



Application Guide

Simulation with Virtual iC7 Industry Application

MyDrive® Virtual

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Introduction

1 Introduction

1.1 Purpose of the Guide

This application guide provides information on using simulation models to assess the performance of iC7 drives in an application and is intended for qualified personnel such as automation engineers and system designers who have experience in designing application systems. The intended audience of this guide is expected to be familiar with simulation tools and simulation models based on the FMI standard. The simulation tool shown in the examples in this guide is Simulink.

Instructions for using the different simulation tools are not in the scope of this guide. Refer to the documentation of the simulation tool in use for the instructions.

1.2 Version History

This guide is regularly reviewed and updated. All suggestions for improvement are welcome.

The original language of this guide is English.

Table 1: Version History

Version	Remarks
AB436544831461, version 0301	The information in this version is based on application software version 4.0.7 and firmware version 5.0.8.
AB436544831461, version 0201	The information in this version is based on application software version 3.2.4 and firmware version 4.0.7.
AB436544831461, version 0101	First version. The information in this guide is based on application software version 2.1.8 and firmware version 2.2.1.

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2 Overview of MyDrive® Virtual

2.1 Simulation Models for Motor Applications

Danfoss offers different MyDrive® Virtual models depending on the application software and simulation use case.

4 different model scopes are available for motor control applications:

- Application model
- Drive model
- Drive-train model
- Drive system model

The number of parts included in the model scopes vary and the choice of the model depends on the simulation use case.

Table 2: Elements of Simulation Model Scopes

Simulation model	Application software	Control firmware	Converter model	Machine models	Load models
Application	x	-	-	-	-
Drive	x	x	x	_	-
Drive-train	x	x	x	x	-
Drive system	x	x	x	x	x

Application model

The application model contains the complete application software. A basic plant model is added to cover the basic functionality of the drive, such as starting and stopping the drive and configuring ramp behavior. The parameter menu of the application is also available as part of the application software. The drive can be controlled through I/O and fieldbus.

Drive model

The drive model simulates the complete iC7 drive containing application software, firmware, and a model of the drive hardware. As the drive model contains the complete drive software, full functionality is available, including the full drive parameter menu which can be accessed in the FMU parameter menu.

The DriveSize parameter menu can be used to select the drive size from a list that is modeled in the drive hardware.

Drive-train model

The drive-train model contains the same assets as the drive model and an additional motor model. Certain IM and PM motors can be selected from the *Motor* menu to be modeled in the motor hardware plant part. A load model must be connected externally, and external motor speed has to be fed back to the drive-train model.

The drive-train model is recommended if the load behavior of the application is known or exists as a model to simulate drive performance under these conditions.

Drive system model

The drive system model contains the complete drive system: a drive-train model and a model of the motor load.

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3 Parameters

3.1 Parameter Overview

Accessing and configuring the parameters depend on the simulation tool that is used to run a MyDrive[®] Virtual model. The simulation tool used in the examples in this guide is Simulink. Some features may not be available in other simulation tools.

Each MyDrive® Virtual model can be parameterized.

description		
Value	Unit	Description
)		
	Value	Value Unit

Figure 1: Parameter Menu in Simulink

 1
 Name of the simulation model
 2
 Software versions included in the simulation model

 3
 Parameter search
 4
 Available parameter menus

 The parameter search is not available in all simulation tools.
 4
 Available parameter menus

NOTICE

In Simulink, changing an existing parameter is allowed during the simulation. The value changes immediately.

• Consider if the change during simulation makes sense. For example, changing the motor type during runtime is not a valid use case for simulation.

3.2 Parameter Menus

The parameter menu is split into 2 parts:

• Drive parameter menu

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Hardware configuration menu

The drive parameter menu is used for configuring the drive. The structure of the menu reflects the menu of the iC7 drive, which the simulation model is based on. In this example, the simulation model is for the Industry application software package.

The hardware configuration menu is used for selecting a motor and a specific drive size variant for simulation. The structure and content of the hardware configuration menu depend on the available simulation model and are different for motor and grid applications.

pentitio D	ocumentation	TTHE			
Parameters	Simulation	n Input Outpu	ut		
ilter by nam	e or descript	tion			
Param	neter	Value	Unit	Description	
E Indust	гуАрр				
> 🗄 M1	Grid				
> 🗄 M2	Power_Conv	ersion_DC_Link			
> 🗄 M3	_FiltersBrak	e_Chopper			
> 🗄 M4	Motor				
> 🗄 M5	Application				
> 🗄 M6	Maintenance	eService			
> 🗄 M7	Functional_S	Safety			
> 🗄 M8	Customizati	on			
> 🗄 M9	_10				
> 🗄 M10	0_Connectivit	ty			
E Motor					
DriveS	ize				

1 Drive parameter configuration menu 2 Hardware configuration menu

3.3 Drive Parameter Configuration Menu

Drive parameters included in the application software can be configured. In this example, the default value of parameter Motor Control Principle is changed from U/f control to VVC+ control by changing the selection from [0] to [1]. The parameter menu includes a help text which provides more information about the purpose of the parameter and what are the available selections for the parameter.

IMPORTANT: Status parameters are not included in the parameter menu.

Because of restrictions in the FMI standard, it is not possible to write back parameter values from the simulation model to the parameter menu. Therefore, readout parameters are not included in the parameter menu, but are removed.

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_IndustryDriveTrainStd [Co-Simulation, v2.0]																												
MU Block		0.0123																										
Dantoss IC/ Drive - AppVersion: 2.1.8 - FwVersion: 2.2.	1 - ModelVers	sion: 0.4																										
open rmo bocumentation file																												
Parameters Simulation Input Output																												
Filter by name or description																												
Parameter	Value	Unit														Descript	tion											
🕶 🖪 IndustryApp																												
> 🖪 M1_Grid																												
> M2_Power_Conversion_DC_Link																												
M3_Filters_Brake_Chopper																												
✓ I M4_Motor																												
> 🖪 M4_1_Status																												
> 🔣 M4_2_Motor_Data																												
✓ I M4_3_Motor_Control																												
✓ Ⅲ M4_3_1_General_Settings																												
P4_3_1_1_Motor_Control_Principle	int32(1)	IndustryApp.	M4_Motor.	or.M4_3	4_3_N	Mot	otor_(Contr	trol.M4	/4_3_1_	Gener	ral_Sett	tings.P4_	3_1_1_1	Motor_Co	ontrol_Prin	nciple: Se	elects the	motor co	ontrol pr	inciple.	0: U/f Cor	ntrol, 1:	VVC+ Co	ontrol,	2: FVC	+ Contro	ol, -
P4_3_1_2_Breakaway_Current_Boost	boolean(0)	IndustryApp.	M4_Motor.	or.M4_	4_3_N	Mot	otor_(Contr	trol.M4	14_3_1_	Gener	ral_Sett	tings.P4_	3_1_2_E	Breakawa	ay_Current	Boost:	Enable b	eakaway	current	boost, w	hich temp	orarily	allows hi	igher s	tarting	current.	
M4_3_2_Uf_Settings																												
> 🖪 M4_3_3_FVC_Settings																												
M4_3_4_VVC_Uf_Settings																												
> 🖪 M4_5_Protection																												
✓ III M5_Application																												
> 🖪 M5_1_Status																												
> 🗄 M5_2_Protection																												
> 🖪 M5_3_Load																												
> 🖪 M5_4_Operation_Mode																												
> M5_5_Control_Places																												
> M5_6_Start_Settings																												
> M5_7_Stop_Settings																												
✓ 🖽 M5_8_Speed_Control																												
> 🖪 M5_8_1_Status																												
✓ III M5_8_2_Speed_Controller																												
P5_8_2_1_Proportional_Gain	20	IndustryApp.	M5_Applica	lication	on.MS	M5_8	_8_Sp	peed_	Contr	trol.M5	5_8_2_5	Speed_	Controlle	er.P5_8	_2_1_Pro	portional_	Gain: Se	ts the Pro	oportiona	Gain o	the spe	ed control	fler in %	i/Hz.				
R P5_8_2_2_Integration_Time	0.1	s IndustryApp.	M5_Applica	lication	on.MS	M5_8	_8_Sp	peed_	Contr	trol.M5	5_8_2_9	Speed_	Controlle	er.P5_8	_2_2_Inte	gration_Ti	ime: Set	s the Inte	gration Ti	me of t	ne speed	controlle	r.					
P5_8_2_3_Acceleration_Feedforward	0	% IndustryApp.	M5_Applica	lication	on.MS	M5_8	_8_Sp	peed_	Contr	trol.M5	5_8_2_9	Speed_	Controlle	er.P5_8	_2_3_Acc	eleration_l	Feedfor	ward_Gai	n: Acceler	ation Fe	edforwa	rd bypasse	es the s	peed cor	ntrolle	r by ad	ding tor	que r
P5_8_2_4_Acceleration_Feedforward	0	s IndustryApp.	M5_Applica	lication	on.MS	M5_8	_8_Sp	peed_	I_Contr	trol.M5	5_8_2_9	Speed_	Controlle	er.P5_8	_2_4_Acc	eleration_l	Feedfon	ward_Filt	er_Time_C	on: Aco	eleration	Feedforw	ard byp	basses the	ie spee	d cont	roller by	addi
		1																										

Figure 3: Example of the Drive Parameter Menu in Simulink

1	Title bar	2	Parameter value
	In Simulink, it is possible to sort the parameters by clicking the <i>Parameter</i> text in the title bar.		
3	Parameter index number	4	Unit of parameter value
5	Available selections for parameter value		

For detailed information about parameters, see the relevant application guide.

3.4 Hardware Configuration Menu

In this example, a motor is configured using the hardware configuration parameter menu and the motor plant simulation model.

The Motor Configuration menu can be divided into 2 main groups:

- Customizable motor configurations
- Preconfigured motor configuration setups

The customizable motor configurations support induction and synchronous motors. The customizable configurations are M0 and M1 in <u>Figure 4</u>. Preconfigured motor setups are loaded with the dedicated motor data. In this example, the preconfigured motor data is the OGD motor, which is indicated as M2 in <u>Figure 4</u>.

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Parameters

FMU Block	.0]		
Danfoss iC7 Drive - AppVersion: 2.1.8 - FwVe	rsion: 2.2.1 - ModelVe	rsion: 0	4
Open FMU Documentation File			
Parameters Simulation Input Outp	ut		
Elter bu name or description			
Filter by hane of description			
Parameter	Value	Unit	Description
> 🖻 IndustryApp			
V 🖪 Motor			
MotorSelection	int32(0)		Motor.MotorSelection: Motor.Value.MotorSelection
- > 🗄 M0_Asyn_Ind_Motor_Customizable			
> 🗄 M1_Permanent_Magnet_Motor_Cust	omizable		
M2_ogd_P3k958N3000Z3E120SPM			
Motor_Type	int32(1)		Motor.M2_ogd_P3k958N3000Z3E120SPM.Motor_Type: Motor saturated q-axis inductance
Number_of_Pole_Pairs	int32(5)		Motor.M2_ogd_P3k958N3000Z3E120SPM.Number_of_Pole_Pairs: Motor pole pair number
R Nominal_Power	3958	W	Motor.M2_ogd_P3k958N3000Z3E120SPM.Nominal_Power: Motor nominal shaft prever
R Nominal_Current	7.2	A	Motor.M2_ogd_P3k958N3000Z3E120SPM.Nominal_Current: Motor nominal current
R Nominal_Speed	3000	rpm	Motor.M2_ogd_P3k958N3000Z3E120SPM.Nominal_Speed: Motor nominal shaft speed
R Nominal_Frequency	250	Hz	Motor.M2_ogd_P3k958N3000Z3E120SPM.Nominal_Frequency: Motor nominal frequency
R Nominal_Voltage	480	V	Motor.M2_ogd_P3k958N3000Z3E120SPM.Nominal_Voltage: Motor nominal voltage
R Stator_Resistance_Rs	0.5	Ω	Motor.M2_ogd_P3k958N3000Z3E120SPM.Stator_Resistance_Rs: Motor stator resistance
R Back_EMF	120	V	Motor.M2_ogd_P3k958N3000Z3E120SPM.Back_EMF: Stator nominal induced voltage (back e.m.f voltage) line-line RMS at 1000 rpm
R daxis_Inductance_Ld	0.005	н	Motor.M2_ogd_P3k958N3000Z3E120SPM.daxis_Inductance_Ld: Motor saturated d-axis inductance
R daxis_Inductance_LdSat	0.005	H	Motor.M2_ogd_P3k958N3000Z3E120SPM.daxis_Inductance_LdSat: Motor saturated d-axis inductance
R qaxis_Inductance_Lq	0.005	Н	Motor.M2_ogd_P3k958N3000Z3E120SPM.qaxis_Inductance_Lq: Motor saturated q-axis inductance
R qaxis_Inductance_LqSat	0.005	H	Motor.M2_ogd_P3k958N3000Z3E120SPM.qaxis_Inductance_LqSat: Motor saturated q-axis inductance
> E DriveSize			

Figure 4: Example of the Hardware Configuration Parameter Menu in Simulink

1Motor selection value2Parameter for induction motor configuration3Preconfigured OGD motor

The complete motor setup is visible in the parameters under *M2_ogd_P3k958N3000Z3E120SPM*. The values come from a motor database and are used to configure the motor plant model inside the simulation model. As with drive parameters, changing the values is allowed, for example to simulate temperature changes of the motor by changing the value of parameter *Stator Resistance Rs*.

3.5 DriveSize Menu

The drive variant for the simulation is selected in the *DriveSize* menu. The number of the drive size is included in the name as a prefix and in the value.

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Paran	neters Simulation Input Output		
Filter	by name or description		
	Parameter	Value U	Init
	IndustryApp		
> =	Motor	6	
-	DriveSize		
DriveSizeSetup		int32(0)	DriveSize.DriveSizeSetup: DriveSize.Value.DriveSizeSetup
I	D0_iC7_60_FX02_3N05_9A2	int32(0)	DriveSize.D0_iC7_60_FX02_3N05_9A2: DriveSize.Value.D0_iC7_60_FX02_3N05_9A2
-[D1_iC7_60_FX03_3N05_16A	int32(1)	DriveSize.D1_iC7_60_FX03_3N05_16A: DriveSize.Value.D1_iC7_60_FX03_3N05_16A
[D2_iC7_60_FX04_3N05_24A	int32(2)	DriveSize.D2_iC7_60_FX04_3N05_24A: DriveSize.Value.D2_iC7_60_FX04_3N05_24A
[D3_iC7_60_FX05_3N05_43A	int32(3)	DriveSize.D3_iC7_60_FX05_3N05_43A: DriveSize.Value.D3_iC7_60_FX05_3N05_43A
[D4_iC7_60_FX06_3N05_61A	int32(4)	DriveSize.D4_iC7_60_FX06_3N05_61A: DriveSize.Value.D4_iC7_60_FX06_3N05_61A
-			

Value of the parameter
 Current rating of the drive in the parameter value
 Current rating of the drive in the parameter value

For more information on the current ratings of drives, refer to the drive-specific design guides.

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Parameters

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4 I/O Interface

4.1 Overview

Each FMU model comes with a collection of inputs and outputs, which fulfill the typical needs when performing simulations. Danfoss has defined a standard I/O interface for each model.

The inputs and outputs are based on the FMI standard and can be 1 of the following data types:

- Integer: 32-bit signed integer, int32
- Real: 64-bit floating point, double
- Boolean: 1-bit boolean, bool

NOTICE

Depending on the simulation tool, using incorrect data types may cause errors.

• Make sure that signals of the correct data types are handed over to MyDrive[®] Virtual.

The interface descriptions in this guide reflect application software version 4.0.7 and firmware version 5.0.8. For more information about the control and functionality of Industry application software, refer to *i*C7 Series Industry Application Guide.

4.2 Events

Models containing control firmware also simulate event behaviors. Output *Exception Status* indicates the occurrence of events during simulation. Exception statuses and event levels are explained in Table 3.

Table 3: Descriptions of Exception Status Values

Exception status value	Event level
1	None
2	Info
3	Warning
4	Fault

The Events.log file created by the MyDrive®Virtual FMU model includes detailed information about events. The log file is stored in the work folder of the simulation tool, and contains the exact timestamp when the event occurred during the simulation, the event code, event level, and resulting actions. For more information on the occurrences, see the *i*C7 Series Industry Application Guide.

```
At simulation time: 0.0000200s -> Occurrence[5301] set to WARNING with Inverter action: NONE and BrakeAction: NONE (03/01/24);
At simulation time: 0.0050200s -> Occurrence[5301] set to REMOVED with Inverter action: NONE and BrakeAction: NONE (03/01/24);
At simulation time: 0.8000200s -> Occurrence[5171] set to INFO with Inverter action: NONE and BrakeAction: NONE (03/01/24);
At simulation time: 3.8000200s -> Occurrence[5291] set to WARNING with Inverter action: NONE and BrakeAction: NONE (03/01/24);
At simulation time: 6.1000200s -> Occurrence[5291] set to REMOVED with Inverter action: NONE and BrakeAction: NONE (03/01/24);
At simulation time: 6.9000200s -> Occurrence[5172] set to INFO with Inverter action: NONE and BrakeAction: NONE (03/01/24);
At simulation time: 7.2652000s -> Occurrence[4178] set to FAULT with Inverter action: COAST and BrakeAction: NONE (03/01/24);
At simulation time: 7.2804000s -> Occurrence[4164] set to WARNING with Inverter action: NONE and BrakeAction: NONE (03/01/24);
At simulation time: 10.5050200s -> Occurrence[4178] set to REMOVED with Inverter action: NONE and BrakeAction: NONE (03/01/24);
At simulation time: 10.5050200s -> Occurrence[4178] set to REMOVED with Inverter action: NONE and BrakeAction: NONE (03/01/24);
At simulation time: 10.5050200s -> Occurrence[4164] set to REMOVED with Inverter action: NONE and BrakeAction: NONE (03/01/24);
At simulation time: 10.5050200s -> RESET signal detected (03/01/24);
At simulation time: 10.5050200s -> RESET signal detected (03/01/24);
At simulation time: 12.2504000s -> Occurrence[4164] set to REMOVED with Inverter action: NONE and BrakeAction: NONE (03/01/24);
At simulation time: 27.0264000s -> Occurrence[4178] set to FAULT with Inverter action: NONE and BrakeAction: NONE (03/01/24);
At simulation time: 27.0264000s -> Occurrence[4178] set to FAULT with Inverter action: COAST and BrakeAction: NONE (03/01/24);
```

Figure 6: Example of an Events.log File

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4.3 Industry Application Std Model

Table 4: Industry Application Std Model Inputs

Name	Туре	Description
FbCtrlWord	Integer	Fieldbus control word
FbSpeedRef	Integer	Fieldbus speed reference
Digln10113	Boolean	Digital input 10113
Digln10114	Boolean	Digital input 10114
Digln10115	Boolean	Digital input 10115
Digln10116	Boolean	Digital input 10116
Digln10117	Boolean	Digital input 10117
Digln10118	Boolean	Digital input 10118
Analn10133	Real	Analog input 10133
Analn10134	Real	Analog input 10134

Table 5: Industry Application Std Model Outputs

Name	Туре	Description
FbStatusWord	Integer	Fieldbus status word
FbMainActualValue	Integer	Fieldbus main actual value
AppSpecStatusWord	Integer	Application-specific status word
MotorCtrlStatusWord	Integer	Motor control status word
DigOut10115	Boolean	Digital output 10115
DigOut10116	Boolean	Digital output 10116
AnaOut10131	Real	Analog output 10131
FreqRef	Real	Frequency reference
FreqActual	Real	Frequency actual output

4.4 Industry Drive Std Model

Table 6: Industry Drive Std Model inputs

Name	Туре	Description
FbCtrlWord	Integer	Fieldbus control word
FbSpeedRef	Integer	Fieldbus speed reference
FbTorqueRef	Integer	Fieldbus torque reference
Digln10113	Boolean	Digital input 10113
DigIn10114	Boolean	Digital input 10114

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Table 6: Industry Drive Std Model inputs (continued)

Name	Туре	Description
Digln10115	Boolean	Digital input 10115
Digln10116	Boolean	Digital input 10116
Digln10117	Boolean	Digital input 10117
Digln10118	Boolean	Digital input 10118
Analn10133	Real	Analog input 10133
Analn10134	Real	Analog input 10134
GridVoltage	Real	Grid voltage LL RMS
MotorEuvw	Real	Motor voltage phases U, V, and W
Motorlsuvw	Real	Motor stator current phases U, V, and W

Table 7: Industry Drive Std Model Outputs

Name	Туре	Description
FbStatusWord	Integer	Fieldbus status word
FbMainActualValue	Integer	Fieldbus main actual value
AppSpecStatusWord	Integer	Application specific status word
MotorCtrlStatusWord	Integer	Motor control status word
MotorCtrlReadyStatusWord	Integer	Motor control ready status word
MotorCtrlRegulatorStatusWord	Integer	Motor control regulator status word
DigOut10115	Boolean	Digital output 10115
DigOut10116	Boolean	Digital output 10116
AnaOut10131	Real	Analog output 10131
FreqRef	Real	Frequency reference
FreqActual	Real	Actual frequency output
DcLinkVoltage	Real	DC-link voltage
MotorSpeed	Real	Motor speed
MotorTorque	Real	Motor torque
MotorTorquePct	Real	Motor torque in percent of nominal torque
ConverterUuvw	Real	Converter output voltage phase U, V, and W
OutputCurrent	Real	Output current
OutputCurrentPct	Real	Output current in percent of nominal current
OutputVoltage	Real	Output voltage

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Table 7: Industry Drive Std Model Outputs (continued)

Name	Туре	Description
OutputVoltagePct	Real	Output voltage in percent of nominal voltage
ExceptionStatus	Integer	Exception status: 1 None 2 Info 3 Warning 4 Fault

4.5 Industry Drive Train Std Model

Table 8: Industry Drive Train Std Model Inputs

Name	Туре	Description
FbCtrlWord	Integer	Fieldbus control word
FbSpeedRef	Integer	Fieldbus speed reference
FbTorqueRef	Integer	Fieldbus torque reference
Digln10113	Boolean	Digital input 10113
Digln10114	Boolean	Digital input 10114
Digln10115	Boolean	Digital input 10115
Digln10116	Boolean	Digital input 10116
Digln10117	Boolean	Digital input 10117
Digln10118	Boolean	Digital input 10118
Analn10133	Real	Analog input 10133
Analn10134	Real	Analog input 10134
GridVoltage	Real	Grid Voltage LL RMS
WmExtern	Real	Omega motor from external load

Table 9: Industry Drive Train Std Model Outputs

Name	Туре	Description
FbStatusWord	Integer	Fieldbus status word
FbMainActualValue	Integer	Fieldbus main actual value
AppSpecStatusWord	Integer	Application-specific status word
MotorCtrlStatusWord	Integer	Motor control status word
MotorCtrlReadyStatusWord	Integer	Motor control ready status word
MotorCtrlRegulatorStatusWord	Integer	Motor control regulator status word
DigOut10115	Boolean	Digital output 10115

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Table 9: Industry Drive Train Std Model Outputs (continued)

Name	Туре	Description
DigOut10116	Boolean	Digital output 10116
AnaOut10131	Real	Analog output 10131
FreqRef	Real	Frequency reference
FreqActual	Real	Actual frequency output
DcLinkVoltage	Real	DC-link voltage
MotorSpeed	Real	Motor speed
MotorTorque	Real	Motor torque
MotorTorquePct	Real	Motor torque in percent of nominal torque
MotorTm	Real	Motor torque towards load model
OutputCurrent	Real	Output current
OutputCurrentPct	Real	Output current in percent of nominal torque
Motorlsuvw[3]	Real	Motor current phase U, V, and W
OutputVoltage	Real	Output voltage in percent of nominal torque
OutputVoltagePct	Real	Output voltage in percent of nominal voltage
MotorUsuvw[3]	Real	Motor voltage phases U, V, and W
ExceptionStatus	Integer	Exception status:
		1 None
		2 Info
		3 Warning
		4 Fault

4.6 Industry System Std Model

Table 10: Industry System Std Model Inputs

Name	Туре	Description
FbCtrlWord	Integer	Fieldbus control word
FbSpeedRef	Integer	Fieldbus speed reference
FbTorqueRef	Integer	Fieldbus torque reference
Digln10113	Boolean	Digital input 10113
Digln10114	Boolean	Digital input 10114
Digln10115	Boolean	Digital input 10115
Digln10116	Boolean	Digital input 10116
Digln10117	Boolean	Digital input 10117
Digln10118	Boolean	Digital input 10118

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Table 10: Industry System Std Model Inputs (continued)

Name	Туре	Description
Analn10133	Real	Analog input 10133
Analn10134	Real	Analog input 10134
GridVoltage	Real	Grid voltage LL RMS
LoadReferenceTorque	Real	Load motor torque reference in Newton meters
LoadInertiaFactor	Real	The inertia factor sets the plant moment of inertia that is con- nected to the motor shaft.
LoadFriction	Real	Friction constant sets the friction load that linearly follows the motor shaft speed. Friction constant at 100 corresponds to 50 Nm load at nominal speed.
QuadraticLoadConst	Real	A quadratic constant sets the load that follows the squared mo- tor shaft speed. A quadratic constant set to 100 corresponds to a 50 Nm load at nominal speed.
MechBrakeSignal	Real	Mechanical brake enable signal
MotorInertia	Real	Motor inertia

Table 11: Industry System Std Model Outputs

Name	Туре	Description
FbStatusWord	Integer	Fieldbus status word
FbMainActualValue	Integer	Fieldbus main actual value
AppSpecStatusWord	Integer	Application specific status word
MotorCtrlStatusWord	Integer	Motor control status word
MotorCtrlReadyStatusWord	Integer	Motor control ready status word
MotorCtrlRegulatorStatusWord	Integer	Motor control regulator status word
DigOut10115	Boolean	Digital output 10115
DigOut10116	Boolean	Digital output 10116
AnaOut10131	Real	Analog output 10131
FreqRef	Real	Frequency reference
FreqActual	Real	Actual frequency output
DcLinkVoltage	Real	DC-link voltage
MotorSpeed	Real	Motor speed
MotorTorque	Real	Motor torque
MotorTorquePct	Real	Motor torque in percent of nominal torque
OutputCurrent	Real	Output current
OutputCurrentPct	Real	Output current in percent of nominal current

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I/O Interface

Table 11: Industry System Std Model Outputs (continued)

Name	Туре	Description
Motorlsuvw[3]	Real	Motor current phase U, V, and W
OutputVoltage	Real	Output voltage
OutputVoltagePct	Real	Output voltage in percent of nominal voltage
MotorUsuvw[3]	Real	Motor voltage phases U, V, and W
ExceptionStatus	Integer	Exception status: 1 None 2 Info 3 Warning 4 Fault

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5.1 I/O Preset Reference Control with High Inertia and Fan Load

5.1.1 Configuring I/O Preset Reference Control with High Inertia and Fan Load

The speed preset-reference configuration example shows how to use the digital I/O to select different preset references and configure the start of DC-motor current injection for smooth speed ramp-up.



Figure 7: Industry Drive-Train Model and I/O Preset Reference Control Configuration

IMPORTANT: The menu index numbers and names of parameters are based on the currently available software. Refer to the latest version of the application guide for the most recent information on parameters.

The basic setup of the drive simulation consists of the following configuration steps:

- **1.** Actual motor configuration
- 2. Motor load configuration
- 3. Current rating selection
- 4. Drive input configuration
- 5. Drive parameter configuration
 - a. Drive motor data
 - **b.** Motor control principle
 - c. Start settings
 - d. Control places
 - e. I/O control
 - f. Speed reference

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Application Notes

g. Speed ramps

5.1.2 Model Input Configuration

In this example, the inputs are used as follows:

- Digital input 10113 is used for starting forward after 0.5 s.
- Digital input 10114 is used for Stop after 10 s.
- Digital input 10115 is used for reversing.
- Digital input 10116 is used for preset-reference bit 0 that goes high after 3 s.
- Digital input 10117 is used for preset-reference bit 1 that goes high after 5 s.
- Digital input 10118 is used for preset-reference bit 2 that goes high after 8 s.
- Grid supply voltage is set to 420 V line-line RMS.

Table 12: Model Input Configuration

Name	Initial value	Final value	Step time [s]	Description
FbControlWord	0	0	0	Fieldbus control word (Not used for this example.)
FbSpeedRef	0x3000	0x3000	0	Fieldbus reference (Not used for this example.)
Digln10113	0	1	0.5	Digital input 10113, used for Start forward.
Digln10114	1	0	10	Digital input 10114, used for Stop inverse.
Digln10115	0	0	0	Digital input 10115, used for reversing.
Digln10116	0	1	3	Digital input 10116, used for preset-reference bit 0.
Digln10117	0	1	5	Digital input 10117, used for preset-reference bit 1.
Digln10118	0	1	8	Digital input 10118, used for preset-reference bit 2.
Analn10133	0	0	0	Analog input 10133
Analn10134	0	0	0	Analog input 10134
GridVoltage	420	420	0	Line-Line RMS grid voltage
WmExtern	-	-	-	Feedback speed from load in rad./s.

5.1.3 Motor Selection

In this example, a customizable 7.5 kW, 4-pole, 400 V induction motor is configured for the simulation. Parameters must be configured in menu index *4 Motor*.

Table 13: Motor Type Selection

Name	Value	Description
MotorSelection	Int32(0)	Select the motor types available in the model.

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Parameter	Value	Unit	Description
M4_2_Motor_Data			
M4_2_1_General_Settings			
P4_2_1_1_Motor_Type	int32(0)		Select the motor type.; Max: 65535; Min: 0; Number: 407
P4_2_1_2_Number_of_Pole_Pairs	int32(2)		Set the number of pole pairs. For example, a 4-pole motor is set as 2 pole pairs.; Max: -; Min: -; Number: 406
P4_2_1_3_AMA_Mode	int32(0)		Select the Automatic Motor Adaptation (AMA) mode.; Max: 4; Min: 0; Number: 420
P4_2_1_4_Rs_Measurement_at_start	int32(0)		Determine when a Rs measurement is performed.; Max: -; Min: -; Number: 432
R P4_2_1_5_Motor_Cable_Length	100	m	Set the motor cable length.; Max: 10000; Min: 0; Number: 425
M4_2_2_Motor_Nameplate_Data			
R P4_2_2_1_Nominal_Power	7.5	kW	Set the nominal motor shaft power.; Max: -; Min: -; Number: 405
R P4_2_2_2_Nominal_Current	15	A	Set the nominal motor current.; Max: -; Min: -; Number: 400
R P4_2_2_3_Nominal_Speed	1460	rpm	Set the nominal motor shaft speed.; Max: 100000; Min: 0; Number: 402
R P4_2_2_4_Nominal_Frequency	50	Hz	Set the nominal motor frequency.; Max: 2000; Min: 0; Number: 403
R P4_2_2_5_Nominal_Voltage	400	V	Set the nominal motor voltage.; Max: -; Min: -; Number: 401
M4_2_3_Induction_Motor			
R P4_2_3_1_Stator_Resistance_Rs	0.65174	Ω	Set the motor stator resistance. Overwritten by AMA.; Max: 1000000; Min: 0; Number: 408
R P4_2_3_2_Rotor_Resistance_Rr	0.38705	Ω	Set the motor rotor resistance. Overwritten by AMA.; Max: 1000000; Min: 0; Number: 409
R P4_2_3_3_Iron_Loss_Resistance_Rfe	727	Ω	Set the motor iron-loss equivalent resistance.; Max: 11000000000; Min: 0; Number: 413
R P4_2_3_4_Stator_Leakage_Reactance_Xls	1.1	Ω	Max: 3141.6; Min: 0; Number: 440
R P4_2_3_5_Rotor_Leakage_Reactance_XIr	1.61	Ω	Max: 3141.6; Min: 0; Number: 441
P4_2_3_6_Magnetizing_Reactance_Xm	34.0015	Ω	Max: 3141.6; Min: 0; Number: 442

Figure 8: Motor Type Selection in Simulink

Table 14: Motor Type Selection

Name	Value	Description
MotorSelection	Int32(0)	Select the motor types available in the model.

Table 15: Motor Data

Name	Value	Description
Motor_Type	Int32(0)	0: Induction motor
		1: Permanent magnet motor
Number_of_Pole_Pairs	Int32(2)	Motor pole pair number
Nominal_Power	7500	Motor nominal shaft power
Nominal_Current	14.6	Motor nominal current
Nominal_Speed	1450	Motor nominal shaft speed
Nominal_Frequency	50	Motor nominal frequency
Nominal_Voltage	400	Motor nominal voltage
Stator_Resistance_Rs	0.7531	Motor stator resistance
Rotor_Resistance_Rr	0.4678	Motor rotor resistance
Iron_Loss_Resistance_Rfe	762.4	Motor iron loss equivalent resistance
Stator_Leakage_Lls	0.0044	Stator leakage inductance
Rotor_Leakage_Llr	0.0044	Rotor leakage inductance
Magnetizing_Lm	0.1312	Magnetizing inductance

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5.1.4 Drive Selection

In this example, an iC7-Automation frequency converter (iC7 FX03-3N05-16A) is selected to run the 7.5 kW motor. For details on drive variants, refer to the drive-specific design guide.

Table 16: Drive Selection

Name	Value	Description
DriveSizeSetup	Int32(9)	Select the drive variant available in the model.

Parameter	Value	Unit	Description
E Industry			
E Motor			
🗄 DriveSize			
DriveSizeSelection	int32(7)		DriveSize.Value.DriveSizeSelection
D0_iC7_60_FX02_3N05_1A3	int32(0)		DriveSize.Value.D0_iC7_60_FX02_3N05_1A3
D1_iC7_60_FX02_3N05_1A8	int32(1)		DriveSize.Value.D1_iC7_60_FX02_3N05_1A8
D2_iC7_60_FX02_3N05_2A4	int32(2)		DriveSize.Value.D2_iC7_60_FX02_3N05_2A4
D3_iC7_60_FX02_3N05_3A0	int32(3)		DriveSize.Value.D3_iC7_60_FX02_3N05_3A0
D4_iC7_60_FX02_3N05_4A0	int32(4)		DriveSize.Value.D4_iC7_60_FX02_3N05_4A0
D5_iC7_60_FX02_3N05_5A6	int32(5)		DriveSize.Value.D5_iC7_60_FX02_3N05_5A6
D6_iC7_60_FX02_3N05_7A2	int32(6)		DriveSize.Value.D6_iC7_60_FX02_3N05_7A2
D7_iC7_60_FX02_3N05_9A2	int32(7)		DriveSize.Value.D7_iC7_60_FX02_3N05_9A2
D8_iC7_60_FX02_3N05_12A5	int32(8)		DriveSize.Value.D8_iC7_60_FX02_3N05_12A5
D9_iC7_60_FX03_3N05_16A	int32(9)		DriveSize.Value.D9_iC7_60_FX03_3N05_16A
D10_iC7_60_FX04_3N05_24A	int32(10)		DriveSize.Value.D10_iC7_60_FX04_3N05_24A
D11_iC7_60_FX04_3N05_31A	int32(11)		DriveSize.Value.D11_iC7_60_FX04_3N05_31A
D12_iC7_60_FX05_3N05_38A	int32(12)		DriveSize.Value.D12_iC7_60_FX05_3N05_38A
D13_iC7_60_FX05_3N05_43A	int32(13)		DriveSize.Value.D13_iC7_60_FX05_3N05_43A
D14_iC7_60_FX06_3N05_61A	int32(14)		DriveSize.Value.D14_iC7_60_FX06_3N05_61A
D15_iC7_60_FA07_3N05_90A	int32(15)		DriveSize.Value.D15_iC7_60_FA07_3N05_90A

Figure 9: Drive Size Selection in Simulink

5.1.5 Load Configuration

In this example, the load is configured as a high-inertia load system (10 x motor inertia) and a fan torque characteristic, with quadratic torque as function of speed. Nominal motor torque is configured at nominal motor speed.

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5.1.6 **Drive Parameter Configuration**

5.1.6.1 Drive Motor Data

Table 17: Drive Motor Data

Index	Parameter name	Setting	Description
4.2.1.1	Motor Type	Int32(0)	0: Induction motor
			1: Permanent magnet motor
4.2.1.2	Number of Pole Pairs	Int32(2)	Motor pole pair number
4.2.2.1	Nominal Power	7500	Motor nominal shaft power
4.2.2.2	Nominal Current	14.6	Motor nominal current
4.2.2.3	Nominal Speed	1450	Motor nominal shaft speed
4.2.2.4	Nominal Frequency	50	Motor nominal frequency
4.2.2.5	Nominal Voltage	400	Motor nominal voltage
4.2.3.1	Motor Stator Resistance	0.7531	Motor stator resistance
4.2.3.2	Rotor Resistance	0.4678	Motor rotor resistance
4.2.3.3	Iron Loss Resistance	762.4	Motor iron loss equivalent resistance
4.2.3.4	Stator Leakage Reactance	1.3823	2*pi*50 Hz*0.0044Henry
4.2.3.6	Rotor Leakage reactance	1.3823	2*pi*50 Hz*0.0044Henry
4.2.3.6	Magnetizing Reactance	41.218	2*pi*50 Hz*0.1312Henry



Figure 10: Drive Motor Data in Simulink

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5.1.6.2 Motor Control Principle

In this example, FVC+ is selected as the motor control principle.

Table 18: Motor Control Principle Parameter

Index	Parameter name	Setting	Description
4.3.1.1	Motor Control Principle	int32(2)	Selects the motor control prin- ciple. • 0: U/f Control • 1: VVC+ Control • 2: FVC+ Control

Parameter	Value	Unit	Description
🕶 🛅 Industry			
> 🖪 M1_Grid			
> 🗄 M2_Power_ConversionDC_Link			
> 🛃 M3_Filters_Brake_Chopper			
✓ 🖪 M4_Motor			
> 🛃 M4_1_Motor_Status			
> 🛃 M4_2_Motor_Data			
✓ 🖪 M4_3_Motor_Control			
✓ Ⅰ M4_3_1_General_Settings			
P4_3_1_1_Motor_Control_Principle	int32(2)		Select the motor control principle.; Max: 65535; Min: 0; Number: 2503
P4_3_1_2_Breakaway_Current_Boost	bcolean(0)		Enables the breakaway current boost, which temporarily allows a higher starting current.;
P4_3_1_5_Motor_Feedback_Mode	int32(0)		Select the feedback mode.; Max: 2; Min: 0; Number: 2502
P4_3_1_6_Motor_Feedback_Test_Mode	int32(0)		Select the motor feedback test mode.; Max: 1; Min: 0; Number: 421
> 🖪 M4_3_2_Uf_Settings			
> 🖪 M4_3_3_FVC_Settings			
> 🖪 M4_3_4_VVCUf_Settings			
> 🖪 M4_5_Protection			
✓			

Figure 11: Motor Control Principle in Simulink

5.1.6.3 Start Settings

In this example, 60% of nominal motor current is injected for 0.5 s with a current rise time of 0.1 s.

Table 19: Start Setting Parameters

Index	Parameter name	Setting	Description
5.6.2.1	DC Start Time	0.5	Set the DC current injection time in stop state before running.
5.6.2.2	DC Start Rise Time	0.1	Set the time to ramp the current from zero to the speci- fied injection level.
5.6.2.3	DC Start Current	60	Set the stator DC current in percent of motor nominal current. This current is injected in the stop state before running.

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Parameter	Value	Unit	Description	2
✓ 🖪 Industry				
> 🖪 M1_Grid				
> 🖪 M2_Power_ConversionDC_Link				
> 🔢 M3_Filters_Brake_Chopper				
> 🖪 M4_Motor				
✓ I M5_Application				
> 🖪 M5_2_Protection				
> 🖪 M5_3_Load				
> 🖪 M5_4_Operation_Mode				
> 🖪 M5_5_Control_Places				
✓				
> 🖪 M5_6_1_General_Settings				
✓ I M5_6_2_DC_Start				
R P5_6_2_1_DC_Start_Time	0.5	s	Set the duration of the current injection during DC start.; Max: 10000; Min: 0; Number	r: 2264
R P5_6_2_2_DC_Start_Current_Rise_Time	0.1	s	Set the time to ramp the current from 0 to the specified injection level.; Max: 100; Min	n: 0; Number: 2265
R P5_6_2_3_DC_Start_Current	60	%	Set the DC current in % of nominal motor current. This current is injected during the	DC start time.; Max: 1000; Min: 0; Number: 2263
> 🖪 M5_6_3_Synchronous_Motor_Start				
> 🛃 M5_7_Stop_Settings				
> 🛃 M5_8_Speed_Control				
> 🖪 M5_9_Torque_control				
> 🖪 M5_10_Process_Control				
> 🖪 M5_11_Inching				
> 🖪 M5_12_Mechanical_Brake_Control				
> 🖪 M5_26_Additional_Status_Outputs				
> 🛃 M5_27_Fieldbus_Process_Data				

Figure 12: Start Settings in Simulink

5.1.6.4 Control Places

In this example, I/O control is selected.

Table 20: Control Place Parameter

Index	Parameter name	Setting	Description
5.5.2.1	Control Place Selection	int32(3)	Select active control place. • 0: PC Control • 1: Local Control 2: Fieldbug Control
			 2: Fleidbus Control 3: I/O Control 4: Advanced Control

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Parameter	Value	Unit	Description
Industry			
M1_Grid			
M2_Power_ConversionDC_Link			
M3_Filters_Brake_Chopper			
M4_Motor			
M5_Application			
> 🖪 M5_2_Protection			
> 🖪 M5_3_Load			
> 🖪 M5_4_Operation_Mode			
✓			
> 🗄 M5_5_1_Control_Places_Status			
✓			
P5_5_2_1_Control_Place_Selection	int32(3)		Select the active control place.; Max: 4; Min: 1; Number: 114
P5_5_2_7_Control_Place_Independent_Reset	boolean(1)		Enable faults to be reset from all control places.; Max: 1; Min: 0; Number: 109
P5_5_2_9_Alternative_Control_Place_Selection	int32(4)		Select the alternative control place.; Max: 4; Min: 1; Number: 115
P5_5_2_10_Alternative_Control_Place_Input	int32(0)		Select the digital input terminal for activating the alternative control place.; Max: 29999; Min: 0;
> 🖪 M5_5_3_Local_Control			
> 🖪 M5_5_4_Fieldbus_control			

Figure 13: Control Place Selection in Simulink

5.1.6.5 **I/O Control**

In this example:

- Digital input 10113 is set to control the Start forward.
- Digital input 10114 is set to control Stop inverse.
- Digital input 10115 is set to control Reversing.
- Reset is set to zero.

Table 21: I/O Control Parameters

Index	Parameter name	Setting	Description
5.5.5.1.1	Start Input	Int32(10113)	Set the digital input for starting.
5.5.5.1.3	Stop Inverse Input	Int32(10114)	Set the digital input for stopping.
5.5.5.1.5	Reversing Input	Int32(10115)	Set the digital input for inverting the reference signal. It does not provide a start signal.
5.5.5.1.6	Reset Input	Int32(0)	Set the digital input for resetting faults.

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M5_5_5_1_Commands		
P5_5_5_1_1_Start_Input	int32(10113)	Select the digital input for the start command.; 0: False, 1: True, ; Max: 29999; Min: 0; Number: 200
P5_5_5_1_2_Start_Backward_Input	int32(0)	Select the digital input for the start command in the backward direction.; 0: False, 1: True, ; Max: 29999; Min: 0; Number: 210
P5_5_5_1_3_Stop_Inverse_Input	int32(10114)	Select the digital input for the inverted stop command.; 0: False, 1: True, ; Max: 29999; Min: 0; Number: 201
P5_5_5_1_4_Coast_Inverse_Input	int32(1)	Select the digital input for the inverted coast command.; 0: False, 1: True, ; Max: 29999; Min: 0; Number: 202
P5_5_5_1_5_Reversing_Input	int32(10115)	Select the digital input for inverting the reference signal. The reverse command does not provide a start signal.; 0: False, 1: True, ; Max: 29999; Min: 0;
P5_5_5_1_6_Reset_Input	int32(0)	Select the digital input for resetting faults.; 0: False, 1: True, ; Max: 29999; Min: 0; Number: 203
P5_5_5_1_8_Start_Signal_Mode	int32(0)	Select the mode of the start signal.; 0: State High Start, 1: Rising Edge Start, 2: High Pulse Start, ; Max: 2; Min: 0; Number: 211
M5_5_5_2_References		
P5_5_5_2_1_IO_Speed_Reference		
1,1]	int32(3)	Select the speed reference sources for when the drive operates in I/O control. Select 2 sources to combine them into 1 reference value.; 0: None, 2: F
1,2]	int32(0)	Select the speed reference sources for when the drive operates in I/O control. Select 2 sources to combine them into 1 reference value.; 0: None, 2: F
P5_5_5_2_2_IO_Speed_Reference_Logic	int32(0)	Select how to form the speed reference out of the 2 sources when operating in I/O control.; 0: Source 1, 1: Source 2, 2: Sum, 3: Subtract, 4: Divide, 5:
P5_5_5_2_3_IO_Speed_Reference_Toggle_Input	int32(0)	Select an input for toggling between the 2 speed reference sources selected, when operating in I/O control and toggling logic is used. A low signal s
> H P5_5_5_2_4_IO_Torque_Reference		
P5_5_5_2_5_IO_Torque_Reference_Logic	int32(0)	Select how to form the torque reference out of the 2 sources when operating in I/O control.; 0: Source 1, 1: Source 2, 2: Sum, 3: Subtract, 4: Divide, 5
> H P5_5_5_2_6_IO_Process_Reference		
P5 5 5 2 7 10 Process Reference Logic	int32(0)	Select how to form the process control reference out of the 2 sources when operating in I/O control · O: Source 1. 1: Source 2. 2: Sum 3: Subtract 4:

Figure 14: I/O Control Selection in Simulink

5.1.6.6 Speed Reference

In this example:

- Preset references 1, 2, 4, and 8 are used for controlling the speed reference.
- Preset reference bit 0 is connected to digital input 10116.
- Preset reference bit 1 is connected to digital input 10117.
- Preset reference bit 2 is connected to digital input 10118.

Table 22: Speed Reference Parameters

Index	Parameter name	Setting	Description
5.5.5.2.1	IO Speed Reference[1,1]	5	 Select the speed reference sources for when the drive operates in I/O control. Define multiple entries for combining several sources into 1 reference value. 0: None 2: Fieldbus Reference 3: Analog Input Reference 1 4: Analog Input Reference 2 5: Preset Reference 8: Process Ctrl. Reference
5.8.4.7	Preset Speed Selector	0	 Set the number of the preset reference to be used. 0: Bit Selection 1: Preset 1 2: Preset 2 3: Preset 3 4: Preset 4 5: Preset 5 6: Preset 6 7: Preset 7 8: Preset 8
5.8.4.8	Preset Speed 1	300	Set the value of the preset reference 1.
5.8.4.9	Preset Speed 2	600	Set the value of the preset reference 2.

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Table 22: Speed Reference Parameters (continued)

Index	Parameter name	Setting	Description
5.8.4.11	Preset Speed 4	1200	Set the value of the preset reference 4.
5.8.4.15	Preset Speed 8	1500	Set the value of the preset reference 8.
5.8.4.16	Preset Speed Bit 0 Input	10116	Set the digital input to be used as bit 0 for addressing the preset reference.
5.8.4.17	Preset Speed Bit 1 Input	10117	Set the digital input to be used as bit 1 for addressing the preset reference.
5.8.4.18	Preset Speed Bit 2 Input	10118	Set the digital input to be used as bit 2 for addressing the preset reference.

Table 23: Truth Table for Preset Reference Number

Preset speed bit 0	Preset speed bit 1	Preset speed bit 2	Preset speed nr.
0	0	0	1
1	0	0	2
0	1	0	3
1	1	0	4
0	0	1	5
1	0	1	6
0	1	1	7
1	1	1	8

1921 - 21	100.0		
Parameter	Value	Unit	Description
✓			
P5_8_4_1_Speed_Reference_1_Input	int32(10133)		Select the input terminal or a predefined fixed value for the speed reference.; Max: 29999; Min: 0; N
P5_8_4_2_Speed_Reference_2_Input	int32(10134)		Select the input terminal or a predefined fixed value for the speed reference.; Max: 29999; Min: 0; N
R P5_8_4_3_Speed_Reference_1_Max	3000	rpm	Set the maximum value of the reference. It defines the upper point for the scaling of the reference
R P5_8_4_4_Speed_Reference_1_Min	0	rpm	Set the minimum value of the reference. It defines the lower point for the scaling of the reference in
R P5_8_4_5_Speed_Reference_2_Max	3000	rpm	Set the maximum value of the reference. It defines the upper point for the scaling of the reference
R P5_8_4_6_Speed_Reference_2_Min	0	rpm	Set the minimum value of the reference. It defines the lower point for the scaling of the reference in
P5_8_4_7_Preset_Speed_Reference_Selector	int32(0)		Select the preset reference. The preset reference can be selected as a fixed value or by 3 digital inp
R P5_8_4_8_Preset_Speed_1	300	rpm	Set the value of the preset reference.; Max: 30000; Min: -30000; Number: 703
R P5_8_4_9_Preset_Speed_2	600	rpm	Set the value of the preset reference.; Max: 30000; Min: -30000; Number: 704
R P5_8_4_10_Preset_Speed_3	900	rpm	Set the value of the preset reference.; Max: 30000; Min: -30000; Number: 705
R P5_8_4_11_Preset_Speed_4	1200	rpm	Set the value of the preset reference.; Max: 30000; Min: -30000; Number: 706
R P5_8_4_12_Preset_Speed_5	1500	rpm	Set the value of the preset reference.; Max: 30000; Min: -30000; Number: 707
R P5_8_4_13_Preset_Speed_6	1800	rpm	Set the value of the preset reference.; Max: 30000; Min: -30000; Number: 708
R P5_8_4_14_Preset_Speed_7	2100	rpm	Set the value of the preset reference.; Max: 30000; Min: -30000; Number: 709
R P5_8_4_15_Preset_Speed_8	1500	rpm	Set the value of the preset reference.; Max: 30000; Min: -30000; Number: 710
P5_8_4_16_Preset_Speed_Reference_Bit_0_In	int32(10116)		Select the digital input used as bit 0 addressing the preset reference.; Max: 29999; Min: 0; Number:
P5_8_4_17_Preset_Speed_Reference_Bit_1_In	int32(10117)		Select the digital input used as bit 1 for addressing the preset reference.; Max: 29999; Min: 0; Numb
P5_8_4_18_Preset_Speed_Reference_Bit_2_In	int32(10118)		Select the digital input used as bit 2 for addressing the preset reference.; Max: 29999; Min: 0; Numb
R P5_8_4_19_Fieldbus_Speed_Reference_Scale	1500	rpm	Set the fieldbus reference scale equal to 100% reference.; Max: 30000; Min: 0; Number: 1723

Figure 15: Speed Reference Settings in Simulink

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5.1.6.7 Speed Ramps

In this example, ramp 1 is configured to 5 s ramp-up time and 5 s ramp-down time.

Table 24: Speed Ramp Parameters

Index	Parameter name	Setting	Description
5.8.6.2.2	Ramp 1 Accel. Time	5	Acceleration time from 0 to nominal speed.
5.8.6.2.3	Ramp 1 Decel. Time	5	Deceleration time from nominal speed to 0

M5_8_Speed_Control			
M5_8_1_Speed_Control_Status			
M5_8_2_Speed_Controller			
M5_8_3_Speed_Limits_and_Monitor			
M5_8_4_Speed_Reference			
M5_8_5_Reference_Freeze			
M5_8_6_Speed_Ramps			
> 🗄 M5_8_6_1_Speed_Ramp_Settings			
✓			
P5_8_6_2_1_Ramp_1_Type	int32(0)		Select the ramp type.; 0: Linear Ramp, 1: S-Ramp, ; Max: 1; Min: 0; Number: 1125
R P5_8_6_2_2_Ramp_1_AccelTime	5	s	Set the acceleration time from 0 to nominal motor speed.; Max: 10000; Min: 0; Number: 1101
R P5_8_6_2_3_Ramp_1_DecelTime	5	s	Set the deceleration time from nominal motor speed to 0.; Max: 10000; Min: 0; Number: 1105
P5_8_6_2_4_SRamp_1_Accel_Increase_Time	1	s	Set the ramp acceleration increase time for S-ramp.; Max: 10000; Min: 0; Number: 1109
P5_8_6_2_5_SRamp_1_Accel_Decrease_Time	1	s	Set the ramp acceleration decrease time for S-ramp.; Max: 10000; Min: 0; Number: 1113
R P5_8_6_2_6_SRamp_1_Decel_Increase_Time	1	s	Set the ramp deceleration increase time for S-ramp.; Max: 10000; Min: 0; Number: 1117
R P5_8_6_2_7_SRamp_1_Decel_Decrease_Time	1	s	Set the ramp deceleration decrease time for S-ramp.; Max: 10000; Min: 0; Number: 1121
> 🗄 M5_8_6_3_Ramp_2			
> 🛃 M5_8_6_4_Ramp_3			
> 🛃 M5_8_6_5_Ramp_4			
> 🖪 M5_8_6_6_Variable_Ramp			

Figure 16: Speed Ramp Settings in Simulink

5.1.7 Simulation Results

After completing the simulation configuration, the results are shown as graphs.

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Figure 17: Example of Simulation Results Configuring I/O Control with Industry Application

5.2 iC Speed Profile

5.2.1 Configuring iC Speed Profile

The iC Speed Profile configuration example shows how the Industry Drive-Train Std model can be controlled using the fieldbus profile iC Speed Profile.



Figure 18: Industry Drive-Train Model and iC Speed Profile Configuration

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IMPORTANT: The menu index numbers and names of parameters are based on the currently available software. Refer to the latest version of the application guide for the most recent information on parameters.

5.2.2 **I/O Connections**

In this example, *FbControlWord* and *FbReference* inputs are used to control the drive. *FreqLimitPos* and *FreqLimitNeg* are set to 60 Hz and -60 Hz, and *GridVoltage* to 420 V. *WM_Extern* gets the feedback from the load model. Other inputs are not used and are set to 0 or false.

Output *MotorTm* is used to hand over torque to the load model. *FbStatusWord* and *FreqActual* are tracked as well as all other outputs of interest.

5.2.3 Parameter Setup

In this example, fieldbus is selected for the control place. The relevant parameter settings can be combined with other control settings, using different drive variants.

Table 25: Control Place Parameters

Index	Parameter name	Setting	Description
5.5.2.1	Control Place Selection	int32(2)	 Select active control place. 0: PC Control 1: Local Control 2: Fieldbus Control 3: I/O Control 4: Advanced Control
5.5.4.1.1	FB Speed Reference	int32(2)	 Select the speed reference sources for when the drive operates in fieldbus control. Define multiple entries for combining several sources into 1 reference value. 0: None 2: Fieldbus Reference 3: Analog Input Reference 1 4: Analog Input Reference 2 5: Preset Reference 8: Process Ctrl. Reference
5.8.4.19	Fieldbus Speed Reference 100 Scale	1500 RPM	Set the fieldbus reference scale equal to 100% reference.
10.3.1.2	Fieldbus Profile	int32(101)	 Select the fieldbus profile – CtrlWord/StatusWord interpretation. 101: Danfoss Speed Profile 201: PROFIdrive Application Class 1

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Parameter	Value	Unit	Description
✓ 🛃 M5_Application			
> 🖪 M5_2_Protection			
> 🖪 M5_3_Load			
> 🛃 M5_4_Operation_Mode			
✓			
> 🖪 M5_5_1_Control_Places_Status			
✓			
P5_5_2_1_Control_Place_Selection	int32(2)		Select the active control place.; Max: 4; Min: 1; Number: 114
P5_5_2_7_Control_Place_Independent_Reset	boolean(1)		Enable faults to be reset from all control places.; Max: 1; Min: 0; Number: 109
P5_5_2_9_Alternative_Control_Place_Selection	int32(4)		Select the alternative control place.; Max: 4; Min: 1; Number: 115
P5_5_2_10_Alternative_Control_Place_Input	int32(0)		Select the digital input terminal for activating the alternative control place.; Max: 29999;
> 🖪 M5_5_3_Local_Control			
✓ I M5_5_4_Fieldbus_control			
✓ 🖪 M5_5_4_1_References			
P5_5_4_1_1_Fieldbus_Speed_Reference			
ⅠⅠ [1,1]	int32(2)		Industry.Value.M5_Application.M5_5_Control_Places.M5_5_4_Fieldbus_control.M5_5_4_1_F
Ⅰ [1,2]	int32(0)		Industry.Value.M5_Application.M5_5_Control_Places.M5_5_4_Fieldbus_control.M5_5_4_1_F
P5_5_4_1_2_Fieldbus_Speed_Reference_Logic	int32(0)		Select how to form the speed reference out of the 2 inputs when operating in fieldbus c
P5_5_4_1_3_Fieldbus_Speed_Reference_Toggle_Input	int32(0)		Select an input for toggling between the 2 speed reference sources selected, when oper

Figure 19: Control Place Selection for Fieldbus Control in Simulink

	Parameter	Value	Unit	Description		
~ 🗄	Industry					
>	🗄 M1_Grid					
> [M2_Power_ConversionDC_Link					
> [M3_FiltersBrake_Chopper					
> [M4_Motor					
>	M5_Application					
>	M6_MaintenanceService					
> [M7_Functional_Safety					
> [M8_Customization					
~	M10_Connectivity					
`	M10_3_Protocols					
	✓					
	P10_3_1_2_Fieldbus_Profile	int32(101)		Select the fieldbus profile. The selection affects the interpretation of the control word and sta		
	P10_3_1_3_Fieldbus_Fault_Response	int32(1)		Select the behavior when a fieldbus fault occurs.; Max: 10; Min: 1; Number: 1303		
	P10_3_1_4_No_Fieldbus_Connection_Response	int32(1)		Select the response in case there is no fieldbus connection.; Max: 10; Min: 1; Number: 1327		
	P10_3_1_12_Process_Data_Timeout_Response	int32(10)		Select the response to a process data timeout.; Max: 10; Min: 1; Number: 1341		
	P10_3_1_13_Process_Data_Timeout_Control_Place	int32(1)		Select the alternative control place to be used in case of filedbus timeout. This is only valid in		

Figure 20: Settings for Fieldbus Control in Simulink

5.2.4 Fieldbus Control Word

In this example:

- A startup sequence is configured to start up the drive.
- Bit 8 is configured to activate the jog function.
- Quick stop bit 4 is configured to stop the drive.

Table 26: Control Word Bits

Time	Step	Bit	Value
0 s	Init	FbControlWord – all	0
0.5 s	Fieldbus Activate	10 – Data valid	1

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Table 26: Control Word Bits (continued)

Time	Step	Bit	Value
1 s	Remove Stop	3 – No coast	1
		4 – No quick stop	1
		5 – No hold	1
1.5 s	Start	6 – Start	1
11.5 s	Activate Jog	8 – Jog	1
21.5 s	Deactivate Jog	8 – Jog	0
26.5 s	Quick Stop	4 – No quick stop	0

The functions of all bits in the iC Speed Profile control word are explained in 5.2.5 Control Word (CTW).

5.2.5 Control Word (CTW)

Table 27: iC Speed Profile Control Word Bits

Bit number	Name	Description
0+1	Preset reference selector	00: Preset reference 1 01: Preset reference 2 10: Preset reference 3 11: Preset reference 4
2	Reserved	Reserved for future use. Any control words sent to the device should keep this bit at 0 to ensure compatibility with future extensions of the control word.
3	No coast/Coast	1: No function. 0: Causes the drive to immediately coast the motor.
4	No quick stop/Quick Stop	 No function. Quick stops the drive and ramps down the motor speed to stop as de- fined with the quick stop ramp parameter.
5	No hold/Hold output frequency	1: No function. 0: Hold the present output frequency (in Hz).
6	Start/No start	 1: If the other starting conditions are fulfilled, this selection allows the drive to start the motor. 0: Stops the drive and ramps down the motor speed as defined with the ramp down parameter.
7	Fault acknowledge	$0 \Rightarrow 1$: Acknowledge faults. Acknowledge is edge-triggered, when the logic is changed from 0 to 1. Faults can only be acknowledged is the triggering condition has been re- moved and any required acknowledgment has been done. 0: No function.

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Table 27: iC Speed Profile Control Word Bits (continued)

Bit number	Name	Description
8	Jog/No jog	 Sets the output frequency to the jog speed defined with the jog speed parameter. No function.
9	Ramp select	1: Ramp 2 is active. 0: Ramp 1 is active.
10	Data valid	 Use process data (control by PLC). Ignore the current process data. This is linked to the submodule where the CTW is present. If signals are to be covered, the CTW/STW profile (for example, the iC Speed Profile) must be part of the signals list. Use the previously processed data when the data valid bit was true (no control by PLC).
11	Reserved	Reserved for future use.
12	User defined	These bits are reserved for application-specific advanced control. For
13	User defined	more information, refer to the <i>Parameter Descriptions</i> chapter in the appli- cation guide.
14	User defined	
15	User defined	

5.2.6 FbReference

The *FbReference* signal is a 32-bit signal. Hex value 0x4000 represents 100% of the reference scale, which is defined in the parameters. In this example, it is set to 50 Hz.

5.2.7 Load Configuration

The general load model is configured for motor M0 (default). Load step of 12.3 Nm is applied when the drive is running at FreqRef.

5.2.8 Fieldbus Status Word

The functions of all bits in the iC Speed Profile status word are explained in 5.2.9 Status Word (STW) in iC Speed Profile.

5.2.9 Status Word (STW) in iC Speed Profile

Table 28: iC Speed Profile Status Word Bits

Bit number	Name	Description
0	Control ready	1 = The device controls are ready and react to process data.0 = The device controls are not ready and do not react to process data.
1	Frequency converter ready	 1 = The frequency converter is ready for operation. 0 = The frequency converter is not ready for operation. This status does not involve faults and warnings as they are indicated in their respective bits elsewhere.

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Table 28: iC Speed Profile Status Word Bits (continued)

Bit number	Name	Description
2	Coast	 1 = There are no active coast signals, and the motor can start when a start signal is given. 0 = The frequency converter has an active coast signal and has released the motor.
3	Fault	 1 = A fault has occurred, and an acknowledge signal is required to re-es- tablish operation. 0 = There are no faults.
4	Reserved	Reserved.
5	Reserved	Reserved.
6	Reserved	Reserved.
7	Warning	1 = A warning is active. 0 = There are no warnings.
8	Speed=reference	 1 = The current motor speed matches the current speed reference within a given tolerance. The tolerance is product specific. 0 = The motor runs, but the current speed is different from the current speed reference, for example while the speed ramps up or down during start or stop.
9	Bus control/Local operation	 1 = The device is controlled and reacting to I/O and process data. 0 = The device does not react on commands from the fieldbus, for 1 of the following reasons: CTW bit 10 = 0. HMI is in local mode. MyDrive[®] Insight has taken control. Control places do not include fieldbus.
10	Frequency limit	 1 = The output frequency is within the defined motor limits. 0 = The output frequency has exceeded the defined motor limits. The speed limits are set with the parameters: P 5.8.3.1 Positive Speed Limit P 5.8.3.2 Negative Speed Limit P 5.8.3.3 Minimum Speed Limit
11	Operation	 1 = The process is running, and the motor can be running or start at any time. 0 = There are no active start requests, and the process does not run. The motor is coasted and is not started.
12	Reserved	Reserved.
13	Reserved	Reserved.
14	User defined	These bits are reserved for application-specific advanced control. For
15	User defined	more information, refer to the Parameter Descriptions chapter in the application guide.

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5.2.10 Simulation Results



After completing the simulation configuration, the results are shown as graphs.

Figure 21: Example of Simulation Results for Configuring iC Speed Profile with Industry Application



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