

TIA_PN_PowerSupply_ctrIX DRIVE

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Platform	TIA PORTAL
Controller	S7-1200
Library	TIA_PN_ctrlX_DRIVE
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1. Description

The Power Supply function blocks are the interfaces to control ctrlX DRIVE Power Supplies from Siemens PLCs over PROFINET. These function blocks will be able to identify the power supply internal states and handles the transitions between the power supply state machine, control the operation mode, clear power supply error, and get diagnostic information from the power supply. The function blocks described in this document are compatible with Siemens S7-1200 and S7-1500 PLCs.

2. Configuration

This section explains various settings required in the PLC, ctrlX IO in PLC and ctrlX DRIVE.

2.1 Overview

The figure below gives an overview of a Siemens PLC and ctrlX DRIVE network.

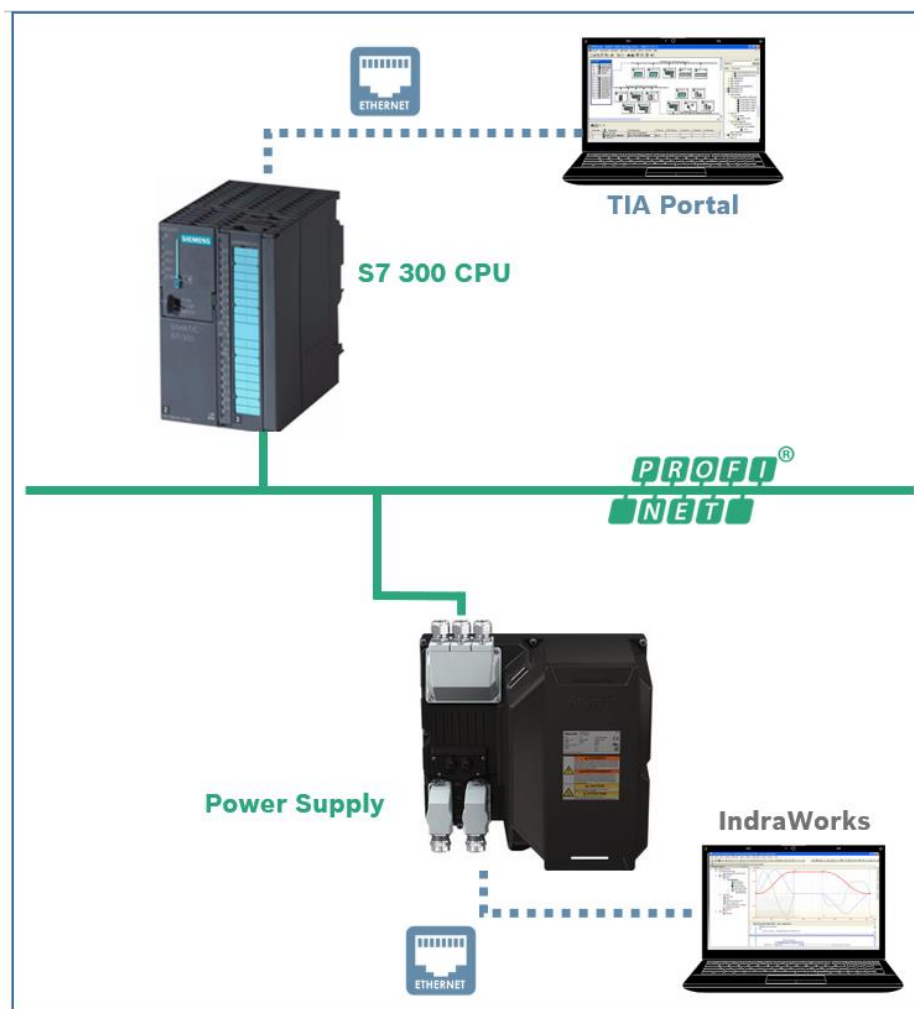


Fig - 01: System Overview

2.2 Configuration – ctrlX DRIVE Engineering Tool

The master communication settings of CtrlX drive must be set to PROFINET as shown in the image below.

Settings | IP settings | Slot 0 | Slot 1

Active protocol PROFINET®

Selected protocol PROFINET®

Communication status: A0007 Operational

Master communication - sub-device coupling active

Application profile Sercos profile

Device name: ctrlx-drive-xcd

Vendor ID: 0x011F

Device ID: 0x2602

Target mode after run-up: Automatic run-up to OM (operating mode)

Reaction to failure of cycl. communication: As error (F4xxx) and config. error reaction of the application

[Signal status word](#) [Signal control word](#) [Reboot...](#)

Fig - 02: Master communication configuration – ctrlX DRIVE Engineering

In the Application Profile select the Sercos Profile in the Master Communication Settings. If this setting is not done the function block will not work.

The AT & MDT lists, signal control word and signal status word, operation mode settings must be configured as shown in the images below. These settings are required by the function block for Power Supply Modes operation. These settings can also be loaded by using the parameter file provided in the deliverable.

Settings | IP settings | Slot 0 | Slot 1

Producer asynchronous

Status: prepare

Number: 105

Producer cycle time: 3000.000 us

Max. connection length: 56

Current conn. length: 20

Connection class: -1

[Process data](#)

Data configuration

Offset	IDN	+	x
0	S-0-0135 : Drive status word	+	x
2	S-0-0144 : Signal status word	+	x
4	S-0-0386 : Active position feedback value	+	x
8	S-0-0535 : Active velocity feedback value	+	x
12	S-0-0390 : Diagnostic message number	+	x
16	S-0-1720.0.2 : Power supply status word	+	x

Fig - 03: AT settings– ctrlX DRIVE Engineering

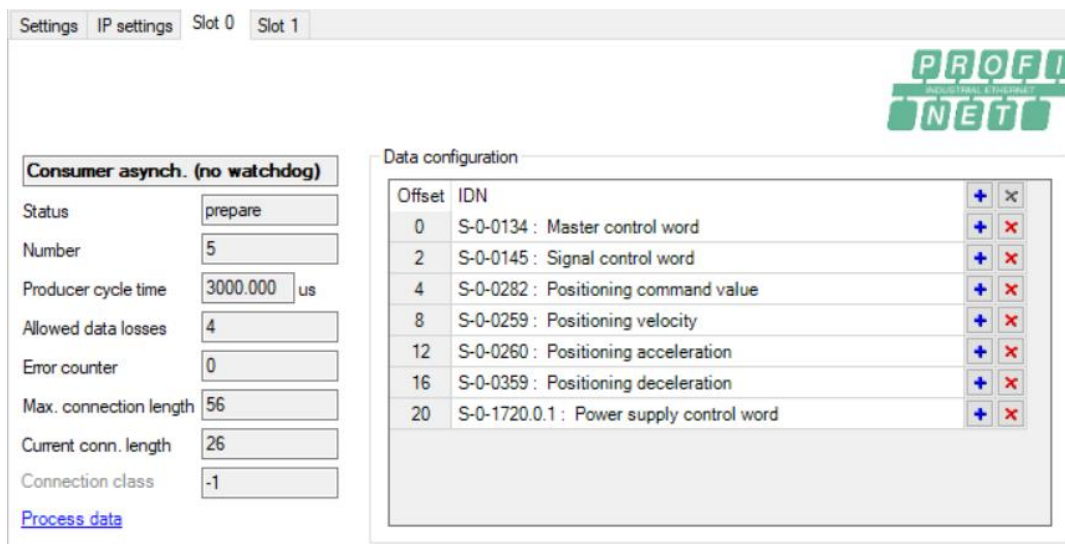


Fig - 04: MDT settings – ctrlX DRIVE Engineering

2.3 Configuration – TIA Portal

2.3.1 Hardware and Network Configuration

- The S7-1200 PLC acts as the PROFINET fieldbus master. The Power Supply must be connected to the PLC over the PROFINET network. The PLC can be configured and programmed using TIA portal software over Ethernet. The Power Supply can be configured using ctrlX DRIVE Engineering Tool software over Ethernet.
- The Power Supply must be configured as an IO device in the PROFINET IO system. The network connection diagram is shown below.

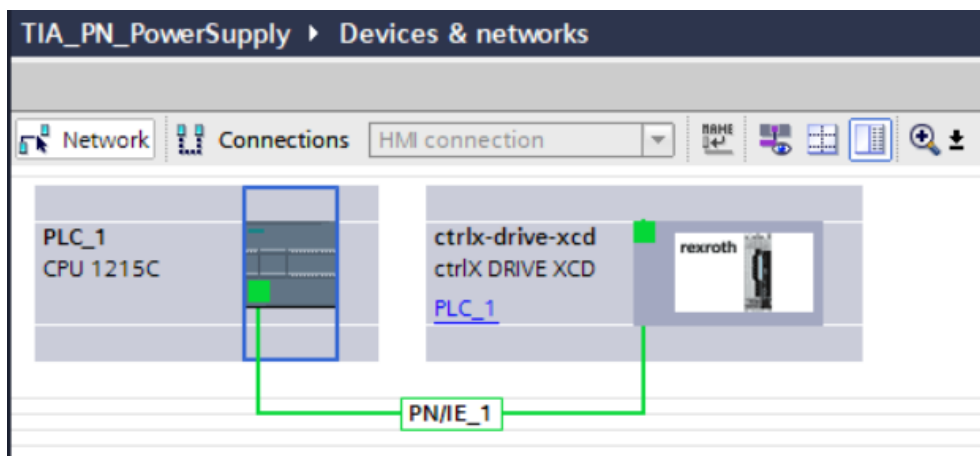


Fig - 05: Devices and Networks

2.3.2 Address Configuration

The process image addresses need to be given as inputs to the function block when calling it in the user program. These addresses are used to exchange data between the PROFINET memory area and the function block memory. The same addresses that are set in the Power Supply configuration window must be given as inputs to the function block as shown in the image below.

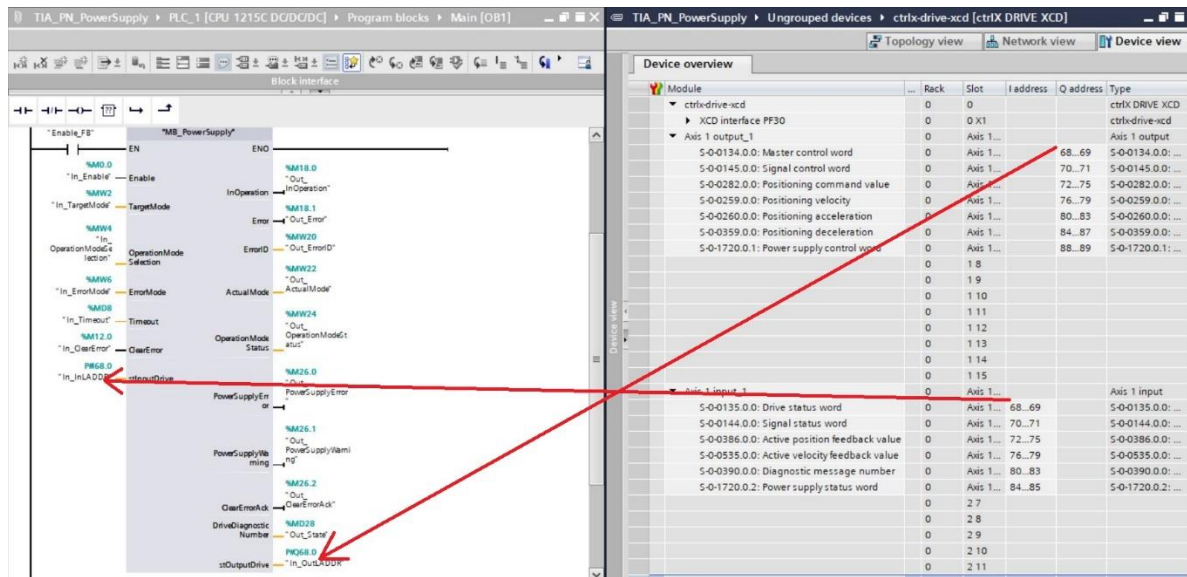


Fig - 06: Address Configuration

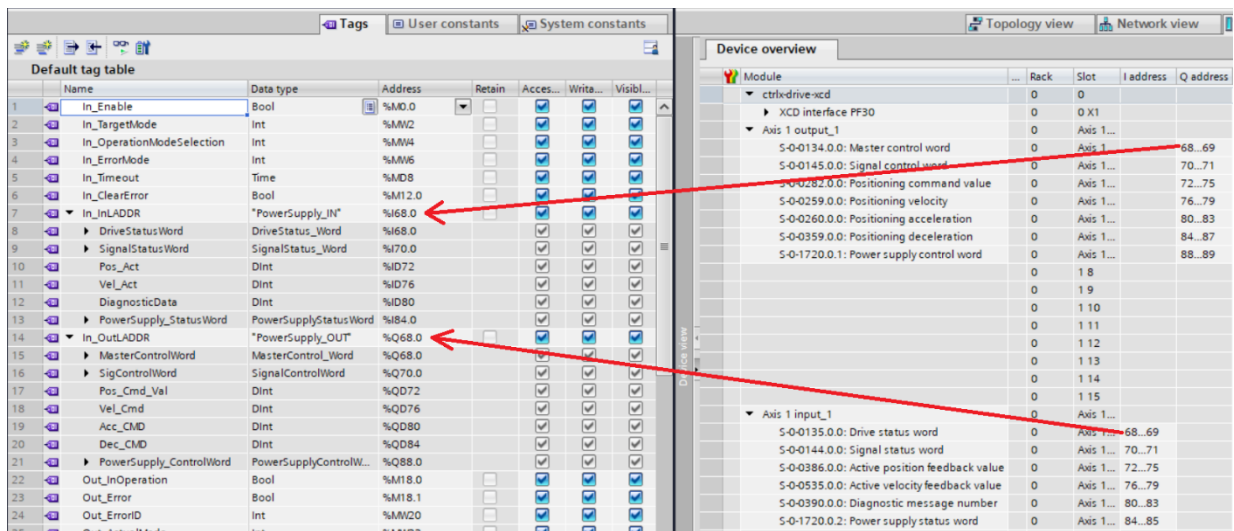


Fig - 07: Linking the IO Card Address to FunctionBlock Tags

As shown in the image above the I_address and Q_address values set in the Power Supply configuration window must be set to the function block inputs stInputDrive and stOutputDrive respectively in the

user program. A mismatch in the values between the configuration and user program will compromise the integrity of the function block data.

3. Function Block 'FB_PowerSupply'

3.1 Brief Description

This function block will monitor and control the power supply. The main functionality of this function block is to execute a transition of the power supply to the requested target mode.

The status word will be used by the function block to identify the current state of the power supply state machine. The target mode to be reached by the power supply state machine is already available at the TargetMode input. The function block will know the path to be taken to reach the target mode. So the function block will initiate the power supply to move to the next immediate state. This moving to the next immediate state will continue until the power supply reaches the target mode through various states.

In case of a function block error the state handling will be put on hold until the error is cleared. In case the power supply moves to the error state – the target mode and error mode together will decide the next immediate state for the power supply. The time taken for the power supply to reach the target mode from the actual mode will be monitored. If this time exceeds the timeout input an error will be set and the state machine handling will be held.

If the enable input of the function block is reset during any time, the function block will identify the current state of the power supply and then decide if it is necessary to bring the power supply to DC power off state. The Error, ErrorID outputs provide the necessary information in case of any function block errors. The outputs of the function block will be updated during every PLC scan. Any change in the state it would immediately reflect on the function block outputs. Additionally the option to clear power supply error is provided via the ClearError input. The rising edge of this input will initiate the error clear command **S-0-0099** for the power supply. The status of successful error clear will be made available through the ClearErrorAck output of the function block. The diagnostic information of the power supply will be continuously updated to the function block output State. Below are the AT and MDT list for this function block.

The screenshot shows the configuration interface for the FB_PowerSupply function block. It includes tabs for Settings, IP settings, Slot 0, and Slot 1. The main configuration area is divided into two sections: 'Producer asynchronous' and 'Data configuration'.

Producer asynchronous settings:

- Status: prepare
- Number: 105
- Producer cycle time: 3000.000 us
- Max. connection length: 56
- Current conn. length: 20
- Connection class: -1

Data configuration table:

Offset	IDN		
0	S-0-0135 : Drive status word	+	x
2	S-0-0144 : Signal status word	+	x
4	S-0-0386 : Active position feedback value	+	x
8	S-0-0535 : Active velocity feedback value	+	x
12	S-0-0390 : Diagnostic message number	+	x
16	S-0-1720.0.2 : Power supply status word	+	x

At the bottom left, there is a link labeled 'Process data'.

Fig - 08: FB_PowerSupply AT list

Settings IP settings Slot 0 Slot 1

PROFI
INDUSTRIAL ETHERNET
NET

Consumer asynch. (no watchdog)

Status:

Number:

Producer cycle time: us

Allowed data losses:

Error counter:

Max. connection length:

Current conn. length:

Connection class:

[Process data](#)

Data configuration

Offset	IDN		
0	S-0-0134 : Master control word	<input type="button" value="+"/>	<input type="button" value="X"/>
2	S-0-0145 : Signal control word	<input type="button" value="+"/>	<input type="button" value="X"/>
4	S-0-0282 : Positioning command value	<input type="button" value="+"/>	<input type="button" value="X"/>
8	S-0-0259 : Positioning velocity	<input type="button" value="+"/>	<input type="button" value="X"/>
12	S-0-0260 : Positioning acceleration	<input type="button" value="+"/>	<input type="button" value="X"/>
16	S-0-0359 : Positioning deceleration	<input type="button" value="+"/>	<input type="button" value="X"/>
20	S-0-1720.0.1 : Power supply control word	<input type="button" value="+"/>	<input type="button" value="X"/>

Fig - 09: FB_PowerSupply MDT list

Status	Target parameter	Bit number
Bit 0: <input type="radio"/>	S-0-0000: <empty>	0
Bit 1: <input type="radio"/>	S-0-0000: <empty>	0
Bit 2: <input type="radio"/>	S-0-0000: <empty>	0
Bit 3: <input type="radio"/>	S-0-0000: <empty>	3
Bit 4: <input type="radio"/>	S-0-0000: <empty>	5
Bit 5: <input type="radio"/>	S-0-0099: C0500 Reset class 1 diagnostics	0
Bit 6: <input type="radio"/>	S-0-0000: <empty>	1
Bit 7: <input type="radio"/>	S-0-0000: <empty>	2
Bit 8: <input type="radio"/>	S-0-0000: <empty>	0
Bit 9: <input type="radio"/>	S-0-0000: <empty>	0
Bit 10: <input type="radio"/>	S-0-0000: <empty>	0
Bit 11: <input type="radio"/>	S-0-0000: <empty>	0
Bit 12: <input type="radio"/>	S-0-0000: <empty>	0
Bit 13: <input type="radio"/>	S-0-0000: <empty>	0
Bit 14: <input type="radio"/>	S-0-0000: <empty>	0
Bit 15: <input type="radio"/>	S-0-0000: <empty>	0

Fig - 10: Signal control word settings – ctrlXDriveEngineering

3.2 Interface Description

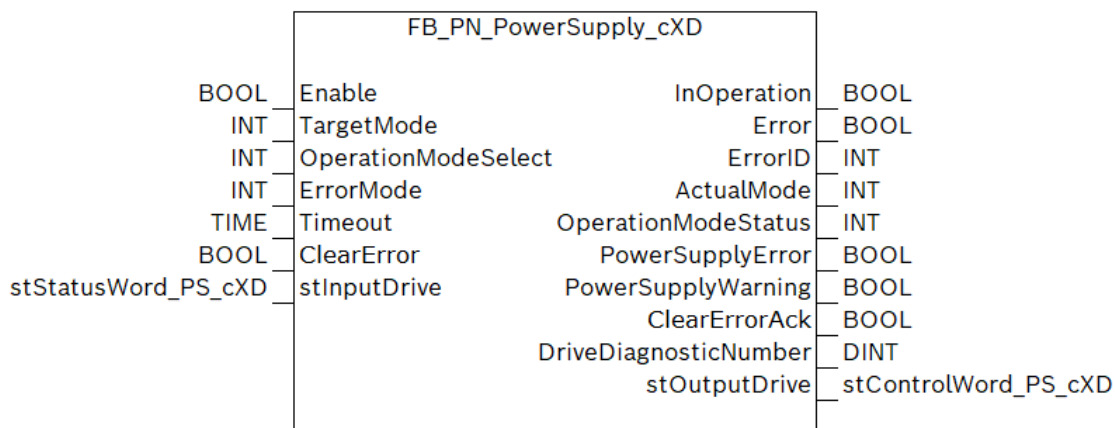


Fig - 11: Interface Overview – FB_PN_PowerSupply_cXD

3.3 Input and Output Description

I/O Type	Name	Data Type	Comment
VAR_INPUT	Enable	BOOL	Enable processing of the function block
	TargetMode	INT	Target mode to be reached by the power supply – refer to section 4.4 in this document below
	OperationModeSelection	INT	Operating Modes possible for a power supply – refer to section 4.3 in this document below
	ErrorMode	INT	Error transition handling input for power supply – refer to section 4.2 in this document below
	ClearError	BOOL	Clearing an error in the drive by the “Clear error” command S-0-0099. After the error has been cleared, the selected enabling can be enabled again.
	Timeout	TIME	Max time allowed from any ActualMode -> TargetMode
	stInputDrive	HW_IO	Input address of the AT parameters from hardware configuration for the power supply.
	InOperation	BOOL	Function Block is Inoperation
	Error	BOOL	Indicates that an error occurred
	ErrorID	INT	ErrorID(see ErrorID – refer to section 5 in this document below)

VAR_OUTPUT	ActualMode	INT	Actual state of the state machine of the power supply– refer to section 4.1 in this document below
	OperationModeStatus	INT	Current Operating Mode for the power supply – refer to section 4.3 in this document below
	PowerSupplyError	BOOL	Error internal to the power supply has occurred
	PowerSupplyWarning	BOOL	Warning internal to the power supply has occurred
	ClearErrorAck	BOOL	Confirmation that the command “Clear error” S-0-0099 was executed successfully.
	stOutputDrive	HW_IO	Output address of the MDT parameters from hardware configuration for the power supply.
	DriveDiagnosticNumber	WORD	Diagnostic message number

3.4 Min-/Max-Default-Values and Takeover of Inputs

The following table describes the minimum, maximum and default values of the block inputs.

Name	Data Type	Min. Value	Max. Value	Default Value	Takeover
Enable	BOOL			FALSE	Continuous
TargetMode	INT	1	6	1=MAINS_OFF_NO_DISCHARGE	Continuous
OperationMode Selection	INT	1	4	1=OPERATIONMODE1	Continuous
ErrorMode	INT	1	2	1=ERROR_TRANSITION_NO_DISCHARGE	Continuous
ClearError	BOOL			FALSE	Continuous
Timeout	TIME	n.def.	n.def.	T#10s	Continuous

4. Datatypes

4.1 Power Supply Actual Mode

The Actual Mode output of the function blocks will be of data type INT (integer). This mode has 8 values as explained below. Each value will provide information about the current state of the power supply state machine.

Value	Description	Comments
1	MAINS_OFF	The power supply is not connected to the mains. If there is an output to control the mains contactor, the mains contactor is switched off.

2	DC_POWER_OFF	The mains contactor is powered on. DC charging is not yet started
3	DC_BUS_CHARGING	The charging of the DC bus capacity is in progress. This process can be interrupted by changing the Target mode input if it is required.
4	DC_DISCHARGING	The capacity of the DC bus is being discharged to low voltage level. This process can be interrupted by changing the Target mode input if it is required.
5	DC_BUS_CHARGED	The DC bus is charged to the peak voltage of the mains. The operation mode is not active.
6	OPERATION_MODE	The selected operation mode is active.
7	ERROR	The power supply detected an error, and the error bit in the power supply status is set to '1' and the corresponding status code is set in S-0-0390.
99	UNKNOWN_STATE	The status word of the power supply doesn't correspond to a valid state. Error will be declared by the function block.

4.2 Power Supply Error Mode

The Error Mode input of the function blocks will be of data type INT (integer). This mode has two values as described below. Each value will decide the state to which the power supply should switch to when it exits from an error state.

Value	Description	Comments
1	ERROR_TRANSITION_NO_DISCHARGE	The function block will switch either to Mains off or DC power off depending on the Target mode – DC discharging will not be done
2	ERROR_TRANSITION_DISCHARGE	The function block will switch to DC discharging and complete it before switching to the next state

Note: There can be contradicting combination of inputs between ErrorMode and TargetMode. In such cases the priority of execution will be given to the TargetMode irrespective of the Error Mode input value. This is explained with an example below.

If actual mode is in Error State and given targetmode is DC_POWER_OFF_NO_DISCHARGE and error mode is ERROR_TRANSITION_DISCHARGE then in this situation, when the power supply exits the Error state, the TargetMode requires the power supply to switch to DC power off state without discharging the DC bus, but the ErrorMode requires the power supply to do the discharging of DC bus before switching to the next state. In this situation the priority will be given to TargetMode and the power supply will be switched to DC power off mode without discharging the DC bus.

4.3 Power Supply Operation Mode Selection/Status

The OperationModeSelection/Status input & output of the function block will be of data type INT. This mode has four values as follows. The value of this mode will reflect on the bits 8 & 9 of the control and status words.

Value	Description	Comments
1	Primary Operation mode	Binary value 0 = 0b00, S-0-1709.0.01
2	Secondary operation mode 1	Binary value 1 = 0b01, S-0-1709.0.02
3	Secondary operation mode 2	Binary value 2 = 0b10, S-0-1709.0.03
4	Secondary operation mode 3	Binary value 3 = 0b11, S-0-1709.0.04

4.4 Power Supply Target Mode

The TargetMode input of the function blocks will be of data type INT. This mode has six values as shown below. Each value of this mode will decide the final state to be reached by the power supply state machine. This input can be changed at any point of execution of the function block. As explained in the section 4.3, when there are contradicting inputs between TargetMode and ErrorMode the priority of execution will be give to the TargetMode.

Value	Description	Comments
1	MAINS_OFF_NO_DISCHARGE	The power supply should immediately switch to the mains off state
2	MAINS_OFF_DISCHARGE	The power supply should do the discharging of the dc bus and finally move to the mains off state
3	DC_POWER_OFF_NO_DISCHARGE	The power supply should switch to the DC power off state regardless of its current ActualMode
4	DC_POWER_OFF_DISCHARGE	The power supply should do the discharging of the dc bus and then switch to the DC power off state
5	DC_BUS_CHARGED	The power supply should switch to the DC bus charged state
6	OPERATION_MODE	The power supply should switch to the operation mode

5. Error Handling

The function block can reach an error state due to invalid inputs or due to the elapse of timeout timer. In both cases the function block will declare an error and stop operation. The user needs to correct the reason for the error and then reset and set the Enable input again to resume the function block operation.

ErrorID	Comment
1000	Operation mode selection input is invalid
1001	Target mode input is invalid
1002	Error mode input is invalid
1003	Actual mode is in unknown State
1004	Transition timeout elapsed (Actual mode -> Target mode)

6. Sample Program Overview

The provided sample program gives the user a brief idea of how to implement the function blocks with its respective instances

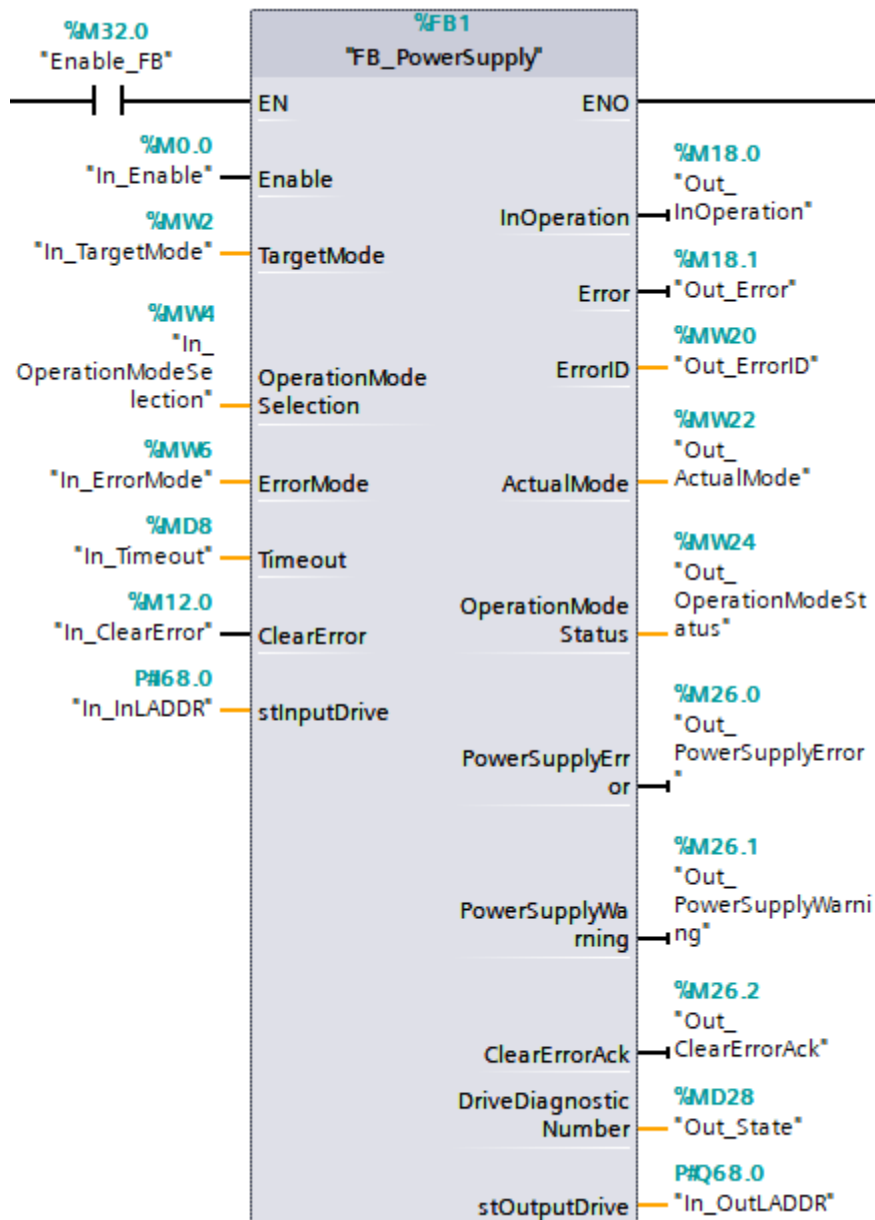


Fig - 12: Function Call – MB_PowerSupply

6.1 Target Mode: DC_POWER_OFF_NO_DISCHARGE

Initially when the ctrlX DRIVE is connected to PLC and Powered ON by default the ctrlX DRIVE Power Supply mode is MAINS_OFF.

To change the Power Supply mode from the Function Block, use the Target Mode tag. In the target Mode tag provide the proper input (DC_POWER_OFF_NO_DISCHARGE), where the functional block writes the respective data to the S-Parameter(S-0-1720.0.1) and check the Visualization of Power Supply from MAINS_OFF to DC_POWER_OFF_NO_DISCHARGE in the below figure.

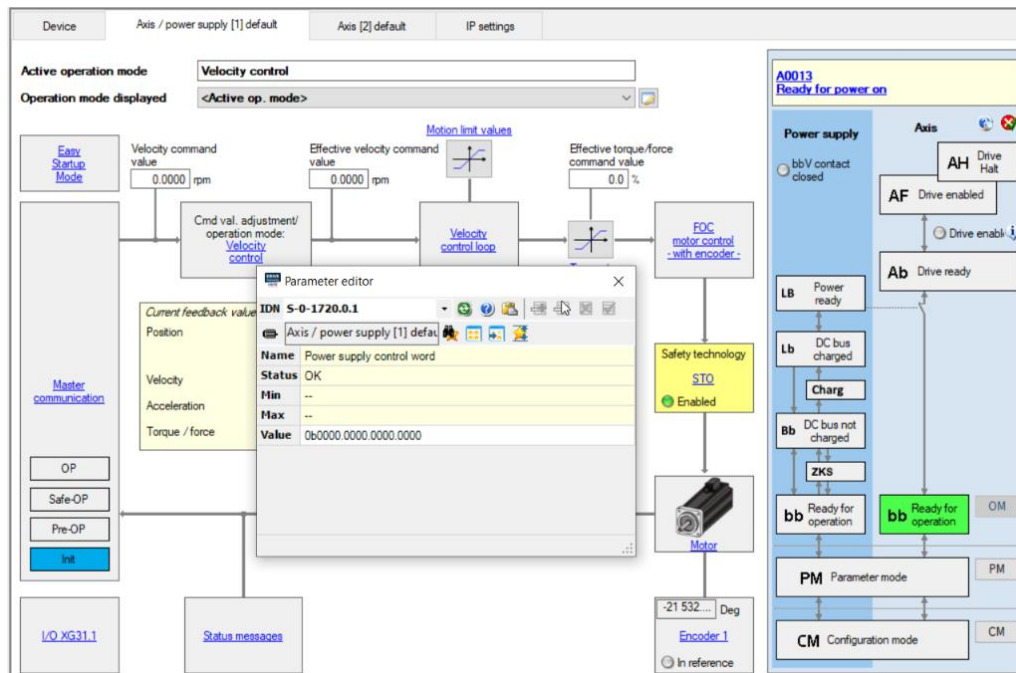


Fig - 13: PowerSupply Mode Mains_Off

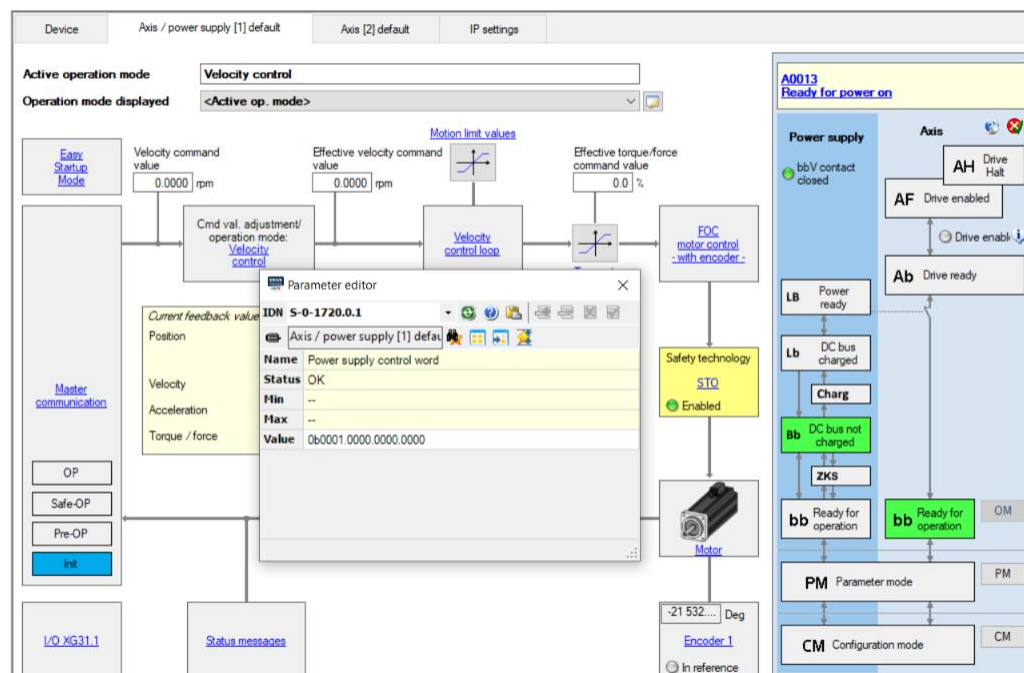


Fig - 14: PowerSupply DC_BUS_Not Charged/DC_POWER_OFF

6.2 Target Mode: DC_BUS_CHARGED

Now let's change the Power Supply mode from DC_POWER_OFF to DC_BUS_CHARGED and visualize the change in the ctrlX DRIVE using ctrlX DRIVE Engineering Tool.

To change the Power Supply mode from the Function Block, use the Target Mode tag. In the target Mode tag provide the proper input (DC_BUS_CHARGED), where the functional block writes the respective data to the S-Parameter(S-0-1720.0.1) and check the Visualization of Power Supply from DC_POWER_OFF to DC_BUS_CHARGED via DC_BUS_CHARGING in the below figure.

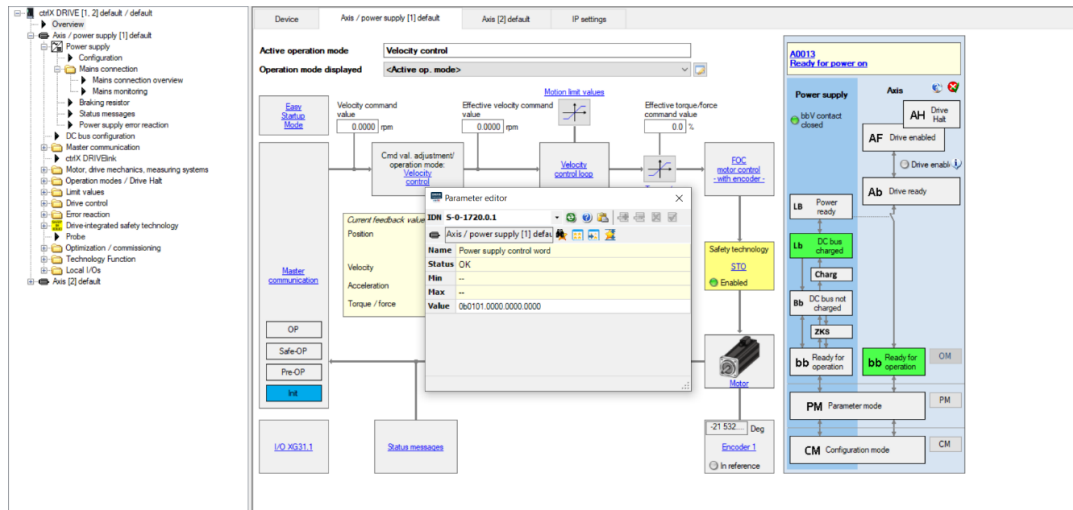


Fig - 15: PowerSupply Mode DC_BUS_CHARGED

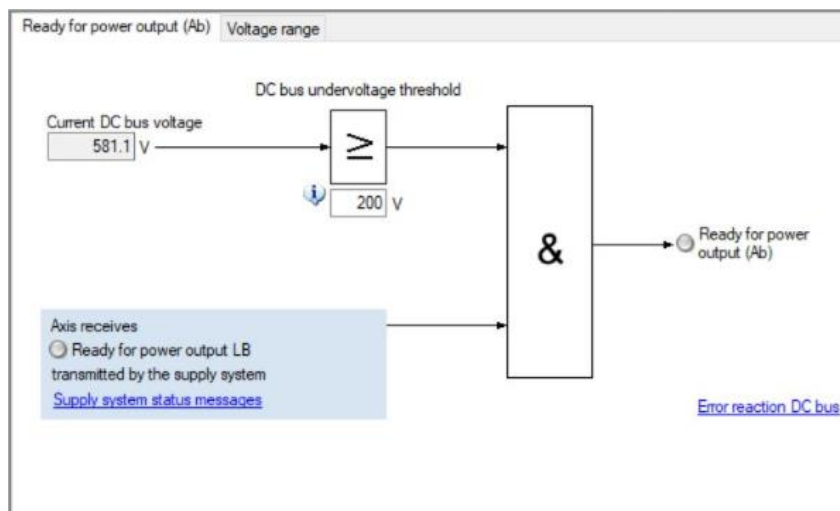


Fig - 16: DC BUS VOLTAGE Measurement

6.3 Target Mode: OPERATION_MODE

Now let's change the Power Supply mode from DC_BUS_CHARGED to OPERATION_MODE and visualize the change in the ctrlX DRIVE using ctrlX DRIVE Engineering Tool.

To change the Power Supply mode from the Function Block, use the Target Mode tag. In the target Mode tag provide the proper input (OPERATION_MODE), where the functional block writes the respective data to the S-Parameter(S-0-1720.0.1) and check the Visualization of Power Supply from DC_BUS_CHARGED to OPERATING_MODE in the below figure.

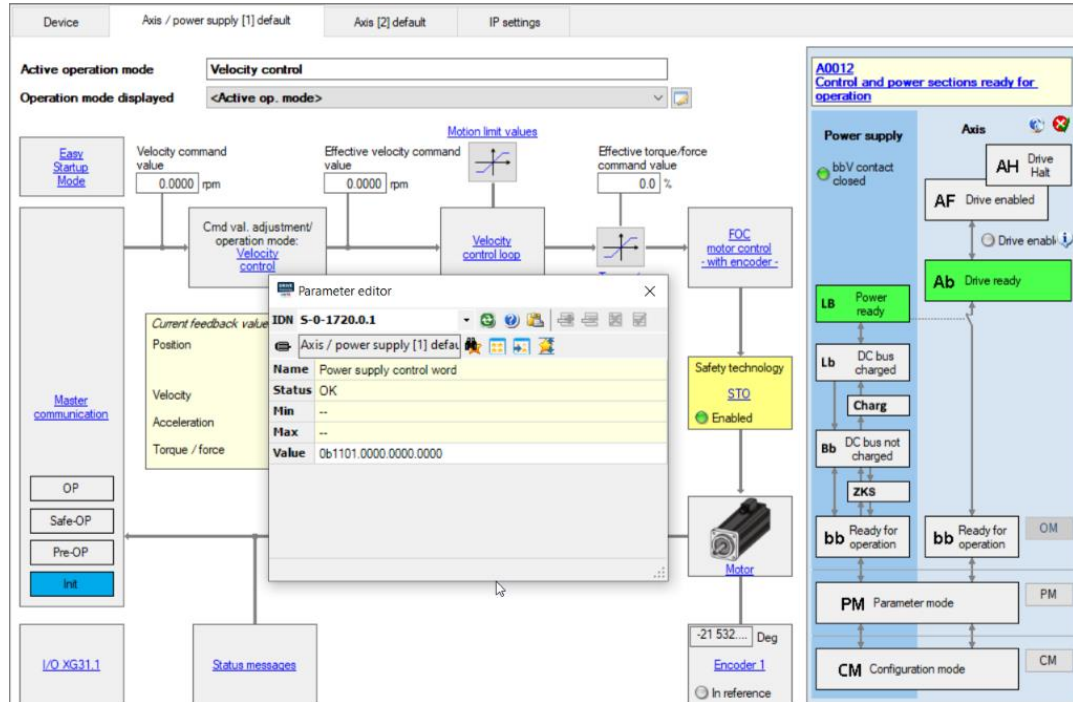


Fig - 17: PowerSupply Mode OPERATION_MODE

6.4 Target Mode: DC_POWER_OFF_NO_DISCHARGE

Now let's change the Power Supply mode from OPERATION_MODE to DC_BUS_CHARGED and visualize the change in the ctrlX DRIVE using ctrlX DRIVE Engineering Tool.

To change the Power Supply mode from the Function Block, use the Target Mode tag. In the target Mode tag provide the proper input (DC_POWER_OFF_NO_DISCHARGE), where the functional block writes the respective data to the S-Parameter(S-0-1720.0.1) and check the Visualization of Power Supply from OPERATING_MODE to DC_POWER_OFF_NO_DISCHARGE in the below figure.

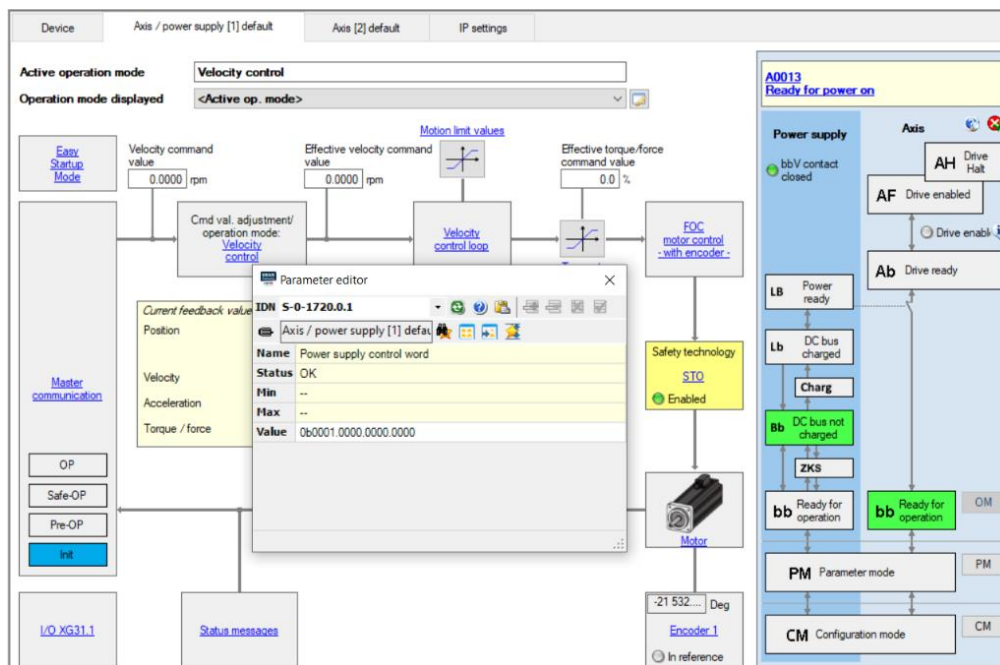


Fig - 18: PowerSupply Mode DC_POWER_OFF

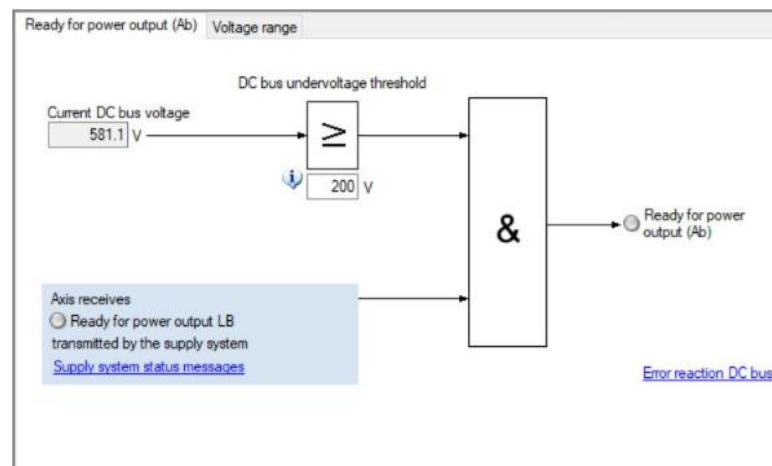


Fig - 19: DC_BUS Voltage Measurement

6.5 Target Mode: DC_POWER_OFF_DISCHARGE

Now let's change the Power Supply mode from OPERATION_MODE to DC_POWER_OFF_DISCHARGE and visualize the change in the ctrlX DRIVE using ctrlX DRIVE Engineering Tool.

To change the Power Supply mode from the Function Block, use the Target Mode tag. In the target Mode tag provide the proper input (DC_POWER_OFF_DISCHARGE), where the functional

block writes the respective data to the S-Parameter(S-0-1720.0.1) and check the Visualization of Power Supply from OPERATING_MODE to DC_POWER_OFF_DISCHARGE via DC_BUS_DISCHARGING in the below figure.

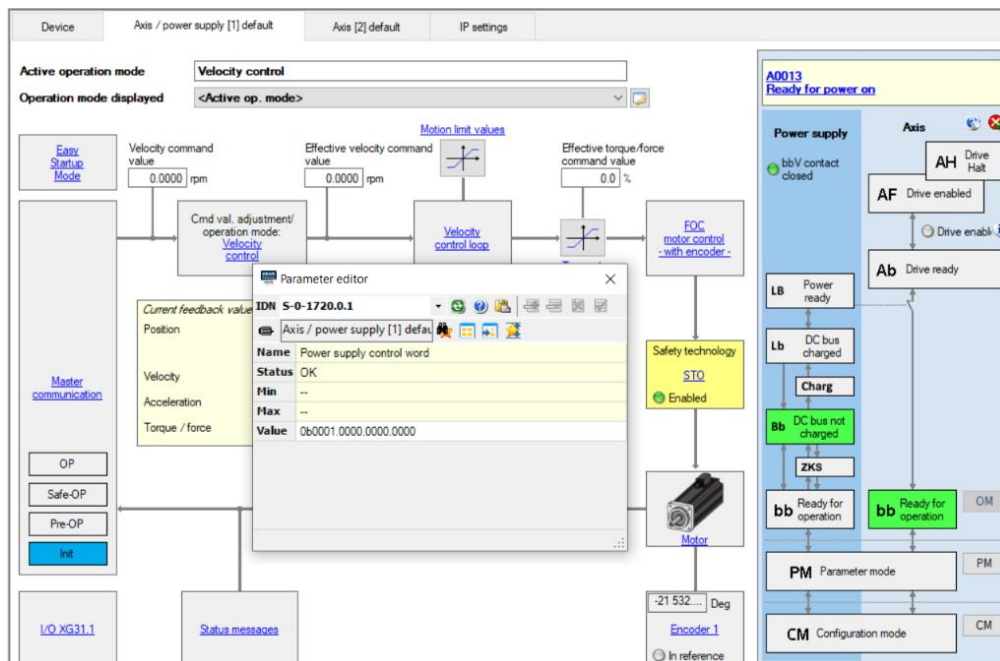


Fig - 20: PowerSupply Mode DC_POWER_OFF

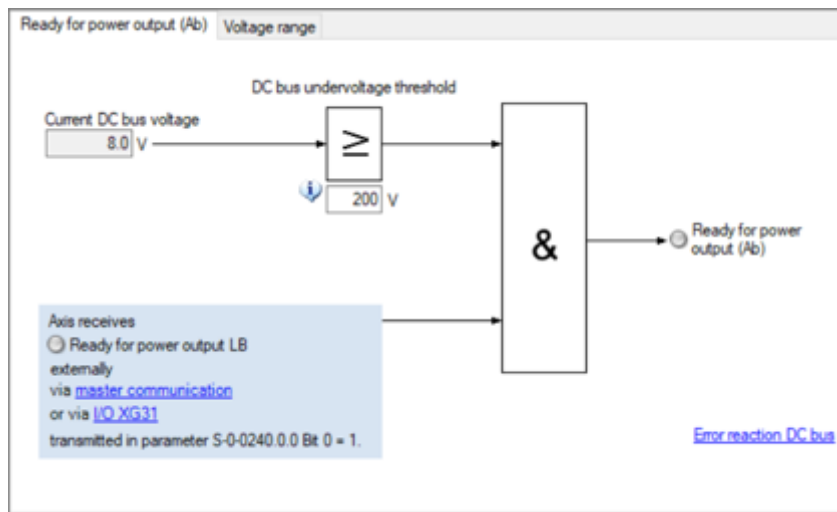


Fig - 21: DC_BUS Voltage Measurement

6.6 Target Mode: MAINS_OFF_NO_DISCHARGE

Now let's change the Power Supply mode from OPERATION_MODE to MAINS_OFF_NO_DISCHARGE and visualize the change in the ctrlX DRIVE using ctrlX DRIVE Engineering Tool.

To change the Power Supply mode from the Function Block, use the Target Mode tag. In the target Mode tag provide the proper input (MAINS_OFF_NO_DISCHARGE), where the functional block writes the respective data to the S-Parameter(S-0-1720.0.1) and check the Visualization of Power Supply from OPERATING_MODE to MAINS_OFF_NO_DISCHARGE via DC_BUS_POWER_OFF in the below figure.

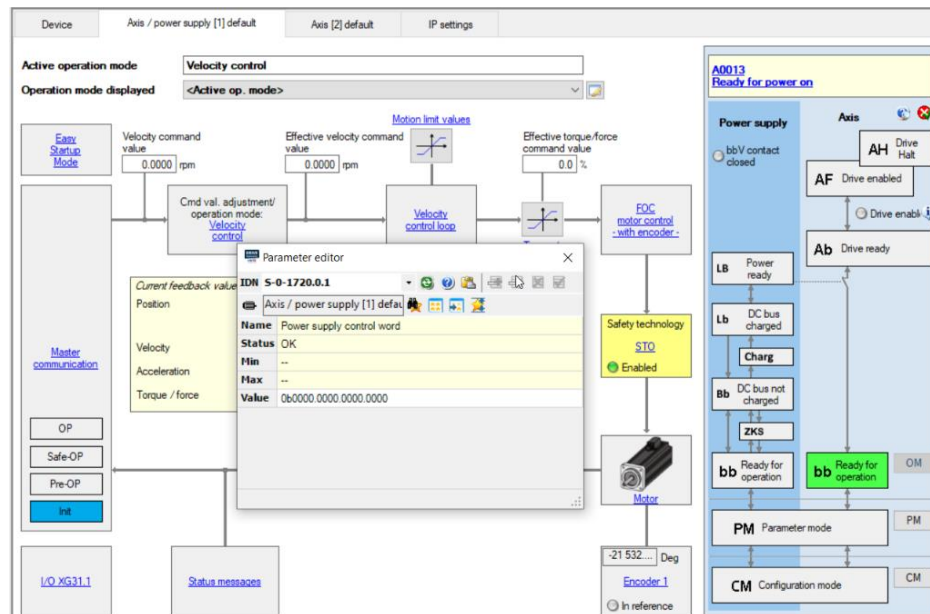


Fig - 22: PowerSupply Mode Mains_OFF

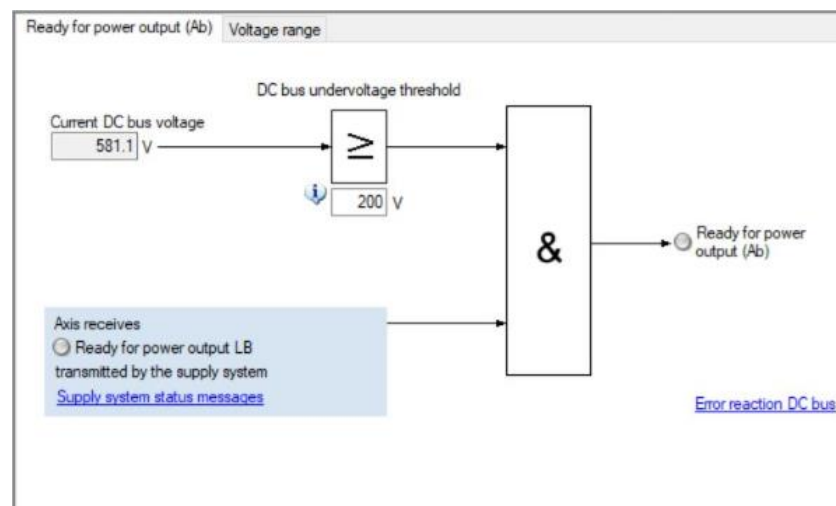


Fig - 23: DC_BUS Voltage Measurement

6.7 Target Mode: MAINS_OFF_DISCHARGE

Now let's change the Power Supply mode from OPERATION_MODE to MAINS_OFF_DISCHARGE and visualize the change in the ctrlX DRIVE using ctrlX DRIVE Engineering Tool.

To change the Power Supply mode from the Function Block, use the Target Mode tag. In the target Mode tag provide the proper input (MAINS_OFF_DISCHARGE), where the functional block writes the respective data to the S-Parameter(S-0-1720.0.1) and check the Visualization of Power Supply from OPERATING_MODE to MAINS_OFF_DISCHARGE via DC_BUS_DISCHARGING and DC_BUS_POWER_OFF in the below figure.

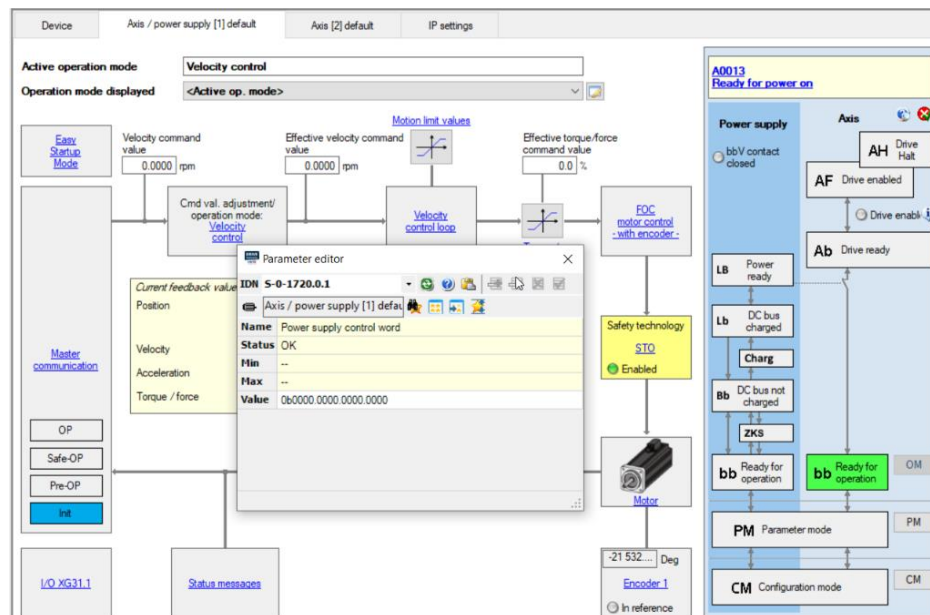


Fig - 24: PowerSupply Mode Mains_OFF

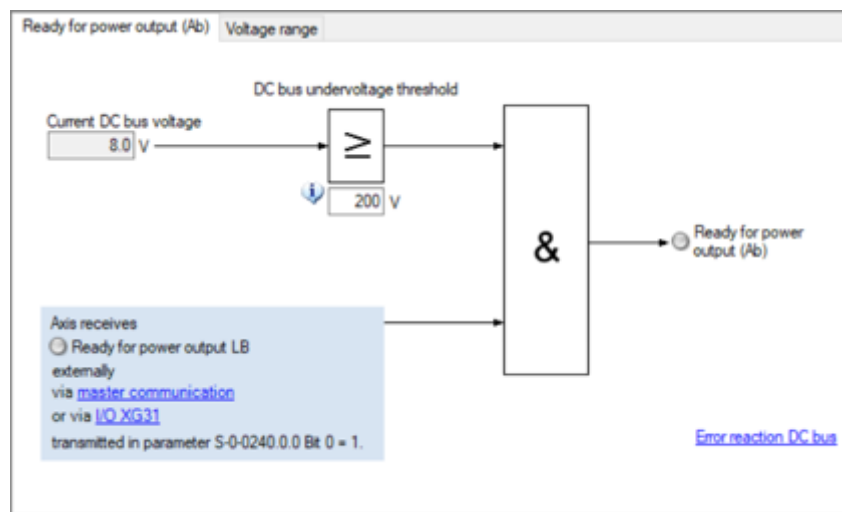


Fig - 25: DC_BUS Voltage Measurement

7. Version History

Version	Date (dd.mm.yyyy)	Editor	Remarks
1.0	13/10/2022	Kishore Raju P	Initial Version
1.0.1	18/10/2022	Kishore Raju P	BaseLined Version
1.0.2	19/06/2023	Kishore Raju P	657295 : status Bits Modified