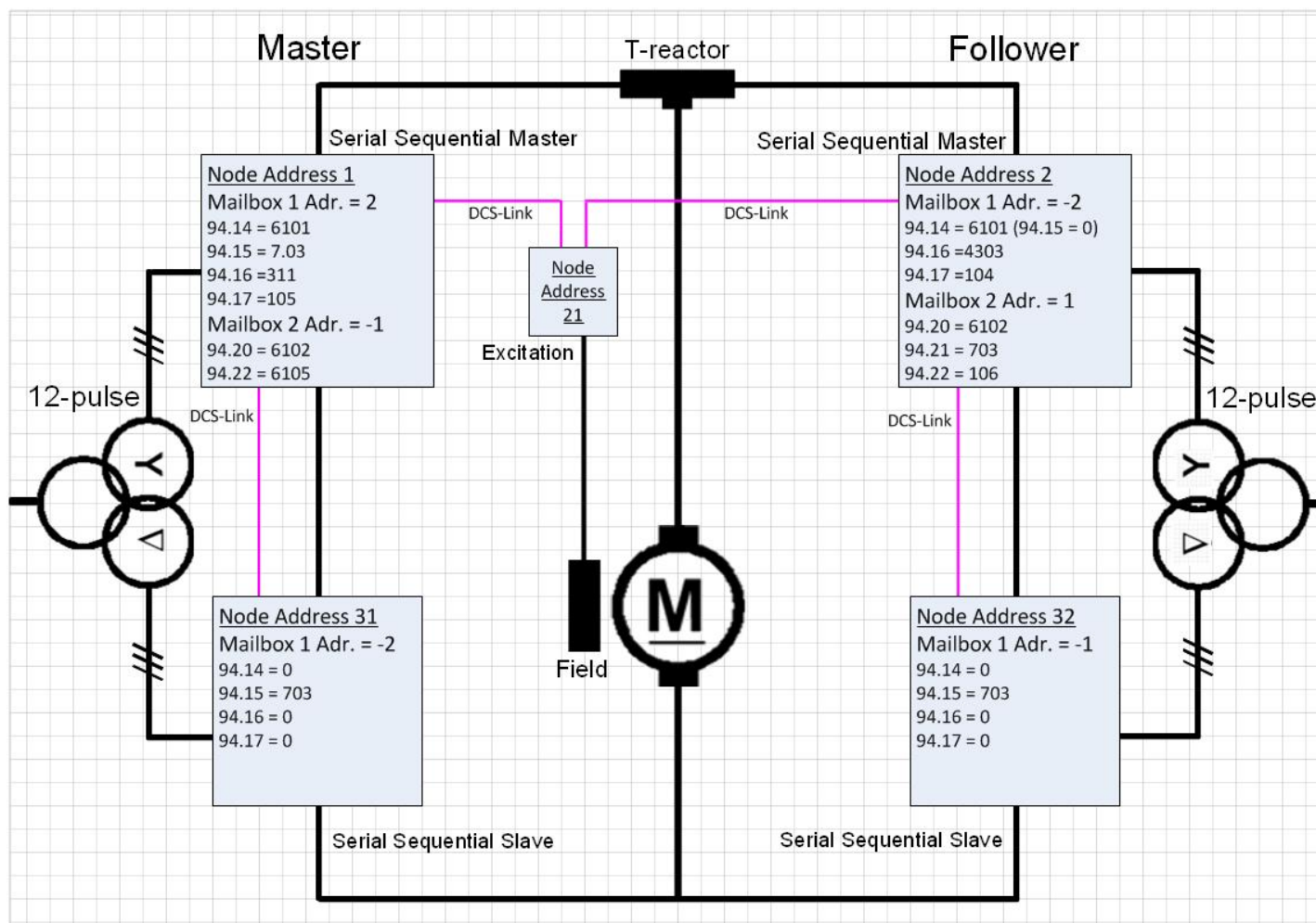
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General overview



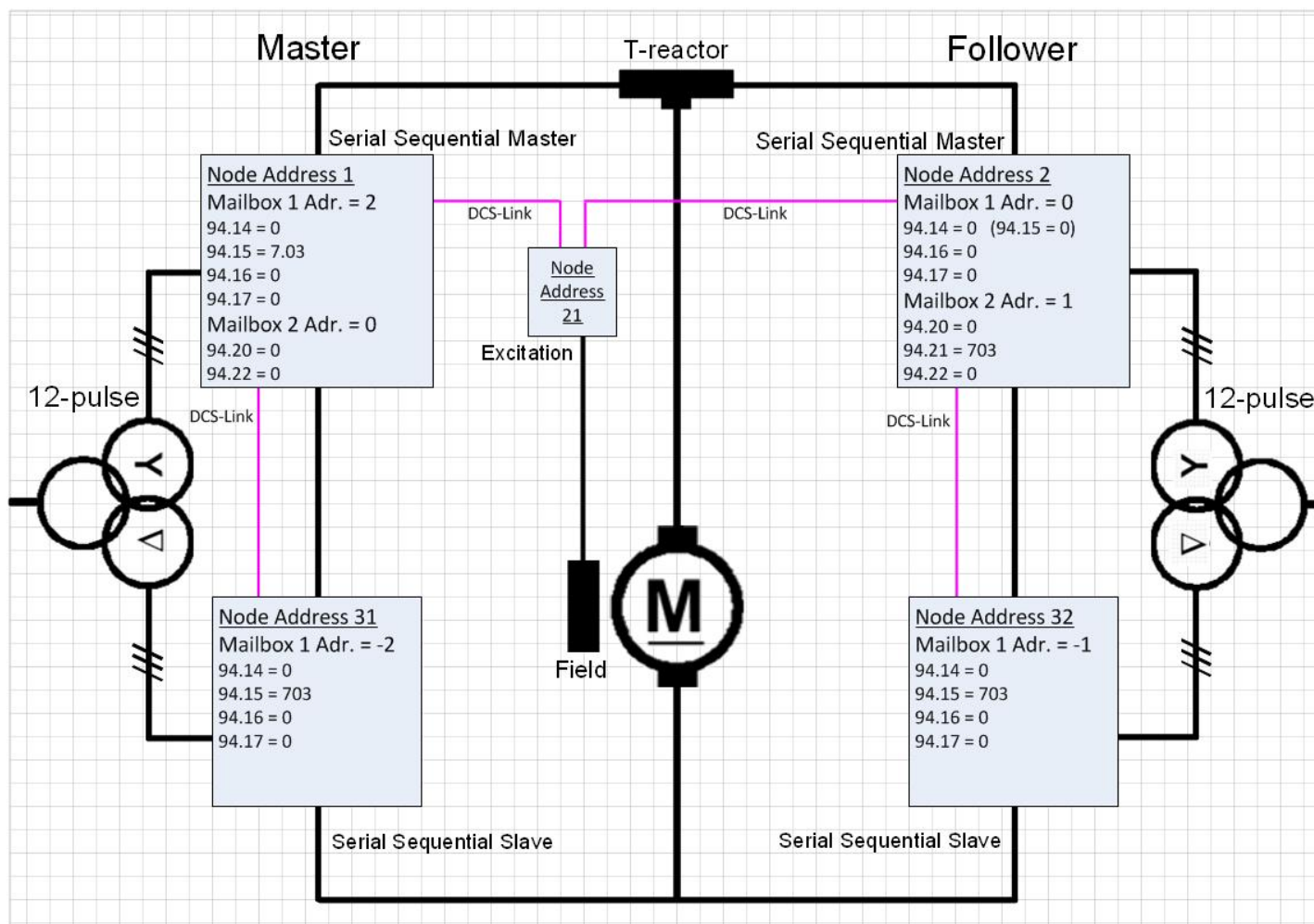
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DCS link mailbox communication with **complete** system



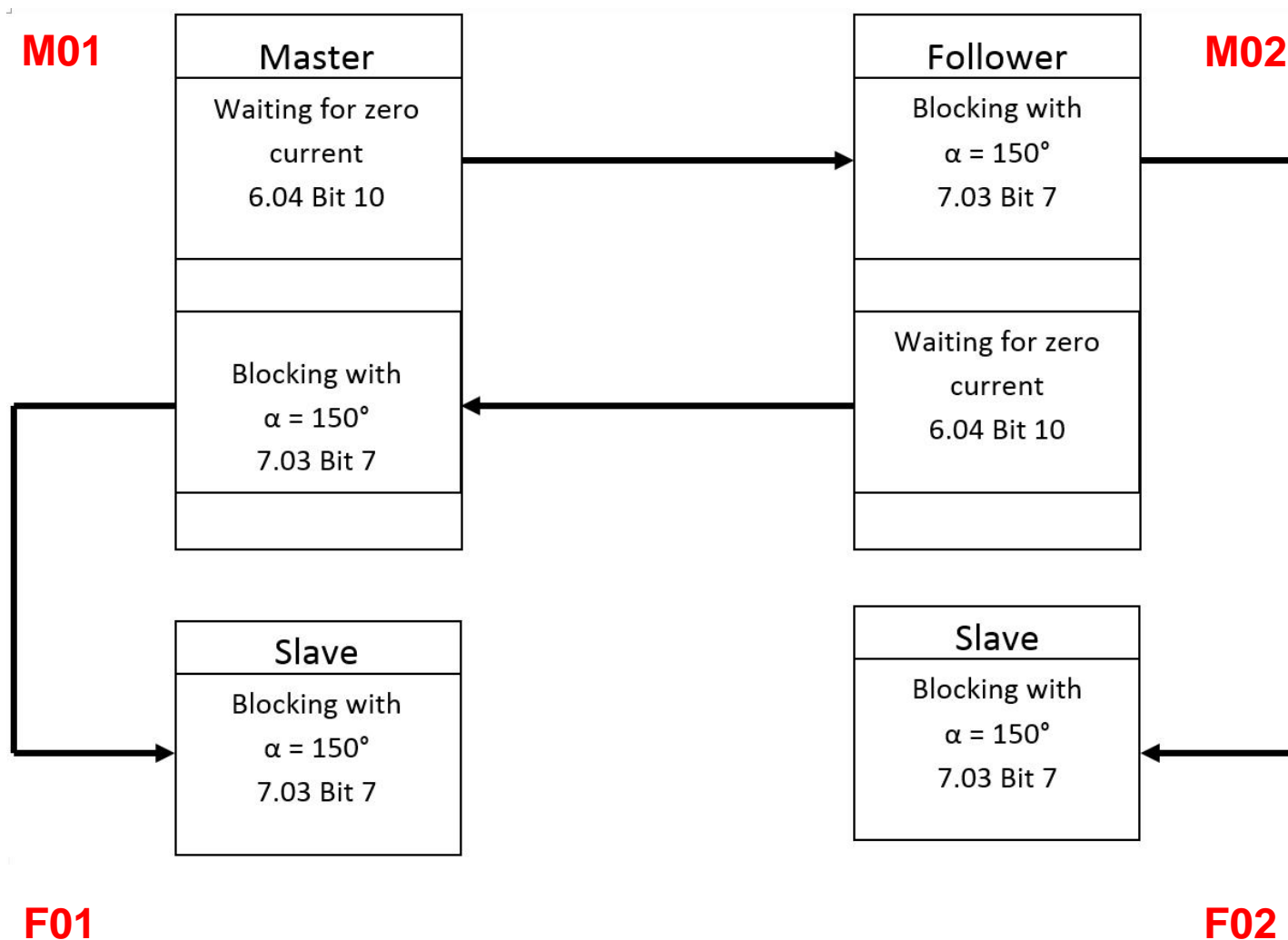
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DCS link mailbox communication with **half** system



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Zero current detection + bridge reversal (24P interlock)



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Zero current detection + bridge reversal (24P interlock)

Signal / Parameter name				min.	max.	def.	unit	E/C
7.03 AuxCtrlWord2 (auxiliary control word 2, ACW2) The auxiliary control word 2 can be written to by AP or overriding control:								
Bit	Name	Value	Comment					
B7	ForceAlphaMax	1	force single firing pulses and set firing angle (α) to <i>ArmAlphaMax</i> (20.14)					
The 24 pulse Interlock between the Master's and the Follower's 12 pulse serial master is written to the 12 pulse serial slaves.								

Signal / Parameter name				min.	max.	def.	unit	E/C
6.04 CurCtrlStat2 (2nd current controller status) 2nd current controller status word. The current controller will be blocked, <i>CurRefUsed</i> (3.12) is forced to zero and <i>ArmAlpha</i> (3.13) is forced to the value of <i>ArmAlphaMax</i> (20.14) if any of the bits is set (0 == OK):								
Bit	Value	Meaning						
B10	1	waiting for zero current, if <i>ZeroCurTimeOut</i> (97.19) is elapsed before bit 10 is set back to 0 F557ReversalTime [<i>FaultWord4</i> (9.04) bit 8] is set. This Bit is used for the 24 pulse Interlock in CoDeSys.						
	0	no action						
B15	1	Current controller not released.						
	0	no action						
This Bit is used for the 24 pulse Interlock in CoDeSys.								

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System selection – configuration possibility

	Master 01 left side	Master 02 (Follower) right side
Complete system	Speed controller 50% motor current Field exciter control E-Stop function active 24 pulse zero current detection and bridge reversal interlocking Control of serial slave	Current follower 50% motor current E- stop function NOT active Control of serial slave
Half system left side emergency configuration	Speed controller Full motor current Field exciter control E-stop function active Control of serial slave	Branch OFF
Half system right side emergency configuration	Branch OFF	Speed controller** Full motor current Field exciter control E-stop function active Control of serial slave

**see next slide

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Special setting in Master 02 (Follower) right side

Signal / Parameter name				min.	max.	def.	unit	E/C
7.02 AuxCtrlWord (auxiliary control word 1, ACW1)				-	-	-		
The auxiliary control word 1 can be written to by AP or overriding control:								
Bit	Name	Value	Comment					
B8	BalSpeedCtrl	1	speed controller output is forced to <i>BalRef</i> (24.11)					
		0	no action					
<u>This bit is written by CoDeSys on the Follower drive:</u>								
CompleteSys:	Parameter 7.02 Bit 8 = TRUE; (7.02 = 256; Speed Controller disabled)							
HalfSysOn:	Parameter 7.02 Bit 8 = FALSE (7.02 = 0; Speed Controller enabled)							
BranchOff:	Parameter 7.02 Bit 8 = FALSE (7.02 = 0; Speed Controller enabled)							

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System selection – configuration possibilities

SysSelDigInp 60.05	SelApplOpMode 60.01	DI11	DI2	SysOpModeAct 60.04
ON	Master	ON	OFF	CompleteSys
ON	Master	OFF	ON	HalfSysOn
ON	Master	OFF	OFF	BranchOff
ON	Follower	ON	OFF	CompleteSys
ON	Follower	OFF	ON	HalfSysOn
ON	Follower	OFF	OFF	BranchOff
OFF	Master	X	X	CompleteSys
OFF	Follower	X	X	CompleteSys
OFF	NotUsed	X	X	Manual

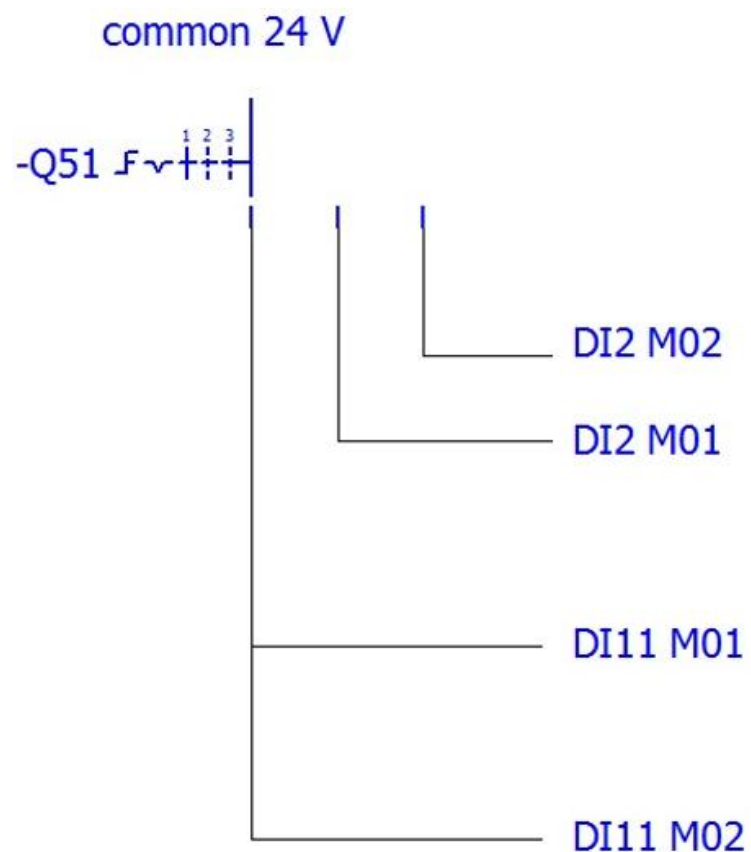
To be set in **both**

12 pulse serial **slaves**

if the 24 pulse application
program is running there!

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System selection by digital input (60.05 = ON)



	DI11 M01 & DI11 M02	DI2 M01	DI2 M02
complete system M01 + M02 , position 1 of switch Q51	1	0	0
half system - M01 , position 2 of switch Q51	0	1	0
half system - M02 , position 3 of switch Q51	0	0	1

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Application program – Parameter switch / DW Monitor

(* Set up valid parameters *)

```
ParSet1001( byGroup:= 10,byIndex:= 1, wOR:= Par_1001);
ParSet1009( byGroup:= 10,byIndex:= 9, wOR:= Par_1009);
ParSet2103( byGroup:= 21,byIndex:= 3, wOR:= Par_2103);
ParSet2104( byGroup:= 21,byIndex:= 4, wOR:= Par_2104);
ParSet4302( byGroup:= 43,byIndex:= 2, wOR:= Par_4302);
ParSet9408( byGroup:= 94,byIndex:= 8, wOR:= Par_9408);
ParWrite9412(byGroup:= 94,byIndex:= 12, wVal:= Par_9412);
ParSet9413( byGroup:= 94,byIndex:= 13, wOR:= Par_9413);
ParWrite9414(byGroup:= 94,byIndex:= 14, wVal:= Par_9414);
ParWrite9415(byGroup:= 94,byIndex:= 15, wVal:= Par_9415);
ParWrite9416(byGroup:= 94,byIndex:= 16, wVal:= Par_9416);
ParWrite9417(byGroup:= 94,byIndex:= 17, wVal:= Par_9417);
ParWrite9418(byGroup:= 94,byIndex:= 18, wVal:= Par_9418);
ParSet9419( byGroup:= 94,byIndex:= 19, wOR:= Par_9419);
ParWrite9420(byGroup:= 94,byIndex:= 20, wVal:= Par_9420);
ParWrite9421(byGroup:= 94,byIndex:= 21, wVal:= Par_9421);
ParWrite9422(byGroup:= 94,byIndex:= 22, wVal:= Par_9422);
ParWrite9903(byGroup:= 99,byIndex:= 3, wVal:= Par_9903);
ParWrite9912(byGroup:= 99,byIndex:= 12, wVal:= Par_9912);
```

Name	Value	OPC Address
10.01: CommandSel	Local I/O	{0}{1}Par.10.1
10.09: E Stop	DI5	{0}{1}Par.10.9
21.03: StopMode	RampStop	{0}{1}Par.21.3
21.04: E StopMode	RampStop	{0}{1}Par.21.4
43.02: CurSel	CurRef311	{0}{1}Par.43.2
94.08: M1FexNode	21	{0}{1}Par.94.8
94.12: MailBox1	2	{0}{1}Par.94.12
94.13: MailBoxCycle1 [ms]	3	{0}{1}Par.94.13
94.14: TmtRecVal1.1	0	{0}{1}Par.94.14
94.15: TmtRecVal1.2	703	{0}{1}Par.94.15
94.16: TmtRecVal1.3	0	{0}{1}Par.94.16
94.17: TmtRecVal1.4	0	{0}{1}Par.94.17
94.18: MailBox2	0	{0}{1}Par.94.18
94.19: MailBoxCycle2 [ms]	100	{0}{1}Par.94.19
94.20: TmtRecVal2.1	0	{0}{1}Par.94.20
94.21: TmtRecVal2.2	0	{0}{1}Par.94.21
94.22: TmtRecVal2.3	0	{0}{1}Par.94.22
99.03: M1NomCur [A]	4770	{0}{1}Par.99.3
99.12: M1UsedFexType	DCS800-S01	{0}{1}Par.99.12

Actual application operation mode:

Name	Value	OPC Address
60.01: SelApplOpMode	Master	{0}{1}Par.60.1
60.02: DRV_is_Master	TRUE	{0}{1}Par.60.2
60.03: DRV_is_Follower	FALSE	{0}{1}Par.60.3
60.04: SysOpModeAct	HalfSysOn	{0}{1}Par.60.4
60.05: SysSelDigInp	ON	{0}{1}Par.60.5
60.06: MotorNomCur [A]	4770	{0}{1}Par.60.6

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Configuration parameters (Group 60)

Index	Signal / Parameter name	min.	max.	def.	unit	E/C
Group 60	Quasi 24 pulse Configuration parameters					
60.01	SelApplOpMode (selection parameter for the operation mode) The implemented selection functions are: 0 = NotUsed 1 = Master 2 = Follower Selection whether a serial sequential master drive (43.01 = 4) is used as Master or Follower . NotUsed is mandatory if the SDCS-MEM-8 card is installed with the implemented program in a serial sequential slave drive (43.01 = 5). In this mode the program has at least no function and is running with a dummy task. NotUsed in a serial sequential master drive (43.01 = 4) can help during commissioning to operate with the 2 serial sequential branches independently. Internal name : SelApplOpMode <div> Type: C Volatile: N </div>	NotUsed	Follower	Notused	'	E

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Configuration parameters (Group 60)

60.02	DRV_is_Master (drive is master indication) This signal indicates that the drive is selected with 60.01 = 1 as Master . Internal name : Drive_is_Master Int. Scaling: 1 == 1 Type: Boolean (FALSE / TRUE) Volatile: Y	FALSE	TRUE	FALSE	E
60.03	DRV_is_Follower (drive is follower indication) This signal indicates that the drive is selected with 60.01 = 2 as Follower . Internal name : Drive_is_Follower Int. Scaling: 1 == 1 Type: Boolean (FALSE / TRUE) Volatile: Y	FALSE	TRUE	FALSE	E
60.04	SysOpModeAct (display of the actual selected operation mode) The operation modes that can be selected are: 0 = CompleteSys 1 = HalfSysOn 2 = BranchOff 3 = Manual	CompleteSys	Manual	CompleteSys	E

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Configuration parameters (Group 60)

0 (CompleteSys):

a.) Depends on DI2, DI11 and 60.01 if 60.05 = ON.

See configuration table:

SysSelDigInp 60.05	SelApplOpMode 60.01	DI11	DI2	SysOpModeAct 60.04
ON	Master	ON	OFF	CompleteSys
ON	Master	OFF	ON	HalfSysOn
ON	Master	OFF	OFF	BranchOff
ON	Follower	ON	OFF	CompleteSys
ON	Follower	OFF	ON	HalfSysOn
ON	Follower	OFF	OFF	BranchOff
OFF	Master	X	X	CompleteSys
OFF	Follower	X	X	CompleteSys
OFF	NotUsed	X	X	Manual

b.) Depends just on the parameter set up in 60.01 with “Master” or “Follower” in configuration with parameter 60.05 = OFF.

1 (HalfSysOn) and 2 (BranchOff):

Depends on DI2, DI11 and 60.01 if 60.05 = ON.

See configuration table above.

3 (Manual):

Depends just on parameter 60.01 in configuration with parameter 60.05 = OFF.

If 60.01 = NotUsed half system control can be realized by customer defined parameter set up manually.

Type: C Volatile: Y

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Configuration parameters (Group 60)

60.05	<p>SysSelDigInp (parameter to control the selection source) The parameter configures the control of the selection source:</p> <p>ON = System Selection by Digital Inputs (Default since version 1.2.0)</p> <p>OFF = System Selection by 60.01</p> <p>ON: The System Operation Mode (CompleteSys, HalfSysOn, BranchOff) can be selected by Digital Inputs (DI2 and DI11). 60.01 is important to configure the branch function (Master or Follower) with the complete system active.</p> <p>OFF: If 60.01 is set to Master or Follower then 60.04 is set to 0 (CompleteSys). If 60.01 is set to NotUsed then 60.04 is set to Manual which means that the branch handling need to be realized manually (user defined parameter sets For HalfSysOn or Branch OFF).</p> <p>Internal name : SysSelDigInp</p> <p style="text-align: right;">Type: C Volatile: N</p>	OFF	ON	ON		E
60.06	<p>MotorNomCur (Motor Nominal Current) Parameter for set up of the Nominal Motor Current.</p> <p>This Parameter is used to modify 99.03 (M1NomCur) via CoDeSys in dependence on which operation is active: Complete Sys with the half Nominal Current (2385 A) each for Master and Follower or a Half System with the full Nominal Current (4770 A).</p> <p>Internal name : MotorNomCur</p> <p>Int. Scaling: 1 == 1 A Type: I Volatile: N</p>	0	30000	4770	A	E

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Master-Follower CW/SW parameters (Group 61)

Index	Signal / Parameter name	min.	max.	def.	unit	E/C
Group 61	Master-Follower CW/SW - application parameters					
61.01	CW_CC_Follower (control word from the Master) The assembled control word (61.01) from the Master with use of parameters 7.04 (UMCW), 8.01 (MSW) and 6.04 (CurCtrlStat2) in combination with some logic blocks is written by CoDeSys from the Master via DCS link Mailbox to parameter 7.01 of the Follower. To see the whole logic conjunction of the control word from the Master please refer to the task description of "PLC_PRG_Master" in the CoDeSys program documentation. Internal name : CW_CCF_6101 Type: I Volatile: Y	0	65535	0	'	U
61.02	SW_CC_Follower (status word from Follower) The assembled status word from the Follower with use of parameters 8.01 and 6.04 is written by CoDeSys from the Follower via DCS link Mailbox to the Master. To see the whole logic conjunction of the SW_CC_Follower please refer to the task description of "PLC_PRG_Follower" in the CoDeSys program. Internal name : SW_CCF_6102 Type: I Volatile: Y	0	65535	0	'	U

Quasi 24 pulse project ArcelorMittal Dąbrowa Górnicza Master-Follower CW/SW parameters (Group 61)

61.03	Trig_Time_Fault (Trigger time on master for Trip of “Follower in fault state”) Trigger time on Master in ms for Trip of “Follower in Fault State”. Internal name : TrigTime_Fault Int. Scaling: 1 == 1 ms Type: I Volatile: N	0	10000	1000	'
61.04	Fault_Dly_Time (Delay time on master for Trip of “Follower in fault state”) Delay time on Master in ms for Trip of “Follower in Fault State”. Internal name : Fault_DlyTime Int. Scaling: 1 == 1 ms Type: I Volatile: N	0	10000	50	'
61.05	MotCurFollower (motor current actual of the Follower) The motor current actual in parameter 1.06 of the Follower is transferred via DCS link mailbox to this parameter which is then only used in the Master. Internal name : MotCurFollower Int. Scaling: 100 == 1 % Type: SI Volatile: Y	-32767	32767	0	%

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Master-Follower CW/SW parameters (Group 61)

61.06	MotCurAll (total motor current actual in A) The motor current actual in parameter 1.06 of the Master and the motor current actual in parameter 61.05 of the Follower are added. The result as a percentage value is divided by 10000 and then multiplied with MotorNomCur which is the nominal motor current in parameter 60.06. $\text{MotCurAll} = [(1.06 * 61.05) / 10000] * \text{MotorNomCur}$ Internal name : MotCurAll Int. Scaling: 1 == 1 A Type: SI Volatile: Y	-32767	32767	0	A	E
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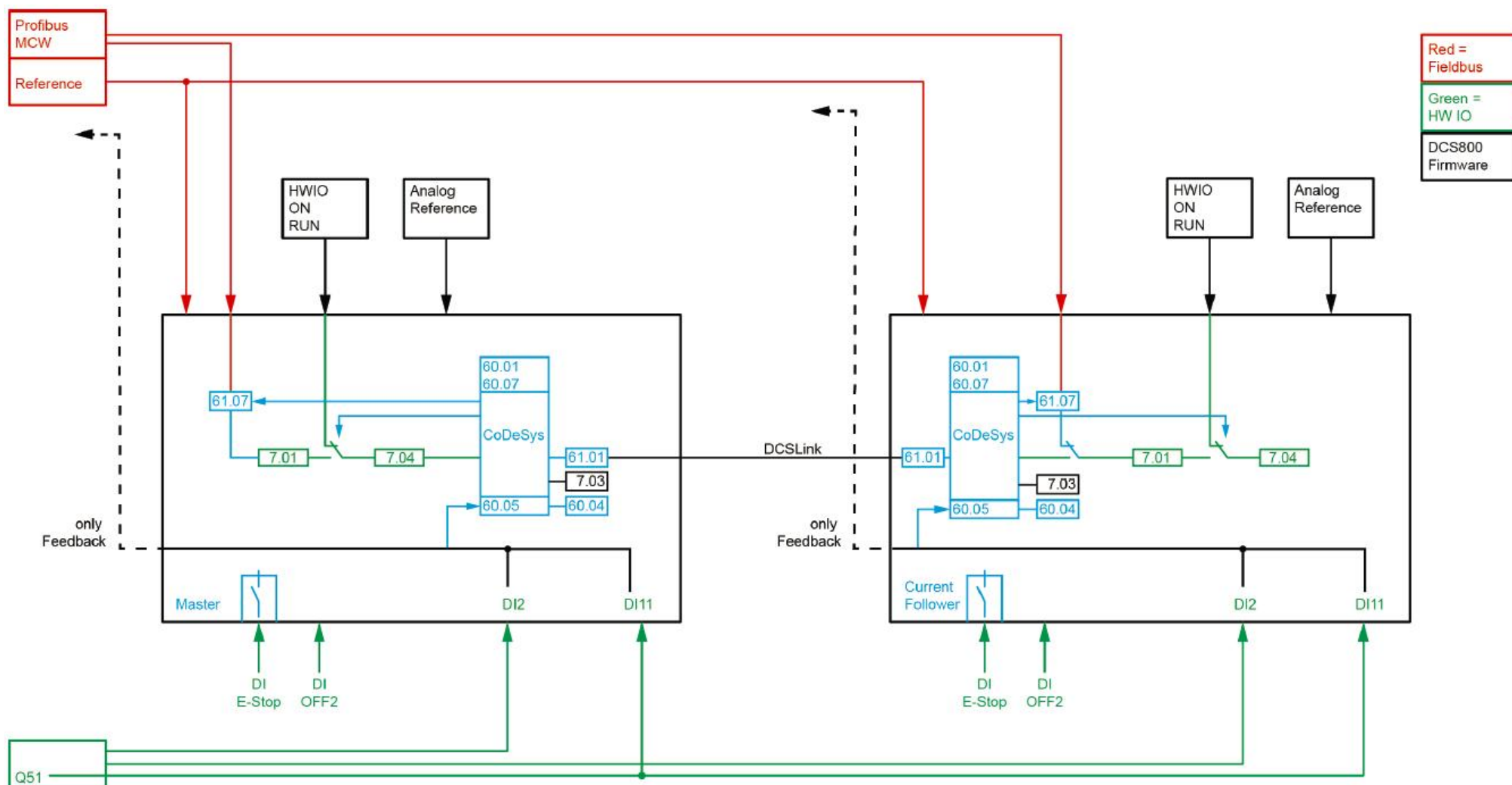
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Fault-Alarm-Text (Group 62)

Index	Signal / Parameter name	min.	max.	def.	unit	E/C
Group 62	<div>Fault-Alarm-Text</div> <div>Quasi 24 pulse application</div>					
60.01	<div>Faulttext (parameter for the displayed fault text of the error event F610)</div> <div>The fault text implemented is:</div> <div><div><div>Name</div><div>Fault 610:</div><div>Internal name</div><div>Type:</div></div><div><div>→</div><div>→</div><div>:</div><div>C</div></div><div><div>Description</div><div>Follower in Fault State</div></div><div><div>→</div><div>→</div></div><div><div>Message</div><div>F610 TripFollower</div></div></div>	TripFollower	TripFollower	TripFollower	-	E

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Update Version 1.3.5 for Profibus communication



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Additional configuration parameter (Group 60)

60.07	<p>ControlSelection (selection parameter for the command control) The implemented selection functions are:</p> <p>0 = Local_IO</p> <p>1 = Fieldbus</p> <p>Command selection in parameter 10.01 is set to Local I/O (60.07 = 0) or MainCtrlWord (60.07 = 1).</p> <p>If the drive is Master and selected as CompleteSys (60.04 = 0) or HalfSys (60.04 = 1) then 10.01 is set according to 60.07.</p> <p>If the drive is Follower then 10.01 is only set according to 60.07 as HalfSys (60.04 = 1). As CompleteSys (60.04 = 0) the Follower is controlled by the Master.</p> <p>In BranchOFF (60.04 = 2) the control of the drive is disabled.</p> <p>Internal name : ControlSelect</p> <p style="text-align: right;">Type: C Volatile: N</p>	Local IO	Fieldbus	Local IO	,	E
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Additional parameter in Group 61

61.07	<p>MCW_Fieldbus (main control word from the fieldbus)</p> <p>This parameter has to be mapped to the fieldbus communication area (Group 90) as data buffer for the main control word sent by the overriding control. If selected by ControlSelection parameter 60.07 = 1 (Fieldbus) the value of this data buffer is written into parameter 7.01 (MCW).</p> <p>If the drive is Master and selected as CompleteSys (60.04 = 0) or HalfSys (60.04 = 1) then 61.07 is written to 7.01.</p> <p>If the drive is Follower then parameter 61.07 is only written to parameter 7.01 as HalfSys (60.04 = 1). As CompleteSys (60.04 = 0) the Follower is controlled by the Master. In this case parameter 61.01 (CW_CC_Follower) is written to parameter 7.01.</p> <p>In BranchOFF (60.04 = 2) the main control word in parameter 7.01 is written by 0.</p> <p>Internal name : MCW_Fieldbus</p> <p style="text-align: right;">Type: I Volatile: Y</p>	0	65535	0	-	E
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