4.7 Modules

The HIQuad X system is a modular system that can be equipped with various modules. The following modules are available for the system:

- F-CPU 01 processor module
- F-IOP 01 I/O processing module
- F-COM 01 communication module
- I/O modules, see Chapter 4.11
- F-PWR 01 power supply unit (24/5 V)
- F-PWR 02 buffer module

4.8 F-CPU 01 Processor Module

The CPU operating system controls the user programs running in a processor module.

4.8.1 Operating System

Tasks:

- Controlling the cyclic run of the user programs.
- Performing the self-tests of the module.
- Controlling safety-related communication via safe**ethernet.**
- Managing the processor modules' redundancy (synchronization).

4.8.1.1 General Cycle Sequence

Phases:

1. Reading of the input data.
2. Processing of the user program.
3. Writing of the output data.
4. Other activities, e.g., reload processing.

4.8.1.2 Operating System States

States that can be recognized by the user:

- LOCKED
- STOP/VALID CONFIGURATION
- STOP/INVALID CONFIGURATION
- STOP/LOADING OS
- RUN
- RUN/UP STOP

Use the LEDs on the module to recognize the operating state. All LEDs must be taken into account, see the module-specific manuals.
SILworX displays the operating states in the online view.

State	Description	The state is entered:
LOCKED	The processor module is reset to the factory settings (SRS, network settings, etc.).	Connecting the supply voltage to the processor module while the mode switch is set to Init.
STOP/VALID CONFIGURATION	Processor module stopped: A valid configuration is available in the memory.	Stopping the processor module using SILworX.
		Applying the supply voltage ▪ Autostart is disabled in the project configuration or ▪ Mode switch is set to Stop and the processor module starts by itself.
		A fault occurred.
STOP/INVALID CONFIGURATION	Processor module stopped: No valid configuration is available in the memory.	Loading with error.
STOP/LOADING OS	Processor module stopped: The operating system is loaded in the non-volatile memory.	Loading the operating system using SILworX.
RUN	The user program is running.	From the STOP/VALID CONFIGURATION state: SILworX command.
		Applying the supply voltage, the following conditions must be met: ▪ A valid project configuration is loaded. ▪ Autostart is enabled in the project configuration. ▪ The mode switch is not set to Init. ▪ The mode switch is set to Run if the processor module starts by itself.
RUN/UP STOP	The user program is not running. This state is used for testing the inputs/outputs and communication.	From the STOP/VALID CONFIGURATION state: SILworX command SILworX.

Table 18 provides an overview of the operating system states and indicates the conditions for entering them.

State	Description	The state is entered:
LOCKED	The processor module is reset to the factory settings (SRS, network settings, etc.).	Connecting the supply voltage to the processor module while the mode switch is set to Init.
STOP/VALID CONFIGURATION	Processor module stopped: A valid configuration is available in the memory.	Stopping the processor module using SILworX.
		Applying the supply voltage ▪ Autostart is disabled in the project configuration or ▪ Mode switch is set to Stop and the processor module starts by itself.
		A fault occurred.
STOP/INVALID CONFIGURATION	Processor module stopped: No valid configuration is available in the memory.	Loading with error.
STOP/LOADING OS	Processor module stopped: The operating system is loaded in the non-volatile memory.	Loading the operating system using SILworX.
RUN	The user program is running.	From the STOP/VALID CONFIGURATION state: SILworX command.
		Applying the supply voltage, the following conditions must be met: ▪ A valid project configuration is loaded. ▪ Autostart is enabled in the project configuration. ▪ The mode switch is not set to Init. ▪ The mode switch is set to Run if the processor module starts by itself.
RUN/UP STOP	The user program is not running. This state is used for testing the inputs/outputs and communication.	From the STOP/VALID CONFIGURATION state: SILworX command SILworX.

Table 18: Operating System States, States Entered

Table 19 specifies how the user may intervene during the corresponding states.

State	Possible user interventions
LOCKED	▪ Changing the factory settings. ▪ Using a PADT command to stop (STOP state). ▪ Using a PADT command to start (RUN state).
STOP/VALID CONFIGURATION	▪ Loading the user program. ▪ Starting the user program. ▪ Loading the operating system. ▪ Taking preliminary actions for forcing variables.
STOP/INVALID CONFIGURATION	▪ Loading the user program. ▪ Loading the operating system.
STOP/LOADING OS	None. Once the loading process is completed, the processor module stops (STOP state).
RUN	▪ Stopping the user program. ▪ Forcing variables. ▪ Performing the test.
RUN/UP STOP	▪ Using a PADT command to stop (STOP state).

Table 19: Operating System States, User Interventions

i The cycle time increases by the number of modules used in the system. This applies irrespective of whether or not the modules are included in the configuration.

- **Connecting additional extension racks with several modules during operation can cause the watchdog time to be exceeded!**

4.8.2 Behavior in the Event of Faults

If faults occur, the processor module enters the error stop state and tries to restart. It performs a complete self-test which can also cause another error stop.

If a fault is still present, the module restarts with reduced functionality to prevent a reboot loop.

Once the processor module has properly run for one minute, the next error stop to occur is considered the first *error stop* attempting a restart.

i Use the PADT for troubleshooting and removing the cause of the fault, e.g., by loading a new application.

4.9 F-IOP 01 I/O Processing Module

The I/O processing module manages the I/O bus of the H41X base rack and that of the extension racks. The I/O bus is used to exchange process data between I/O modules and the I/O processing module. The module's tasks include exchanging data with the processor modules and providing the watchdog signal to the output modules via system bus A and system bus B.

4.10 F-COM 01 Communication Module

The communication module is equipped with 2 Ethernet interfaces and 1 fieldbus interface allowing the HIQuad X system to communicate with external systems. The module is approved for use in the safety-related HIQuad X system and can be employed to transport safety-related protocols.

4.11 I/O Modules

The following table shows the I/O modules that can be used for HIQuad X:

Module	Cable plug	Channels	SIL	Type	Data sheet HI number
F 3221	Z 7116 / 3221	16	---	DI	HI 803 174 E
F 3224A	Z 7114 / 3224	4	---	DI; (Ex)i	HI 803 175 E
F 3236	Z 7116 / 3236	16	3	DI	HI 803 176 E
F 3237	Z 7108 / 3237	8	3	DI	HI 803 177 E
F 3238	Z 7008 / 3238	8	3	DI; (Ex)i	HI 803 178 E
F 3240	Z 7130 / 3240	16	3	DI 110 VDC	HI 803 179 E
F 3248	Z 7130 / 3248	16	3	DI 48 VDC	HI 803 180 E
F 3322	Z 7136 / 3322	16	---	DO 0.5 A	HI 803 181 E
F 3325	Z 7025 / 3325	6	---	Supply module	HI 803 182 E
F 3330	Z 7138 / 3330	8	3	DO 0,5 A	HI 803 183 E
F 3331	Z 7138 / 3331	8	3	DO 0.5 A	HI 803 184 E
F 3333	Z 7134 / 3333	4	3	DO 2 A	HI 803 185 E
F 3334	Z 7134 / 3334	4	3	DO 2 A	HI 803 186 E
F 3335	Z 7035 / 3335	4	3	DO; (Ex)i	HI 803 187 E
F 3349	Z 7150 / 3349	8	3	DO 0.5 A	HI 803 188 E
F 3422	Z 7139 / 3422	8	---	Relay 60 VDC	HI 803 189 E
F 3430	Z 7149 / 3430	4	3	Relay 110 VDC	HI 803 190 E
F 5220	Z 7152 / 5220	2	3	Counter	HI 803 191 E
F 6215	Z 7127 / 6215	8	---	AI	HI 803 192 E
F 6217	Z 7127 / 6217	8	3	AI	HI 803 193 E
F 6220	Z 7062 / 6220	8	3	Thermocouple; (Ex)i	HI 803 194 E
F 6221	Z 7063 / 6221	8	3	AI; (Ex)i	HI 803 195 E
F 6705	Z 7126 / 6705	2	3	AO	HI 803 196 E
F 6707	Z 7126 / 6706	2	---	AO	HI 803 197 E

Table 20: Possible I/O Modules to Be Used in HIQuad X

4.11.1 Scope of Application of the I/O Modules

Refer to the safety manual (HI 803 209 E) for more information on the standards used to certify the I/O modules.

i For the scope of application of the I/O modules, observe the revisions, see the modernization manual (HI 803 235 E).

4.11.2 Mounting Position

The I/O modules must be mounted vertically. The vertical mounting position automatically results from the horizontal position of the rack within a control cabinet.