SIEMENS

SIMATIC

Embedded Automation Software Development Kit for EC31

Programming Manual

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Introduction

Conventions

- *EC31*

  In the documentation, the term *embedded controller* or *device* is also used to designate the *EC31* product.
- *S7 Modular Embedded Controller*

  The entire *S7 modular embedded controller* system - consisting of an embedded controller with PC upgrades, signal modules and expansion modules is abbreviated to *S7-mEC*.

Purpose of this document

This document contains information that you will need to program with the software development kit (SDK) for the *S7-mEC* system. It is intended for use by programmers who commission the device themselves.

Scope

This document applies to all supplied variants of the *S7-mEC*, and describes the EC31, product release V1.1 or higher.

Basic knowledge required

The *S7-mEC* system must only be used by qualified personnel. Knowledge of the following is considered essential:

- Set-up guidelines for SIMATIC S7-300
- PC skills
- C/C++ programming skills
- Windows XP/XP Embedded operating systems

Position in the Information Landscape

For further information on using the hardware, refer to the relevant equipment manuals.

Table of contents

1 Description

1.1 Software Development Kit

Software Development Kit (SDK)

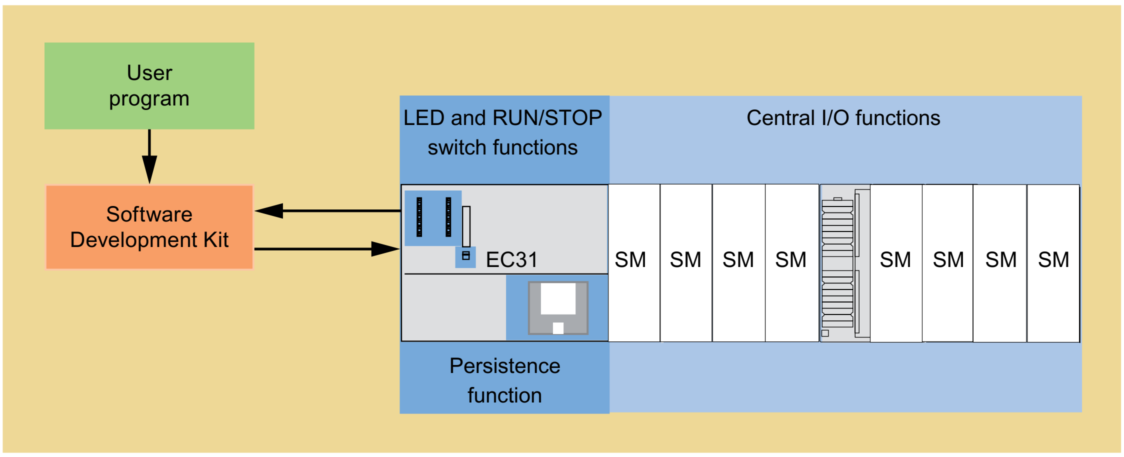
An SDK contains programs and definitions for specific software, and provides functions for creating C user programs.
The SDK programming interface for the embedded controller thus allows access to the signal modules on the backplane bus (central I/O), EC31 displays and operator controls, the storage locations for retentive data (persistence), and notifications for interrupts, RUN/STOP switch changes, and power failures.

Functions

The SDK subdivides the components for the functions into the following groups:

- ECCIO ... - Components for central I/O
- ECLEDRS ... - Components for LED and RUN/STOP switches
- ECPERS ... - Components for persistence

Schematic diagram



1.2 Sample program

Sample program included as standard

The EC31 is supplied as standard with a complete program that calls up all the SDK functions for an S7-mEC structure with a digital input module, and an analog output module by way of example. This example illustrates the basic program structure, and the individual phases of a normal application. You will find the source code both preinstalled on the EC31, and on the "S7-mEC Software & Documentation" CD-ROM provided.

Opening the sample program

On the EC31, you can open the folder containing the Visual Studio sample program project from the Windows task bar using the following command:

Start > All Programs > SIMATIC > S7-mEC > EC31 > SDK Software > ecExample

Programming 2

2.1 Creating a program

Requirements

- The C/C++ programming environment, such as Visual Studio 2005, is installed on the embedded controller EC31, or on an external engineering PC.
- You have access to the SDK header files. These are contained on the EC31, and on the Software & Documentation CD-ROM under ...\SDK\inc\.
- You will find the DLL files on the EC31 under C:\Windows\System32\

Note

Remote debugging

Remote debugging (Microsof Visual Studio 2005 or higher) allows you to start the application directly on EC31. To do this you have to install the monitor (Msvsmon.exe), which is supplied with every Visual Studio, on EC31. You can find the required project settings and releases on the Internet at Microsoft Software Development Network (MSDN), under "Remote Debugging".

SDK header files and libraries

Needed for ...	Header file	DLL file
Central I/O functions • for accessing the signal modules via the backplane bus • for assigning parameters to signal modules • for detecting interrupts using callback functions, and responding to them	eccio.h	eccio.dll
LED and RUN/STOP switch functions • for activating LEDs on the EC31 • for detecting changes in the status of the RUN/STOP switch on the EC31	ecledrs.h	ecledrs.dll
Persistence functions • for saving retentive data • for detecting a power failure (POWER OFF)	ecpers.h	ecpers.dll

---

Note

Header files on the EC31

On the EC31, you can open the folder containing the header files for SDK from the Windows task bar using the following command:

Start > (All Programs) > SIMATIC > S7-mEC > EC31 > SDK Software > Header Files

---

Creating a program

1. Incorporate the header files and the DLL files that you will need for your user program into your project.
2. Use the SDK functions to program the user program.
3. Compile your project.

   Result: The "*.exe" user program can be transferred to the EC31.

Note

Under Windows XP Embedded, other programs or connected devices can have a negative impact on the time taken to access the backplane bus.

2.2 Program structure

Typical structure

When it runs, a user program is typically divided into 3 phases:

- Initialization phase
- Productive mode
- End phase

Rules

Note the following points when you program:

- The functions of the *initialization phase* activate the necessary components from the SDK via the user program. The functions of the *end phase* end these components. The functions must be used in the program.
- The functions for *productive mode* are optional.

Central I/O functions

Phase	Function

Initialization	`eccio_initialize`
	`eccio_output_control`
	`eccio_def_par_write_single`
	`eccio_def_par_write_broadcast`

Productive mode	`eccio_check_bus` `eccio_ack_alarm`
	`eccio_write_dataset` `eccio_read_dataset`
	`eccio_read_data` `eccio_write_data`
Ending	`eccio_deinitialize`

LED and RUN/STOP switch functions

Phase	Function
Initialization	`ecledrs_initialize` `ecledrs_registerswitchchangecbk`
Productive mode	`ecledrs_write`
Ending	`ecledrs_deregisterswitchchangecbk` `ecledrs_deinitialize`

Persistence functions

Phase	Function
Initialization	`ecpers_initialize`
Productive mode	`ecpers_readblock` `ecpers_writeblock`
Ending	`ecpers_deinitialize`

Flow diagram for a user program

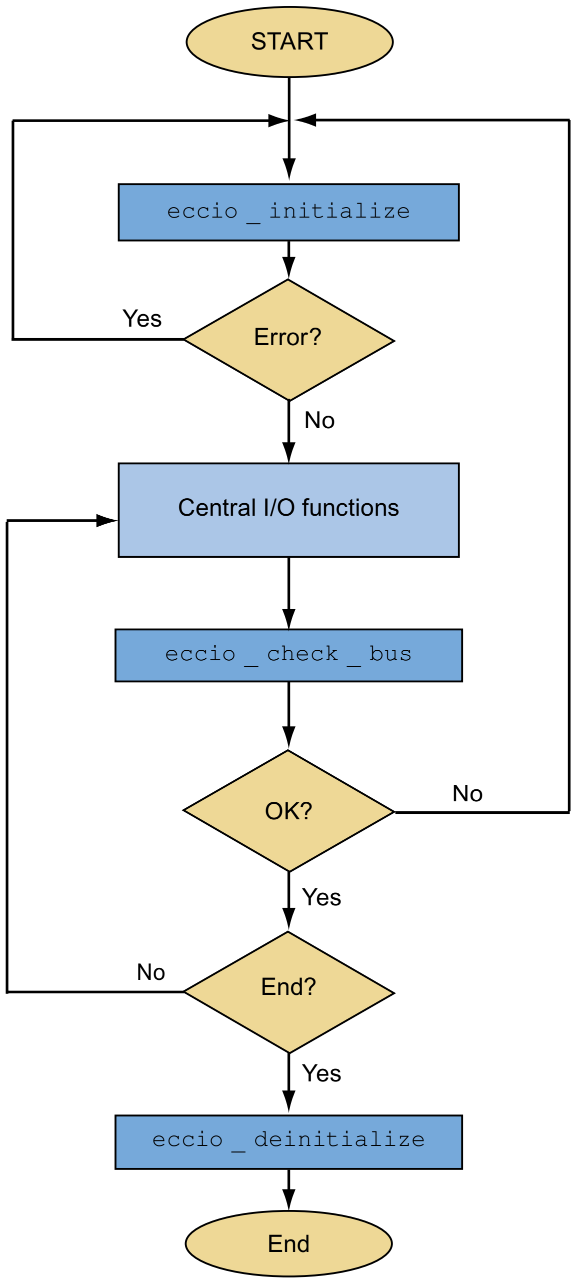


Figure 2-1 Program flow diagram

Note

Ending the user program

Always use the eccio_deinitialize call to end the user program.

2.3 Addressing signal modules

Addressing signal modules via GeoAddr

Central I/O functions require the signal modules concerned to be addressed. The signal modules are addressed in the relevant functions with the `GeoAddr` data type using the `Rack` and `Slot` parameters.

The following diagram shows the maximum configuration on the central I/O with the relevant numbers for `Rack` and `Slot`. Slot 3 on each rack is reserved for the interface module (IM), so counting for the signal modules starts from 4.

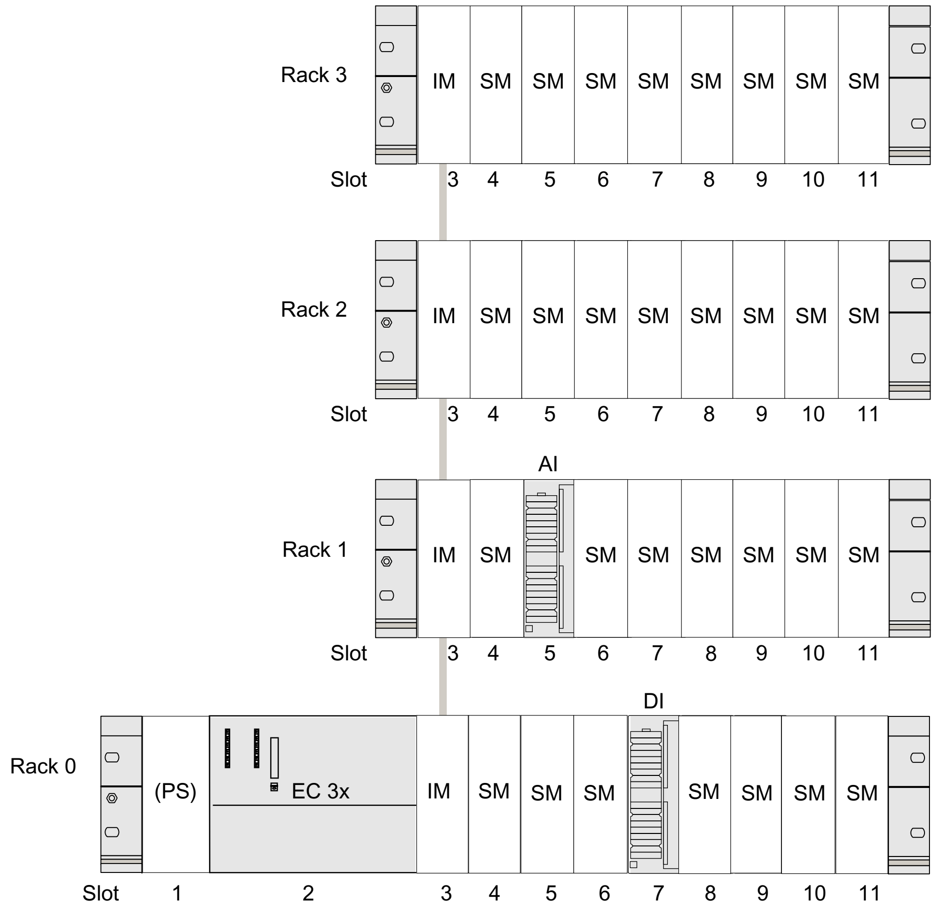


Figure 2-2 Addressing of signal modules

Examples - addressing signal modules via the GeoAddr parameter

The signal modules marked in the picture are addressed as follows:

- Addressing for the digital input module DI

```
GeoAddr digital_input;
digital_input.rack = 0;
digital_input.slot = 7;
```

- Addressing for the analog input module AI

```
GeoAddr analog_input;
analog_input.rack = 1;
analog_input.slot = 5;
```

See also

GeoAddr (Page 47)

2.4 Callback functions

How it works

Callback functions are specified by the user program. A callback function may be assigned any name.

A callback event is an asynchronous event that is called by the EC-CIO interface.
It interrupts the flow of the user program, and starts the callback function in a separate thread.

Callback functions

The following callback functions may be defined in the SDK for S7-mEC:

Callback function	Callback event	Registered by ...
alarm_notification	Hardware interrupt / diagnostic error interrupt at a signal module	`eccio_initialize()`
switch_change_notification	Change in the status of the RUN/STOP switch on the EC31	`ecledrs_registerswitchchangecbk()`
power_fail_notification	Power failure on the EC31	`ecpers_initialize()`

Runtime coordination for callbacks

A callback function can interrupt the user program at any time. Callback functions for different events can also interrupt one another. A callback function must therefore be designed to run multiple times, including simultaneously (reentrant) because it can be called from different threads. In practice, this means that the writing and reading of shared tags must be protected by synchronization mechanisms.

Avoid waits in callback functions, particularly when entering Critical Sections. A further call to a callback function would be blocked by the same callback event. Instead, you should keep your stored data as separate as possible.

A separate callback function can be registered for each callback event. It is also possible to combine multiple callback events in a single callback function, however.

Sample declarations for user-defined callback functions

```
void  ecciocB_AlarmNotification (AlarmInfo*  alarm_data);
void  ecledrsCB_SwitchChangeNotification (unsigned char  state);
void  ecpersCB_PowerFailNotification (void);
```

See also

eccio_initialize (Page 19)

ecledrs_registerswitchchangecbk (Page 38)

ecpers_initialize (Page 41)

Functions 3

3.1 Overview

The SDK provides components for the following functions:

- Central I/O
- LED and RUN/STOP switch
- Persistence

Central I/O functions

Name	Description
Basic functions	
`eccio_initialize`	The user program uses this function to register the embedded controller on the backplane bus.
`eccio_deinitialize`	The user program uses this function to deregister the embedded controller on the backplane bus.
`eccio_output_control`	This function activates / deactivates the outputs of the signal modules.
`eccio_check_bus`	This function compares the current configuration on the backplane bus with the list of stations that were identified using the `eccio_initialize` function.
`eccio_ack_alarm`	This function acknowledges interrupts from signal modules.

Reading and writing data	
`eccio_read_data`	This function reads 1, 2 or 4 bytes from an input module.
`eccio_write_data`	This function writes 1, 2 or 4 bytes to an output module.

Assigning parameters to signal modules	
`eccio_read_dataset`	This function reads data blocks up to 240 bytes long from a signal module.
`eccio_write_dataset`	This function writes data blocks up to 240 bytes long to a signal module. • Assigning parameters to signal modules • Setting the type of measurement and measuring ranges (voltage and current) • Enabling / disabling interrupts
`eccio_def_par_write_single`	This function transfers the parameter assignment status to **one** signal module.
`eccio_def_par_write_broadcast`	This function transfers the parameter assignment status to **all** signal modules on the backplane bus.

LED and RUN/STOP switch functions

Name	Description
`ecledrs_initialize`	This function initializes the LED and RUN/STOP switch functions.
`ecledrs_deinitialize`	This function ends the LED and RUN/STOP switch functions.
`ecledrs_write`	This function is used to control LEDs on the EC31.
`ecledrs_registerswitchchangecbk`	This function activates the status monitoring for the RUN/STOP switch on the EC31.
`ecledrs_deregisterswitchchangecbk`	This function deregisters the status monitoring for the RUN/STOP switch.

Persistence functions

Name	Description
`ecpers_initialize`	This function initializes the persistence functions.
`ecpers_deinitialize`	This function ends the persistence functions.
`ecpers_readblock`	This function reads data from a retentive memory.
`ecpers_writeblock`	This function writes data to a retentive memory.

3.2 Central I/O functions

3.2.1 Basic functions

3.2.1.1 eccio_initialize

Description

This function initializes the backplane bus, and registers a user-defined callback function that is called in response to an interrupt at a signal module.

Once the call has been processed successfully, it sends the list of stations to all signal modules plugged into the backplane bus. The DC5V LED on the EC31 lights up to indicate that the control voltage is present at the connected signal modules.

Requirement:

- The signal modules are supplied with voltage.
- The `ident` and `alarm_notification` parameters were successfully initialized.

Note

Call the function in the user program **before** the other central I/O functions.

If the function is called a second time, the backplane bus is reset, and the stations are identified once again.

Syntax

```
unsigned short  eccio_initialize(
      BusEnum*                     ident,
      FP_EC_CIO_ALARM_NOTIFICATION   alarm_notification,
      unsigned short               config_flags )
```

Parameter

Name	Type	Description	Data type
ident	out	List of stations containing all the signal modules on the backplane bus.	BusEnum*
alarm_notification	in	Pointer to a user function that is called in the event of an interrupt.	-
config_flags	in	Permitted values: 0: *EC_INITFLAGS_DO_DISABLE_OUTPUT_ON_STOP* Safe backplane bus configuration enabled. This means that the backplane bus is dependent on the position of the RUN/STOP switch. 1: *EC_INITFLAGS_DONT_DISABLE_OUTPUT_ON_STOP* Safe backplane bus configuration disabled. This means that the backplane bus does not depend on the position of the RUN/STOP switch.	unsigned short

Safe backplane bus configuration

With the "Safe backplane bus configuration", the backplane bus responds according to the position of the RUN/STOP switch on the embedded controller.

Requirement:
The signal module outputs are enabled using the `eccio_output_control` function.

- Switch in STOP position:

  The outputs of all the signal modules are disabled.
- Switch in RUN position once more:

  The outputs of the signal modules are not automatically enabled.

Note

Always enable the outputs of the signal modules using the `eccio_output_control` function.

Return value

- EC_CIO_OK
- EC_CIO_E_PARAM
- EC_CIO_E_STATE
- EC_CIO_E_BUS
- EC_CIO_E_UNKNOWN
- EC_CIO_E_DRIVER

See also

eccio_deinitialize (Page 21)

eccio_output_control (Page 22)

Callback functions (Page 15)

Return values (Page 51)

3.2.1.2 eccio_deinitialize

Description

This function ends the use of the central I/O functions on the backplane bus.

- It stops all operations on the backplane bus.
- It disables the signal module outputs.
- The backplane bus is switched off (POWER OFF).
- The DC5V LED goes out, but this does not switch off the EC31.

Note

Call the function in the user program when all central I/O functions have ended.

Syntax

```
unsigned short  eccio_deinitialize(  )
```

Return value

- EC_CIO_OK
- EC_CIO_E_STATE
- EC_CIO_E_FATAL
- EC_CIO_E_BUS
- EC_CIO_E_UNKNOWN

See also

eccio_initialize (Page 19)

Return values (Page 51)

3.2.1.3 eccio_output_control

Description

This function enables or disables the outputs of the signal modules.

Enable the outputs so that write functions can be executed at outputs.

Syntax

```
unsigned short  eccio_output_control(
            unsigned short   req_state)
```

Parameter

Name	Type	Description	Data type
`req_state`	in	Permitted values • EC_CIO_PERI_ENABLE: enables the outputs • EC_CIO_PERI_DISABLE: disables the outputs	unsigned short

Return values

- EC_CIO_OK
- EC_CIO_E_PARAM
- EC_CIO_E_STATE
- EC_CIO_E_BUS
- EC_CIO_E_UNKNOWN
- EC_CIO_E_DRIVER

See also

eccio_initialize (Page 19)

eccio_check_bus (Page 23)

Return values (Page 51)

3.2.1.4 eccio_check_bus

Description

This function compares the current configuration on the backplane bus with the list of stations that were identified using the `eccio_initialize` function. If the configuration differs from the saved list of stations, then the function returns the value EC_CIO_E_BUS.

Use the `eccio_initialize` function to initialize the bus again before starting further operations.

Syntax

```
unsigned short eccio_check_bus (void)
```

Return values

- EC_CIO_OK
- EC_CIO_E_BUS
- EC_CIO_E_UNKNOWN
- EC_CIO_E_DRIVER

See also

eccio_output_control (Page 22)

Return values (Page 51)

3.2.1.5 eccio_ack_alarm

Description

This function acknowledges interrupts at a signal module. It must be called after the interrupt has been processed.

Note

The signal module cannot report a second interrupt until the first interrupt has been acknowledged.

Syntax

```
unsigned short   eccio_ack_alarm (
        unsigned char   alarm_type )
```

Parameter

Name	Type	Description	Data type
alarm_type	in	Permitted values: • EC_CIO_PROCESS_ALARM • EC_CIO_DIAGNOSTIC_ALARM	unsigned char

Return value

- EC_CIO_OK
- EC_CIO_E_PARAM
- EC_CIO_E_STATE
- EC_CIO_E_BUS
- EC_CIO_E_UNKNOWN
- EC_CIO_E_DRIVER

See also

AlarmInfo (Page 50)

Return values (Page 51)

3.2.1.6 Callback alarm_notification

Description

The user-defined callback function is called when a process interrupt, or diagnostic interrupt is triggered at a signal module. When the `eccio_initialize` function is called, a pointer to the callback function is passed as a parameter. You can choose any name. The return value must be of the type `void`. The function writes the interrupt information in a structure of the type `alarminfo`.

Requirement

Parameters must be assigned to the relevant signal modules to trigger interrupts via the callback functions.

Rules

- The interrupt must be acknowledged using the `eccio_ack_alarm` function which must be called after the interrupt has been processed.
- If synchronization mechanisms are used, any blocks must be cancelled before the callback function is ended in order to avoid blockages.

NOTICE

Processing interrupts

In SIMATIC automation systems, process and diagnostic interrupts are triggered acyclically in response to specific events, rather than cyclically. As a result, they are relatively infrequent. If signal modules trigger interrupts too frequently, they can impact negatively on the stability of the operating system. For example, several interrupts in succession could block the operating system for a long period.

We therefore recommend that you implement your applications so that interrupts are only triggered in exceptional circumstances.

Syntax

Sample declaration:
```
void  usr_alarm_cbf(AlarmInfo*   alarm_data)
```

Parameter

Name	Type	Description	Data type
alarm_data	in	Pointer to a structure with interrupt information	AlarmInfo*

3.2.2 Reading and writing data

3.2.2.1 eccio_read_data

Description

This function reads 1, 2 or 4 bytes from an input module.

Requirement:

- `eccio_initialize()` was executed successfully.
- The DC5V LED on the EC31 lights up
- The signal module is plugged in.
- The signal module is contained in the list of stations created by `eccio_initialize()`.
- There are no faults in the signal module.
- Signal modules that are to be assigned parameters using parameter assignment data blocks 0 and 1 must receive at least the default values before the function can be executed.

Syntax

```
unsigned short  eccio_read_data (
       GeoAddr          geo,
       void*            pret_buffer,
       unsigned char    length )
```

Parameter

Name	Type	Description	Data type
geo	in	Address of the signal module	GeoAddr
pret_buffer	out	Pointer to a buffer that holds the data.	void*
length	in	Permitted values: 1, 2, 4	unsigned char

Return values

- EC_CIO_OK
- EC_CIO_E_PARAM
- EC_CIO_E_STATE
- EC_CIO_E_BUS
- EC_CIO_E_UNKNOWN
- EC_CIO_E_DRIVER

Reference

For information about the signal modules, refer to the *S7-300 Automation System, Module data* equipment manual. You will find the documentation on the Internet at:

http://support.automation.siemens.com/WW/view/en/8859629

See also

Return values (Page 51)

3.2.2.2 eccio_write_data

Description

This function writes 1, 2 or 4 bytes to an output module.

Requirement:

- `eccio_initialize()` was executed successfully.
- The DC5V LED on the EC31 lights up
- The signal module is plugged in.
- The signal module is contained in the list of stations created by `eccio_initialize()`.
- The signal module supports the writing of data of the appropriate length.
- There are no faults in the signal module.
- The signal module's outputs have been enabled.
- Signal modules that are to be assigned parameters using parameter assignment data blocks 0 and 1 must receive at least the default values before the function can be executed.

Syntax

```
unsigned short  eccio_write_data (
       GeoAddr         geo,
       void*           pbuffer,
       unsigned char   length )
```

Parameter

Name	Type	Description	Data type
geo	in	Address of the signal module	GeoAddr
pbuffer	in	Pointer to a buffer that holds the data.	void*
length	in	Permitted values: 1, 2, 4	unsigned char

Return values

- EC_CIO_OK
- EC_CIO_E_PARAM
- EC_CIO_E_STATE
- EC_CIO_E_BUS
- EC_CIO_E_UNKNOWN
- EC_CIO_E_DRIVER

Reference

For information about the signal modules, refer to the *S7-300 Automation System, Module data* equipment manual. You will find the documentation on the Internet at:

http://support.automation.siemens.com/WW/view/de/8859629

See also

Return values (Page 51)

3.2.3 Assigning parameters to signal modules

3.2.3.1 Basic principles - parameter assignments

Default settings

In their as-delivered state, all modules with parameters in the S7 automation system are set to default values that are suitable for standard applications. These default values allow the modules to be used immediately without making any additional settings. To determine whether the signal modules can be assigned parameters, and to find the default values, refer to the module descriptions in the "S7-300 Automation System, Module Data" reference manual.

Assigning module parameters

The picture below shows the program flow for assigning parameters to signal modules on the backplane bus of the EC31.

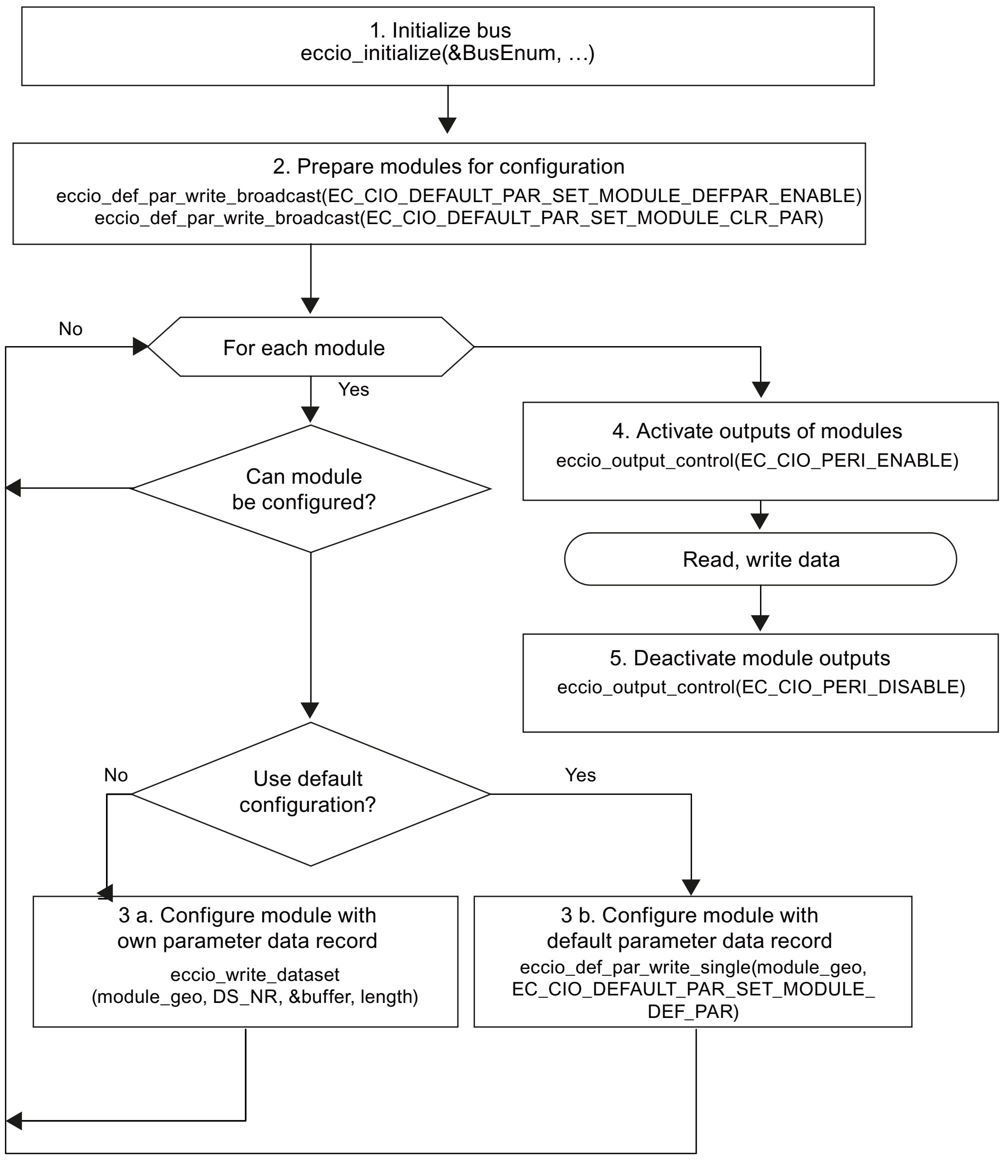

1. Initialize bus
eccio_initialize(&BusEnum, …)
2. Prepare modules for configuration
eccio_def_par_write_broadcast(EC_CIO_DEFAULT_PAR_SET_MODULE_DEFPAR_ENABLE)
eccio_def_par_write_broadcast(EC_CIO_DEFAULT_PAR_SET_MODULE_CLR_PAR)
No
For each module
Yes
Can module be configured?
4. Activate outputs of modules
eccio_output_control(EC_CIO_PERI_ENABLE)
Read, write data
5. Deactivate module outputs
eccio_output_control(EC_CIO_PERI_DISABLE)
No
Use default configuration?
Yes
3 a. Configure module with own parameter data record
eccio_write_dataset
(module_geo, DS_NR, &buffer, length)
3 b. Configure module with default parameter data record
eccio_def_par_write_single(module_geo, EC_CIO_DEFAULT_PAR_SET_MODULE_DEF_PAR)

Figure 3-1 Program flow - Assigning module parameters

Note

All relevant modules must be assigned parameters

Never assign parameters to signal modules with parameters in your user program (step 3.a or 3.b).

3.2.3.2 eccio_read_dataset

Description

This function reads parameter assignment data blocks up to 240 bytes long from a signal module.

Requirements:

- `eccio_initialize()` was executed successfully.
- The signal module is plugged in.
- The signal module is contained in the list of stations created by `eccio_initialize()`.
- The signal module supports the reading of data blocks.
- The data blocks correspond to the structure described in the *S7-300 Automation System, Module data* equipment manual.

Syntax

```
unsigned long  eccio_read_dataset (
      GeoAddr         geo,
      unsigned char   ds_nr,
      unsigned char*  pbuffer,
      unsigned short  length )
```

Parameter

Name	Type	Description	Data type
geo	in	Address of the signal module	GeoAddr
ds_nr	in	Number of the data block	unsigned char
pbuffer	out	Pointer to a buffer that holds the data.	unsigned char*
length	in	Length of the data block	unsigned short

Return values

- EC_CIO_OK
- EC_CIO_E_PARAM
- EC_CIO_E_STATE
- EC_CIO_E_BUS
- EC_CIO_E_UNKNOWN
- EC_CIO_E_DRIVER
- EC_CIO_W_LENGTH

Reference

For information about the signal modules, refer to the *S7-300 Automation System, Module data* equipment manual. You will find this on the Internet at:

http://support.automation.siemens.com/WW/view/en/8859629

See also

GeoAddr (Page 47)

Return values (Page 51)

3.2.3.3 eccio_write_dataset

Description

This function writes parameter assignment data blocks up to 240 bytes long to a signal module. The function can be used to carry out the following operations:

- Assigning parameters to signal modules
- Setting the types of measurement and measuring ranges (voltage and current)
- Enabling / disabling interrupts

Note

When they receive the parameter assignment data blocks, signal modules need several milliseconds for the internal reassignment. They cannot be accessed during this time.

Syntax

```
unsigned long  eccio_write_dataset (
      GeoAddr         geo,
      unsigned char   ds_nr,
      unsigned char*  pbuffer,
      unsigned short  length )
```

Parameter

Name	Type	Description	Data type
geo	in	Address of the signal module	GeoAddr
ds_nr	in	Number of the data block	unsigned char
pbuffer	in	Pointer to a buffer with the data to be written.	unsigned char*
length	in	Length of the data block	unsigned short

Return values

- EC_CIO_OK
- EC_CIO_E_PARAM
- EC_CIO_E_STATE
- EC_CIO_E_BUS
- EC_CIO_E_UNKNOWN
- EC_CIO_E_DRIVER

Reference

For information about the signal modules, refer to the *S7-300 Automation System, Module data* equipment manual. You will find this on the Internet at:
http://support.automation.siemens.com/WW/view/de/8859629

See also

eccio_def_par_write_single (Page 32)
eccio_def_par_write_broadcast (Page 33)
GeoAddr (Page 47)
Return values (Page 51)

3.2.3.4 eccio_def_par_write_single

Description

This function transfers the default parameter assignment to **one** signal module.

Note

Do not run the default parameter assignment unless the signal module has not already been assigned parameters using the `eccio_write_dataset` function.

Syntax

```
unsigned short   eccio_def_par_write_single(
       GeoAddr         geo,
       unsigned short   par_stat )
```

Parameter

Name	Type	Description	Data type
geo	in	Address of the signal module	GeoAddr
par_stat	in	Permitted values: • EC_CIO_DEFAULT_PAR_SET_MODULE_DEF_PAR • EC_CIO_DEFAULT_PAR_SET_MODULE_CLR_PAR • EC_CIO_DEFAULT_PAR_SET_MODULE_DEFPAR_ENABLE • EC_CIO_DEFAULT_PAR_SET_MODULE_PAR_DS	unsigned short

You will find information about the meaning of the parameter values, and how they are used in the user program at Basic principles - parameter assignments (Page 28).

Return value

- EC_CIO_OK
- EC_CIO_E_PARAM
- EC_CIO_E_STATE
- EC_CIO_E_BUS
- EC_CIO_E_UNKNOWN
- EC_CIO_E_DRIVER

See also

eccio_write_dataset (Page 31)

Return values (Page 51)

3.2.3.5 eccio_def_par_write_broadcast

Description

This function transfers the default parameter assignment to **all** the signal modules on the backplane bus.

Note

Do not run the default parameter assignment unless the signal modules have not already been assigned parameters using the `eccio_write_dataset` function.

Syntax

```
unsigned short   eccio_def_par_write_broadcast(
          unsigned short   par_stat )
```

Parameter

Name	Type	Description	Data type
par_stat	in	Permitted values: • EC_CIO_DEFAULT_PAR_SET_MODULE_DEF_PAR • EC_CIO_DEFAULT_PAR_SET_MODULE_CLR_PAR • EC_CIO_DEFAULT_PAR_SET_MODULE_DEFPAR_ENABLE • EC_CIO_DEFAULT_PAR_SET_MODULE_PAR_DS	unsigned short

You will find information about the meaning of the parameter values, and how they are used in the user program at .

Return value

- EC_CIO_OK
- EC_CIO_E_PARAM
- EC_CIO_E_STATE
- EC_CIO_E_BUS
- EC_CIO_E_UNKNOWN
- EC_CIO_E_DRIVER

See also

eccio_write_dataset (Page 31)

Return values (Page 51)

3.3 LED and RUN/STOP switch functions

3.3.1 ecledrs_initialize

Description

This function initializes the LED and RUN/STOP switch functions. Together with the other functions on the EC31, it is used to control LEDs, and to detect changes in the status of the RUN/STOP switch.

Note

Call the function in the user program **before** the other LED and RUN/STOP switch functions.

Syntax

```
unsigned short  ecledrs_initialize(void)
```

Return value

- EC_LEDRS_OK
- EC_LEDRS_E_MISSINGDRIVER
- EC_LEDRS_E_STATE
- EC_LEDRS_E_UNKNOWN

See also

ecledrs_deinitialize (Page 35)

Return values (Page 51)

3.3.2 ecledrs_deinitialize

Description

This function ends the use of the LED and RUN/STOP switch functions on the EC31.

Note

Call the function in the user program when all LED and RUN/STOP switch functions have ended.

Syntax

```
unsigned short  ecledrs_deinitialize(void)
```

Return value

- EC_LEDRS_OK
- EC_LEDRS_E_STATE
- EC_LEDRS_E_UNKNOWN

See also

ecledrs_initialize (Page 34)

Return values (Page 51)

3.3.3 ecledrs_write

Description

This function is used to control the LEDs on the EC31. It transfers the selected status to the controlled LEDs. The defines may be ORed to control several LEDs at the same time.

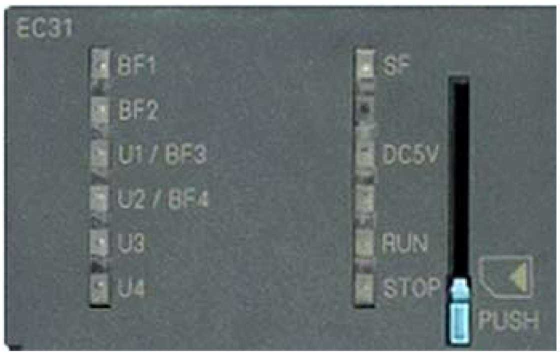


Figure 3-2 LEDs on the EC31

Syntax

```
unsigned short  ecledrs_write (
       unsigned short  led,
       unsigned char   state)
```

Parameter

Name	Type	Description	Data type
led	in	LED on the EC31 to be activated.	unsigned short
state	in	Status with which the activated LED should respond.	unsigned char

LED	Color	Meaning
EC_LEDRS_BF1	Red	Bus fault 1 LED
EC_LEDRS_BF2	Red	Bus fault 2 LED
EC_LEDRS_U1BF3	Red	User 1 / Bus fault 3 LED
EC_LEDRS_U2BF4	Red	User 2 / Bus fault 4 LED
EC_LEDRS_U3	Yellow	User 3
EC_LEDRS_U4	Green	User 4
EC_LEDRS_SF	Red	System fault LED
EC_LEDRS_DC5V	Green	5V supply for the backplane bus (cannot be programmed)
EC_LEDRS_RUN	Green	RUN LED
EC_LEDRS_STOP	Yellow	STOP LED

STATE	Meaning
EC_LEDRS_STATE_ON	Activated LED lights up
EC_LEDRS_STATE_OFF	Activated LED goes out
EC_LEDRS_STATE_BLINK_SLOW	Activated LED flashes slowly (0.5 Hz)
EC_LEDRS_STATE_BLINK_FAST	Activated LED flashes quickly (2 Hz)

Return value

- EC_LEDRS_OK
- EC_LEDRS_E_STATE
- EC_LEDRS_E_UNKNOWN
- EC_LEDRS_E_PARAM

See also

Return values (Page 51)

3.3.4 ecledrs_registerswitchchangecbk

Description

This function registers a callback function that signals changes in the status of the RUN/STOP switch on the EC31. The specified callback function is called for every status change. When it is registered, the callback function is called for the first time, and the current switch position is displayed.

Note

If the switch position changes very quickly (RUN-STOP-RUN), only the most recently registered switch position is signaled, rather than all the intermediate states.

Monitoring of the status of the RUN/STOP switch is only ended with the `ecledrs_deregisterswitchchangecbk` function.

Callback function

Sample declaration for a user-defined callback function:

```
unsigned short  switch_cbf(
       unsigned char  newstate)
```

Note

The callback function should execute as few operations are possible so as not to block the system.

Syntax

```
unsigned short  ecledrs_registerswitchchangecbk(
       FP_EC_LEDRS_SWITCH_CHANGE_CBK   prunstopchangecallback)
```

Parameter

Name	Type	Description	Data type
`prunstopchangecallback`	in	Pointer to user functions that are called in response to a change in status of the RUN/STOP switch on the EC31.	-

Return value

- EC_LEDRS_OK
- EC_LEDRS_E_PARAM
- EC_LEDRS_E_STATE
- EC_LEDRS_E_UNKNOWN

See also

Callback functions (Page 15)

Callback switch_change_notification (Page 40)

Return values (Page 51)

3.3.5 ecledrs_deregisterswitchchangecbk

Description

This function ends the status monitoring for the RUN/STOP switch on the EC31 via the user program.

Note

Call the function in the user program when all RUN/STOP switch functions have ended.

Syntax

```
unsigned short  ecledrs_deregisterswitchchangecbk(void)
```

Return value

- EC_LEDRS_OK
- EC_LEDRS_E_STATE
- EC_LEDRS_E_UNKNOWN

See also

Return values (Page 51)

3.3.6 Callback switch_change_notification

Description

The user-defined callback function is called in response to changes in the status of the RUN/STOP switch on the EC31. When the `ecledrs_registerswitchchangecbk` function is called, a pointer to the callback function is passed as a parameter. You can choose any name. The return value must be of the type `void`. The response to status changes is defined by the program.

The following status changes are signaled (output parameter `state`)

Definition	Meaning
EC_LEDRS_SWITCH_RUN	Toggle to the RUN state
EC_LEDRS_SWITCH_STOP	Toggle to the STOP state
EC_LEDRS_SWITCH_MRES	Toggle to the MRES state

The callback function remains active, and signals any status changes that occur until it is deregistered by calling the `ecledrs_deregisterswitchchangecbk` function.

Syntax

Sample declaration:
```
void register_switch_change_cbf (unsigned char  state)
```

Parameter

Name	Type	Description	Data type
state	out	Status change	unsigned char

See also

ecledrs_registerswitchchangecbk (Page 38)

3.4 Persistence functions

3.4.1 ecpers_initialize

Description

This function initializes the persistence functions on the EC31. A user-defined callback function is called if the power fails. This allows up to 256 KB data to be saved after a power failure.

Note

Call the function **before** the other persistence functions.

Syntax

```
unsigned short   ecpers_initialize(
      FP_EC_PERS_PFCALLBACK   pfcallback,
      unsigned long*          pmaxlength)
```

Sample declaration for a user-defined callback function

```
void   FP_EC_PERS_PFCALLBACK(void)
```

Parameter

Name	Type	Description	Data type
pfcallback	in	Pointer to the user-defined callback function to be called in response to a power failure on the embedded controller.	-
pmaxlength	out	Determines the size of the available retentive memory for saving data in the event of a power failure.	unsigned long*

Return value

- EC_PERS_OK
- EC_PERS_E_PARAM
- EC_PERS_E_OPENDRIVER
- EC_PERS_E_MAPPING_MEMORY
- EC_PERS_E_REGISTER_POWERFAIL
- EC_PERS_E_ALREADY_INITIALIZED

See also

ecpers_deinitialize (Page 42)

ecpers_readblock (Page 43)

Return values (Page 51)

3.4.2 ecpers_deinitialize

Description

This function ends the use of the persistence functions on the EC31.

The previously registered callback function will not be called again after this function.

Note

Call the function in the user program when the persistence functions have ended.

Syntax

```
unsigned short  ecpers_deinitialize(void)
```

Return value

- EC_PERS_OK
- EC_PERS_E_NOT_INITIALIZED

See also

ecpers_initialize (Page 41)

Return values (Page 51)

3.4.3 ecpers_readblock

Description

This function reads data from a retentive memory.

Syntax

```
unsigned short  ecpers_readblock(
         void*           pbuffer,
         unsigned long   offset,
         unsigned long   length)
```

Parameter

Name	Type	Description	Data type
pbuffer	in	Pointer to a buffer that holds the data.	void*
offset	in	Offset of the retentive memory in which the written data is to be read. The value must be less than *`pmaxlength`. *`pmaxlength` is used in the `ecpers_initialize` function.	unsigned long
length	in	Determines the size of the data to be read. The value must be greater than 0 and less than or equal to *`pmaxlength - offset`. *`pmaxlength` is used in the `ecpers_initialize` function.	unsigned long

Return value

- EC_PERS_OK
- EC_PERS_E_PARAM
- EC_PERS_E_NOT_INITIALIZED

See also

ecpers_initialize (Page 41)

Return values (Page 51)

3.4.4 ecpers_writeblock

Description

This function writes data to a retentive memory.

Syntax

```
unsigned short  ecpers_writeblock(
         void*           pbuffer,
         unsigned long   offset,
         unsigned long   length)
```

Parameter

Name	Type	Description	Data type
pbuffer	in	Pointer to a buffer that contains the data to be written.	void*
offset	in	Offset of the retentive memory in which the data is to be written. The value must be less than *`pmaxlength`. *`pmaxlength` is used in the `ecpers_initialize` function.	unsigned long
length	in	Determines the size of the data to be written. The value must be greater than 0 and less than or equal to *`pmaxlength - offset.` *pmaxlength is used in the `ecpers_initialize` function.	unsigned long

Return value

- EC_PERS_OK
- EC_PERS_E_PARAM
- EC_PERS_E_NOT_INITIALIZED

See also

ecpers_initialize (Page 41)

3.4.5 Callback power_fail_notification

Description

This user-defined callback function is called in response to a power failure on the EC31 if there is still data to be saved, for example. When the `ecpers_initialize` function is called, a pointer to the callback function is passed as a parameter. You can choose any name. The return value must be of the type `void`.

The callback function remains active until it is deregistered by calling the `ecpers_deinitialize` function.

Only one callback function of this type may be registered.

Syntax

Sample declaration:

```
void   FP_EC_PERS_PFCALLBACK(void)
```

Parameter

None

Appendix A

A.1 Data types

A.1.1 GeoAddr

Description

The `GeoAddr` structure contains the address of a signal module.

Syntax

```
typedef struct
{
     unsigned char  rack;
     unsigned char  slot;
     unsigned char  reserved;
     unsigned char  subaddress;
}GeoAddr;
```

Parameter

Name	Description	Data type	Range of values
rack	Number of the rack that contains the signal module.	unsigned char	0...3
slot	Slot that contains the signal module.	unsigned char	4...11
subaddress	Offset of the logical address	unsigned char	0...255

See also

Addressing signal modules (Page 13)

A.1.2 BusEnum

Description

The `BusEnum` structure contains a list of the signal modules on the backplane bus.

Syntax

```
typedef struct
{
     Module_Info Peril[MAX_MODULE_COUNT];
     unsigned short  Module_Count;
     unsigned short  Rack_Count;
     unsigned short  Rack_Slot_Count[MAX_RACK_COUNT];
     unsigned short  reserved;
     unsigned char  reserved;
     unsigned char  reserved;
} BusEnum;
```

Parameter

Name	Description	Data type	Range of values
Module_Info Peril	List of signal modules	-	-
Module_Count	Number of all signal modules	unsigned short	0...32
Rack_Count	Number of all racks	unsigned short	1...4
Rack_Slot_Count	Number of signal modules	unsigned short	0...8
Rack_Im_Type	reserved	unsigned short	-
Rack_Is_Im_Available	reserved	unsigned char	-
Rack_Is_Im_Plugged	reserved	unsigned char	-

A.1.3 Module_Info

Description

The `Module_Info` structure contains the address of a plugged-in signal module.

Syntax

```
typedef struct
{
     unsigned short  reserved;
     unsigned char   Plugged;
     unsigned char   Rack;
     unsigned char   Slot;
} Module_Info;
```

Parameter

Name	Description	Data type	Range of values
Type	reserved	unsigned short	-
Plugged	Is the signal module plugged in?	unsigned char	1: true 0: false
Rack	Number of the rack that contains the signal module.	unsigned char	0...3
Slot	Slot into which the signal module is plugged.	unsigned char	4...11

A.1.4 AlarmInfo

Description

The `AlarmInfo` structure contains the address of a signal module that signals an interrupt, and information about the interrupts.

Syntax

```
typedef struct
{
     GeoAddr  geo_address;
     unsigned short   Status_Wd1;
     unsigned short   Status_Wd2;
     unsigned short   Alarm_Coming;
     unsigned char    Alarm_Type;
} AlarmInfo;
```

Parameter

Name	Description	Data type	Range of values
Geo_address	Address of the signal module that triggered the interrupt	GeoAddr	-
Status_Wd1	First status word contained in the interrupt message.	unsigned short	Depends on the module
Status_Wd2	Second status word contained in the interrupt message.	unsigned short	Depends on the module
Alarm_Coming	• A process interrupt is always "coming". • A diagnostic interrupt may be "going", or "coming".	unsigned short	0: EC_ALARM_COMING 1: EC_ALARM_GOING
Alarm_Type	Interrupt type: • Process interrupt • Diagnostic interrupt	unsigned char	0: EC_CIO_PROCESS _ALARM 1: EC_CIO_DIAGNOSTIC _ALARM

Reference

For information about the signal modules, refer to the *S7-300 Automation System, Module data* equipment manual. You will find it on the Internet at: http://support.automation.siemens.com/WW/view/en/8859629.

See also

eccio_ack_alarm (Page 24)

A.2 Return values

Return values

The following tables contain the return values for the functions, and options for eliminating errors.

Return values and remedies

Table A- 1 Return values for central I/O functions

Name	Description	Remedy
EC_CIO_OK	The call was successfully processed.	-
EC_CIO_E_PARAM	A parameter is incorrect or does not correspond to the range of values.	Check the parameters, and call the function again.
EC_CIO_E_STATE	The call is not possible in this state.	Check the function and order of the calls: • A call was sent after the backplane bus was deinitialized with `eccio_deinitialize`. • A call was sent before the backplane bus was initialized with `eccio_initialize`.
EC_CIO_E_FATAL	The driver was unable to process the call.	Check whether the signal modules are plugged in correctly.

Name	Description	Remedy
EC_CIO_E_BUS	Error on the backplane bus	• A module is not detected. Check if the module is correctly inserted. Call `eccio_initialize` to update the list of stations. • The address of a module is incorrect: Check the parameters in the `GeoAddr` structure. • The signal module has not been assigned parameters, or the wrong parameters were assigned: Call `eccio_write_dataset` to assign parameters to the signal module. Follow the documentation for the signal modules. • Check whether the module supports the function. If a Read / Write function failed, check whether the function supports the necessary byte length. Follow the documentation for the signal modules. • The current configuration differs from the saved list of stations: Call `eccio_check_bus` to compare the current configuration on the backplane bus with the list of stations. If there are any differences, call `eccio_initialize` to update the list of stations. • The identification of the stations on the backplane bus is incomplete. Cause: Modules are in a temporarily unavailable state: Call `eccio_initialize` again after a short waiting period. • A module was unplugged or plugged in while the backplane bus was being initialized, and the stations need to be identified. • Check whether the device is defective.
EC_CIO_E_UNKNOWN	Internal error	• Check the access rights • Contact your local SIEMENS partner.
EC_CIO_E_DRIVER	Driver missing or is defective.	Install the driver, and restart the call.
EC_CIO_W_LENGTH	Data record too long.	Only for eccio_read_dataset(): Some signal modules support only the reading of 4 bytes or 16 bytes for data record 0 and data record 1. If you try to read a greater length of one of these two data records for such signal modules, the return value EC_CIO_W_ LENGTH indicates that only 4 bytes (data record 0) or 16 bytes (data record 1) were actually read.

Table A- 2 Return values for LED functions

Name	Description	Remedy
EC_LEDRS_OK	The call was successfully processed.	-
EC_LEDRS_E_MISSINGDRIVER	The driver is not installed, or is defective.	Install the driver, and restart the call.
EC_LEDRS_E_STATE	The call is not possible in this state.	Check the order of the calls: • A call was sent after the LED component was deinitialized with `ecledrs_deinitialize`. • A call was sent before the LED component was initialized with `ecledrs_initialize`. • `ecledrs_initialize` was called more than once.
EC_LEDRS_E_UNKNOWN	Internal error	• Check the access rights • Contact your local SIEMENS partner.
EC_LEDRS_E_PARAM	At least one parameter is incorrect, or does not correspond to the range of values.	Check the parameters, and restart the call.

Table A- 3 Return values for persistence functions

Name	Description	Remedy
EC_PERS_OK	The call was successfully processed.	-
EC_PERS_E_PARAM	A parameter is 0, or is not permitted for the Read / Write function.	Check the parameters, and restart the call.
EC_PERS_E_OPENDRIVER	The persistence driver could not be opened.	Check whether the driver is installed.
EC_PERS_E_MAPPING_MEMORY	Driver error while assigning the retentive memory.	• Check whether the driver is installed, and is working. • Check the hardware configuration
EC_PERS_E_REGISTER_POWERFAIL	Another application has already registered a callback function.	Check whether other applications are active.
EC_PERS_E_ALREADY_INITIALIZED	The persistence components have already been initialized.	Check the order of the calls.
EC_PERS_E_NOT_INITIALIZED	The persistence components were not initialized.	Check the order of the calls.

A.3 Values for data block 0

Some modules can generate interrupts when there is diagnostic information available. These "diagnostic interrupts" must be enabled by the entry in parameter assignment data block 0 (DS0). The settings are shown in the table below. Please note that some modules also require settings in parameter assignment data block 1.

DS0 values for analog modules

Table A- 4 DS0 values for analog modules

Module	Order number	DS0 value if "Diagnostic interrupt disabled"	DS0 value if "Diagnostic interrupt enabled"
SM 331; AI 8 x 13 bit	6ES7331-1KF01-0AB0	(no interrupts, parameter assignment information only)	
SM 331; AI 8 x 12 bit diagnostic interrupt / process interrupt	6ES7331-7KF02-0AB0	00 00	FF 01
SM 331; AI 2 x 12 bit diagnostic interrupt / process interrupt	6ES7331-7KB02-0AB0	00 00	03 01
SM 332, AO 4 x 12 bit diagnostic interrupt	6ES7332-5HD01-0AB0	00 00	0F 00
SM 332; AO 2 x 12 bit	6ES7332-5HB01-0AB0	00 00	03 00
SM 332; AO 8 x 12 bit	6ES7332-5HF00-0AB0	00 00	FF 00

Further references

For further information about the parameter assignment data block 1 for the signal modules, refer to the *S7-300 Automation System, Module Data* equipment manual, 02/2007.

You will find a detailed description of how to analyze the diagnostic data from signal modules in the user program in the STEP 7 documentation.

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