User's Manual

R-IN32M3 Module (RY9012A0)

User's Manual: Software API Description

RENESAS MCU
R-IN32M3-EC

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General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)
   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on
   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state
   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins
   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals
   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.
6. Voltage application waveform at input pin
   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
7. Prohibition of access to reserved addresses
   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products
   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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How to Use This Manual

1. Purpose and Target Readers

This manual is designed to provide the user with an understanding of the hardware functions and electrical characteristics of the R-IN32M3 Module. It is intended for users designing application systems incorporating the MCU. A basic knowledge of electric circuits, logical circuits, and MCUs is necessary in order to use this manual.

Particular attention should be paid to the precautionary notes when using the manual. These notes occur within the body of the text, at the end of each section, and in the Usage Notes section.

The revision history summarizes the locations of revisions and additions. It does not list all revisions. Refer to the text of the manual for details.

The following documents apply to the R-IN32M3 Module. Make sure to refer to the latest versions of these documents. Last four digits of document number (described as ****) indicate version information of each document. The newest versions of the documents listed may be obtained from the Renesas Electronics Web site.

Document Type	Description	Document Title	Document No.
Data Sheet	Hardware overview and electrical characteristics	R-IN32M3 Module Datasheet	R19DS0109ED****
User's manual for Hardware	Hardware specifications (pin assignments, peripheral function specifications, electrical characteristics, timing charts) and operation description	R-IN32M3 Module User's Manual: Hardware	R19UH0122ED****
User's manual for Software	Description of API	R-IN32M3 Module User's Manual: Software	This User's manual
Quick Start Guide	Information on application examples Sample program for Host CPU.	R-IN32M3 Module Application Note: Quick Start Guide	R12QS0042ED****
Renesas Technical Update	Product specifications, updates on documents, etc.	Available from Renesas Electronics Web site.	

2. Notation for Numbers and Symbols

Note:
Explanation of a point marked “Note” in the text

Caution:
Item deserving extra attention

Remark:
Supplementary explanation to the text

3. List of Abbreviations and Acronyms

Abbreviation	Full Form
AC	Application Controller
ACK	Acknowledge
ADS	Automation Device Specification
API	Application Programming Interface
APMS	Acyclic Protocol Machine Sender
CC	Communication Controller
CIP	Common Industrial Protocol
CM	Configuration Manager
CPU	Central Processing Unit
DC	Distributed Clock
DD	Device Detection
DHCP	Dynamic Host Configuration Protocol
EDT	EtherCAT Design Tool
ESC	EtherCAT Slave controller
GOAL	Generic Open Abstraction Layer
HTTP	Hypertext Transfer Protocol
HTTPD	Hypertext Transfer Protocol Daemon
I/O	Input / Output
IP	Internet Protocol
IOCS	Input Output Object Consumer Status
IOPS	Input Output Object Provider Status
LLDP	Link Layer Discovery Protocol
MA	Media Adapter
MAC	Media Access Control
MCTC	Micro Core to Core
NVS	Non-Volatile Storage
OSAL	Operating System Abstraction Layer
PDI	Process Data Interface
PDO	Process Data Object
PLC	Programmable Logic Controller
RPC	Remote Procedure Call
SDO	Service Data Objects
SII	Slave Information Interface
SNMP	Simple Network Management Protocol
SPI	Serial Peripheral Interface
TCP	Transmission Control Protocol
TLV	Type Length Value
UART	Universal Asynchronous Receiver Transmitter
UDP	User Datagram Protocol
uGOAL	micro Generic Open Abstraction Layer

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1. Introduction

This manual describes the various application programming interface (API) functions which have been developed to ease the design of application software for the R-IN32M3 Module, which is available as a dual-port device.
The R-IN32M3 Module has been designed for the fast development of industrial communications applications. The R-IN32M3 Module includes a microcontroller which acts as a communications controller (CC). The CC with its firmware (binary software) executes the network communication with industrial communication standards such as PROFINET, EtherNet/IP™, EtherCAT® and other networks. The application controller (AC) is a user defined microcontroller. This AC with a set of CC runs the application specific software without the need to take care for the specific requirements of the communication protocol of the targeted industrial network. It communicates with the CC using a set of APIs which are supplied by Renesas in source code for an easy integration with the user's application software. Communication between CC and AC uses the protocol "Core to Core" (C2C). The following diagram illustrates the controllers and their interfaces.

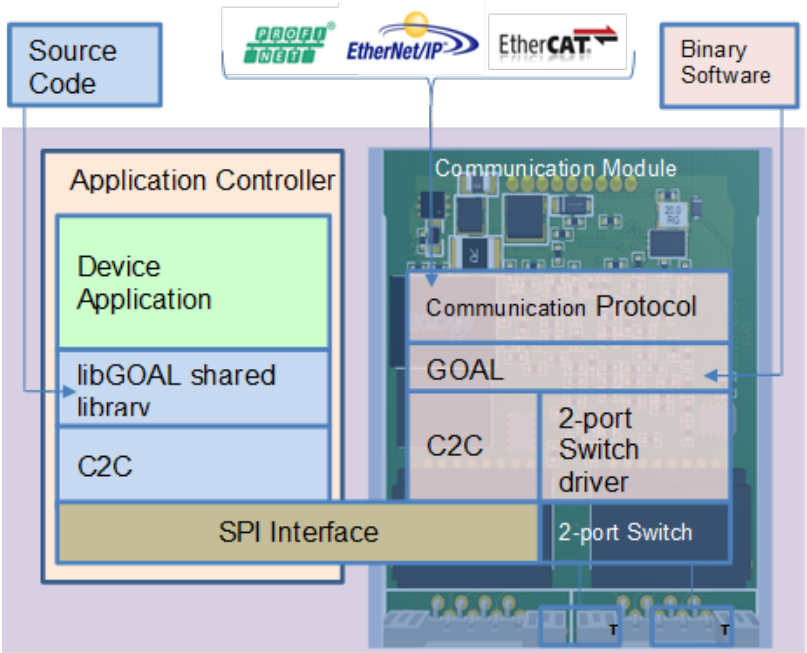

Figure 1.1 Interfaces between Communication Controller and Application Controller

GOAL is a Generic Open Abstraction Layer and libGOAL the source coded API to control the communication controller from the application software. Both components GOAL and C2C are combined under the term of OSAL.

uGOAL inherits GOAL but simplifies its configuration and dramatically reduces the memory size used.

Note: Some of the industrial networking protocols mentioned in the figure above may not yet be released.

1.1 Industrial Ethernet Protocol Features

R-IN32M3 Module supports the following features in a condition of firmware Ver2.1.0.0 or later.

PROFINET
- PROFINET IO Conformance Class B
- Minimum Cycle time 1ms
- Minimum read/write 1434 Byte process data (*1)
- Supports LLDP, SNMP
- Supports MRP(Media Redundancy Protocol)
- Supports Alarm Queue
- Supports web browser and http

EtherNet/IP
- Minimum Cycle time 1ms
- Maximum connection size 495 Bytes (*1)
- Supports DLR (Device Level Ring)
- Supports QoS
- Supports ACD
- Supports web browser and http

EtherCAT
- EtherCAT communication profile

  CAN application protocol over EtherCAT (CoE)

  Ethernet over EtherCAT (EoE)

  File Access over EtherCAT (FoE)
- Supports Explicit Device ID
- Supports; Free-Run, Sync Manager and Distributed Clocks (DC)
- Maximum PDO 1408 Byte (*1)

(*1) The size of cyclic process data limits communication period.

2. Document Structure

Table 2.1 Contents of This Document

Section	Contents
Introduction	Introduction of this document
Document Structure	This section
Device architecture	Introduction of the R-IN32M3 Module architecture
Application	Guideline for application programming
Communication stack	Description of the communication interface of the module
API	Listing and explaination of the available APIs of the R-IN32M3 Module
Examples	Description of the examples
Trouble Shooting	List of common usage problems
Targets	Target specific information

3. Device Architecture

3.1 Architecture

The module software contains a domain specific middleware (GOAL / uGOAL) with several software stacks that can be utilized to build applications in the domain of industrial communication. The following software stacks are provided:

- Device Detection : A simple protocol for device management
- PROFINET : A communication stack for PROFINET communication
- EtherNet/IP : A communication stack for EtherNet/IP communication
- EtherCAT : A communication stack for EtherCAT communication
- Webserver : A simple web server for application specific management and information provision
- TCP/IP Stack : A TCP/IP stack which provides UDP and TCP channels

The device is utilized by an application controller (AC). Both controllers (application controller and communication controller) communicate cyclically, where the communication is dictated by the application controller (AC). The application controller (AC) contains the application which runs services of the communication controller (CC) to build a customer application.

3.2 Interface

3.2.1 Hardware Interface

The R-IN32M3 Module pins interface with power supply and SPI, which is a slave interface.

Table 3.1 Pin Description

Pin	Signal	I/O	Description
1	V_{cc}	—	3.3V ±0.15V DC power supply
2	GND	—	Ground
3	/SS	I	Slave Select. Active low to enable slave device
4	/RESET	I	Reset of the whole R-IN32M3 Module. Active low
5	MISO	O	Master In Slave Out. Data from slave to master
6	MOSI	I	Master Out Slave In. Data from master to slave
7	SCLK	I	Serial clock. Master provides the clock to shift the data
8	SYNC0	O	EtherCAT Sync signal for distributed clocks
9	SYNC1	O	EtherCAT Sync signal for distributed clocks

3.2.2 SPI Software Interface

The software interface of the R-IN32M3 Module contains various layers, which provide communication channels according to the requirements of the communication data. Over SPI a frame of up to 128 bytes of data is cyclically transferred, where the communication is initiated by the AC.

The SPI frame contains multiple segments of data, typically real time data from communication stacks and non-real-time data, which originates from RPC (Remote Procedure Call). A detailed description of the communication stack is given in the following sections.

3.2.3 Integration of Communication Layers / Middleware

All layers of the required communication protocol and the AC is implemented using the GOAL / uGOAL middleware. The AC requires to be based on an implementation of this middleware. To utilize a certain feature set of the CC (as fieldbus stack PROFINET), wrapper functionality is required that implements the RPC functions. These wrappers require the GOAL / uGOAL, thus the target platform must support the GOAL / uGOAL middleware.

4. Application

4.1 Introduction

This document provides information about how to build an application for the R-IN32M3 Module.

4.2 Hardware Setup

The module provides a management interface, where initial configuration can be done. These properties can be stored permanently within the device. Following properties are provided to configure the SPI interface:

Table 4.1 SPI Configuration

Variable	Description	Default Value
SPI_TYPE	SPI master/slave configuration	1 = SLAVE
SPI_MODE	SPI timing mode	0 = MODE0
SPI_UNITWIDTH	SPI single transfer size	0 = 8 bits
SPI_BITORDER	SPI bit transfer direction	0 = MSB
SPI_TRANSFERSIZE	SPI packet transfer size	128

The module does only support
SPI_TYPE slave,
SPI_UNITWIDTH of 8 bits,
SPI_TRANSFERSIZE of 128 bytes,
SPI bitorder MSB.

The SPI mode can be configured according to Table 4.2, SPI Mode Configuration.

Table 4.2 SPI Mode Configuration

Value	SPI MODE
0	Mode 0
1	Mode 1
2	Mode 2
3	Mode 3

4.3 Basic Application Setup

A basic application consists of the optional function calls appl_init, appl_setup and appl_loop. It follows the design philosophy of the GOAL / uGOAL middleware.

4.4 Default Features

By default, the CC will start a web server (on port 8080) for the firmware update feature and an instance of Device Detection for management using the Management Tool.

It is not possible by an AC to disable the web server on the CC. However, the AC can start another instance of the web server.

It is possible for an AC to limit by default full management access through Device Detection in different ways. Please refer to the corresponding section in the documentation.

4.5 Features

4.5.1 Device Detection

4.5.1.1 Initial state

On the communication controller (CC) the feature “Device Detection” (DD) is enabled by default. This allows full access to all variables and logs on the CC. DD bases on a simple UDP based protocol with no encryption whatsoever.

Thus, an application can and should limit the access to a feasible range. Limitation of features and access is possible on various levels.

4.5.1.2 Initial disabling of features by application

This property is applied at application start-up when the AC setup is executed.

With the call of goal_ddNew() from appl_setup() a bitmask can be passed with bits representing single functions of DD. Please refer to the API documentation of DD for possible values.

If all bits are set, all features (hello, get, set, get_list, wink) are enabled.

4.5.1.3 Initial disabling of features by CM variable

The mechanism (described in section 4.5.1.2) can also be set before application start by setting the corresponding Configuration Manager (CM) variable FEATURE_DISABLE (see section 4.9.1). Each request processed by the device detection module will utilize the value of this variable to determine if the request can be processed.

Please note, that any call of goal_ddNew will overwrite the value of this variable, if a different initialization value is passed.

4.5.1.4 Temporary enable features of the device detection

This property is applied at an arbitrary time, for example when configured using a web site provided by the AC.

```
GOAL_STATUS_T goal_ddSessionFeatureActivate(
    GOAL_DD_T *pHdlDd,                  /**< dd handle */
    uint32_t bitmaskFeatures            /**< bitmask with feature enable bits set */
);
```

- The parameter bitmask contains bits representing features being enabled
- Those bits overwrite the disable bits from CM for the current session

4.5.1.5 Filtering and access rights

This property is applied at start-up of the AC.

Using filters, it is possible to limit access to CM variables by groups (module ids) and variables (variable ids). Currently some filters are predefined for usage. These can be enabled using following function:

```
GOAL_STATUS_T goal_ddFilterAdd(
    GOAL_DD_T *pHdlDd,                          /**< dd handle */
    GOAL_DD_ACCESS_FILTER_SET_T setId           /**< set id */
);
```

This function works on a created instance of DD, thus requires passing of a valid DD handle. The **setId** can be used with following values:

Table 4.3 DD Filter IDs

Set UD	Description
GOAL_DD_ACCESS_FILTER_SET_ALL	Complete access to all variables
GOAL_DD_ACCESS_FILTER_SET_BASIC	Filter for minimal function of the management tool
GOAL_DD_ACCESS_FILTER_SET_HIDDEN	Filter for hiding information

Note: Please refer to the API documentation of DD for detailed information.

4.5.2 PNIO

The communication controller (CC) contains a full featured PROFINET slave stack. For application see 5.4 Communication Stack-PROFINET.

4.5.3 EtherNet/IP

The communication controller (CC) contains a full featured EtherNet/IP slave stack. For application see 5.6 Communication Stack- EtherNet/IP.

4.5.4 EtherCAT

The communication controller (CC) contains a full featured EtherCAT slave stack. For application see 5.8 Communication Stack- EtherCAT.

4.5.5 Generic Data Provider

For fieldbus communication applications a generic data provider is available, which contains generalized information and LED status for the application.

Table 4.4 MCTC Status Information

Data Provider Information	PROFINET	EtherNet/IP	EtherCAT
GOAL_MCTC_DP_STATUS_FLG_CONN	Connection	Connection	Connection (ESM-State == OP)
GOAL_MCTC_DP_STATUS_FLG_ERR	Error	Error	Application Layer Error
GOAL_MCTC_DP_STATUS_FLG_VALID	-	Process data valid	
GOAL_MCTC_DP_LED_WINK	DCP blink signaling	-	
GOAL_MCTC_DP_LED_RED1	Error	Module Status red	EC ERR LED
GOAL_MCTC_DP_LED_RED2	Maintainance	Network Status red	-
GOAL_MCTC_DP_LED_GREEN1	Connection	Module Status green	EC RUN LED
GOAL_MCTC_DP_LED_GREEN2	DCP blink signaling	Network Status green	-

4.5.6 Ethernet Startup Delay

With integration of EtherCAT in version 2.0.0.0 of the communication controller (CC), an additional functionality was integrated which allows dedicated startup of the network by the application controller (AC). Depending on the chosen communication stack (e.g. PROFINET or EtherCAT), the network interface is brought up in the required mode.

The communication controller (CC) without an application controller (AC) however would never start the network in this scenario. Thus, a fallback was implemented, which by default brings up the network after 5 seconds after startup of the communication controller (CC). In this case, the module supports only TCP/UDP. This behaviour can be configured using a ccm variable (module id 72, variable id 13).

Following table shows configuration options:

Table 4.5 ethernet timeout configuration

Timeout value	function
0	default timeout enabled (5 seconds)
1 ... 254	value determines timeout in seconds
255	timeout disabled

If powering of the AC and establishing of the communication between AC and CC take longer than the configured timeout, it needs to be increased.

4.6 External Reset

The module provides an external reset input, where the AC can perform a reset of the R-IN32M3 Module.

Caution:

Do not perform this reset during a firmware update of the CC. This will prevent proper update functionality. Therefore, it is recommended to utilize this reset only if the AC is initially powered up (cold start).

4.7 RPC Synchronization Reset

4.7.1 Communication Controller (CC)

By default, the CC does not perform a reset implicitly.
The CC requests the AC to perform a power cycle if necessary. This occurs if a previously booted and configured AC is connected to a newly started CC.

4.7.2 Application Controller (AC)

The AC performs a reset of its application on request of the CC, e.g. when the CC restarts. This can happen during a firmware update.
The AC can perform a reset of the CC by using the hardware RESET signal.

Caution:

Do not perform this reset during a firmware update of the CC. This will prevent proper update functionality.

4.8 IP Setting

IP settings can be done with the CM interface.

Table 4.6 IP Configuration with CM

Step	Action	Remark
1	Set CM Variable GOAL_ID_NET:IP	Configure IP address
2	Set CM Variable GOAL_ID_NET:NETMASK	Configure Netmask
3	Set CM Variable GOAL_ID_NET:GW	Configure Gateway
4	Set CM Variable GOAL_ID_NET:Valid to 1	Set IP configuration to valid
5	Set CM Variable GOAL_ID_NET:DHCP_ENABLED to 0	Disable DHCP
6	Set CM Variable GOAL_ID_NET:COMMIT to 1	Apply IP settings

Note: To enable DHCP set the CM Variable GOAL_ID_NET:DHCP_ENABLED to 1 and perform a power cycle.

4.9 R-IN32M3 Module Management Interface

Each variable that configures the R-IN32M3 Module has a management interface grouped by module ID depend on each purpose.

The tables for each management interface (per module ID) are as follows, and each table information is as of the R-IN32M3 Module firmware version 2.1.0.0.

The configuration variables can be accessed from the application by using the Module ID and variable ID.

- Read the value by appl_ccmCfgVarGet() function
- Write the value by appl_ccmCfgVarSet() function
- Save permanently the values to non-volatile memory by appl_ccmCfgSave() function

4.9.1 Device Detection (DD)

Module ID = GOAL_ID_DD (34)

Table 4.7 DD Management Interface

Variable Name	Variable ID	Type	Max. Size	Long Description
MODULENAME	0	STRING	20	Customer specific name of the module
CUSTOMERID	1	UINT32	4	Customer Id
RESERVED	2	UINT8	1	—
FEATURE_DISABLE	3	UINT32	4	Each bit disables a function: bit 0, disable "HELLO DETECTION" bit 1, disable WINK bit 2, disable GETLIST bit 3, disable GET VALUE bit 4, disable SET VALUE

4.9.2 PNIO

Module ID = GOAL_ID_PNIO (27)

Table 4.8 PNIO Management Interface

Variable Name	Variable ID	Type	Max. Size	Long Description
STATION_NAME	0	GENERIC	255	—
VENDOR_ID	1	UINT16	2	—
DEVICE_ID	2	UINT16	2	—
VENDOR	3	GENERIC	255	—
IM0HWREV	4	UINT16	2	—
IM0SWREVPREF	5	UINT8	1	—
IM0SWREVENH	6	UINT8	1	—
IM0SWREVBUGFIX	7	UINT8	1	—
IM0SWREVINTCHG	8	UINT8	1	—
IM0SWREVCNT	9	UINT16	2	—
IM0PROFILEID	10	UINT16	2	—
IM0PROFILETYPE	11	UINT16	2	—
IM0ORDERID	12	GENERIC	(20+1)	—
IM0SERIALNR	13	GENERIC	(16+1)	—
IM1TAGFUNC	14	GENERIC	32	—
IM1TAGLOC	15	GENERIC	22	—
IM2DATA	16	GENERIC	16	—
IM3DESC	17	GENERIC	54	—
IM4SIG	18	GENERIC	54	—
HOLDFCT	19	UINT32	4	—
SYSCAP	20	UINT32	4	—
PORTDESC	21	GENERIC	LLDP_PORT_DESC_LEN	—
SYSDESC	22	GENERIC	LLDP_SYS_DESC_LEN	—
TXINTERV	23	UINT32	4	—
MANADDR	24	UINT32	4	—
SYSTEM_NAME	25	STRING	LLDT_SYS_NAME_LEN	—
IFSUBTYPE	26	UINT32	4	—
PDPORTDATA	27	GENERIC	sizeof(PN_REC_PDPORT DATA_CFT_T	—
FS_HELLO_MODE	28	UINT32	4	—
FS_HELLO_INTERVAL	29	UINT32	4	—
FS_HELLO_RETRY	30	UINT32	4	—
FS_HELLO_DELAY	31	UINT32	4	—

4.9.3 Logging Manager (LM)

Module ID = GOAL_ID_LM (35)

Table 4.9 LM Management Interface

Variable Name	Variable ID	Type	Max. Size	Long Description
VERSION	0	UINT8	1	Version information for LM interface
READBUFFER	1000	GENERIC	128	Buffer for reading online logging from deivce
CNT	1001	UINT16	2	Control word for online log access
EXLOG_READBUFFER	1002	GENERIC	128	Buffer for reading exception logging from deivce
EXLOG_CNT	1003	UINT16	2	Control word for exception log access
EXLOG_SIZE	1004	UINT32	4	Indicator for exception log size
EXLOG_USAGE	1005	UINT8	1	Indicator for exception log usage
EXLOG_ERASE	1006	UINT8	1	Command: *, Erase Exception Log

4.9.4 NET

Module ID = GOAL_ID_NET (12)

Table 4.10 NET Management Interface

Variable Name	Variable ID	Type	Max. Size	Long Description
IP	0	IPV4	4	IP address of first interface
NETMASK	1	IPV4	4	NETMASK of first interface
GW	2	IPV4	4	GATEWAY of first interface
VALID	3	UINT8	1	Validity of IP address: 0, Stored IP address is not valid, interface settings originate from network stack of system 1, Stored IP address is valid, will be applied to interface at start of device
DHCP_ENABLED	4	UINT8	1	DHCP enable: 0, DHCP disabled 1, DHCP enabled
DHCP_STATE	5	UINT8	1	DHCP state: 0, DHCP initialized 1, DHCP server selecting 2, DHCP requesting configuration 3, DHCP ip address bound 4, DHCP renewing configuration 5, DHCP rebinding ip address to interface
DNS0	6	IPV4	4	First DNS server of first interface
DNS1	7	IPV4	4	Second DNS server of first interface
HOSTNAME	8	STRING	20	Hostname of first interface
COMMIT	1000	UINT8	1	Command: *, Apply IP settings

4.9.5 BOOT

Module ID = GOAL_ID_BOOT (37)

Table 4.11 BOOT Management Interface

Variable Name	Variable ID	Type	Max. Size	Long Description
SIGNATURE	0	GENERIC	16	Signature of booted image
BLVERSION	1	STRING	16	Bootloader Version
FWVERSION	2	STRING	16	Firmware Version
RESET_CAUSE	1000	UINT8	1	Reset cause: 0, Unspecified 1, Firmware Update Requested 2, Watchdog 3, Firmware Commit Required 4, Reserved
IMAGE_NUMBER	1001	UINT8	1	Booted image number
IMAGE_COUNTER	1002	UINT8	1	Booted image counter

4.9.6 Config Manager (CM)

Module ID = GOAL_ID_CM (2)

Table 4.12 CM Management Interface

Variable Name	Variable ID	Type	Max. Size	Long Description
VERSION	0	UINT32	4	Version information for CM interface
SAVE	1000	UINT8	1	Command: *, Save CM to Flash

4.9.7 ETH

Module ID = GOAL_ID_ETH (4)

Table 4.13 ETH Management Interface

Variable Name	Variable ID	Type	Max. Size	Long Description
MAC	0	GENERIC	6	—
LINK	1000	UINT32	4	Link status mask of interfaces
SPEED	1001	UINT32	4	Port speed mask of interfaces
DUPLEX	1002	UINT32	4	Port Duplex mask of interfaces
PORTCNT	1003	UINT32	4	Number of interfaces

4.9.8 EIP

Module ID = GOAL_ID_EIP (23)

Table 4.14 EIP Management Interface

Variable Name	Variable ID	Type	Max. Size	Long Description
INCARNATIONID	0	UINT32	4	Used to create unique Connection IDs across power cycles
DOMAIN	1	GENERIC	EIP_CM_ DOMAIN_LEN	Part of TCP/IP Interface Object attribute 5
HOST	2	GENERIC	EIP_CM_ HOST_LEN	TCP/IP Interface Object attribute 6
ENCAPTIMEOUT	3	UINT16	2	TCP/IP Interface Object attribute 13
PORTCFG	4	GENERIC	sizeof(OPENER_ PORT_CFG_T)	Ethernet Link Object attributes 6 & 9 (Interface Control & Admin State)
QOS_VLAN	5	UINT8	1	QoS Object attribute 1
QOS_URGENT	6	UINT8	1	QoS Object attribute 4
QOS_SCHEDULED	7	UINT8	1	QoS Object attribute 5
QOS_HIGH	8	UINT8	1	QoS Object attribute 6
QOS_LOW	9	UINT8	1	QoS Object attribute 7
QOS_EXPLICIT	10	UINT8	1	QoS Object attribute 8
TTL	11	UINT8	1	TCP/IP Interface Object attribute 8 TTL value of IP Header for Multicast Messages
MC_CTRL	12	UINT8	1	TCP/IP Interface Object attribute 9 Choose how to allocate Multicast Addresses 0: calculate address from device's IP address 1: use Mcast Start Address + offset
MC_NUM	13	UINT16	2	TCP/IP Interface Object attribute 9 Number of allocated Multicast Addresses for EtherNet/IP
MC_START	14	UINT32	4	TIP/IP Interface Object attribute 9 first allocated Multicast Adress
ACD_ENABLED	15	UINT8	1	ACD enable: 0, ACD disabled 1, ACD enabled
ACD_LAST_CONFLICT	16	GENERIC	8	MAC of the device that caused the last address conflict

4.9.9 HTTP

Module ID = GOAL_ID_HTTP (25)

Table 4.15 HTTP Management Interface

Variable Name	Variable ID	Type	Max. Size	Long Description
HTTP_CHANNELS_MAX	0	UINT16	2	Determines the number of possible connections to the HTTP server
HTTPS_CHANNELS_MAX	1	UINT16	2	Determines the number of possible connections to the HTTPS server
USERLEVEL0	2	STRING	32	Authentication data for level 0
USERLEVEL1	3	STRING	32	Authentication data for level 1
USERLEVEL2	4	STRING	32	Authentication data for level 2
USERLEVEL3	5	STRING	32	Authentication data for level 3

4.9.10 CCM

Module ID = GOAL_ID_CCM (72)

Table 4.16 R-IN32M3 Module Management Interface

Variable Name	Variable ID	Type	Max. Size	Long Description
SPI_TYPE	0	UINT8	1	SPI Type (currently only slave supported): 0, SPI Master 1, SPI Slave
SPI_MODE	1	UINT8	1	SPI Mode: 0, CPOL=0; CPHA=0 1, CPOL=0; CPHA=1 2, CPOL=1; CPHA=0 3, CPOL=1; CPHA=1
SPI_SPEED	2	UINT8	1	SPI Speed in Master Mode
SPI_UNITWIDTH	3	UINT8	1	Bitsize of one single transfer unit: 0, 8 bits 1, 16 bits 2, 32 bits
SPI_BITORDER	4	UINT8	1	Bitorder of SPI transfers: 0, MSB first 1, LSB first
SPI_TRANSFERSIZE	5	UINT16	2	Minimum transfer size of single transmission frame
COMM_FAULT_ERROR_STATE	6	UINT8	1	Fault action to execute when communication to AC was lost during a cyclic connection: 0, Enter fault state (disable connection) 1, Keep running (keep connection)
COMM_SYNC_RESET	7	UINT8	1	Behavior when a sync reset request was received from AC: 0, Do nothing 1, Perform reset of CC
FW_UPDATE_COMMIT_DISABLE	8	UINT8	1	Optional disable of the additional commit step during firmware update: 0, Firmware update requires commit step 1, Firmware update doesn't require a commit step
FOE_FILENAME	9	STRING	32	EtherCAT FoE update file name
FOE_PASSWORD	10	UINT32	4	EtherCAT FoE update password
FOE_UPDATE_REQUIRES_BOOT	11	UINT8	1	EtherCAT FoE update required state
FOE_FILENAME_MATCH_LEN	12	UINT8	1	EtherCAT FoE update file name match length
ETH_SWITCH_MODE_TIMEOUT	13	UINT8	1	General timeout for Ethernet interface activation
UPTIME	1000	UINT32	4	Number of seconds since start of device

4.9.11 QUEUE

Module ID = GOAL_ID_QUEUE (42)

Table 4.17 QUEUE Management Interface

Variable Name	Variable ID	Type	Max. Size	Long Description
SMALLBUFSIZE	0	UINT16	2	size of a small memory buffer
SMALLBUFNUM	1	UINT16	2	amount of small memory buffers
MEDBUFSIZE	2	UINT16	2	size of a medium memory buffer
MEDBUFNUM	3	UINT16	2	amount of medium memory buffers
BIGBUFSIZE	4	UINT16	2	size of a big memory buffer
BIGBUFNUM	5	UINT16	2	amount of big memory buffers

4.9.12 SNMP

Module ID = GOAL_ID_SNMP (75)

Table 4.18 SNMP Management Interface

Variable Name	Variable ID	Type	Max. Size	Long Description
MIB2_SYS_LOCATION	0	STRING	255	—
MIB2_SYS_CONTACT	1	STRING	255	—
MIB2_SYS_NAME	2	STRING	255	—

4.9.13 MCTC

Module ID = GOAL_ID_MCTC (94)

Table 4.19 MCTC Management Interface

Variable Name	Variable ID	Type	Max. Size	Long Description
PRC_DISABLE	0	UINT8	4	RPC mode: 0, Enabled 1, Disabled
ID	1000	UINT32	4	Instance ID
STAT_RESET	1001	UINT32	4	Number of MCTC communications resets
STAT_RPC_TIMEOUTS	1002	UINT32	4	Number of MCTC RPC timeouts
STAT_RPC_DELAY_MIN	1003	UINT32	4	Minimum time for RPC request
STAT_RPC_DELAY_MAX	1004	UINT32	4	Maximum time for RPC request
STAT_RPC_DELAY_MEAN	1005	UINT32	4	Median time for RPC request
STAT_RPC_COUNT	1006	UINT32	4	Number of RPC requests

4.10 Firmware Update

4.10.1 Update the Communication Controller (CC)

Firmware update of the communication controller (CC) is possible in the field. It is done using the Management Tool. This tool uses the http protocol to transfer a firmware package to the device.

4.10.1.1 Firmware package

Firmware image is bundled within a package. This package contains a signed firmware, which secures only acceptance of firmware from the device originator. Thus, it is possible for the device to check authenticity of the firmware image.

4.10.1.2 Control interface

By default, a firmware update is possible at any time. The communication controller (CC) provides an interface to enable and disable the firmware update process. An application controller (AC) should use this interface as there are situations where a firmware update should not be accepted. This should be deactivated during an active cyclic connection to the PLC.
For usage of this interface see section 6.1, Device Specific Functions.

Optionally the application controller (AC) can register for events regarding firmware update. Then a start and finish of transfer is signalled to the application controller (AC). Its task is also to trigger the reboot to the bootloader and performance of the actual firmware update. Beside that a failed or succeeded firmware update is reported to the application controller (AC).

The callback function can be registered using appl_ccmFwUpdateCbReg().

```
/****************************************************************************/
/** firmware update callback
 *
 */
static void appl_fwUpdateCb(
    FW_UPDATE_SOURCE_T source,                  /**< fw update source */
    FW_UPDATE_STATUS_T state,                   /**< fw update status */
    uint8_t progress                            /**< fw update progress */
)
{
    switch (state) {
        default:
        case FW_UPDATE_IDLE:
            goal_logInfo("fw update state : IDLE");
            break;
        case FW_UPDATE_TRANSFER_INIT:
            goal_logInfo("fw update state : TRANSFER INIT");
            switch (source) {
                case FW_UPDATE_SOURCE_RPC:
                    goal_logInfo("fw update source : RPC");
```

```
                    break;
                case FW_UPDATE_SOURCE_HTTP:
                    goal_logInfo("fw update source : HTTP");
                    break;
                case FW_UPDATE_SOURCE_FOE:
                    goal_logInfo("fw update source : FOE");
                    break;
            }
            break;
        case FW_UPDATE_TRANSFER:
            goal_logInfo("fw update state : TRANSFER, progress = %d", progress);
            break;
        case FW_UPDATE_TRANSFER_DONE:
            goal_logInfo("fw update state : TRANSFER DONE");

            goal_logInfo("performing update, rebooting CCM module");
            /* perform actual update */
            appl_ccmFwUpdateExecute();
            break;
        case FW_UPDATE_ABORT:
            goal_logInfo("fw update state : ABORT");
            break;
        case FW_UPDATE_COMMIT_PENDING:
            goal_logInfo("fw update state : PENDING");
            break;
        case FW_UPDATE_COMMIT_DONE:
            goal_logInfo("fw update state : UPDATE DONE");
            break;
    }
}
```

4.10.1.3 Firmware update sequence

Firmware update is a two-step process. At first the firmware is uploaded to the http server of the CC. Following checks are done during this check:

1. This upload uses authentication with authentication level 0, where credentials are checked if configured for the HTTPD module. Those variables are configurable through the RPC interface of the HTTPD service. By default, these credentials are empty. Thus, any attempt to authenticate is accepted.

2. The firmware update must be allowed by the AC. By default, this is the case. However, the AC can disable this function using the RPC interface.

If at the end of the transfer a valid firmware is detected, the CC restarts and enters the bootloader. This CC checks the signature of the firmware and writes the correctly signed firmware to the memory of the device. As a fallback, the previously run firmware is kept.
After restart of the CC a successful communication to the Management Tool is required to permanently enable the updated firmware. If this is possible, the CC will restart again, and the bootloader will mark the new firmware as the current firmware. If this fails, the bootloader will revert to the original firmware with the next power cycle.

4.10.1.4 Keep update functionality while disabling DD

An application integrator might want to disable the DD feature to not expose any internal information of the device. Disabling is possible. However, to allow a firmware update using the Management Tool, the following steps need to be implemented:

1. Disabling DD by default
When calling the API function goal_ddNew, a bitmask can be passed, that determines the active DD features. If the predefined value GOAL_DD_FEAAT_NO is used, DD is disabled completely. Internally this value is stored to the CM variable FEATURE_DISABLE, which state also can be saved permanently to flash.

2. Introducing a switch to temporarily enable DD features
If a firmware update shall be processed, minimal DD features need to be set temporarily.
These are:
- HELLO REQUEST
- SET CONFIG
- GET CONFIG
- SET IP

This can be done using the API function goal_ddSessionFeatureActivate() with the following arguments:

```
goal_ddSessionFeatureActivate(pHdlDd, GOAL_DD_FEAT_GETCONFIG |
                                      GOAL_DD_FEAT_SETCONFIG |
                                      GOAL_DD_FEAT_SETIP);
```

The temporary switch, to enable the management interface, can be implemented using the web server.
As a result, the device will be invisible for the Management Tool. For firmware update, the required interface is temporarily activated, thus allowing to update the communication controller (CC) firmware.

4.10.2 Update Possibilities for Application Controller (AC)

By default, there is no firmware update available for the application controller (AC). However, the module provides mechanisms for implementing such a feature within the customer application. Following, two possible solutions are shown in next sections.

4.10.2.1 AC firmware update over HTTP

The application controller (AC) can provide a web site or tool-based firmware update over HTTP transport, utilising the provided RPC interface of the HTTPD service. As a starting point, the HTTPD example goal_http/02_post can be used on the AC and the example program 01_pnio_io_mirror can be used on the CC.

For latter, data for firmware update transported using a HTTP POST request will be processed in the call-back function httpDataCbPost, for example as shown in the following sample code:

```
1.  /******************************************************************************/
2.  /** goal http data callback
3.   *
4.   */
5.  static GOAL_STATUS_T httpDataCbPost(
6.      GOAL_HTTP_APPLCB_DATA_T *pCbInfo          /**< pointer to callback info struct */
7.  )
8.  {
9.      GOAL_STATUS_T res = GOAL_OK;              /* result */
10.     static uint32_t uploadDataLen = 0;        /* recent uploaded data length */
11.
12.     if (hdlUplHtml == pCbInfo->hdlRes) {
13.         /* check request method */
14.         switch (pCbInfo->reqType)
15.         {
16.         case GOAL_HTTP_FW_POST_START:
17.             /* reset data length */
18.             uploadDataLen = 0;
19.             GOAL_HTTP_RETURN_OK_204(pCbInfo);
20.             break;
21.
22.         case GOAL_HTTP_FW_POST_DATA:
23.
24.             /* process data */
25.             GOAL_MEMCPY(pDst, pCbInfo->cs.pData, pCbInfo->cs.lenData);
26.             uploadDataLen += pCbInfo->cs.lenData;
27.
28.             GOAL_HTTP_RETURN_OK_204(pCbInfo);
29.             break;
30.
31.         case GOAL_HTTP_FW_POST_END:
32.             GOAL_HTTP_RETURN_OK_204(pCbInfo);
33.             break;
34.
35.         case GOAL_HTTP_FW_REQ_DONE_OK:
36.         case GOAL_HTTP_FW_REQ_DONE_ERR:
37.             res = GOAL_OK;
38.             break;
39.
40.         default:
41.             /* return error */
42.             GOAL_HTTP_RETURN_ERR_403(pCbInfo);
43.             break;
44.         }
```

```
45.   }
46.   else {
47.       /* return error */
48.       GOAL_HTTP_RETURN_ERR_404(pCbInfo);
49.   }
50.   return res;
51.}
```

4.10.2.2 AC firmware update over TCP

```
1.  /*****************************************************************************/
2.  /** TCP Server Callback
3.   *
4.   * Process TCP data stream segments
5.   */
6.  static void tcpCallback(
7.      GOAL_MA_CHAN_TCP_T *pMaTcpHdl,              /**< MA handle */
8.      GOAL_NET_CB_TYPE_T cbType,                  /**< callback type */
9.      struct GOAL_NET_CHAN_T *pChan,              /**< channel descriptor */
10.     struct GOAL_BUFFER_T *pBuf                  /**< GOAL buffer */
11.)
12.{
13.     GOAL_NET_ADDR_T remote;                     /* remote address */
14.     GOAL_STATUS_T res;                          /* result */
15.
16.     if (cbType == GOAL_NET_CB_NEW_SOCKET) {
17.         goal_logInfo("new TCP listener");
18.     }
19.     else if (cbType == GOAL_NET_CB_NEW_DATA) {
20.
21.         /* process data */
22.
23.         goal_logDbg("Data received on tcp socket %p", (void *) pChan);
24.     }
25.}
```

5. Communication Stack

5.1 Introduction

This section lists all functions that are used to configure the communication stacks. These functions must be called within appl_setup() before goal_New() was called. Otherwise these functions have no effect. Each configuration has a default value that will be applied if no other value was set.

5.2 SPI Data Exchange

The communication with the R-IN32M3 Module uses the well-known Serial Peripheral Interface (SPI). A transfer must always be triggered by the application core (AC) and must at least be once during the heartbeat timeout. The implementation in the R-IN32M3 Module updates the SPI data after each transfer to make sure it doesn't interrupt a running transfer.

5.2.1 Clock Domains and Communication Cycle

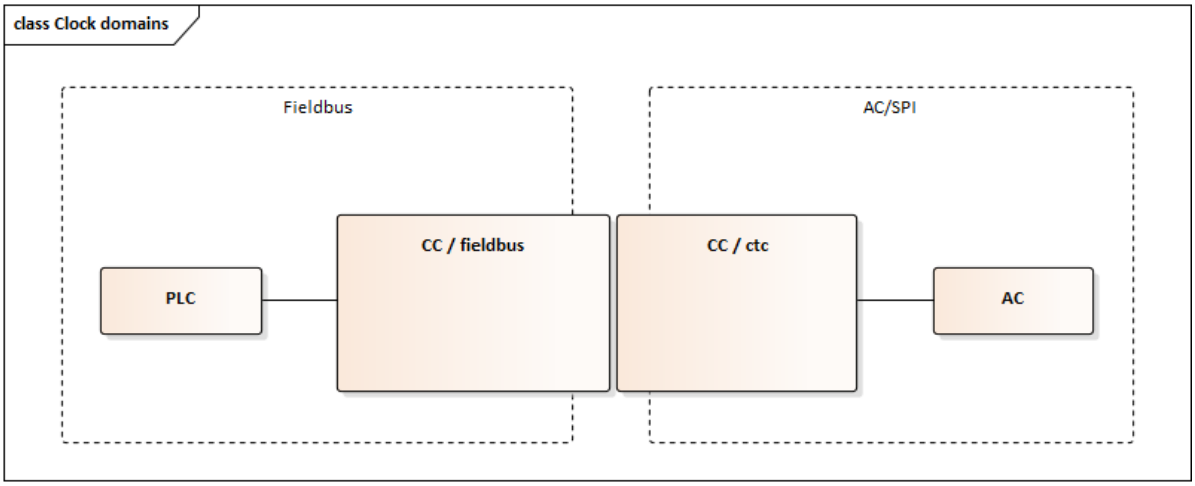

Figure 5.1 ctc Clock Domains

Operation of the device includes two clock domains, which run independently of each other. The first clock domain is on the fieldbus side. Commonly the PLC interacts with the device in one clock domain, where the PLC controls the timing of the output data. The second clock domain is driven by the AC which, through initiation of the SPI cycle, reads the output data from the device and updates input data for the next fieldbus cycle. Therefore, a specific timing of the process data is set up as shown in Figure 5.2, Communication Cycle.

Following data transports occur:
1. New output data from PLC
2. Processing of output data in CC and preloading of SPI transfer buffer
3. A finished SPI transfer initiated by the AC executes data exchange between AC and CC
4. Preloading of new input data for the next SPI transfer
5. A finished sequential SPI transfer executes data exchange between AC and CC, thus providing new input data for the next fieldbus transfer

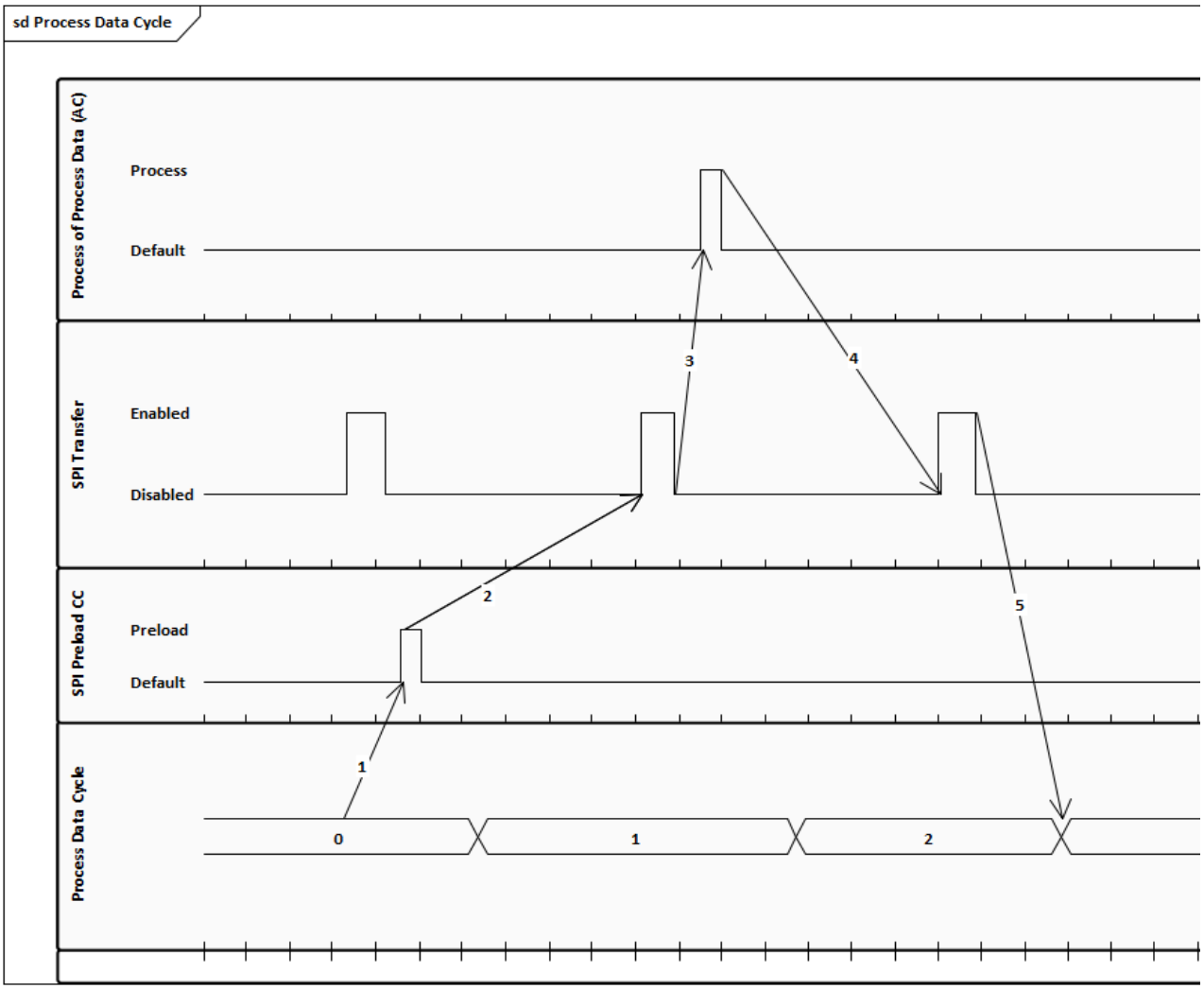

Figure 5.2 Communication Cycle

5.2.2 Technical Data

- Transfer length:
  - Cyclic only: 72 Bytes
  - Cyclic + RPC data: 128 Bytes
- Baud-rate: min, ..., max
- Delay between SPI transfers: 0.5 ms ... Heartbeat Timeout (1 second)
- Minimal round-trip time: 4 ... 6 ms (depending on the used protocol and setup)

5.2.3 SPI Timing

Following simplified diagram shows basic SPI timing which must be considered by the application controller (AC).

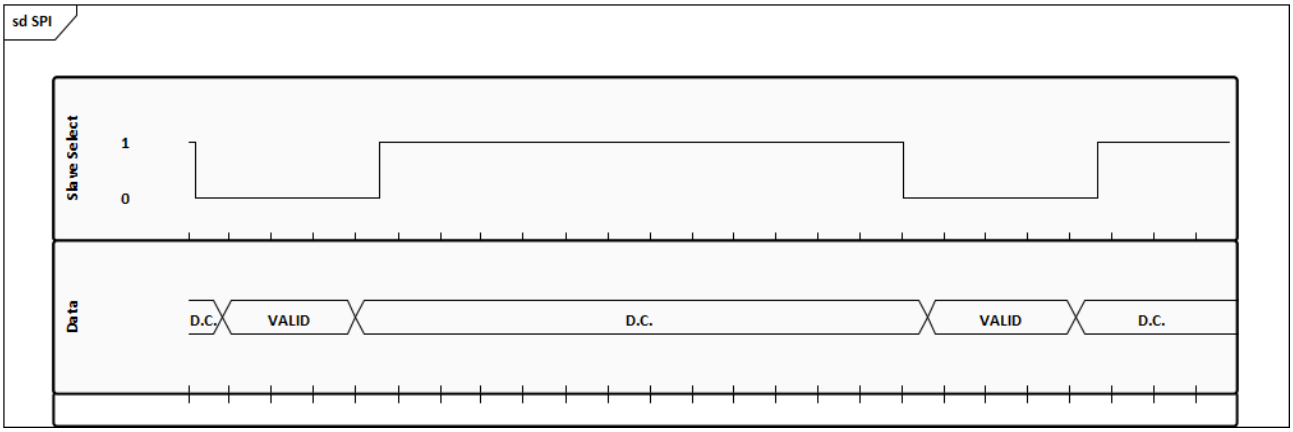

Figure 5.3 Basic SPI Timing

5.2.3.1 SPI Speed

Default SPI speed of the communication controller (CC) is 2 MHz.

5.2.3.2 SPI Setup Timing

In Figure 5.3, Basic SPI Timing, the communication scheme between AC and CC is shown. Following time needs to be considered by the AC during communication.

SPI Setup Time: Time between activation of the CC using the Slave Select signal and first data

The SPI Setup Time must at least be 10 ns, before the CC accepts data over SPI.

5.2.3.3 SPI Cycle Time

This time is the distance between two consecutive SPI transfers. Between two transfers a minimum time of 250 us must be kept to secure proper processing in the CC.

5.2.4 SPI Frame Structure

The SPI frame must contain the structure from Table 5.1, SPI Frame Structure to get accepted by the R-IN32M3 Module.

Table 5.1 SPI Frame Structure

Bytes 0..1	**Byte 2**	**Byte 3**	**Bytes 4 .. 76**	**Bytes 77 .. 127**
Fletcher-16 Checksum with Offset 0x0007 (little endian)	Sequence	Data Length	Cyclic Data	RPC Data

The same layout is sent back by the device containing its local sequence counter. The sequence counter is tracked and if it doesn't change during the heartbeat timeout the communication gets stopped until the sequence is updated again.

5.2.4.1 Fletcher 16 Checksum (16 Bits)

To calculate the Fletcher-16 checksum can be used.
Start index is byte 4 and end is at 127. After the calculation the value 0x0007 needs to be added to not have false positives if the whole area is set to zeros. In the frame the value has a width of 16 bits and needs to have the little-endian encoding.

5.2.4.2 Sequence Counter (8 Bits)

The sequence counter must be incremented on each sent out frame to be recognized as new data. It can start at any 8-bit value.

5.2.4.3 Data Length (8 Bits)

If only cyclic data is transferred the data length can be set from 0 to 73 bytes. When using RPC over SPI the data length needs to have a fixed value of 124.

5.3 Remote Procedure Call (RPC)

The RPC protocol used by the C2C implementation of the R-IN32M3 Module is transferred in byte 77 – 127. RPC transfers are always acknowledged to minimize data loss on erroneous transfers as good as possible. Also, the RPC calls can be larger than the available 50 bytes as the R-IN32M3 Module internally stores each received RPC frame in a ring-buffer and waits until a partitioned transfer is completed before proceeding with the request.

5.3.1 RPC Frame

5.3.1.1 Structure

The RPC frame must contain the structure from Table 5.2, RPC Frame Structure to be accepted by the R-IN32M3 Module.

Table 5.2 RPC Frame Structure

Bytes 0..1	Byte 2	Byte 3	Byte 4	Byte 5	Bytes 6 .. 49
Fletcher-16 Checksum with Offset 0x0007 (little endian)	Local Sequence	Remote Sequence Acknowledge	Data Length	Flags	Data

Each time a new local sequence is sent the R-IN32M3 Module will respond with the corresponding acknowledge in the second transferred frame. If no acknowledge was received the AC can retransmit its frame to re-request the acknowledge.

5.3.1.2 Fletcher-16 Checksum (16 Bits)

To calculate the Fletcher-16 checksum can be used.
Start index is byte 6 and end is at the included data length. After the calculation the value 0x0007 needs to be added to not have false positives if the whole area is set to zeros. In the frame the value has a width of 16 bits and needs to have the little-endian encoding.

5.3.1.3 Local Sequence (8 Bits)

The sequence counter must be incremented for each RPC frame with changed data. For each unseen incremental frame, the R-IN32M3 Module will put the transferred data into its internal ring-buffer and after the length matches it will process the RPC call.

5.3.1.4 Remote Sequence Acknowledge (8 Bits)

For each processed received RPC frame the AC needs to send out an acknowledge. If the received frame doesn’t match the expected sequence the AC must leave the acknowledge on the previous sequence to trigger a resend from the R-IN32M3 Module. If the resend fails the AC can also perform a re-sync.

5.3.1.5 Data Length (8 Bits)

Contains the length of the RPC data and must be between 0 (acknowledge-only frame) and 44.

5.3.2 Flags (8 Bits)

5.3.2.1 Structure

Table 5.3 RPC Header Flags

Bit 0	Bit 1	Bit 2	Bit 3
Sync Request	Sync Acknowledge	Reserved	Request Acknowledge

5.3.2.2 Sync Request

If set to 1 the R-IN32M3 Module enters the RPC synchronization.

5.3.2.3 Sync Acknowledge

During the Sync Request both sides need to set the Sync Acknowledge flag, see section 5.3.3, RPC Synchronization for details.

5.3.2.4 Request Acknowledge

Forces an acknowledge from the partner device.

5.3.3 RPC Synchronization

Before the R-IN32M3 Module is ready to operate and after a synchronization is lost the RPC must be synchronized. This is triggered by setting the Sync Request flag to 1.

Table 5.4 RPC Synchronization

AC	R-IN32M3 Module
Sync Request = 1 Local Sequence = 0 Local Sequence Acknowledge = 0 Remote Sequence Acknowledge = 0	
	Sync Request = 1 Local Sequence = 0 Local Sequence Acknowledge = 0 Remote Sequence Acknowledge = 0
Sync Request = 0 Sync Acknowledge = 1 Local Sequence = 1 RPC_Send(<empty>)	
	RPC_Receive() → Remote Sequence Acknowledge = 1 Sync Request = 0 Sync Acknowledge = 1 Local Sequence = 1 RPC_Send(<empty>)
RPC_Receive() → Local Sequence Acknowledge = 1	

→ Remote Sequence Acknowledge = 1 Sync Acknowledge = 0 RPC_Start()	
	RPC_Receive() → Local Sequence Acknowledge = 1 RPC_Start()

5.3.4 RPC Protocol

5.3.4.1 Introduction

The GOAL RPC protocol uses a virtual push/pop stack to call remote API functions with arguments. Each call must have a return value that is usually set to GOAL_OK when the call succeeded.

5.3.5 RPC Request/Response

5.3.5.1 Structure

An RPC request/response consists of the parts shown in Table 5.5, RPC Request Structure and Table 5.6, RPC Response Structure.

Table 5.5 RPC Request Structure

Byte 0..1	**Byte 2..5**	**Byte 6..9**	**Byte 10..13**	**Byte 14**	**Byte 15**	**Byte 16..x**	**Byte (x+1)..(x+3)**
Static Identifier 0xaa, 0xee	Data Length from Byte 6 to x	Function Id (little endian)	RPC Id (little endian)	CTC Id	Flags	Data	Fletcher-16 Checksum with Offset 0x0007 (little endian)

Table 5.6 RPC Response Structure

Byte 0..1	**Byte 2..5**	**Byte 6 .. x**	**Byte x+1**	**Byte x+2**	**Byte (x+3)..(x+4)**
Static Identifier 0xaa, 0xee	Data Length From Byte 6 to Flags (included)	Response Data	CTC Id	Flags	Fletcher-16 Checksum with Offset 0x0007 (little endian)

5.3.5.2 Static Identifier

The 2-byte static identifier is used on the R-IN32M3 Module to detect the start of a new RPC request or response. If the identifier is also contained in the data bytes the Fletcher-16 checksum will make sure that it is not handled as a thread in the same way as an RPC request/response.

5.3.5.3 Data Length

The data length contains the count of bytes starting with the “Function Id” and ending with the last data byte.

5.3.5.4 RPC Id

The RPC id is the module or group id. For example, GOAL PROFINET uses the RPC id GOAL_ID_PNIO to register its calls.

5.3.5.5 Function Id

The function id is used as a sub id to map the function calls in the specific to their handlers.

5.3.5.6 CTC Id

The CTC id is used to match requests and responses to their specific MCTC internal handle. A response must use the same CTC id as the request.

5.3.5.7 Flags

The flags define the type of the request, see Table 5.7, RPC Request/Response Flags for details.

Table 5.7 RPC Request/Response Flags

Bit 0..1
0 – Response 1 – Request 2 – Info (Request without waiting for a response)

5.3.5.8 Data

The data part contains the virtual stack of the RPC request/response.

5.3.5.9 Fletcher-16 Checksum (16 Bits)

To calculate the Fletcher-16 checksum can be used.
Start index is byte 16 and end is at the included data length. After the calculation, the value 0x0007 needs to be added to not have false positives if the whole area is set to zeros. In the frame the value has a width of 16 bits and needs to have the little-endian encoding.

5.4 Communicational Stack – PROFINET

This section lists the API functions that are provided by GOAL PROFINET.

5.4.1 goal_pnioCfgVendorIdSet – Set Vendor Id

Configures the vendor id. Default: 0x02c7 (Renesas Electronics); It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.8 goal_pnioCfgVendorIdSet Parameter

Parameter	Description
uint16_t idVendor	Vendor ID

5.4.2 goal_pnioCfgDeviceIdSet – Set Device Id

Configures the device id. Default: 0x0300; It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.9 goal_pnioCfgDeviceIdSet Parameter

Parameter	Description
uint16_t idDevice	Device ID

5.4.3 goal_pnioCfgVendorNameSet - Set Vendor Name

Configures the vendor name. Returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.10 goal_pnioCfgVendorNameSet Parameter

Parameter	Description
const char *strVendor	Vendor Name

5.4.4 goal_pnioCfgPortDescSet - Set LLDP Port Description

Configures the LLDP port description. Default: “TestPort”; It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.11 goal_pnioCfgPortDescSet Parameter

Parameter	Description
const char *strDescPort	Port Description

5.4.5 goal_pnioCfgSystemDescSet - Set LLDP System Description

Configures the LLDP system description. Default: “PROFINET System”; It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.12 goal_pnioCfgSystemDescSet Parameters

Parameter	Description
const char *strSystem	System Description

5.4.6 goal_pnioCfgOrderIdSet - Set Order Id

Configures the order id. It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.13 goal_pnioCfgOrderIdSet Parameters

Parameter	Description
const char *strOrder	Order Id

5.4.7 goal_pnioCfgSerialNumSet - Set Serial Number

Configures the serial number. It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.14 goal_pnioCfgSerialNumSet Parameters

Parameter	Description
const char *strNumSerial	Serial Number

5.4.8 goal_pnioCfgHwRevSet - Set Hardware Revision

Configures the hardware revision.; It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.15 goal_pnioCfgHwRevSet Parameters

Parameter	Description
uint16_t idRevHw	Hardware Revision

5.4.9 goal_pnioCfgSwRevPrefixSet - Set Software Revision Prefix

Configures the software revision prefix. Default: “P”

- “V” - official
- “R” - revision
- “P” - prototype
- “U” - under test
- “T” - test device

It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.16 goal_pnioCfgSwRevPrefixSet Parameters

Parameter	Description
const char chrRevSwPrefix	Software Revision Prefix

See example 15_config_set for a demonstration.

5.4.10 pnioCfgSwRevFuncEnhSet - Set Software Revision Functional Enhancement

Configures the software revision functional enhancement. Default: 0x50
It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.17 goal_pnioCfgSwRevFuncEnhSet Parameters

Parameter	Description
uint8_t idRevSwFuncEnh	Software Revision Functional Enhancement

5.4.11 goal_pnioCfgSwRevBugfixSet - Set Software Revision Bugfix

Configures the software revision bugfix. Default: 3
It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.18 goal_pnioCfgSwRevBugfixSet Parameters

Parameter	Description
uint8_t idRevSwBugfix	Software Revision Bugfix

5.4.12 goal_pnioCfgSwRevIntChgSet - Set Software Revision Internal Change

Configures the software revision internal change. Default: 0x18
It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.19 goal_pnioCfgSwRevIntChgSet Parameters

Parameter	Description
uint8_t idRevSwIntChg	Software Revision Internal Change

5.4.13 goal_pnioCfgSwRevCntSet - Set Software Revision Counter

Configures the software revision counter. Default: 0x0000
It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.20 goal_pnioCfgSwRevCntSet Parameters

Parameter	Description
uint16_t idRevSwRevCnt	Software Revision Counter

5.4.14 goal_pnioCfgIm1TagFuncSet - Set I&M1 Tag Function

Configures the I&M1 tag function. Default: “”
It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.21 goal_pnioCfgIm1TagFuncSet Parameters

Parameter	Description
const char *strIm1TagFunc	I&M1 Tag Function

5.4.15 goal_pnioCfgIm1TagLocSet - Set I&M1 Tag Location

Configures the I&M1 tag location. Default: “”
It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.22 goal_pnioCfgIm1TagLocSet Parameters

Parameter	Description
const char *strIm1TagLoc	I&M1 Tag Location

5.4.16 goal_pnioCfgIm2DateSet - Set I&M2 Date

Configures the I&M2 date. Default: “”
It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.23 goal_pnioCfgIm2DateSet Parameters

Parameter	Description
const char *strIm2Date	I&M2 Date

5.4.17 goal_pnioCfgIm3DescSet - Set I&M3 Description

Configures the I&M3 description. Default: “”
It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.24 goal_pnioCfgIm3DescSet Parameters

Parameter	**Description**
const char *strIm3Desc	**I&M3 Description**

5.4.18 goal_pnioCfgIm4SigSet - Set I&M4 Signature (Functional Safety)

Configures the I&M4 signature. Default: “”
It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.25 goal_pnioCfgIm4SigSet Parameters

Parameter	Description
const char *strIm4Sig	I&M4 Signature

5.4.19 goal_pnioCfgLldpOrgExtSet - Configure LLDP Organizationally-specific Extension

Configures the LLDP organizationally-specific extension.
Default: GOAL_TRUE It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.
Warning: This function should not be used as the behavior can break conformity.

Table 5.26 goal_pnioCfgLldpOrgExtSet Parameters

Parameter	Description
GOAL_BOOL_T flgLldpOrgExt	LLDP Organizationally-specific Extension Flag

5.4.20 goal_pnioCfgLldpOptTlvSet - Configure LLDP Optional TLV Parameters

Configures the LLDP optional TLV parameters. Default: GOAL_TRUE
These parameters contain:

- port description
- system name
- system description
- system capabilities
- management address
- object ID

It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.
Warning: This function should not be used as the behavior can break conformity.

Table 5.27 goal_pnioCfgLldpOptTlvSet Parameters

Parameter	Description
GOAL_BOOL_T flgLldpOptTlv	LLDP Optional TLV Parameters Flag

5.4.21 goal_pnioCfgLldpGenMacSet - Configure LLDP Port MAC Address Generation

Configures the automatic LLDP port MAC address generation. If set to GOAL_TRUE the LLDP port-specific MAC addresses are automatically generated by adding the port id to the host port MAC address.
Default: GOAL_TRUE It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.
Warning: If this functionality is enabled (default) every device uses at least two MAC addresses (real plus one per port) in an ascending order. To use specific virtual port MAC addresses this feature must be disabled and the driver must provide different MAC addresses per request (GOAL_ETH_PORT_HOST and port specific requests).

Table 5.28 goal_pnioCfgLldpGenMacSet Parameters

Parameter	Description
GOAL_BOOL_T flgLldpGenMac	Automatic LLDP MAC Generation Flag

5.4.22 goal_pnioCfgIm14SupportSet - Configure I&M 1-4 Support

Configures the GOAL PROFINET stack I&M 1-4 support. If set to GOAL_FALSE the stack denies I&M 1-4 requests. Default: GOAL_TRUE It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.
Warning: This function should be used carefully because it can break conformity.

Table 5.29 goal_pnioCfgIm14SupportSet Parameters

Parameter	Description
GOAL_BOOL_T flgIm14Support	I&M 1-4 Support Flag

5.4.23 goal_pnioCfgIm14CbSet - Configure I&M 1-4 Callback

Configures the GOAL PROFINET stack I&M 1-4 callback. If set to GOAL_TRUE the application callback must handle the I&M 1-4 get and set requests. Default: GOAL_FALSE It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.
Warning: This function should be used carefully because it can break conformity.

Table 5.30 goal_pnioCfgIm14CbSet Parameters

Parameter	Description
GOAL_BOOL_T flgIm14Cb	I&M 1-4 Callback Flag

5.4.24 goal_pnioCfgIm0CbSet - Configure I&M 0 Callback

Configures the GOAL PROFINET stack I&M 0 callback. If set to GOAL_TRUE the application callback must handle the I&M 0 get and set requests.
Default: GOAL_FALSE It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.
Warning: This function should be used carefully because it can break conformity.

Table 5.31 goal_pnioCfgIm0CbSet Parameters

Parameter	Description
GOAL_BOOL_T flgIm0Cb	I&M 0 Callback Flag

5.4.25 goal_pnioCfgIm0FilterDataCbSet - Configure I&M 0 Filter Data Callback

Configures the GOAL PROFINET stack I&M 0 filter data callback. If set to GOAL_TRUE the application callback must handle the I&M 0 filter data get and set requests.
Default: GOAL_FALSE
It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.
Warning: This function should be used carefully because it can break conformity.

Table 5.32 goal_pnioCfgIm0FilterDataCbSet Parameters

Parameter	Description
GOAL_BOOL_T flgIm0FilterCb	I&M 0 Filter Data Callback Flag

5.4.26 goal_pnioCfgRecDataBusyBufsizeSet - Configure Record Handle Storage Count

Configures the count of parallel record handles.
Default: 2 It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 5.33 goal_pnioCfgRecDataBusyBufsizeSet Parameters

Parameter	Description
GOAL_BOOL_T cntRecDataBusyBufsize	Record Handle Storage Count

5.4.27 goal_pnioCfgRpcFragReqLenMaxSet - Configure Maximum Record Size

Configures the maximum size in bytes of a record request. This must match the MaxSupportedRecordSize attribute in the GSDML file.
Default: 4068 It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.
Warning: Changing this value to a smaller number can break conformity.

Table 5.34 goal_pnioCfgRpcFragReqLenMaxSet Parameters

Parameter	Description
unsigned int sizeRpcFragMaxReqLen	Maximum Record Size

5.4.28 goal_pnioCfgRpcFragMaxCntSet – Configure Maximum RPC Fragment Number

This function is obsolete. The GOAL PROFINET stack now allows 64 fragmented frames.

5.4.29 goal_pnioCfgRpcFragEnableSet - Configure RPC Fragmentation

Configures the RPC fragmentation feature. If set to GOAL_TRUE RPC fragmentation is enabled.
Default: GOAL_TRUE It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.
Warning: This function should not be used as the behavior can break conformity.

Table 5.35 goal_pnioCfgRpcFragEnableSet Parameters

Parameter	Description
GOAL_BOOL_T flgRpcFragSupport	RPC Fragmentation Enable Flag

5.4.30 goal_pnioCfgRpcSessionMaxCntSet - Configure Maximum RPC Session Count

Configures the maximum count of RPC sessions. Default: 8; It returns a GOAL_STATUS_T status.
This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.
Warning: This function should not be used as the behavior can break conformity.

Table 5.36 goal_pnioCfgRpcSessionMaxCntSet Parameters

Parameter	Description
unsigned int numRpcSessions	RPC Session Count

5.4.31 goal_pnioDmSubslotAdd – Map Subslot Data

The API goal_pnioDmSubslotAdd maps input and output data of the given subslot to the also given instances of the DM.

Table 5.37 goal_pnioDmSubslotAdd API Description

Parameter	Description
GOAL_PNIO_T *pPnio	GOAL PROFINET instance
uint32_t idMiDmPeerFrom	Handle that receives data from CC
uint32_t idMiDmPeerTo	Handle that sends data to CC
GOAL_MI_DM_PART_T **ppPartDataOut	Output pointer to store the DM partition
GOAL_MI_DM_PART_T **ppPartDataIn	Output pointer to store the DM partition
uint32_t idApi	API id
uint16_t idSlot	Slot id
uint16_t idSubslot	Subslot id
uint32_t lenDataOut	Output data length
uint32_t lenDataIn	Input data length

5.4.32 goal_pnioDmSubslotIoxsAdd - Map Subslot IOCS/IOPS

The API goal_pnioDmSubslotIoxsAdd maps IOCS and IOPS states of the given subslot to the given instances of the DM.

Table 5.38 goal_pnioDmSubslotIoxsAdd API Description

Parameter	Description
GOAL_PNIO_T *pPnio	GOAL PROFINET instance
uint32_t idMiDmPeerFrom	Handle that receives data from CC
uint32_t idMiDmPeerTo	Handle that sends data to CC
GOAL_MI_DM_PART_T **ppPartIocsOut	Output pointer to store the DM partition
GOAL_MI_DM_PART_T **ppPartIopsOut	Output pointer to store the DM partition
GOAL_MI_DM_PART_T **ppPartIocsIn	Output pointer to store the DM partition
GOAL_MI_DM_PART_T **ppPartIopsIn	Output pointer to store the DM partition
uint32_t idApi	API id
uint16_t idSlot	Slot id
uint16_t idSubslot	Subslot id

5.4.33 goal_pnioDmApduAdd – Map APDU Status

The API goal_pnioDmApduAdd maps the APDU status to the given instance of the DM.

Table 5.39 goal_pnioDmApduAdd API Description

Parameter	Description
GOAL_PNIO_T *pPnio	GOAL PROFINET instance
uint32_t idMiDmPeerTo	(Ignored) Handle that sends data to CC
GOAL_MI_DM_PART_T **ppPartApduOut	Output pointer to store the DM partition

5.4.34 goal_pnioDmDpAdd – Map Data Provider Status

The API goal_pnioDmDpAdd maps the Data Provider status to the given instance of the DM.

Table 5.40 goal_pnioDmDpAdd API Description

Parameter	Description
GOAL_PNIO_T *pPnio	GOAL PROFINET instance
uint32_t idMiDmPeerTo	(Ignored) Handle that sends data to CC
GOAL_MI_DM_PART_T **ppPartDp	Output pointer to store the DM partition

5.5 Application Callbacks – PROFINET

5.5.1 Introduction

To use the full potential of PROFINET the stack allows you to interact at several stages of the protocol. For example, you can withhold the sending of the application ready signal to the PLC or handle record data reads and writes to specific slots.
The first thing to use the callback system is to provide a callback function that the stack can call every time it wants to communicate with the application. The callback function must have the following prototype:

```
GOAL_STATUS_T appl_pnioCb (
GOAL_PNIO_T *pPnio,                    /**< PROFINET handle */
GOAL_PNIO_CB_ID_T id,                  /**< callback id */
GOAL_PNIO_CB_DATA_T *pCb               /**< callback parameters */
);
```

It is registered with the call to goal_pnioNew which takes the pointer to the callback function as second parameter.

```
res = goal_pnioNew(&pPnio, APPL_PNIO_ID, appl_pnioCb);
```

Now every time the appl_pnioCb is called, the GOAL_PNIO_CB_ID_T value contains the reason of the call. The GOAL_PNIO_CB_DATA_T structure contains an array of multiple unions where each array element has a special meaning depending on the GOAL_PNIO_CB_ID_T value.
The following subsections will provide you with the details on the available callback ids.

5.5.2 GOAL_PNIO_CB_ID_ALARM_ACK_TIMEOUT - Timeout Waiting for Alarm ACK

Indicate that a timeout occurred in APMS while waiting for an alarm acknowledge.

Table 5.41 TIMEOUT - Timeout Waiting for Alarm ACK

Parameter	Description
cb->data[0].idAr	application relation id
cb->data[1].u16	timed out alarm sequence number

5.5.3 GOAL_PNIO_CB_ID_ALARM_NOTIFY_ACK - Alarm Notification ACK Received

Indicates that an alarm notification ACK was received.

Table 5.42 Alarm Notification ACK Received

Parameter	Description
cb->data[0].idAr	application relation id
cb->data[1].u16	alarm priority (low, high)
cb->data[2].pAlarmNotifyAck	GOAL_PNIO_ALARM_NOTIFY_ACK_T structure pointer

5.5.4 GOAL_PNIO_CB_ID_ALARM_NOTIFY - Alarm Notification Received

Indicates that an alarm notification was received. If the callback isn't handled or GOAL_OK is returned the PROFINET stack will automatically acknowledge the received alarm notification.

Table 5.43 Alarm Notification Received

Parameter	Description
cb->data[0].idAr	application relation id
cb->data[1].u16	alarm priority (low, high)
cb->data[2].pAlarmNotify	GOAL_PNIO_ALARM_NOTIFY_T structure pointer
cb->data[3].u32	user data length
cb->data[4].pCu8	user data pointer

5.5.5 GOAL_PNIO_CB_ID_APPL_READY - Application Ready Response Received

Indicate that an application ready response was received. The return value must be GOAL_OK.

Table 5.44 Application Ready Response Received

Parameter	Description
cb->data[0].idAr	application relation id

5.5.6 GOAL_PNIO_CB_ID_BLINK - Blink Request

Indicates that a DCP signal request was received and fills the callback data with the necessary information.

cb->data[0].stateDcpBlink tells the application the initial signal request (START), the correct time to toggle the signal (TOGGLE) and when the signal phase is over (FINISH). This information can be used if the application wants to fully represent the signal by itself.

The second possibility is to use the cb->data[1].stateDcpLight data which contains either GOAL_PNIO_DCP_LIGHT_OFF or GOAL_PNIO_DCP_LIGHT_ON which can be used to handover the signal indicator directly to a LED or blink function.
If variant 1 or 2 is used then the callback has to return GOAL_OK_SUPPORTED otherwise the stack handles the blinking by itself by calling goal_targetSetLeds with the GOAL_PNIO_LED_SIGNAL define. For stack internal handling the implementation of goal_targetGetLeds and goal_targetSetLeds is mandatory.

Table 5.45 Blink Request

Parameter	Description
cb->data[0].stateDcpBlink	DCP blink state (start, toggle, finish)
cb->data[1].stateDcpLight	DCP light state (on, off)

Return Values	Description
GOAL_OK	signal handled stack internal
GOAL_OK_SUPPORTED	application handles signal

```
case GOAL_PNIO_CB_ID_BLINK:

#if FIRST_SCENARIO
    /***************************/
    /* first scenario: act on blink state */
    /*************************/
    swtich (cb->data[0].stateDcpBlink) {

        case GOAL_PNIO_DCP_BLINK_START:
            /* start blinking */
            break;

        case GOAL_PNIO_DCP_BLINK_TOGGLE:
            /* toggle signal */
            break;

        case GOAL_PNIO_DCP_BLINK_FINISH:
            /* switch signal off */
            break;
    }

    res = GOAL_OK_SUPPORTED;
    break;
#endif /* FIRST_SCENARIO */

#if SECOND_SCENARIO
    /*************************************/
    /* second scenario: act on light state */
    /*************************************/
    vendorBlinkFunction(cb->data[1].stateDcpLight);
    res = GOAL_OK_SUPPORTED;
    break;
#endif /* SECOND_SCENARIO */

#if THIRD_SCENARIO
    /*************************************************/
    /* third scenario: do nothing / PROFINET stack handles signal */
    /*****************************************************/
#endif /* THIRD_SCENARIO */
```

5.5.7 GOAL_PNIO_CB_ID_CONNECT_FINISH - Connect Request Done

Indicates that a connect request was fully processed and allows the application to cancel it by setting the error status and return a value that is not ***GOAL_OK***.

Table 5.46 Connect Request Done

Parameter	Description
cb->data[0].idAr	application relation id
cb->data[1].pStatus	pointer to PROFINET status

5.5.8 GOAL_PNIO_CB_ID_CONNECT_REQUEST - Connect Request

Indicates that the processing of a connect request has been started. The parameter pointer is set to ***NULL***.

5.5.9 GOAL_PNIO_CB_ID_CONNECT_REQUEST_EXP_START- Expected Submodule Block Start

Indicates that an expected submodule block starts. This can be used to unplug all modules before the request callback for each module comes in.

Table 5.47 Expected Submodule Block Start

Parameter	Description
cb->data[0].idAr	application relation id

5.5.10 GOAL_PNIO_CB_ID_END_OF_PARAM - Param End Received

Indicates that the parameter end information was received.

Table 5.48 Param End Received

Parameter	Description
cb->data[0].idAr	application relation id

5.5.11 GOAL_PNIO_CB_ID_END_OF_PARAM_PLUG – Plug Param End Received

Indicates the plug parameter end information was received.

Table 5.49 Plug Param End Received

Parameter	Description
cb->data[0].idAr	application relation id
cb->data[1].u16	plug handle

5.5.12 GOAL_PNIO_CB_ID_EXP_SUBMOD - Expected Submodule

Indicates an expected submodule which can be plugged immediately.

Table 5.50 Expected Submodule

Parameter	Description
cb->data[0].idAr	application relation id
cb->data[1].u32	API
cb->data[2].u16	slot number
cb->data[3].u16	subslot number
cb->data[4].u32	module ident number
cb->data[5].u32	submodule ident number
cb->data[6].valBool	module flag (true = module, false = submodule)

5.5.13 GOAL_PNIO_CB_ID_FACTORY_RESET - Factory Reset

Indicates a factory reset. The parameter pointer is set to ***NULL*.**

5.5.14 GOAL_PNIO_CB_ID_IO_DATA_TIMEOUT - Cyclic Timeout

Indicates that an output endpoint timed out.

5.5.15 GOAL_PNIO_CB_ID_NET_IP_SET - IP Configuration Update

Indicate that the IP configuration was updated. The internal change flag indicates if the change was triggered by PROFINET DCP (PN_TRUE) or by an external caller like DHCP (PN_FALSE).

Table 5.51 IP Configuration Update

Parameter	Description
cb->data[0].u32	ip address
cb->data[1].u32	netmask
cb->data[2].u32	gateway
cb->data[3].valBool	temporary setting flag
cb->data[4].valBool	internal update flag

5.5.16 GOAL_PNIO_CB_ID_NEW_AR - New Application Relation

Indicates a new application relation. A return value different from ***GOAL_OK*** drops the AR and replies with an error.

Table 5.52 New Application Relation

Parameter	Description
cb->data[0].idAr	application relation id

5.5.17 GOAL_PNIO_CB_ID_NEW_IO_DATA - New IO Data

Indicates reception of new IO data.

Table 5.53 New IO Data

Parameter	Description
cb->data[0].u16	cyclic frame id
cb->data[1].u16	data length
cb->data[2].pCu8	data pointer

5.5.18 GOAL_PNIO_CB_ID_PLUG_READY - Plug Ready Response Received

Indicates that a plug ready response was received.

Table 5.54 Plug Ready Response Received

Parameter	Description
cb->data[0].idAr	application relation id

5.5.19 GOAL_PNIO_CB_ID_READ_RECORD - Read Record Data

Indicates that record data that couldn't be handled by the stack itself should be read. Before this callback is called, the stack checks if the API, slot and subslot combination is valid.
If the function returns GOAL_OK, the request will be denied with "invalid index".
To handle the request the callback needs to return GOAL_OK_SUPPORTED. It can either respond directly or later by calling goal_pnioRecReadFinish. Also, the now PROFINET status can be set through goal_pnioRecReadFinish.
If the response isn't GOAL_OK or GOAL_OK_SUPPORTED the stack will automatically respond with application read error.
The parameter "sequence number" is used later when the response is sent to detect if the request has expired.

Table 5.55 Read Record Data

Parameter	Description
cb->data[0].pStatus	unused (pointer to PROFINET status)
cb->data[1].idAr	application relation id
cb->data[2].u32	API
cb->data[3].u16	slot
cb->data[4].u16	subslot
cb->data[5].u16	record index
cb->data[6].pU8	unused (pointer to store record data)
cb->data[7].u32	maximum record read data length
cb->data[8].i32	internal record handle
cb->data[9].u32	sequence number handle

Example callback code:

```
case GOAL_PNIO_CB_ID_READ_RECORD:
    GOAL_PNIO_STATUS_T statusPnio = { 0, 0, 0, 0 }; /* PNIO Status */

    /* only process application index */
    if (RECORD_DATA_INDEX != pCb->data[5].u16) {
        return GOAL_OK;
    }

    goal_logInfo("CB: Read Request for record %x at api %"FMT_u32", slot %u, subslot %u",
                 pCb->data[5].u16, pCb->data[2].u32, pCb->data[3].u16, pCb->data[4].u16);

    /*
     * Process the record data and set error codes if something went wrong.
     * The following example shows a length check. Length should be 3
     * according to GSD.
     */
    if (RECORD_DATA_LENGTH > pCb->data[7].u32) {
        goal_logInfo("CB: Invalid data size in read request %"FMT_u32"!", pCb->data[7].u32);

        statusPnio.decode = GOAL_PNIO_ERR_DECODE_PNIORW;
        statusPnio.code1 = GOAL_PNIO_ERR_CODE1_PNIORW_ACCESS_INVAL_RANGE;
    }

    goal_pnioRecReadFinish(pHdlPnio, pCb->data[8].i32, &statusPnio, &recordBuf[0],
                           RECORD_DATA_LENGTH, pCb->data[9].u32);

    return GOAL_OK_SUPPORTED;
```

5.5.20 GOAL_PNIO_CB_ID_RELEASE_AR - Release Application Relation

Indicates that an application relation was released.

Table 5.56 Release Application Relation

Parameter	Description
cb->data[0].idAr	application relation id

5.5.21 GOAL_PNIO_CB_ID_RESET_TO_FACTORY - Reset To Factory

Indicates a reset to factory request. If there is a separate request handling outside of the stack the application must return GOAL_OK_SUPPORTED.
If the application doesn’t return from the callback with GOAL_OK or GOAL_OK_SUPPORTED the DCP error “0x04 suboption not set” is sent back to the DCP set request sender.

Table 5.57 Reset To Factory

Parameter	Description
cb->data[0].u16	reset to factory action

5.5.22 GOAL_PNIO_CB_ID_STATION_NAME - Station Name Changed

Indicates a station name change. If the permanent flag is set to GOAL_TRUE, the station name is stored in NVS, otherwise the station name is only stored temporarily and the NVS value is cleared.

Table 5.58 Station Name Changed

Parameter	Description
cb->data[0].pCu8	name of station
cb->data[1].u32	name of station length
cb->data[2].valBool	permanent flag

5.5.23 GOAL_PNIO_CB_ID_WRITE_RECORD - Write Record Data

Indicates that record data that couldn’t be handled by the stack itself should be written. Before this callback is called, the stack checks if the API, slot and subslot combination is valid.
If the function returns GOAL_OK the request will be denied with “invalid index”.
To handle the request the callback needs to return GOAL_OK_SUPPORTED. It can either respond directly or later by calling goal_pnioRecWriteFinish. Also, the now PROFINET status can be set through goal_pnioRecWriteFinish.
If the response isn't GOAL_OK or GOAL_OK_SUPPORTED the stack will automatically respond with application read error.
The parameter "sequence number" is used later when the response is sent to detect if the request has expired.

Table 5.59 Write Record Data

Parameter	Description
cb->data[0].pStatus	unused (pointer to PROFINET status)
cb->data[1].idAr	application relation id
cb->data[2].u32	API
cb->data[3].u16	slot
cb->data[4].u16	subslot
cb->data[5].u16	record index
cb->data[6].pCu8	pointer to read record data from
cb->data[7].u32	record data length
cb->data[8].i32	internal record handle
cb->data[9].valBool	subslot locked status flag
cb->data[10].u32	sequence number handle

Example callback code:

```
case GOAL_PNIO_CB_ID_WRITE_RECORD:
    GOAL_PNIO_STATUS_T statusPnio = { 0, 0, 0, 0 }; /* PNIO Status */

    /* only process application index */
    if (RECORD_DATA_INDEX != pCb->data[5].u16) {
        return GOAL_OK;
    }

    goal_logInfo("CB: Write Request for record %x at api %"FMT_u32", slot %u, subslot %u",
                 pCb->data[5].u16, pCb->data[2].u32, pCb->data[3].u16, pCb->data[4].u16);

    /*
     * Process the record data and set error codes if something went wrong.
     * The following example shows a length check. Length should be 3
     * according to GSD.
     */
    if (RECORD_DATA_LENGTH > pCb->data[7].u32) {
        goal_logInfo("CB: Invalid data size in write request %"FMT_u32"!", pCb->data[7].u32);

        statusPnio.decode = GOAL_PNIO_ERR_DECODE_PNIORW;
        statusPnio.code1 = GOAL_PNIO_ERR_CODE1_PNIORW_ACCESS_INVAL_RANGE;
    } else {
        goal_logInfo("CB: Record data: 0x%x 0x%x 0x%x", pCb->data[6].pCu8[0],
                     pCb->data[6].pCu8[1], pCb->data[6].pCu8[2]);
        GOAL_MEMCPY(&recordBuf[0], &pCb->data[6].pCu8[0], RECORD_DATA_LENGTH);
    }
    goal_pnioRecWriteFinish(pHdlPnio, pCb->data[8].i32, &statusPnio, pCb->data[10].u32);

    return GOAL_OK_SUPPORTED;
```

5.5.24 GOAL_PNIO_CB_ID_INIT - Stack Initialized

Indicates that the PROFINET stack is fully initialized. The parameter pointer is set to *NULL*. At this point it is safe to create the device configuration.

5.5.25 GOAL_PNIO_CB_ID_LLDP_UPDATE - LLDP Update

Signalizes that the device on the partner port changed.

Table 5.60 LLDP Update

Parameter	Description
cb->data[0].u32	GOAL Ethernet Port Id

5.5.26 GOAL_PNIO_CB_ID_CONN_REQ_EXP_FINISH - Connect Request Expected Submodule Block Finish

This callback is called after the Expected Submodule Block in the Connect Request has been parsed.

Table 5.61 Connect Request Expected Submodule Block Finish

Parameter	Description
cb->data[0].idAr	application relation id

5.5.27 GOAL_PNIO_CB_ID_STATION_NAME_VERIFY - DCP Station Name Verification

Let the application verify a DCP Station Name Set Request.

If the function returns a GOAL error status the set request will be denied.

Table 5.62 DCP Station Name Verification

Parameter	Description
cb->data[0].pCu8	pointer to station name (unterminated)
cb->data[1].u32	length of station name
cb->data[2].valBool	permanent flag (permanent = true)

5.5.28 GOAL_PNIO_CB_ID_NET_IP_SET_VERIFY - DCP IP Configuration Verification

Let the application verify a DCP IP Configuration Set Request.

If the function returns a GOAL error status the set request will be denied.

Table 5.63 DCP IP Configuration Verification

Parameter	Description
cb->data[0].u32	IP address
cb->data[1].u32	netmask
cb->data[2].u32	gateway
cb->data[3].valBool	temporary flag (temporary = true)

5.6 Communication Stack – EtherNet/IP

This section lists the API functions that are provided by GOAL EtherNet/IP.

5.6.1 goal_eipCfgVendorIdSet

Set the Vendor ID of this EtherNet/IP stack instance. The vendor ID is assigned by the ODVA.

Default Value: 1105

Table 5.64 goal_eipCfgVendorIdSet Parameters

Parameter	Description
uint16_t vendorId	Vendor ID

```
res = goal_eipCfgVendorIdSet(1105);
```

5.6.2 goal_eipCfgDeviceTypeSet

Set the Device Type of this EtherNet/IP stack instance. Valid values are defined by the CIP specification.
Default Value: 0x2B

Table 5.65 goal_eipCfgDeviceTypeSet Parameters

Parameter	Description
uint16_t deviceType	Device Type

```
res = goal_eipCfgDeviceTypeSet(0x2B);
```

5.6.3 goal_eipCfgProductCodeSet

Set the Product Code of this EtherNet/IP stack instance. This value is defined by the device vendor.

Default Value: 768

Table 5.66 goal_eipCfgProductCodeSet Parameters

Parameter	Description
uint16_t productCode	Product Code

```
res = goal_eipCfgProductCodeSet(768);
```

5.6.4 goal_eipCfgRevisionSet

Set the Revision of the EtherNet/IP stack instance. The revision consists of a major and a minor number. It represents changes in the firmware that affect the device's behaviour.

Default Value: 1.1

Table 5.67 goal_eipCfgRevisionSet Parameters

Parameter	Description
uint8_t revMajor	major revision number
uint8_t revMinor	minor revision number

```
res = goal_eipCfgRevisionSet(1, 1);
```

5.6.5 goal_eipCfgSerialNumSet

Set the Serial Number of the EtherNet/IP stack instance. This number is assigned by the vendor and should be unique for each device.

Default Value: 1

Table 5.68 goal_eipCfgSerialNumSet Parameters

Parameter	Description
uint32_t serial	Serial Number

```
res = goal_eipCfgSerialNumSet(1);
```

5.6.6 goal_eipCfgProductNameSet

Set the Product Name of the EtherNet/IP stack instance. This name is assigned by the vendor. Its maximum length is 32 characters.

Default Value: “EtherNet/IP Adapter”

Table 5.69 goal_eipCfgProductNameSet Parameters

Parameter	Description
const char *strName	Product Name

```
res = goal_eipCfgProductNameSet("EtherNet/IP Adapter");
```

5.6.7 goal_eipCfgDomainNameSet

Set the default Domain Name of the EtherNet/IP stack instance. This name is used as the device’s domain name if no valid configuration were found. Its maximum length is 48 characters.

Default Value: “port.de”

Table 5.70 goal_eipCfgDomainNameSet Parameters

Parameter	Description
const char *strName	default Domain Name

```
res = goal_eipCfgDomainNameSet("example.org");
```

5.6.8 goal_eipCfgHostNameSet

Set the default Host Name of the EtherNet/IP stack instance. This name is used as the device’s host name if no valid configuration were found. Its maximum length is 64 characters.
Default Value: “eipdevice”

Table 5.71 goal_eipCfgHostNameSet Parameters

Parameter	Description
const char *strName	default Host Name

```
res = goal_eipCfgHostNameSet("example_device");
```

5.6.9 goal_eipCfgNumExplicitConSet

Set the maximum number of explicit Connections the device can handle at once.

Default Value: 6

Table 5.72 goal_eipCfgNumExplicitConSet Parameters

Parameter	Description
uint16_t num	number of explicit connections

```
res = goal_eipCfgNumExplicitConSet(10);
```

5.6.10 goal_eipCfgNumImplicitConSetImpl

Set the maximum number of implicit Connections the device can handle at once.

Default Value: 6

Table 5.73 goal_eipCfgNumImplicitConSetImpl Parameters

Parameter	Description
uint16_t num	number of implicit connections

```
res = goal_eipCfgNumImplicitConSetImpl(10);
```

5.6.11 goal_eipCfgEthLinkCountersOn

Disable support for Ethernet Link attributes 4, 5, 12 and 13.

Default Value: GOAL_TRUE

Table 5.74 goal_eipCfgEthLinkCountersOn Parameters

Parameter	Description
GOAL_BOOL_T enable	enable or disable feature

```
res = goal_eipCfgEthLinkCountersOn(GOAL_FALSE);
```

5.6.12 goal_eipCfgEthLinkControlOn

Disable support for Ethernet Link attribute 6.
This function is enabled regardless of the function enable (GOAL_TRUE).

Default Value: GOAL_TRUE

Table 5.75 goal_eipCfgEthLinkControlOn Parameters

Parameter	Description
GOAL_BOOL_T enable	enable or disable feature

```
res = goal_eipCfgEthLinkControlOn(GOAL_FALSE);
```

5.6.13 goal_eipCfgChangeEthAfterResetOn

A change of Ethernet link speeds or duplex modes requires a reset of the device.
This function is enabled regardless of the function enable (GOAL_TRUE).

Default Value: GOAL_FALSE

Table 5.76 goal_eipCfgChangeEthAfterResetOn Parameters

Parameter	Description
GOAL_BOOL_T enable	enable or disable feature

```
res = goal_eipCfgChangeEthAfterResetOn(GOAL_FALSE);
```

5.6.14 goal_eipCfgChangeIpAfterResetOn

A change of the IP address requires a reset of the device.

Default Value: GOAL_FALSE

Table 5.77 goal_eipCfgChangeIpAfterResetOn Parameters

Parameter	Description
GOAL_BOOL_T enable	enable or disable feature

5.6.15 goal_eipCfgNumSessionsSet

Set the number of Encapsulation sessions the device can handle at once.

Default Value: 20

Table 5.78 goal_eipCfgNumSessionsSet Parameters

Parameter	Description
uint16_t num	number of sessions

```
res = goal_eipCfgNumSessionsSet(10);
```

5.6.16 goal_eipCfgTickSet

Set the number of milliseconds of one tick. The stack uses a tick as the smallest unit of time.

Default Value: 10

Table 5.79 goal_eipCfgTickSet Parameters

Parameter	Description
uint32_t ticks	size of 1 tick in ms

```
res = goal_eipCfgTickSet(10);
```

Caution:

This function is deprecated and has no effect. It is kept for compatibility with older firmware versions.

5.6.17 goal_eipCfgO2TRunIdleHeaderOn

Disable the Run/Idle Header for consumed (Originator-to-Target) cyclic data.
This function is enabled regardless of the function enable (GOAL_TRUE).

Default Value: GOAL_TRUE

Table 5.80 goal_eipCfgO2TRunIdleHeaderOn Parameters

Parameter	Description
GOAL_BOOL_T enable	enable or disable feature

```
res = goal_eipCfgO2TRunIdleHeaderOn(GOAL_FALSE);
```

5.6.18 goal_eipCfgT2ORunIdleHeaderOn

Enable the Run/Idle Header for produced (Target-to-Originator) cyclic data.

Default Value: GOAL_FALSE

Table 5.81 goal_eipCfgT2ORunIdleHeaderOn Parameters

Parameter	Description
GOAL_BOOL_T enable	enable or disable feature

```
res = goal_eipCfgT2ORunIdleHeaderOn(GOAL_FALSE);
```

5.6.19 goal_eipCfgQoSOn

Disable support of the QoS attribute 4, 5, 6 and 7.
This function is enabled regardless of the function enable (GOAL_TRUE).

Default Value: GOAL_TRUE

Table 5.82 goal_eipCfgQoSOn Parameters

Parameter	Description
GOAL_BOOL_T enable	enable or disable feature

```
res = goal_eipCfgQoSOn(GOAL_TRUE);
```

5.6.20 goal_eipCfgNumDelayedEncapMsgSet

Set the number of Encapsulation messages that can be delayed at the same time.

Default Value: 2

Table 5.83 goal_eipCfgNumDelayedEncapMsgSet Parameters

Parameter	Description
uint16_t num	number of messages

```
res = goal__eipCfgNumDelayedEncapMsgSet(2);
```

5.6.21 goal_eipCfgDhcpOn

Enable the DHCP client if it is supported by the platform.

Default Value: GOAL_FALSE

Table 5.84 goal_eipCfgDhcpOn Parameters

Parameter	Description
GOAL_BOOL_T enable	enable or disable feature

```
res = goal_eipCfgDhcpOn(GOAL_TRUE);
```

5.6.22 goal_eipCfgDlrOn

Enable support of the DLR object. This feature requires the DLR stack and support of the hardware.

Default Value: GOAL_FALSE

Table 5.85 goal_eipCfgDlrOn Parameters

Parameter	Description
GOAL_BOOL_T enable	enable or disable feature

```
res = goal_eipCfgDlrOn(GOAL_TRUE);
```

5.6.23 goal_eipCfgAcdOn

Enable support of the Address Conflict Detection (ACD).

Default Value: GOAL_FALSE

Table 5.86 goal_eipCfgAcdOn Parameters

Parameter	Description
GOAL_BOOL_T enable	enable or disable feature

```
res = goal_eipCfgAcdOn(GOAL_TRUE);
```

5.6.24 goal_eipCfgAcdConflictFallbackIp

Configure Fallback IP Configuration, if Address Conflict Detection (ACD) detects an address conflict. The device will apply the configured IP if it's configured as device with static IP. If attribute 3 of the TCP/IP Class is set to DHCP, the device will start the DHCP process after a fixed timeout.

- Transit into error state and do nothing: pass ipAddress, subnetMask and gateway = 0,
- Set fallback IP configuration: pass valid IP configuration.

Table 5.87 goal_eipCfgAcdConflictFallbackIp Parameters

Parameter	Description
uint32_t ipAddress	fallback IP address
uint32_t subnetMask	fallback subnet mask
uint32_t gateway	fallback gateway address

```
uint32_t ipAddress = GOAL_NET_IPV4(192, 168, 0, 100);
uint32_t subnetMask = GOAL_NET_IPV4(255, 255, 255, 0);
uint32_t gateway = GOAL_NET_IPV4(192, 168, 0, 1);

res = goal_eipCfgAcdConflictFallbackIp(ipAddress, subnetMask, gateway);
```

5.7 Application Callbacks – EtherNet/IP

5.7.1 Introduction

To use the full potential of EtherNet/IP, the stack allows you to interact at several stages of the protocol. For example, you may receive a callback after new assembly data has arrived.

The stack calls the callback handler registered via the function goal_eipNew(). The callback handler returns a GOAL_STATUS_T value.

Table 5.88 Parameters of the Callback Handler

Parameter	Description
GOAL_EIP_T *pHdlEip	GOAL EtherNet/IP handle
GOAL_EIP_CB_ID_T id	callback id
GOAL_EIP_CB_DATA_T *pCb	callback parameters

The callback parameter is an array of unions that has up to 10 elements.

```
/*****************************************************************************/
/** EtherNet/IP Callback Handler
 * This function collects all callbacks from the stack and decides if the * callback must
 *   be handled.
 */

GOAL_STATUS_T main_eipCallback(
    GOAL_EIP_T *pHdlEip,                    /**< EtherNet IP handle */
    GOAL_EIP_CB_ID_T id,                    /**< callback id */
    GOAL_EIP_CB_DATA_T *pCb                 /**< callback parameters */
  )
{

GOAL_STATUS_T res = GOAL_OK;            /* result */
  switch (id) {
  case
    GOAL_EIP_CB_ID_INIT:
    /* initialize application resources */
    break;
    /* …*/
  }

  return res;
}
```

The following subsections will provide you with the details on the available callback ids.

5.7.2 GOAL_EIP_CB_ID_INIT

The stack was initialized. The application can initialize its resources.

Parameter <none>

Return Value

- GOAL_OK - success
- other - fail

5.7.3 GOAL_EIP_CB_ID_READY

Initialization is done.

Parameter <none>

Return Value <ignored>

5.7.4 GOAL_EIP_CB_ID_CONNECT_EVENT

Inform the application about a connection event

Parameter

Table 5.89 Callback Parameters of GOAL_EIP_CB_ID_CONNECT_EVENT

Element	Member	Data type	Description
0	outputAssembly	uint32_t	instance id of output assembly
1	inputAssembly	uint32_t	instance id of input assembly
2	connectionEvent	uint32_t	GOAL_EIP_CONNECTION_EVENT_*

Return Value <ignored>

5.7.5 GOAL_EIP_CB_ID_ASSEMBLY_DATA_RECV

New data for an assembly has been received.

Parameter

Table 5.90 Callback Parameters of GOAL_EIP_CB_ID_ASSEMBLY_DATA_RECV

Element	Member	Data type	Description
0	instanceNr	uint32_t	instance id of assembly

Return Value

- GOAL_OK - success
- Other - fail

5.7.6 GOAL_EIP_CB_ID_ASSEMBLY_DATA_SEND

Inform application that data of an assembly will be sent.

Parameter

Table 5.91 Callback Parameters of GOAL_EIP_CB_ID_ASSEMBLY_DATA_SEND

Element	Member	Data type	Description
0	instanceNr	uint32_t	instance id of assembly

Return Value

- GOAL_OK - data has changed
- Other - data has not changed

5.7.7 GOAL_EIP_CB_ID_RUN_IDLE_CHANGED

Inform application that the Run/Idle header of consumed cyclic data has changed.

Parameter

Table 5.92 Callback Parameters of GOAL_EIP_CB_ID_RUN_IDLE_CHANGED

Element	Member	Data type	Description
0	outputAssembly	uint32_t	instance id of output assembly
1	inputAssembly	uint32_t	instance id of input assembly
2	runIdleValue	uint32_t	current value of the run/idle flag

Return Value <ignored>

5.7.8 GOAL_EIP_CB_ID_LED_CHANGED

Inform the application that a Module Status or Network Status LED must be changed. The parameter contains a bitmap made of GOAL_EIP_LED_* macros. If a bit is set the corresponding LED must be set. Otherwise it must be cleared.

Parameter

Table 5.93 Callback Parameters of GOAL_EIP_CB_ID_LED_CHANGED

Element	Member	Data type	Description
0	leds	uint32_t	bitmap of active LEDs

Return Value <ignored>

5.7.9 GOAL_EIP_CB_ID_DEVICE_RESET

Inform the application that the device will be reset. Depending on the platform the device is either reset or the reset is only simulated. Therefore, the application must reinitialize its resources. The callback parameter indicates the reset type.

Parameter

Table 5.94 Callback Parameters of GOAL_EIP_CB_ID_DEVICE_RESET

Element	Member	Data type	
0	resetState	uint32_t	GOAL_EIP_RESET_*

Return Value <ignored>

5.7.10 GOAL_EIP_CB_ID_REVISION_CHECK

If the compatibility bit is set in the Electronic Key Segment the application can decide whether a Minor Revision is supported or not. This means the application can decide if it is stil compatible to a previous revision of itself.

Parameter

Table 5.95 Callback Parameters of GOAL_EIP_CB_ID_REVISION_CHECK

Element	Member	Data type	Description
0	minorRevision	uint8_t	requested minor revision of application

Return Value

- GOAL_OK - Revision is supported
- Other - Revision is not supported

5.7.11 GOAL_EIP_CB_ID_ACD_CONFLICT

Inform the application about a detected address conflict. Depending on whether the application return GOAL_OK or GOAL_ERROR, the device will try to solve the conflict with the configured behavior or transit into an error fault. The configuration is done with the function goal_eipCfgAcdConflictFallbackIp().

Parameter

Table 5.96 Callback Parameters of GOAL_EIP_CB_ID_ACD_CONFLICT

Element	Member	Data type	Description
0	acdActivity	uint8_t	ACD status as following: 0 - no conflict detected 1 - ongoing detection 2 - probing IP address 3 - semi active probing
1	acdRemoteMac	uint8_t *	Array of device MAC, which caused address conflict
2	acdArpPru	uint8_t *	Array of raw frame, which caused address conflict
3	flgDhcpEnabled	GOAL_BOOL_T	DHCP enabled

Return Value

- GOAL_OK - Device will append configured behavior
- GOAL_ERROR - Device will transit into an error fault

5.8 Communication Stack –EtherCAT

This section lists the API functions that are provided by GOAL EtherCAT.

5.8.1 CoE API

The CoE module provides indication events to connect the application to the objects and the process data. There are also API functions that trigger the CoE and SDO module.

Parameter

Table 5.97 CoE Indication events

Callback ID	Description
GOAL_ECAT_CB_ID_SDO_UPLOAD	indicate SDO Read access to an object
GOAL_ECAT_CB_ID_SDO_DOWNLOAD	check an object's new data before it is written
GOAL_ECAT_CB_ID_RxPDO_RECEIVED	indicate reception of output process data (objects updated)
GOAL_ECAT_CB_ID_TxPDO_PREPARE	update input process data objects before they are mapped to Sync Manager

5.8.2 EoE API

There is no EoE API parameters since when enabled EoE will internally be connected to the GOAL framework.

5.8.3 FoE API

The FoE module provides indication events that must be implemented by the application.

Parameter

Table 5.98 FOE indication events

Event	Description
GOAL_ECAT_CB_ID_FOE_READ_REQ	open a file for reading
GOAL_ECAT_CB_ID_FOE_WRITE_REQ	open a file for writing
GOAL_ECAT_CB_ID_FOE_READ_DATA	get fragment of read file
GOAL_ECAT_CB_ID_FOE_WRITE_DATA	write fragment of write file
GOAL_ECAT_CB_ID_FOE_ERROR	error occurred, close file

5.8.4 EtherCAT State machine

These functions inform the application about a change in the EtherCAT state machine.

Parameter

Table 5.99 ESM API

Function	Description
goal_ecatEsmStateGet()	get current ESM state

Table 5.100 ESM Events

Event	Description
GOAL_ECAT_CB_ID_NEW_ESM_STATE_ENTERED	indicate new ESM state and possible error
GOAL_ECAT_CB_ID_NEW_ESM_STATE_REQUESTED	indicate an ESM state change request
GOAL_ECAT_CB_ID_EXPLICIT_DEV_ID	get the Explicit Device ID (during state change)

Table 5.101 ESM States

symbol	Description
GOAL_ECAT_ESM_STATE_UNKNOWN	unknown ESM state
GOAL_ECAT_ESM_STATE_INIT	ESM state INIT
GOAL_ECAT_ESM_STATE_PREOP	ESM state PreOP
GOAL_ECAT_ESM_STATE_BOOTSRTAP	ESM state BOOTSTRAP
GOAL_ECAT_ESM_STATE_SAFEOP	ESM state SafeOP
GOAL_ECAT_ESM_STATE_OP	ESM state OP

5.8.5 Data Layer indication functions

These events are called by the EtherCAT library if a data layer event happened.

Parameter

Table 5.102 Data Link Events

Function	Description
GOAL_ECAT_CB_ID_SM_WATCHDOG_EXPIRED	process data reception timeout (Hardware Watchdog)
GOAL_ECAT_CB_ID_NEW_DL_STATE	port state change

5.8.6 Distributed Clock API

If synchronization via Distributed Clocks is activated, the following events are called by the EtherCAT library.

Parameter

Table 5.103 DC Events

Function	Description
GOAL_ECAT_CB_ID_NEW_DC_CONFIG	check the synchronization settings, e.g. cycle time
GOAL_ECAT_CB_ID_DC_FAIL	indicate loss of Sync0 interrupts

5.9 Application Callbacks – EtherCAT

5.9.1 Introduction

To use the full potential of EtherCAT, the stack allows you to interact at several stages of the protocol.

The stack calls the callback handler registered via the function goal_ecatNew(). The callback handler returns a GOAL_STATUS_T value.

Table 5.104 Parameters of the Callback Handler

Parameter	Description
GOAL_ECAT_T *pHdlEcat	GOAL EtherCAT handle
GOAL_ECAT_CB_ID_T id	callback id
GOAL_ECAT_CB_DATA_T *pCb	callback parameters

The callback parameter is an array of unions that has up to 6 elements.

```
/*************************************************************************/
/** EtherCAT Callback Handler
 * This function collects all callbacks from the stack and decides if the
 * callback must be handled.
 */

GOAL_STATUS_T appl_ecatCallback(
   GOAL_ECAT_T *pHdlEcat,                    /**< GOAL EtherCAT handle */
   GOAL_ECAT_CB_ID_T id,                     /**< callback id */
   GOAL_ECAT_CB_DATA_T *pCb                  /**< callback parameters */
 )
{

    GOAL_STATUS_T res = GOAL_OK;             /* result */
    switch (id) {
    case
       GOAL_ECAT_CB_ID_.....:
       break;
    }

    return res;
}
```

Parameters are propagated to the callback function as a array of the data structure GOAL_ECAT_CB_DATA_T.

Callback Data Content Structure

```
typedef union {
    uint16_t index;                     /**< object index */
    uint8_t subIndex;                   /**< object sub-index */
    uint8_t *pData;                     /**< object data */
    uint32_t size;                      /**< object size */
    GOAL_BOOL_T completeAccess;         /**< complete object is accessed */
    uint16_t dlState;                   /**< new Data Link layer state */
    uint32_t dcCycleTime;               /**< current DC cycle time */
    uint32_t dcCycleTimeMin;            /**< minimum supported DC cycle time */
    uint16_t explDevId;                 /**< Explicit device ID */
    uint16_t esmState;                  /**< new ESM state */
    GOAL_BOOL_T esmError;               /**< device is in error state */
    uint16_t statusCode;                /**< status code explaining error */
    uint16_t appStatusCode;             /**< application specific error */
    uint32_t foePassword;               /**< password for file access */
    char *pFileName;                    /**< file to be accessed via FoE */
    uint16_t foeError;                  /**< FOE error code */
    uint32_t foeOffset;                 /**< read/write offset in file */
    uint16_t foeMaxSize;                /**< maximum size of a FOE chunk */
    uint16_t foeActSize;                /**< actual size of a FOE chunk */
    GOAL_BOOL_T foeFinished;            /**< write access finished */
    GOAL_BOOL_T bLedEnable;             /**< led state */
} GOAL_ECAT_CB_DATA_ELEM_T;
```

```
typedef struct {
    GOAL_ECAT_CB_DATA_ELEM_T data[GOAL_ECAT_CB_DATA_MAX]; /**< callback data
elements */
} GOAL_ECAT_CB_DATA_T;
```

Depending on the callback Id parameters and return values are provided and expected in id specific positions within the callback data array.

The following subsections will provide you with the details on the available callback ids.

5.9.2 GOAL_ECAT_CB_ID_SDO_DOWNLOAD

Inform application about SDO write access.

5.9.3 GOAL_ECAT_CB_ID_SDO_UPLOAD

Inform application about SDO read access.

5.9.4 GOAL_ECAT_CB_ID_RxPDO_RECEIVED

Update output data.

5.9.5 GOAL_ECAT_CB_ID_TxPDO_PREPARE

Provide new input data.

5.9.6 GOAL_ECAT_CB_ID_SYNC_FAIL

Inform application that synchronisation operation failed.

5.9.7 GOAL_ECAT_CB_ID_NEW_DL_STATE

Inform application about new datalink layer status.

5.9.8 GOAL_ECAT_CB_ID_NEW_DC_CONFIG

Inform application that new DC configuration.

5.9.9 GOAL_ECAT_CB_ID_DC_FAIL

Inform application that DC synchronisation failed.

5.9.10 GOAL_ECAT_CB_ID_SM_WATCHDOG_EXPIRED

Inform application that sync manager watchdog failed.

5.9.11 GOAL_ECAT_CB_ID_EXPLICIT_DEV_ID

Inform application about request for Explicit Device ID.

5.9.12 GOAL_ECAT_CB_ID_NEW_ESM_STATE_ENTERED

Inform application that new ESM state entered.

5.9.13 GOAL_ECAT_CB_ID_NEW_ESM_STATE_REQUESTED

Inform application that new ESM state requested.

5.9.14 GOAL_ECAT_CB_ID_FOE_READ_REQ

Inform application about FoE read request.

5.9.15 GOAL_ECAT_CB_ID_FOE_READ_DATA

Inform application about FoE read data.

5.9.16 GOAL_ECAT_CB_ID_FOE_WRITE_REQ

Inform application about FoE write request.

5.9.17 GOAL_ECAT_CB_ID_FOE_WRITE_DATA

Inform application about FoE write data.

5.9.18 GOAL_ECAT_CB_ID_FOE_ERROR

Inform application about FoE error.

5.9.19 GOAL_ECAT_CB_ID_RUN_LED_STATE

Inform application that RUN LED state change.

5.9.20 GOAL_ECAT_CB_ID_ERROR_LED_STATE

Inform application that ERROR LED state change.

6. Application Programming Interface

This section lists the API functions that are provided by the R-IN32M3 Module.

6.1 Device Specific Functions

6.1.1 appl_ccmRpcInit

Purpose: Register R-IN32M3 Module API in GOAL (appl_init)

This function registers the R-IN32M3 Module specific API in GOAL and must be called in appl_init. It returns a GOAL_STATUS_T status and has no parameters.

Function Prototype:

```
GOAL_STATUS_T appl_ccmRpcInit(
    void
);
```

Example:

```
/*****************************************************************************/
/** Application Init
 *
 * Build up the device structure and initialize the Profinet stack.
 */
GOAL_STATUS_T appl_init(
    void
)
{
    GOAL_STATUS_T res = GOAL_OK;            /* result */

    /* initialize RPC interface */
    res = appl_ccmRpcInit();
    if (GOAL_RES_ERR(res)) {
        goal_logErr("Initialization of RPC failed");
    }

    return res;
}
```

6.1.2 appl_ccmUpdateAllow

Purpose: Enable firmware update in the R-IN32M3 Module

This function enables the possibility to update the firmware of the R-IN32M3 Module. It returns a GOAL_STATUS_T status and has no parameters.

Function Prototype

```
GOAL_STATUS_T appl_ccmUpdateAllow(
    void
);
```

6.1.3 appl_ccmUpdateDeny

Purpose: Disable firmware update in the R-IN32M3 Module

This function disables the possibility to update the firmware of the R-IN32M3 Module. A possible use of this function is to disable firmware update possibilities during a cyclic communication relation.

It returns a GOAL_STATUS_T status and has no parameters.

Function Prototype:

```
GOAL_STATUS_T appl_ccmUpdateDeny(
    void
);
```

6.1.4 appl_ccmInfo

Purpose: Get version and device information

This function reads information from the R-IN32M3 Module:

- MAC address (serial number)
- Software version
- Device type

Function Prototype:

```
GOAL_STATUS_T appl_ccmInfo(
    char *strVersion,                          /**< target string for version */
    uint8_t lenStrVersion,                     /**< length of str buffer */
    GOAL_ETH_MAC_ADDR_T *macAddress,           /**< mac address buffer */
    uint16_t *pDevType                         /**< device type */
);
```

Example:

```
/* get version and information of ccm */
if (GOAL_RES_OK(res)) {
    res = appl_ccmInfo(strVersion, APPL_VERSION_LEN, &mac, &devType);
}

if (GOAL_RES_OK(res)) {
    goal_logInfo("Device Version : %s", strVersion);
    goal_logInfo("Device Type : %u", devType);
    goal_logInfo("Serial Number: %02x:%02x:%02x:%02x:%02x:%02x",
        mac[0], mac[1], mac[2], mac[3], mac[4], mac[5]);
}
```

6.1.5 appl_ccmFaultStateSet

Purpose: Set behaviour of fieldbus communication on fault

This function determines the behaviour of the R-IN32M3 Module regarding cyclic communication. By default, a cyclic communication is stopped when communication to the application controller (AC) is lost.

Function Prototype:

```
GOAL_STATUS_T appl_ccmFaultStateSet(
    APPL_CCM_FAULT_STATE_T faultState        /**< fault state to enter */
);
```

Example:

```
/* set fault state behavior */
if (GOAL_RES_OK(res)) {
    res = appl_ccmFaultStateSet(APPL_CCM_FAULT_STATE_ENTER);
}
```

6.1.6 appl_ccmCommResetSet

Purpose: Set behaviour of the R-IN32M3 Module on SPI sync reset request

A sync reset request is requested by the AC upon restart if the CC had previously been set up by a running AC.

This function determines the behaviour of the R-IN32M3 Module regarding this reset request. By default, no reset is done. If this option is enabled, reset is done.

The state of this setting is stored in non-volatile memory on the CC. A value of 0 disables the reset. A value of 1 enables the reset.

Function Prototype:

```
GOAL_STATUS_T appl_ccmCommResetSet(
    uint8_t value                    /**< option value */
);
```

Example:

```
/* set sync reset behavior */
if (GOAL_RES_OK(res)) {
    /* enable reset on sync reset request from AC */
    res = appl_ccmCommResetSet(1);
}
```

6.1.7 appl_ccmLogEnable

Purpose: Enable transport of AC log messages to the CC

Once this function is executed, log messages from the AC's logging buffer are continuously transferred to the CC. Those are then accessible as the CC's own log messages through the management interface.

Function Prototype:

```
GOAL_STATUS_T appl_ccmLogEnable(
    void
);
```

Example:

```
/* enable logging to CC */
if (GOAL_RES_OK(res)) {
    res = appl_ccmLogEnable();
}
```

6.1.8 appl_ccmLogToAcEnable

Purpose: Enable transport of CC log messages to the AC
Once this function is executed, log messages from the CC's logging buffer are continuously transferred to the AC. Those are then accessible as the AC's own log messages through the local log mechanism, e.g. serial console, or terminal.

Function Prototype:

```
GOAL_STATUS_T appl_ccmLogToAcEnable(
    void
);
```

Example:

```
/* enable logging from CC to AC */
if (GOAL_RES_OK(res)) {
   res = appl_ccmLogToAcEnable();
}
```

6.1.9 appl_ccmFwUpdateStart

Purpose: Start firmware update of CC using rpc
This function transfers the given data buffer, which contains firmware update data, to the CC.

Function Prototype:

```
GOAL_STATUS_T appl_ccmFwUpdateStart(
uint8_t *pFwData,                    /**< firmware data */
uint32_t fwSize                      /**< size of firmware data */
);
```

Example:

```
if (GOAL_RES_OK(res)) {
    res = appl_ccmFwUpdateStart(pBufFw, fsize);
}
```

6.1.10 appl_ccmFwUpdateExecute

Purpose: Perform actual update of the firmware update
This function performs the actual update of the CC. It must be called after transfer of the firmware data. This requires registration for firmware update events using **appl_ccmFwUpdateCbReg()**. If the application does not register for the events, the function appl_ccmFwUpdateExecute is called by the CC implicitly.

Function Prototype:

```
GOAL_STATUS_T appl_ccmFwUpdateExecute(
    void
);
```

Example:

```
/* perform actual update */
appl_ccmFwUpdateExecute();
```

6.1.11 appl_ccmEcatSsiUpdate

Purpose: Perform update of the EtherCAT SSI data in eeprom
This function allows optionally an initialization of the EtherCAT SSI data in EEPROM. This should only be called once, since some EtherCAT masters rely on settings in the eeprom that should not be overwritten (Configured Station Alias).

Function Prototype:

```
GOAL_STATUS_T appl_ccmEcatSsiUpdate(
unsigned char *pData,                    /**< SSI data */
uint32_t dataLen,                        /**< SSI data length */
GOAL_BOOL_T flgEmptyCheck                /**< empty check before writing */
);
```

Example:

```
/* configure SII in EEPROM before creating the EtherCAT instance */
res = appl_ccmEcatSsiUpdate(
&__09_ecat_slave_eeprom_bin[0],          /* data buffer */
__09_ecat_slave_eeprom_bin_len,          /* data buffer length */
 GOAL_FALSE);
if (GOAL_RES_ERR(res)) {
    goal_logErr("failed to configure EEPROM ssi data");
}
```

6.1.12 appl_ccmFoeUpdateSettings

Purpose: Configure requirements on FoE firmware update
This function allows changing required settings for FoE firmware update.

Function Prototype:

```
GOAL_STATUS_T appl_ccmFoeUpdateSettings(
        char *strName,                          /**< foe firmware filename */
        uint8_t matchLength,                    /**< string match length */
        uint32_t password,                      /**< foe password */
        GOAL_BOOL_T flgBootstrapReq             /**< bootstrap required */
);
```

Example:

```
/* enable FoE */
res = goal_ecatCfgFoeOn(GOAL_TRUE);
if (GOAL_RES_ERR(res)) {
        goal_logErr("failed to enable FoE support");
}

/* enable BOOTSTRAP state */
res = goal_ecatCfgBootstrapOn(GOAL_TRUE);
if (GOAL_RES_ERR(res)) {
        goal_logErr("failed to enable BOOTSTRAP support");
}

/* set settings for ccm firmware update via FoE */
res = appl_ccmFoeUpdateSettings(
        "ccm.efw",                              /* filename beginning */
        0,                                      /* 0 -> match all characters */
        0,                                      /* password */
        GOAL_TRUE);                             /* only update in ESM state bootstrap */
if (GOAL_RES_ERR(res)) {
        goal_logErr("failed to configure FoE firmware update of CC");
        return res;
}
```

Remarks:

For firmware update over FoE to work FoE needs to be enabled using the function goal_ecatCfgFoeOn(GOAL_TRUE). If firmware update is configured to take place on BOOTSTRAP ESM state, support for this state needs to be enabled using goal_ecatCfgBootstrapOn(GOAL_TRUE). Beside that the parameters to appl_ccmFoeUpdateSettings define what required to perform the firmware update:

Table 6.1 appl_ccmFoeUpdateSettings Parameters

Parameter	Type	Description
strName	Char *	filename expected for firmware update
umatchLength	uint8_t	number of characters required to match between the configured foe file name and the foe file name of the update process. If matchLength is zero, all bytes of strName need to match. If strName is a string of length 0, the default file name "ccm.efw”is expected.
password	uint32_t	FoE password expected to accept the firmware update
flgBootstrapReq	bool	if enabled, firmware update will only be accepted in esm state bootstrap

6.1.13 appl_ccmEthMacAddressSet

Purpose: Configure a custom mac address for the device
This function allows changing of the mac address of the device. It needs to be called before any network related function (communication stack start, network initialization).

Function Prototype:

```
1. GOAL_STATUS_T appl_ccmEthMacAddressSet(
2. uint8_t *pMacAddr
3. );
```

Example:

```
1. /* configure MAC address */
2. uint8_t devMacId[8] = {0x02, 0x01, 0x00, 0x00, 0x00, 0x01};
3. res = appl_ccmEthMacAddressSet(&devMacId[0]);
```

6.1.14 appl_ccmNetworkDefaultUp

Purpose: Start default networking
This function starts the CC in standard ethernet mode. It usually is not required to call this function, since protocol stacks automatically start the network in the proper mode.

Function Prototype:

```
GOAL_STATUS_T appl_ccmNetworkDefaultUp(
    void
);
```

Example:

```
/* start default networking */
res = appl_ccmNetworkDefaultUp();
```

6.1.15 appl_ccmNetworkEoEUp

Purpose: Start EtherCAT EoE networking
This function starts the CC in EtherCAT mode. It usually is not required to call this function, since the EtherCAT protocol stacks automatically start the network in the proper mode.

Function Prototype:

```
GOAL_STATUS_T appl_ccmNetworkEoEUp(
    void
);
```

Example:

```
/* start EtherCAT networking */
res = appl_ccmNetworkEoEUp();
```

6.1.16 appl_ccmCfgVarGet

Purpose: Read any config variable
This function provides a mechanism to read any configuration variable of the CC. It required a module id and a variable id, which is documented in chapter 4.9.

Function Prototype:

```
GOAL_STATUS_T appl_ccmCfgVarGet(
    uint32_t modId,                     /**< module id */
    uint32_t varId,                     /**< variable id */
    void *pBuf,                         /**< [out] output buffer */
    uint32_t bufLength,                 /**< buffer length */
    uint32_t *pVarLength,               /**< [out] variable length */
    uint32_t *pVarType                  /**< [out] variable type */
);
```

Example:

```
/* get signature of firmware */
if (GOAL_RES_OK(res)) {
    res = appl_ccmCfgVarGet(
        37, /* module id */
        0,   /* variable id */
        &fwSignature[0],
        sizeof(fwSignature),
        NULL, NULL);
}
```

6.1.17 appl_ccmCfgVarSet

Purpose: Wrote any config variable
This function provides a mechanism to write any configuration variable of the CC. It required a module id and a variable id, which is documented in chapter 4.9.

Function Prototype:

```
GOAL_STATUS_T appl_ccmCfgVarSet(
    uint32_t modId,                    /**< module id */
    uint32_t varId,                    /**< variable id */
    void *pBuf,                        /**< [out] output buffer */
    uint32_t bufLength,                /**< buffer length */
);
```

Example:

```
/* demonstaration for writing of config variables */
valObj = 0x12345678;
if (GOAL_RES_OK(res)) {
res = appl_ccmCfgVarSet(
        34, /* module id dd */
        1, /* variable id customer id */
        &valObj,
        sizeof(valObj));
}
```

6.1.18 appl_ccmCfgSave

Purpose: Store config variable changes permanently
This function provides a mechanism to update the non-volatile storage containing the config variables. The current values of the config variables will be stored.

Function Prototype:

```
GOAL_STATUS_T appl_ccmCfgSave(
    void
);
```

Example:

```
/* store current config variable values */
if (GOAL_RES_OK(res)) {
    res = appl_ccmCfgSave();
}
```

6.2 Device Detection

6.2.1 goal_ddInit - Register GOAL dd API in GOAL (appl_init)

Purpose: This function registers the GOAL dd specific API in GOAL and must be called in appl_init. It returns a GOAL_STATUS_T status and has no parameters.

Function Prototype:

```
GOAL_STATUS_T goal_ddInit (
    void
);
```

Example:

```
GOAL_STATUS_T appl_init( void
)
{
    GOAL_STATUS_T res;                                  /**< GOAL result */

    /* initialize GOAL dd API */
    res = goal_ddInit();
    if (GOAL_RES_ERR(res)) {
        goal_logErr("failed to initialize GOAL dd API");
    }
    return res;
}
```

6.2.2 goal_ddNew - Register GOAL dd API in GOAL (appl_setup)

Purpose: This function creates an instance of GOAL dd in GOAL and must be called in appl_setup. A valid instance is requirement for using the GOAL dd API.

It returns a GOAL_STATUS_T status and has the following parameters.

Table 6.2 goal_ddNew Parameters

Parameter	Description
GOAL_DD_T **ppHdl	returned GOAL dd instance handle
uint32_t bitmaskFeatures	initial instance features to be enabled

The parameter bitmaskFeatures is a bitmask which disables single features of GOAL dd if set:

Table 6.3 Feature Bitmask Parameter

Bit	Feature
0	disable HELLO request (used for device scan detection)
1	disable WINK command
2	disable GETLIST command (read list of available CM variables)
3	disable GETCONFIG command (read cm variables value)
4	disable SETCONFIG command (write cm variables value)
5	disable SETIP command (configure IP through GOAL dd)

Function Prototype:

```
GOAL_STATUS_T goal_ddNew(
    GOAL_DD_T **ppHdlDd,                /**< DD handle */
    uint32_t bitmaskFeatures            /**< initial features */
);
```

Example:

```
static GOAL_DD_T *pHdlDd;               /**< GOAL dd handle */

GOAL_STATUS_T appl_setup(
    void
)
{
   GOAL_STATUS_T res;                   /**< GOAL result */
       /* create GOAL dd instance */
       res = goal_ddNew(&pHdlDd, GOAL_DD_FEAT_ALL);
       if (GOAL_RES_ERR(res)) {
           goal_logErr("failed to create GOAL dd instance");
       }
    return res;
}
```

6.2.3 goal_ddCustomerIdSet - Configure the customer id of GOAL dd instance

Purpose: This function configures the customer Id of the given GOAL dd instance. The customer Id is a property of the underlying protocol which is contained in each request using GOAL dd. There is a special customer Id with value of zero, which causes every request to be processed. If the customer Id is not equal to zero, a request will only be processed if the customer Id of the request equals the customer Id of the GOAL dd instance.

The customer Id is stored in non-volatile memory.

Table 6.4 goal_ddCustomerIdSet Parameters

Parameter	Description
GOAL_DD_T *pHdl	GOAL dd instance handle
uint32_t customerId	instance customer Id

Function Prototype:

```
GOAL_STATUS_T goal_ddCustomerIdSet(
    GOAL_DD_T *pHdlDd,                    /**< dd handle */
    uint32_t cid                          /**< customer ID */
);
```

Example:

```
/* configure DD properties */
res = goal_ddCustomerIdSet(pHdlDd, APPL_DD_CUSTOMER_ID);
if (GOAL_RES_ERR(res)) {
    goal_logErr("failed to configure DD customer id");
}
```

6.2.4 goal_ddModuleNameSet - Configure the name of GOAL dd instance

Purpose: This function configures the module name of the given GOAL dd instance. The module Id is a property of the device stored in non-volatile memory. It is used by the Management Tool for device naming. The module name length is limited to 20 bytes.

Table 6.5 goal_ddModuleNameSet Parameters

Parameter	Description
GOAL_DD_T *pHdl	GOAL dd instance handle
uint8_t *str	instance module name

Function Prototype:

```
GOAL_STATUS_T goal_ddModuleNameSet(
    GOAL_DD_T *pHdlDd,                    /**< dd handle */
    uint8_t *str                          /**< module name */
);
```

Example:

```
res = goal_ddModuleNameSet(pHdlDd, APPL_DD_MODULE_NAME);
if (GOAL_RES_ERR(res)) {
    goal_logErr("failed to configure DD module name");
}
```

6.2.5 goal_ddFeaturesSet - Configure the features of the GOAL dd instance

Purpose: This function configures the features to be disabled for the given GOAL dd instance. This property is stored in the device stored in non-volatile memory.

Table 6.6 goal_ddFeaturesSet Parameters

Parameter	Description
GOAL_DD_T *pHdl	GOAL dd instance handle
uint32_t bitmaskFeatures	instance features bitmask

For parameter description see function “goal_ddNew”.

Function Prototype:

```
GOAL_STATUS_T goal_ddFeaturesSet(
    GOAL_DD_T *pHdlDd,                  /**< dd handle */
    uint32_t bitmaskFeatures            /**< bitmask with feature disable bits set */
);
```

Example:

```
res = goal_ddFeaturesSet(pHdlDd, APPL_DD_FEATURES);
if (GOAL_RES_ERR(res)) {
    goal_logErr("failed to configure DD features");
}
```

6.2.6 goal_ddCallbackReg - Configure callback for GOAL dd instance

Purpose: This function registers a callback to the given GOAL dd instance.

Type of the callback:

```
typedef GOAL_STATUS_T (* GOAL_DD_FUNC_CB_T)(
    struct GOAL_DD_T *pHdlDd,           /**< dd handle */
    GOAL_DD_CB_ID_T cbId,               /**< callback id */
    GOAL_DD_CB_DATA_T *pCbData          /**< callback data */
);
```

Function Prototype:

```
static GOAL_STATUS_T ddCallback(
    GOAL_DD_T *pHdlDd,                  /**< dd handle */
    GOAL_DD_CB_ID_T cbId,               /**< callback ID */
    GOAL_DD_CB_DATA_T *pCbData          /**< callback data */
);
```

Example:

```
/*****************************************************************************/
/** Application Setup
 *
 * This function must setup all used protocol stacks.
 *
 * Notes if CSAP is active:
 *  Steps setup in this stage may be covered by CSAP and therefore must
 *  only contain functions supporting this.
 */
GOAL_STATUS_T appl_setup(
    void
)
{
    GOAL_STATUS_T res;                      /* result */

    res = goal_ddCallbackReg(pHdlDd, (GOAL_DD_FUNC_CB_T) ddCallback);

    return res;
}


/*****************************************************************************/
/** goal dd callback
 *
 */
 static GOAL_STATUS_T ddCallback(
    GOAL_DD_T *pHdlDd,                      /**< dd handle */
    GOAL_DD_CB_ID_T cbId,                   /**< callback ID */
    GOAL_DD_CB_DATA_T *pCbData              /**< callback data */
)
{
    UNUSEDARG(pHdlDd);
    UNUSEDARG(pCbData);

    switch (cbId) {
        case GOAL_DD_CB_ID_WINK:
            goal_logInfo("Wink command received");
            break;
        default:
            break;
    }

    return GOAL_OK;
}
```

6.2.7 goal_ddSessionFeatureActivate - Temporary activation of features of GOAL dd instance

Purpose: This function temporarily enabled features for the given GOAL dd instance. This property is ***not*** stored in non-volatile memory.

Table 6.7 goal_ddSessionFeatureActivation Parameters

Parameter	Description
GOAL_DD_T *pHdl	GOAL dd instance handle
uint32_t bitmaskFeatures	instance features bitmask

ATTENTION: The parameter "bitmaskFeatures" is used to revert to the function for permanent configuration of the features, and a bit set here enables the given feature.

Function Prototype:

```
GOAL_STATUS_T goal_ddSessionFeatureActivate(
    GOAL_DD_T *pHdlDd,                  /** dd handle */
    uint32_t bitmaskFeatures            /** bitmask with feature enable bits set */
);
```

Example:

```
/* temporarily enable capability to respond to hello requests (device detection) */
res = goal_ddSessionFeatureActivte (pHdlDd, GOAL_DD_FEAT_HELLO);
```

6.2.8 goal_ddFilterAdd - Limit access to CM variables

Purpose: By default, an external application as the Management Tool has total access to all CM variables of the device. This is a handy feature for development, but for production purpose one wants to limit access to only the variables that are required for minimal functionality using the Management Tool. Therefore, filters were introduced, which do this task. Following filters are predefined:

Table 6.8 goal_ddFilterAdd filter Sets

Filter ID	Filter Name
0	GOAL_DD_ACCESS_FILTER_SET_ALL
1	GOAL_DD_ACCESS_FILTER_SET_BASIC
2	GOAL_DD_ACCESS_FILTER_SET_HIDDEN

Table 6.9 goal_ddFilterAdd predefined Filters

Filter ID	Filter Actions	Purpose
0	Full access granted to all variables	Development
1	Read Access to all variables of the NET module (IP settings), Read Access to all variables of the ETH module (MAC, status), Full access to all variables of the LM module (logging)	Production Code with minimal support of the Management Tool
2	Disables read access to the web server authentication strings	Production Code

6.2.9 Definition of Filter – GOAL_DD_ACCESS_FILTER_SET_ALL

```
/**< complete access */
static GOAL_DD_VAR_T ddAccessAll[] = {
    {
        .pNext = NULL,
        .modId = GOAL_DD_VAR_ALL,
        .varId = GOAL_DD_VAR_ALL,
        .access = (1 << GOAL_DD_ACCESS_READ) | (1 << GOAL_DD_ACCESS_WRITE)
    }
};
```

6.2.10 Definition of Filter – GOAL_DD_ACCESS_FILTER_SET_BASIC

```
/**< list of variables that are required for basic functionality */
static GOAL_DD_VAR_T ddAccessListBasic[] = {
    {   /* read access to network settings */
        .pNext = (struct GOAL_DD_VAR_T *) &ddAccessListBasic[1],
        .modId = GOAL_ID_NET,
        .varId = GOAL_DD_VAR_ALL,
        .access = (1 << GOAL_DD_ACCESS_READ)
    },
    {   /* read access to ethernet properties */
        .pNext = (struct GOAL_DD_VAR_T *) &ddAccessListBasic[2],
        .modId = GOAL_ID_ETH,
        .varId = GOAL_DD_VAR_ALL,
        .access = (1 << GOAL_DD_ACCESS_READ)
    },
    {   /* access to logs */
        .pNext = NULL,
        .modId = GOAL_ID_LM,
        .varId = GOAL_DD_VAR_ALL,
        .access = (1 << GOAL_DD_ACCESS_READ) | (1 << GOAL_DD_ACCESS_WRITE)
    }
};
```

6.2.11 Definition of Filter – GOAL_DD_ACCESS_FILTER_SET_HIDDEN

```
static GOAL_DD_VAR_T ddAccessListHidden[] = {
    {   /* disable read access to HTTP user level 0 */
        .pNext = (struct GOAL_DD_VAR_T *) &ddAccessListHidden[1],
        .modId = GOAL_ID_HTTP,
        .varId = 2, /* USERLEVEL0 */
        .access = (1 << GOAL_DD_ACCESS_WRITE)
    },
    {   /* disable read access to HTTP user level 1 */
        .pNext = (struct GOAL_DD_VAR_T *) &ddAccessListHidden[2],
        .modId = GOAL_ID_HTTP,
        .varId = 3, /* USERLEVEL1 */
        .access = (1 << GOAL_DD_ACCESS_WRITE)
    },
    {   /* disable read access to HTTP user level 2 */
        .pNext = (struct GOAL_DD_VAR_T *) &ddAccessListHidden[3],
        .modId = GOAL_ID_HTTP,
        .varId = 4, /* USERLEVEL2 */
        .access = (1 << GOAL_DD_ACCESS_WRITE)
    },
    {   /* disable read access to HTTP user level 3 */
        .pNext = NULL,
        .modId = GOAL_ID_HTTP,
        .varId = 5, /* USERLEVEL3 */
        .access = (1 << GOAL_DD_ACCESS_WRITE)
    },
};
```

Function Prototype:

```
GOAL_STATUS_T goal_ddFilterAdd(
    GOAL_DD_T *pHdlDd,                          /**< dd handle */
    GOAL_DD_ACCESS_FILTER_SET_T setId           /**< set id */
);
```

Example:

```
    /* enable for full access */
#if 0
    res = goal_ddFilterAdd(pHdlDd, GOAL_DD_ACCESS_FILTER_SET_ALL);
    if (GOAL_RES_ERR(res)) {
        goal_logErr("failed to set dd access filter");
    }
#endif

    res = goal_ddFilterAdd(pHdlDd, GOAL_DD_ACCESS_FILTER_SET_HIDDEN);
    if (GOAL_RES_ERR(res)) {
        goal_logErr("failed to set dd access filter");
    }
```

6.3 PROFINET Stack Application Programming Interface

6.3.1 goal_pnioInit - Register GOAL PROFINET in GOAL (appl_init)

This function registers GOAL PROFINET in GOAL and must be called in appl_init. Its main functionality is to register a set config manager variable before the NVS storage is initialized.

It returns a GOAL_STATUS_T status and has no parameters.

```
GOAL_STATUS_T appl_init(
    void
)
{
    GOAL_STATUS_T res;                          /**< GOAL result */

    /* initialize GOAL PROFINET */
    res = goal_pnioInit();
    if (GOAL_RES_ERR(res)) {
        goal_logErr("failed to initialize GOAL PROFINET");
    }

    return res;
}
```

6.3.2 goal_pnioNew - Create a GOAL PROFINET Instance (appl_setup)

This function creates a new GOAL PROFINET instance by taking a snapshot of all previously defined variables (goal_pnioCfg API) and allocating the necessary resources. The application must provide a GOAL PROFINET instance id and a call-back handler. The call-back handler can also be NULL to only use GOAL PROFINET stack default behavior.

It returns a GOAL_STATUS_T status and a GOAL PROFINET instance handle.

Table 6.10 goal_pnioNew Parameters

Parameter	Description
GOAL_PNIO_T **ppPnio	returned GOAL PROFINET instance handle
const uint32_t id	GOAL PROFINET instance id
GOAL_PNIO_FUNC_CB_T pFunc	GOAL PROFINET callback function

6.3.3 goal_pnioCfgDcpFactoryResetDisableSet - Configure DCP Factory Reset

Controls if DCP factory reset is available. If set to GOAL_TRUE DCP factory reset will be denied. Default: GOAL_FALSE. It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: This function should not be used as the behavior can break conformity.

Table 6.11 goal_pnioCfgDcpFactoryResetDisableSet Parameters

Parameter	Description
GOAL_BOOL_T flgDcpFactoryResetDisable	DCP Factory Reset Disable Flag

6.3.4 goal_pnioCfgDcpAcceptMixcaseStationSet - Configure DCP Mixcase Stationname Acceptance

Controls if DCP accepts station names with mixed case spelling. If set to GOAL_TRUE DCP accepts mixed case station names. Default: GOAL_FALSE.

It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: This function should not be used as the behavior can break conformity.

Table 6.12 goal_pnioCfgDcpAcceptMixcaseStationSet Parameters

Parameter	Description
GOAL_BOOL_T flgDcpAcceptMixcaseStation	DCP Mixcase Stationname Acceptance Flag

6.3.5 goal_pnioCfgDevDapSimpleSet - Configure Device DAP Simple Mode

Configure the device DAP simple mode. If flgDevDapSimple is GOAL_TRUE the GOAL PROFINET stack automatically creates the DAP and port slots and modules.

Default: GOAL_TRUE

It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: This function should be used carefully because it can break conformity.

Table 6.13 goal_pnioCfgDevDapSimpleSet Parameters

Parameter	Description
GOAL_BOOL_T flgDevDapSimple	Device DAP Simple Mode Flag

6.3.6 goal_pnioCfgDevDapApiSet - Set Device DAP API Number

Configures the device DAP API number. Default: 0

It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: This function should be used carefully because it can break conformity.

Table 6.14 goal_pnioCfgDevDapApiSet Parameters

Parameter	Description
uint32_t idDevDapApi	Device DAP API Number

6.3.7 goal_pnioCfgDevDapSlotSet - Set Device DAP Slot Number

Configures the device DAP slot number. Default: 0

It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: This function should be used carefully because it can break conformity.

Table 6.15 goal_pnioCfgDevDapSlotSet Parameters

Parameter	Description
uint16_t idDevDapSlot	Device DAP Slot Number

6.3.8 goal_pnioCfgDevDapSubslotSet - Set Device DAP Subslot Number

Configures the device DAP subslot number. Default: 1 It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: This function should be used carefully because it can break conformity.

Table 6.16 goal_pnioCfgDevDapSubslotSet Parameters

Parameter	Description
uint16_t idDevDapSubslot	Device DAP Subslot Number

6.3.9 goal_pnioCfgDevDapModuleSet - Set Device DAP Module Id

Configures the device DAP module id. Default: 1 It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: This function should be used carefully because it can break conformity.

Table 6.17 goal_pnioCfgDevDapModuleSet Parameters

Parameter	Description
uint32_t idDevDapMod	Device DAP Module Id

6.3.10 goal_pnioCfgDevDapSubmoduleSet - Set Device DAP Submodule Id

Configures the device DAP submodule id. Default: 1 It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: This function should be used carefully because it can break conformity.

Table 6.18 goal_pnioCfgDevDapSubmoduleSet Parameters

Parameter	Description
uint32_t idDevDapSubmod	Device DAP Submodule Id

6.3.11 goal_pnioCfgNetLinkSafetySet - Configure Device Port Disable Behavior

Configures the device port disable behavior. If flgNetLinkSafety is set to GOAL_TRUE the GOAL PROFINET stack doesn't allow the master to disable all Ethernet interfaces at the same time.

Default: GOAL_TRUE It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: This function should be used carefully because it can break conformity.

Table 6.19 goal_pnioCfgNetLinkSafetySet Parameters

Parameter	Description
GOAL_BOOL_T flgNetLinkSafety	Device Port Disable Behavior

6.3.12 goal_pnioCfgNewIoDataCbSet - Configure New IO Data Callback

Configures the new IO data callback. If flgCbNewIoData is set to GOAL_TRUE, the registered callback function is also called for each arrived cyclic frame. It must return a value as fast as possible as this happens in real time context.

Default: GOAL_FALSE It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: If enabled it produces a very high application load as the callback is called 1000 times a second if the cycle time is set to 1 ms.

Table 6.20 goal_pnioCfgNewIoDataCbSet Parameters

Parameter	Description
GOAL_BOOL_T flgCbNewIoData	New IO Data Callback Flag

6.3.13 goal_pnioCfgDiagBufMaxCntSet - Configure Maximum Diagnosis Entries

Configures the maximum count of diagnosis entries.

Default: 20 It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: Using a too small value can break conformity.

Table 6.21 goal_pnioCfgDiagBufMaxCntSet Parameters

Parameter	Description
unsigned int numDiagBufMax	Maximum Diagnosis Entries

6.3.14 goal_pnioCfgDiagBufMaxDataSizeSet - Configure Maximum Diagnosis Data Size

Configures the maximum size in bytes of each diagnosis entry. Default: 28 It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: Using a value below 28 can break conformity.

Table 6.22 goal_pnioCfgDiagBufMaxDataSizeSet Parameters

Parameter	Description
unsigned int numDiagDataSizeMax	Maximum Diagnosis Data Size

6.3.15 goal_pnioCfglocrBlocksMaxSet – Configure Maximum IOCR Block Buffers

Configures the maximum count of IOCR block buffers. Default: 10 It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: This function should be used carefully because it can break conformity.

Table 6.23 goal_pnioCfglocrBlocksMaxSet Parameters

Parameter	Description
unsigned int numIocrBlocksMax	Maximum IOCR Block Buffers

6.3.16 goal_pnioCfgCrMaxCntSet - Configure Maximum Communication Relation Count

Configures the maximum count of communication relations.

Default: 10 It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: This function should be used carefully because it can break conformity.

Table 6.24 goal_pnioCfgCrMaxCntSet Parameters

Parameter	Description
unsigned int numCrMax	Maximum CR Count

6.3.17 goal_pnioCfgArMaxCntSet - Configure Maximum Application Relation Count

Configures the maximum count of application relations.

Default: 2; It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: This function should be used carefully because it can break conformity.

Table 6.25 goal_pnioCfgArMaxCntSet Parameters

Parameter	Description
unsigned int numArMax	Maximum AR Count

6.3.18 goal_pnioCfgApiMaxCntSet - Configure Maximum API Count

Configures the maximum count of application process identifiers. Setting this value only affects the ModuleDiffBlock logic and needs to be big enough to hold the largest possible GSDML configuration.

Default: 1 It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: This function should not be used as the behavior can break conformity and the GOAL PROFINET stack only supports API 0.

Table 6.26 goal_pnioCfgApiMaxCntSet Parameters

Parameter	Description
unsigned int numApiMax	Maximum API Count

6.3.19 goal_pnioCfgSlotMaxCntSet - Configure Maximum Slot Count

Configures the maximum count of slots. Setting this value only affects the ModuleDiffBlock logic and needs to be big enough to hold the largest possible GSDML configuration.

Default: 12; It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 6.27 goal_pnioCfgSlotMaxCntSet Parameters

Parameter	Description
unsigned int numSlotMax	Maximum Slot Count

6.3.20 goal_pnioCfgSubslotMaxCntSet - Configure Maximum Subslot Count

Configures the maximum count of subslots per slot. Setting this value only affects the ModuleDiffBlock logic and needs to be big enough to hold the largest possible GSDML configuration. Default: 4; It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 6.28 goal_pnioCfgSubslotMaxCntSet Parameters

Parameter	Description
unsigned int numSubslotMax	Maximum Subslot Count Per Slot

6.3.21 goal_pnioCfgSubslotIfSet - Configure Interface Subslot

Configures the interface subslot id.

Default: 0x8000 It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: This function should be used carefully because it can break conformity.

Table 6.29 goal_pnioCfgSubslotIfSet Parameters

Parameter	Description
unsigned int idSubslotIf	Interface Subslot Id

6.3.22 goal_pnioCfgSubslotPortSet - Configure Port Subslot

Configures the port subslot base id.

Default: 0x8001 It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Warning: This function should not be used as the behavior can break conformity.

Table 6.30 goal_pnioCfgSubslotPortSet Parameters

Parameter	Description
unsigned int idSubslotPort	Port Subslot Id

6.3.23 goal_pnioCfgSnmpIdSet - Configure SNMP Instance Id

Configures the GOAL SNMP instance id that is used by the GOAL PROFINET stack. Default: GOAL_ID_INVALID

It returns a GOAL_STATUS_T status.

This function configures the GOAL PROFINET instance and must be called before goal_pnioNew to have an effect.

Table 6.31 goal_pnioCfgSnmpIdSet Parameters

Parameter	Description
idSnmp	GOAL SNMP Instance Id

6.3.24 goal_pnioSlotNew - Create a new slot

Create a new slot. Returns a GOAL_STATUS_T status.

Table 6.32 goal_pnioSlotNew Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
uint32_t idApi	API number (always 0)
uint32_t idSlot	slot number
GOAL_BOOL_T flgAutoGen	generate API automatically if not exist

```
/* create API 0:Slot 1 even if API 0 doesn't exist */
res = goal_pnioSlotNew(pPnio, 0, 1, GOAL_TRUE);
```

6.3.25 goal_pnioSubslotNew - Create a new subslot

Create a new subslot. Returns a GOAL_STATUS_T status.

Table 6.33 goal_pnioSubslotNew Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
uint32_t idApi	API number (always 0)
uint32_t idSlot	slot number
uint32_t idSubslot	subslot number
GOAL_BOOL_T flgAutoGen	generate API and slot automatically if not exist

```
/* create API 0:Slot 1:Subslot 1 even if API 0 and/or * Slot 1 don't exist */
res = goal_pnioSubslotNew(pPnio, 0, 1, 1, GOAL_TRUE);
```

6.3.26 goal_pnioModNew - Create a new module

Create a new module. Returns a GOAL_STATUS_T status.

Table 6.34 goal_pnioModNew Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
uint32_t idMod	module id

```
/* create module with id 0x30 */
res = goal_pnioModNew(pPnio, 0x30);
```

6.3.27 goal_pnioSubmodNew - Create a new submodule

Create a new submodule. Returns a GOAL_STATUS_T status.

Table 6.35 goal_pnioSubmodNew Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
uint32_t idMod	module id
uint32_t idSubmod	submodule id
GOAL_PNIO_MOD_TYPE_T type	submodule type (input, output, both)
uint16_t sizeInput	size of input module
uint16_t sizeOutput	size of output module
GOAL_BOOL_T flgAutogen	generate module if not exist

```
/* create 4 byte input submodule with id 0x30:0x01 even if module * doesn't exist */
res = goal_pnioSubmodNew(pPnio, 0x30, 0x01, GOAL_PNIO_MOD_TYPE_INPUT, 4, 0,
GOAL_TRUE);
```

6.3.28 goal_pnioModPlug - Plug a module into a slot

Plug a module into a slot. Returns a GOAL_STATUS_T status.

Table 6.36 goal_pnioModPlug Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
uint32_t idApi	API (always 0)
uint16_t idSlot	slot number
uint32_t idMod	module id

```
/* plug module 0x30 into slot 1 */
res = goal_pnioModPlug(pPnio, 0, 1, 0x30);
```

6.3.29 goal_pnioSubmodPlug - Plug a submodule into a subslot for cyclic transfer

Plug a submodule into a subslot for Cyclic transfer. Returns a GOAL_STATUS_T status.

Table 6.37 goal_pnioSubmodPlug Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
uint32_t idApi	API (always 0)
uint16_t idSlot	slot number
uint16_t idSubslot	subslot number
uint32_t idMod	module id
uint32_t idSubmod	submodule id

```
/* plug submodule 0x30:0x01 into subslot 1:1 */
res = goal_pnioSubmodPlug(pPnio, 0, 1, 1, 0x30, 0x01);
```

6.3.30 goal_pnioRpcSubmodPlug - Plug a submodule into a subslot for RPC transfer

Plug a submodule into a subslot for RPC transfer. Returns a GOAL_STATUS_T status.

Table 6.38 goal_pnioRpcSubmodPlug Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
uint32_t idApi	API (always 0)
uint16_t idSlot	slot number
uint16_t idSubslot	subslot number
uint32_t idMod	module id
uint32_t idSubmod	submodule id

```
/* plug submodule 0x30:0x01 into subslot 1:1 */
res = goal_pnioRpcSubmodPlug(pPnio, 0, 1, 1, 0x30, 0x01);
```

6.3.31 goal_pnioModPull - Pull a module from a slot

Pull a module from a slot. Returns a GOAL_STATUS_T status.

Table 6.39 goal_pnioModPull Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
uint32_t idApi	API (always 0)
uint16_t idSlot	slot number

```
/* pull module from slot 1 */
res = goal_pnioModPull(pPnio, 0, 1);
```

6.3.32 goal_pnioSubmodPull - Pull a submodule from a subslot

Pull a submodule from a subslot. Returns a GOAL_STATUS_T status.

Table 6.40 goal_pnioSubmodPull Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
uint32_t idApi	API (always 0)
uint16_t idSlot	slot number
uint16_t idSubslot	subslot number

```
/* pull submodule from subslot 1:1 */
res = goal_pnioSubmodPull(pPnio, 0, 1, 1);
```

6.3.33 goal_pnioDataOutputGet - Get output data from a submodule

Get output data from a submodule. Returns a GOAL_STATUS_T status.

Table 6.41 goal_pnioDataOutputGet Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
uint32_t idApi	API (always 0)
uint16_t idSlot	slot number
uint16_t idSubslot	subslot number
char *pBuf	data buffer
uint16_t len	data buffer length
GOAL_PNIO_IOXS_T *pStateIops	pointer for producer state

```
GOAL_PNIO_IOXS_T iops = GOAL_PNIO_IOXS_GOOD;
/* get 4 bytes of output data for slot 1:1 */
res = goal_pnioDataOutputGet(pPnio, 0, 1, 1, &buf, 4, &iops);
```

6.3.34 goal_pnioDataInputSet - Set input data for a submodule

Set input data for a submodule. Returns a GOAL_STATUS_T status.

Table 6.42 goal_pnioDataInputSet Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
uint32_t idApi	API (always 0)
uint16_t idSlot	slot number
uint16_t idSubslot	subslot number
char *pBuf	data buffer
uint16_t len	data buffer length
GOAL_PNIO_IOXS_T stateIops	producer state

```
GOAL_PNIO_IOXS_T iops = GOAL_PNIO_IOXS_GOOD;
/* set 4 bytes of input data for slot 2:1 */
res = goal_pnioDataInputSet(pPnio, 0, 2, 1, &buf, 4, GOAL_PNIO_IOXS_GOOD);
```

6.3.35 goal_pnioApduStatusGet - Get the application protocol data unit status

Get the application protocol data unit status. Returns a GOAL_STATUS_T status.

Table 6.43 goal_pnioApduStatusGet Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
GOAL_PNIO_AR_ID_T idAr	application relation id
GOAL_PNIO_APDU_STATUS_T *pStatusApdu	APDU status pointer

6.3.36 goal_pnioAlarmNotifySend - Send an alarm notification

Send an alarm notification. Returns a GOAL_STATUS_T status.

Table 6.44 goal_pnioAlarmNotifySend Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
uint16_t *pNrAlarmSeq	pointer to store alarm sequence number
GOAL_PNIO_AR_ID_T idAr	application relation id
uint32_t prio	priority
const GOAL_PNIO_ALARM_ NOTIFY_T *pAlarmNotify	pointer to alarm notification
uint16_t lenDataUser	user data length
void *pDataUser	pointer to user data

6.3.37 goal_pnioAlarmNotifySendAck - Send an alarm notification acknowledge

Send an alarm notification acknowledge. Returns a GOAL_STATUS_T status.

Table 6.45 goal_pnioAlarmNotifySendAck Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
GOAL_PNIO_AR_ID_T idAr	application relation id
uint32_t prio	priority
const GOAL_PNIO_ALARM_ NOTIFY_T *pAlarmNotify	pointer to alarm notification
GOAL_PNIO_STATUS_T *pStatus	PROFINET status

uint16_t lenDataUser	user data length
void *pDataUser	pointer to user data

6.3.38 goal_pnioAlarmProcessSend - Send a process alarm

Send a process alarm. Returns a GOAL_STATUS_T status.

Table 6.46 goal_pnioAlarmProcessSend Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
uint32_t api	API
uint16_t slot	slot number
uint16_t subslot	subslot number
uint16_t usi	user structure identifier
uint16_t lenData	data length
uint8_t *pData	pointer to user data

6.3.39 goal_pnioRecReadFinish - Answer a record read request

Answer a record read request. The sequence number is used to detect if the request has expired. If that is the case the response will be silently dropped. Returns a GOAL_STATUS_T status.

Table 6.47 goal_pnioRecReadFinish Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
int32_t hdl	record handle
GOAL_PNIO_STATUS_T *pStatusPnio	PROFINET status pointer
const uint8_t *pData	record data
uint16_t len	record data length
uint32_t numSeq	sequence number

6.3.40 goal_pnioRecWriteFinish - Answer a record write request

Answer a record write request. The sequence number is used to detect if the request has expired. If that is the case the response will be silently dropped. Returns a GOAL_STATUS_T status.

Table 6.48 goal_pnioRecWriteFinish Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
int32_t hdl	record handle
GOAL_PNIO_STATUS_T *pStatusPnio	PROFINET status pointer
uint32_t numSeq	sequence number

6.3.41 goal_pnioDiagExtChanDiagAdd - Add an extended channel diagnosis entry

Add an extended channel diagnosis entry. Returns a GOAL_STATUS_T status.

Table 6.49 goal_pnioDiagExtChanDiagAdd Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
GOAL_PNIO_DIAG_HANDLE_T *pHdl	pointer to store diagnosis handle
uint32_t api	API
uint16_t slot	slot number
uint16_t subslot	subslot number
uint16_t chan	channel index
uint16_t numErr	error number
uint16_t typeExtChanErr	extended channel error type
uint32_t valExtChanAdd	extended channel error value
GOAL_BOOL_T flgMaintReq	maintenance required flag
GOAL_BOOL_T flgMaintDem	maintenance demanded flag
GOAL_BOOL_T flgSubmitAlarm	submit alarm flag
uint16_t typeAlarm	alarm type

6.3.42 goal_pnioDiagChanDiagRemove - Remove a channel diagnosis entry

Remove a channel diagnosis entry. Returns a GOAL_STATUS_T status.

Table 6.50 goal_pnioDiagChanDiagRemove Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
GOAL_PNIO_DIAG_HANDLE_T hdl	diagnosis handle
GOAL_BOOL_T flgSubmitAlarm	submit alarm flag

6.3.43 goal_pnioCyclicCtrl - Control cyclic data received callback

Control cyclic data received callback. If flgCyclic is set to GOAL_TRUE then the callback GOAL_PNIO_CB_ID_NEW_IO_DATA signalizes the reception of new I/O data. This will lead to a much higher system load. For most applications it is sufficient to poll the cyclic data by goal_pnioDataOutputGet. Returns a GOAL_STATUS_T status.

Table 6.51 goal_pnioCyclicCtrl Parameters

Parameter	Description
GOAL_PNIO_T *pPnio	PROFINET data
GOAL_BOOL_T flgCyclic	cyclic data enable flag

6.4 EtherNet/IP Application Programming Interface

6.4.1 goal_eipInit

Initialize GOAL EtherNet/IP. Returns a GOAL_STATUS_T as result. This function must be called within the function appl_init(). No parameters required.

To enable EtherNet/IP support in GOAL, the goal_eipInit function must be called in the appl_init function.

```
static GOAL_EIP_T *pHdlEip; /**< GOAL Ethernet/ IP handle */
GOAL_STATUS_T appl_init( void
)
{
    GOAL_STATUS_T res;                  /* result */

    res = goal_eipInit();
    if (GOAL_RES_ERR(res)) {
        goal_logErr("Initialization of Ethernet/IP failed");
    }
    return res;
}
```

6.4.2 goal_eipNew

Create a GOAL EtherNet/IP instance for the given ID and register a callback. This function must be called within the function appl_setup().

Table 6.52 goal_eipNew Parameters

Parameter	Description
GOAL_EIP_T ** ppEip	[out] EtherNet/IP instance ref
const uint32_t id	ID of EtherNet/IP instance
GOAL_EIP_FUNC_CB_T pFunc	GOAL EtherNet/IP handle application callback

```
res = goal_eipNew(&pHdlEip, EIP_INSTANCE_DEFAULT, main_eipCallback);
```

6.4.3 goal_eipCipClassRegister

Register an application specific CIP class. When the EtherNet/IP stack receives a request for the registered CIP class it is passed to the handler function.

Table 6.53 goal_eipCipClassRegister Parameters

Parameter	Description
GOAL_EIP_T *pHdlEip	GOAL EtherNet/IP handle
uint16_t classId	class ID to be registered
GOAL_EIP_REQ_HANDLER_T pFunc	request handler

```
res = goal_eipCipClassRegister(pEip, APPL_CLASS_ID_PARAMETER, appl_parameterClassHandler);
```

6.4.4 goal_eipCreateAssemblyObject

Adds an CIP instance to the selected Class. Returns a GOAL_STATUS_T as result.

Table 6.54 goal_eipCreateAssemblyObject Parameters

Parameter	Description
GOAL_EIP_T *pHdlEip	GOAL EtherNet/IP handle
uint32_t instanceId	instance number of the assembly object to create
uint16_t len	length of the assembly object's data

```
res = goal_eipCreateAssemblyObject(pHdlEip, GOAL_APP_ASM_ID_INPUT,
GOAL_APP_ASM_SIZE_INPUT);
```

6.4.5 goal_eipCreateAssemblyObjectRpc

Adds an CIP instance for RCP transfer to the selected Class. Returns a GOAL_STATUS_T as result.

Table 6.55 goal_eipCreateAssemblyObjectRpc Parameters

Parameter	Description
GOAL_EIP_T *pHdlEip	GOAL EtherNet/IP handle
uint32_t instanceId	instance number of the assembly object to create
uint16_t len	length of the assembly object's data

```
res = goal_eipCreateAssemblyObjectRpc(pHdlEip, GOAL_APP_ASM_ID_INPUT,
GOAL_APP_ASM_SIZE_INPUT);
```

6.4.6 goal_eipAssemblyObjectGet

Get the pointer to the data array of an assembly.

Table 6.56 goal_eipAssemblyObjectGet Parameters

Parameter	Description
GOAL_EIP_T *pHdlEip	GOAL Ethernet/IP handle
uint32_t instanceId	instance number of the assembly object
uint8_t **ppData	[out] pointer to assembly data
uint16_t *pLen	[out] length of assembly data

```
uint8_t *pData; /* assembly data */
uint32_t len;  /* assembly data length */

res = goal_eipAssemblyObjectGet(pHdlEip, GOAL_APP_ASM_ID_INPUT, &pData, &len);
```

6.4.7 goal_eipAddExclusiveOwnerConnection

Create one Exclusive Owner connection with producing and consuming endpoints.

Table 6.57 goal_eipAddExclusiveOwnerConnection Parameters

Parameter	Description
GOAL_EIP_T *pHdlEip	GOAL EtherNet/IP handle
uint32_t outputAssembly	the O-to-T point to be used for this connection
uint32_t inputAssembly	the T-to-O point to be used for this connection
uint32_t configAssembly	the configuration point to be used for this connection

```
res = goal_eipAddExclusiveOwnerConnection(pHdlEip,GOAL_APP_ASM_ID_OUTPUT,
      GOAL_APP_ASM_ID_INPUT, GOAL_APP_ASM_ID_CONFIG);
```

6.4.8 goal_eipAddInputOnlyConnection

Create multiple Input Only connections with the same producing and consuming endpoints.

Table 6.58 goal_eipAddInputOnlyConnection Parameters

Parameter	Description
GOAL_EIP_T *pHdlEip	GOAL EtherNet/IP handle
uint32_t connNum	the number of the input only connection
uint32_t outputAssembly	the O-to-T point to be used for this connection
uint32_t inputAssembly	the T-to-O point to be used for this connection
uint32_t configAssembly	the configuration point to be used for this connection

```
res = goal_eipAddInputOnlyConnection(pHdlEip, GOAL_APP_IOCON_NUM,
GOAL_APP_ASM_ID_HEARTBEAT_IO, GOAL_APP_ASM_ID_INPUT, GOAL_APP_ASM_ID_CONFIG);
```

6.4.9 goal_eipAddListenOnlyConnection

Create multiple Listen Only connections with the same producing and consuming endpoints.

Table 6.59 goal_eipAddListenOnlyConnection Parameters

Parameter	Description
GOAL_EIP_T *pHdlEip	GOAL EtherNet/IP handle
uint32_t connNum	the number of the listen only connection
uint32_t outputAssembly	the O-to-T point to be used for this connection
uint32_t inputAssembly	the T-to-O point to be used for this connection
uint32_t configAssembly	the configuration point to be used for this connection

```
res = goal_eipAddListenOnlyConnection(pHdlEip, GOAL_APP_LOCON_NUM,
      GOAL_APP_ASM_ID_HEARTBEAT_LO, GOAL_APP_ASM_ID_INPUT,
      GOAL_APP_ASM_ID_CONFIG);
```

6.4.10 goal_eipGetVersion

Get the EtherNet/IP version. Returns a GOAL_STATUS_T as result.

Table 6.60 goal_eipGetVersion Parameters

Parameter	Description
GOAL_EIP_T *pHdlEip	GOAL EtherNet/IP handle
char **ppVersion	[out] EtherNet/IP version

```
char *pVersion; /* version string */
goal_eipGetVersion(pHdlEip, &pVersion);
goal_logInfo("EtherNet/IP stack version: %s", pVersion);
```

6.4.11 goal_eipDeviceStatusSet

Set device status bits. The parameter statusBits uses the GOAL_EIP_STATUS_ macros. They can be combined with binary OR.

Table 6.61 goal_eipDeviceStatusSet Parameters

Parameter	Description
GOAL_EIP_T *pHdlEip	GOAL EtherNet/IP handle
uint16_t statusBits	status bitmap

```
res = goal_eipDeviceStatusSet(pHdlEip, GOAL_EIP_STATUS_CFGRD);
```

6.4.12 goal_eipDeviceStatusClear

Clear device status bits. All bits of statusBits will be cleared. The parameter uses the GOAL_EIP_STATUS_ macros. They can be combined with binary OR.

Table 6.62 goal_eipDeviceStatusClear Parameters

Parameter	Description
GOAL_EIP_T *pHdlEip	GOAL EtherNet/IP handle
uint16_t statusBits	status bitmap

```
res = goal_eipDeviceStatusClear(pHdlEip,GOAL_EIP_STATUS_CFGRD);
```

6.4.13 goal_eipAssemblyObjectWrite

Write data to an Assembly Object.

Table 6.60 goal_eipAssemblyObjectWrite parameters

Parameter	Description
GOAL_EIP_T *pHdlEip	GOAL Ethernet/IP handle
uint32_t instanceId	instance ID of the Assembly object
uint8_t *pData	buffer with write data
uint16_t len	number of bytes to write

```
res = goal_goal_eipAssemblyObjectWrite (pHdlEip, 100, pData, 32);
```

6.4.14 goal_eipAssemblyObjectRead

Read data from an Assembly Object.

Table 6.61 goal_eipAssemblyObjectRead parameters

Parameter	Description
GOAL_EIP_T *pHdlEip	GOAL Ethernet/IP handle
uint32_t instanceId	instance ID of the Assembly object
uint8_t *pData	buffer for read data
uint16_t len	number of bytes to read

```
res = goal_eipAssemblyObjectRead(pHdlEip, 150, pRdBuf, 32);
```

6.4.15 goal_eipIdentitySerialNumberSet

Set the serial number of the device. Each device must have a unique serial number. This function updates the Identity instance attribute, i.e. it changes the Serial Number after the EtherNet/IP instance has been created.

Table 6.62 goal_eipIdentitySerialNumberSet parameters

Parameter	Description
GOAL_EIP_T *pHdlEip	GOAL Ethernet/IP handle
uint32_t serialNum	new Serial Number

```
res = goal_eipIdentitySerialNumberSet (pHdlEip, 12345);
```

6.5 EtherCAT Application Programming Interface

6.5.1 goal_ecatInit

Purpose: Initial registration of EtherCAT library

Function Prototype:

```
GOAL_STATUS_T goal_ecatInit(
  void
);
```

Example:

```
/*****************************************************************************/
/** Application Init *
* This function must initialize GOAL and all used protocol stacks.
* Furthermore application specific resources must be initialized.
*/
GOAL_STATUS_T appl_init(
  void
)
{
  GOAL_STATUS_T res;            /* result */
  /* initialize EtherCAT */
  res = goal_ecatInit();
  if (GOAL_RES_ERR(res)) {
    goal_logErr("Initialization of EtherCAT failed");
  }
   return res;
}
```

6.5.2 goal_ecatNew

Purpose: Create an instance of the EtherCAT Library

Function Prototype:

```
GOAL_STATUS_T goal_ecatNew(
    GOAL_ECAT_T **ppEcat,                    /**< [out] EtherCAT instance ref */
    const uint32_t id,                       /**< instance id */
    GOAL_ECAT_FUNC_CB_T pFunc                /**< EtherCAT callback function */
);
```

Example:

```
/*****************************************************************************/
/* Local variables */
/*****************************************************************************/
static GOAL_ECAT_T *pHdlEcat;                /**< GOAL EtherCAT handle */


/*****************************************************************************/
/** Application Setup
 *
 * Setup the application.
 */
GOAL_STATUS_T appl_setup(
    void
)
{
    GOAL_STATUS_T res;                       /* result */
    goal_logInfo("create new instance");

    res = goal_ecatNew(&pHdlEcat, GOAL_ECAT_INSTANCE_DEFAULT, appl_ecatCallback);
    if (GOAL_RES_ERR(res)) {
        goal_logErr("failed to create a new EtherCAT instance");
        return res;
    }

    return res;
}
```

6.5.3 goal_ecatCfgEmergencyOn

Purpose: Enable Emergency Message support

Function Prototype:

```
GOAL_STATUS_T goal_ecatCfgEmergencyOn(
    GOAL_BOOL_T enable                          /**< enable or disable feature */
);
```

Example:

```
/* enable CoE emergency */
res = goal_ecatCfgEmergencyOn(GOAL_TRUE);
if (GOAL_RES_ERR(res)) {
    goal_logErr("failed to enable CoE Emergency support");
}
```

Remarks:
This function is required to be called before goal_ecatNew.

6.5.4 goal_ecatCfgEmergencyQueueNum

Purpose: Set number of queueable emergency messages

Function Prototype:

```
GOAL_STATUS_T goal_ecatCfgEmergencyQueueNum(
    int16_t num                                 /**< number of queue slots */
);
```

Example:

```
/* set emergency queue size to 8 */
res = goal_ecatCfgEmergencyQueueNum(8);
if (GOAL_RES_ERR(res)) {
    goal_logErr("failed to set CoE Emergency Queue size to 8");
}
```

Remarks:
This function is required to be called before goal_ecatNew.

6.5.5 goal_ecatCfgFoeOn

Purpose: enable FoE support

Function Prototype:

```
GOAL_STATUS_T goal_ecatCfgFoeOn(
    GOAL_BOOL_T enable                    /**< enable or disable feature */
);
```

Example:

```
/* enable FoE */
res = goal_ecatCfgFoeOn(GOAL_TRUE);
if (GOAL_RES_ERR(res)) {
    goal_logErr("failed to enable FoE support");
}
```

Remarks:
This function is required to be called before goal_ecatNew.

6.5.6 goal_ecatCfgExplDevIdOn

Purpose: Enable support for Explicit Device Identification

Function Prototype:

```
GOAL_STATUS_T goal_ecatCfgExplDevIdOn(
    GOAL_BOOL_T enable                    /**< enable or disable feature */
);
```

Example:

```
/* enable Explicit Device Identification */
res = goal_ecatCfgExplDevIdOn(GOAL_TRUE);
if (GOAL_RES_ERR(res)) {
    goal_logErr("failed to enable Explicit Device Identification support");
}
```

Remarks:
This function is required to be called before goal_ecatNew.

6.5.7 goal_ecatCfgBootstrapOn

Purpose: Enable support for BOOTSTRAP ESM state

Function Prototype:

```
);GOAL_STATUS_T goal_ecatCfgBootstrapOn(
    GOAL_BOOL_T enable                          /**< enable or disable feature */
);
```

Example:

```
/* enable BOOTSTRAP state */
res = goal_ecatCfgBootstrapOn(GOAL_TRUE);
if (GOAL_RES_ERR(res)) {
    goal_logErr("failed to enable BOOTSTRAP support");
}
```

Remarks:
This function is required to be called before goal_ecatNew.

6.5.8 goal_ecatCfgDcRequiredOn

Purpose: Enable enforcement of DC mode

Function Prototype:

```
);GOAL_STATUS_T goal_ecatCfgDcRequiredOn(
    GOAL_BOOL_T enable                          /**< enable or disable feature */
);
```

Example:

```
/* enable DC mode only */
res = goal_ecatCfgDcRequiredOn(GOAL_TRUE);
if (GOAL_RES_ERR(res)) {
    goal_logErr("failed to enforce DC mode");
}
```

Remarks:
This function is required to be called before goal_ecatNew.

6.5.9 goal_ecatCfgSizePdoStreamBufSet

Purpose: Configure PDO data buffer

Function Prototype:

```
GOAL_STATUS_T goal_ecatCfgSizePdoStreamBufSet(
    uint16_t size                                   /**< size of PDO stream buffer */
);
```

Example:

```
/* set size of PDO buffer
 *
 * The buffer must be big enough to hold both the input and output data.
 * The size depends on the possible combinations of mappable objects.
 */
res = goal_ecatCfgSizePdoStreamBufSet(APPL_ECAT_PDO_BUF_SIZE);
if (GOAL_RES_ERR(res)) {
    goal_logErr("failed to set PDO buffer size to %d", APPL_ECAT_PDO_BUF_SIZE);
}
```

Remarks:
This function is required to be called before goal_ecatNew.

To utilize maximum process data length for CC the buffer should be configured to 2 * 68 = 136 bytes.

6.5.10 Configure behaviour of LED emulation

Purpose: Configure behaviour of LED emulation

Function Prototype:

```
GOAL_STATUS_T goal_ecatCfgLedStatusIndicator(
    GOAL_BOOL_T enable                              /**< enable or disable feature */
);
```

Example:

```
/* configure dual LED status indicator */
res = goal_ecatCfgLedStatusIndicator(GOAL_FALSE);
if (GOAL_RES_ERR(res)) {
    goal_logErr("failed to configure LED status indicator");
}
```

Remarks:
This function is required to be called before goal_ecatNew.

If set to FALSE, LED emulation will support dedicated RUN and ERROR indicator. If set to TRUE, LED emulation will support combined STATUS indicator.

6.5.11 goal_ecatObjAddrGet

Purpose: get a pointer to the object value

Function Prototype:

```
GOAL_STATUS_T goal_ecatObjAddrGet(
    GOAL_ECAT_T *pEcat,                 /**< EtherCAT instance data */
    uint16_t index,                     /**< object index */
    uint8_t subIndex,                   /**< object sub-index */
    uint8_t **ppData,                   /**< [out] object data pointer reference */
    uint32_t *pSize                     /**< [out] object size reference */
);
```

Example:

```
GOAL_STATUS_T res;                      /* return */
uint8_t errorRegister;                  /* variable */
uint32_t size;                          /* variable size */
res = goal_ecatObjAddrGet(pEcat, 0x1001, 0x0, &errorRegister, &size);
if (GOAL_RES_OK(res)) {
    goal_logInfo("error register contains %d" errorRegister);
}
```

Remarks:
None.

6.5.12 goal_ecatObjValGet

Purpose: get the object value

Function Prototype:

```
GOAL_STATUS_T goal_ecatObjValGet(
    GOAL_ECAT_T *pEcat,                 /**< EtherCAT instance data */
    uint16_t index,                     /**< object index */
    uint8_t subIndex,                   /**< object sub-index */
    uint8_t *pData,                     /**< [out] object data buffer */
    uint32_t *pSize                     /**< [out] object size reference */
);
```

Example:

```
GOAL_STATUS_T res;                      /* return */
uint32_t value = 0;                     /* variable value */
uint32_t size = 0;                      /* variable size */

res = goal_ecatObjValGet(pHdlEcat, 0x1001, 0, (uint8_t *) &value, &size);
if (GOAL_RES_ERR(res)) {
    return res;
}
```

Remarks:
None.

6.5.13 goal_ecatObjValSet

Purpose: set the object value

Function Prototype:

```
GOAL_STATUS_T goal_ecatObjValSet(
    GOAL_ECAT_T *pEcat,                 /**< EtherCAT instance data */
    uint16_t index,                     /**< object index */
    uint8_t subIndex,                   /**< object sub-index */
    uint8_t *pData,                     /**< [in] new object value */
    uint32_t size                       /**< size of new data */
);
```

Example:

```
res = goal_ecatObjValSet(
        pHdlEcat,
        0x1008,
        0x00,
        (uint8_t *) APPL_ECAT_PRODUCT_NAME,
        GOAL_STRLEN(APPL_ECAT_PRODUCT_NAME));
if (GOAL_RES_ERR(res)) {
    goal_logErr("failed to set product name in object dictionary");
     return res;
}
```

Remarks:
None.

6.5.14 goal_ecatdynOdObjAdd

Purpose: add object

Function Prototype:

```
GOAL_STATUS_T goal_ecatdynOdObjAdd(
    GOAL_ECAT_T *pEcat,                 /**< EtherCAT instance data */
    uint16_t index,                     /**< object index */
    uint16_t objTpye,                   /**< object type (VAR, ARRAY, RECORD) */
    uint16_t dataType                   /**< data type of object */
);
```

Example:

```
res = goal_ecatdynOdObjAdd(
    pHdlEcat,
    0x1000,
    GOAL_ECAT_OBJCODE_VAR,
    GOAL_ECAT_DATATYPE_UNSIGNED32);
```

Remarks:
None.

6.5.15 goal_ecatdynOdSubIndexAdd

Purpose: add subindex to object for cyclic transfer

Function Prototype:

```
GOAL_STATUS_T goal_ecatdynOdSubIndexAdd(
    GOAL_ECAT_T *pEcat,                 /**< EtherCAT instance data */
    uint16_t index,                     /**< object index */
    uint8_t subIndex,                   /**< object sub-index */
    uint16_t dataType,                  /**< data type of object */
    uint16_t attr,                      /**< attributes (R/W/mappable,...) */
    uint8_t *pDefVal,                   /**< default value of entry */
    uint8_t *pMinVal,                   /**< minimum value of entry */
    uint8_t *pMaxVal,                   /**< maximum value of entry */
    uint32_t size,                      /**< size of non-numerical objects */
    uint8_t *pVar                       /**< application variable */
);
```

Example:

```
uint32ValueMin = 0x0;
uint32ValueDef = 0x00030191;
uint32ValueMax = 0xFFFFFFFF;

res = goal_ecatdynOdSubIndexAdd(
    pHdlEcat,
    0x1000,
    0x00,
    GOAL_ECAT_DATATYPE_UNSIGNED32,
    EC_OBJATTR_RD | EC_OBJATTR_MAN | EC_OBJATTR_NUMERIC | EC_OBJATTR_NO_LIMITS,
    (uint8_t *) &uint32ValueDef,
    (uint8_t *) &uint32ValueMin,
    (uint8_t *) &uint32ValueMax,
    4,
    NULL);
```

Remarks:
None.

6.5.16 goal_ecatdynOdSubIndexRpcAdd

Purpose: add subindex to object for RPC transfer

Function Prototype:

```
GOAL_STATUS_T goal_ecatdynOdSubIndexRpcAdd(
    GOAL_ECAT_T *pEcat,                 /**< EtherCAT instance data */
    uint16_t index,                     /**< object index */
    uint8_t subIndex,                   /**< object sub-index */
    uint16_t dataType,                  /**< data type of object */
    uint16_t attr,                      /**< attributes (R/W/mappable,...) */
    uint8_t *pDefVal,                   /**< default value of entry */
    uint8_t *pMinVal,                   /**< minimum value of entry */
    uint8_t *pMaxVal,                   /**< maximum value of entry */
    uint32_t size,                      /**< size of non-numerical objects */
    uint8_t *pVar                       /**< application variable */
);
```

Example:

```
uint32ValueMin = 0x0;
uint32ValueDef = 0x00030191;
uint32ValueMax = 0xFFFFFFFF;

res = goal_ecatdynOdSubIndexRpcAdd(
    pHdlEcat,
    0x1000,
    0x00,
    GOAL_ECAT_DATATYPE_UNSIGNED32,
    EC_OBJATTR_RD | EC_OBJATTR_MAN | EC_OBJATTR_NUMERIC | EC_OBJATTR_NO_LIMITS,
    (uint8_t *) &uint32ValueDef,
    (uint8_t *) &uint32ValueMin,
    (uint8_t *) &uint32ValueMax,
    4,
    NULL);
```

Remarks:
None.

6.5.17 goal_ecatdynOdObjNameAdd

Purpose: assign name to object

Function Prototype:

```
GOAL_STATUS_T goal_ecatdynOdObjNameAdd(
    GOAL_ECAT_T *pEcat,                 /**< EtherCAT instance data */
    uint16_t index,                     /**< object index */
    char *pName                         /**< name of object */
);
```

Example:

```
res = goal_ecatdynOdObjNameAdd(pHdlEcat, 0x1000, "Device Type");
```

Remarks:
None.

6.5.18 goal_ecatdynOdSubIndexNameAdd

Purpose: assign name to subindex

Function Prototype:

```
GOAL_STATUS_T goal_ecatdynOdSubIndexNameAdd(
    GOAL_ECAT_T *pEcat,                 /**< EtherCAT instance data */
    uint16_t index,                     /**< object index */
    uint8_t subIndex,                   /**< object sub-index */
    char *pName                         /**< name of sub-index */
);
```

Example:

```
res = goal_ecatdynOdSubIndexNameAdd(pHdlEcat, 0x1018, 1, "Vendor Id");
```

Remarks:
None.

6.5.19 goal_ecatdynOdFinish

Purpose: finish object creation

Function Prototype:

```
GOAL_STATUS_T goal_ecatdynOdFinish(
    GOAL_ECAT_T *pEcat                          /**< EtherCAT instance data */
);
```

Example:

```
/* finish object dictionary creation */
If (GOAL_RES_OK(res)) {
    res = goal_ecatdynOdFinish(pHdlEcat);
}
```

Remarks:
This function ends dynamic creation of objects. It must be called when the last object was created. After calling this function, no additional objects can be created.

6.5.20 goal_ecatEsmStateGet

Purpose: get current ESM state

Function Prototype:

```
GOAL_STATUS_T goal_ecatEsmStateGet(
    GOAL_ECAT_T *pEcat,                         /**< EtherCAT instance data */
    uint8_t *pState                             /**< [out] esm state */
);
```

Example:

```
GOAL_STATUS_T res;                              /* return */
uint8_t state;                                  /* EtherCAT state */

/* check if state is BOOTSTRAP */
res = goal_ecatEsmStateGet(pHdlEcat, &state);
if (GOAL_RES_OK(res) && GOAL_ECAT_ESM_STATE_BOOTSTRAP == state) {
}
```

Remarks:
None.

6.5.21 goal_ecatEmcyReqWrite

Purpose: generate an Emergency Message for transmission

Function Prototype:

```
GOAL_STATUS_T goal_ecatEmcyReqWrite(
    GOAL_ECAT_T *pEcat,                    /**< EtherCAT instance data */
    uint16_t errorCode,                    /**< standard error code */
    uint8_t *pManuErr                      /**< manufacturer error code */
);
```

Example:

```
GOAL_STATUS_T res;                         /* result */
uint8_t errData[5];                        /* dummy error data */

errData[0] = 0x01;
errData[1] = 0x02;
errData[2] = 0x03;
errData[3] = 0x04;
errData[4] = 0x05;

res = goal_ecatEmcyReqWrite(
    pEcat,
    APPL_ECAT_EMCY_DEMO_ERROR_CODE,
    errData);
```

Remarks:
None.

6.5.22 goal_ecatGetVersion

Purpose: Get version information about EtherCAT Library

Function Prototype:

```
GOAL_STATUS_T goal_ecatGetVersion(
    char *strVersion,                    /**< [out] stack version */
    int size                             /**< buffer size */
);
```

Example:

```
char version[10];
res = goal_ecatGetVersion(version, 10);
```

Remarks:
None.

6.5.23 goal_ecatEsmLocalErrorSet

Purpose: Set error from application

Function Prototype:

```
GOAL_STATUS_T goal_ecatEsmLocalErrorSet(
    GOAL_ECAT_T *pEcat,      /**< Ethercat instance data */
    uint16_t errorCode       /**< new AL status code */
);
```

Example:

```
/* set local error */
goal_ecatEsmLocalErrorSet(pEcat, 0x8000);
```

Remarks:
None.

6.6 Networking

6.6.1 goal_netRpcInit - Initialize RPC functionality for networking

Purpose: If networking functionality (IP settings, UDP channel, TCP channel) is required, this function needs to be called during application initialization.

Function Prototype:

```
GOAL_STATUS_T goal_netRpcInit(
    uint32_t id                         /**< id for MA instance */
)
```

Example:

```
/*****************************************************************************/
/** Application Init
 *
 * Initialize the net stack
 */
GOAL_STATUS_T appl_init(
    void
)
{
    GOAL_STATUS_T res;                  /* result */

    /* initialize goal net */
    res = goal_netRpcInit(GOAL_NET_ID_DEFAULT);
    if (GOAL_RES_ERR(res)) {
        goal_logErr("Initialization of goal net RPC failed");
    }

    return res;
}
```

6.6.2 goal_maNetOpen - Open network

Purpose: Open the network media adapter (MA) for usage.

Function Prototype:

```
GOAL_STATUS_T goal_maNetOpen(
    uint32_t id,                        /**< id of NET handler to use */
    GOAL_MA_NET_T **ppNetHdl            /**< pointer to store NET handler */
);
```

Example:

```
/*****************************************************************************/
/** Application Setup
 *
 * This function is called by the GOAL init-stage system to open UDP channels.
 *
 * API functions from earlier stages are allowed to be used here.
 */
GOAL_STATUS_T appl_setup(
    void
  )
  {
      GOAL_STATUS_T res;                /* result */
      GOAL_MA_NET_T *pMaNet;                /* net ma handle */

      res = goal_maNetOpen(GOAL_NET_ID_DEFAULT, &pMaNet);
      if (GOAL_RES_ERR(res)) {
          goal_logErr("error opening network MA");
      }

      return res;
  }
```

6.6.3 goal_maNetClose - Close network

Purpose: Close the network media adapter (MA)

Function Prototype:

```
GOAL_STATUS_T goal_maNetClose(
    GOAL_MA_NET_T *pNetHdl              /**< pointer to store NET handler */
);
```

6.6.4 goal_maNetGetById - Get network media adapter (MA) handle

Purpose:
Get the network media adapter (MA) handle which was previously open for usage
Function Prototype:

```
GOAL_STATUS_T goal_maNetGetById(
    GOAL_MA_NET_T **ppHdlMaNet,        /**< NET handle ref ptr */
    uint32_t id                        /**< MA id */
);
```

Example:

```
res = goal_maNetGetById(&pMaNet, GOAL_NET_ID_DEFAULT);
if (GOAL_RES_ERR(res)) {
    goal_logErr("error getting network MA");
}
```

6.6.5 goal_maNetIpSet – Set IP address

Purpose: Set the network interface IP address

Table 6.63 goal_maNetIpSet Parameters

Parameter	Description
GOAL_MA_NET_T * pentad	GOAL NET handle
uint32_t addrIp	IP address
uint32_t addrMask	Netmask
uint32_t addrGw	Gateway
GOAL_BOOL_T flgTemp	GOAL_TRUE : keep current setting of variable “VALID” GOAL_FALSE : set variable “VALID” to 1

Function Prototype:

```
GOAL_STATUS_T goal_maNetIpSet(
    GOAL_MA_NET_T *pNetHdl,        /**< pointer to store NET handler */
    uint32_t addrIp,               /**< IP address */
    uint32_t addrMask,             /**< subnet mask */
    uint32_t addrGw,               /**< gateway */
    GOAL_BOOL_T flgTemp            /**< temporary IP config flag */
);
```

Example:

```
ip = MAIN_APPL_IP;
nm = MAIN_APPL_NM;
gw = MAIN_APPL_GW;
res = goal_maNetIpSet(pMaNet, ip, nm, gw, GOAL_FALSE);
if (GOAL_RES_ERR(res)) {
    goal_logErr("error while setting IP address");
    return res;
}
```

6.7 TCP Channel

6.7.1 goal_maChanTcpOpen - Open the TCP channel media adapter (MA)

Purpose: Opens the networking media adapter (MA) for further usage. This needs to be done once at application startup.

Function Prototype:

```
GOAL_STATUS_T goal_maChanTcpOpen(
    uint32_t id,                                    /**< MA id */
    GOAL_MA_CHAN_TCP_T **ppHdlMaChanTcp             /**< CHAN_TCP handle ref ptr */
);
```

Example:

```
res = goal_maChanTcpOpen(GOAL_NET_ID_DEFAULT, &pMaTcp);
if (GOAL_RES_ERR(res)) {
    goal_logErr("error getting tcp MA");
    return res;
}
```

6.7.2 goal_maChanTcpNew - Create a new TCP channel

Purpose: This function creates a new TCP channel.

Function Prototype:

```
GOAL_STATUS_T goal_maChanTcpNew(
    GOAL_MA_CHAN_TCP_T *pChanTcpHdl,                /**< pointer to store CHAN_TCP handler */
    GOAL_NET_CHAN_T **ppChanHandle,                 /**< pointer to channel handle */
    GOAL_NET_CHAN_T *pChanOut,                      /**< pointer to channel handle for output */
    GOAL_NET_ADDR_T *pAddr,                         /**< remote address */
    GOAL_NET_TYPE_T type,                           /**< connection type */
    GOAL_MA_CHAN_TCP_CB_T callback                  /**< channel callback */
);
```

Example:

```
/* register TCP server */
GOAL_MEMSET(&addr, 0, sizeof(GOAL_NET_ADDR_T));
addr.localPort = (uint16_t) (MAIN_APPL_TCP_PORT + cnt);
res = goal_maChanTcpNew(pMaTcp, &pChan, NULL, &addr, GOAL_NET_TCP_LISTENER, tcpCallback);
if (GOAL_OK != res) {
    goal_logErr("error while opening TCP server channel on port %"FMT_u32,
                (uint32_t) MAIN_APPL_TCP_PORT + cnt);
    return res;
}
```

6.7.3 goal_maChanTcpActive - Activate a created TCP channel

Purpose: Activate a previously created tcp channel. Once it is activated, it established connection or accepts incoming connection requests.

Function Prototype:

```
GOAL_STATUS_T goal_maChanTcpActivate(
    GOAL_MA_CHAN_TCP_T *pChanTcpHdl,        /**< pointer to store CHAN_TCP handler */
    GOAL_NET_CHAN_T *pChanHandle            /**< channel handle */
);
```

Example:

```
/* activate channel */
res = goal_maChanTcpActivate(pMaTcp, pChanTcp);
if (GOAL_OK != res) {
    goal_logErr("error while enabling TCP channel");
    return;
}
```

6.7.4 goal_maChanTcpSetNonBlocking - Set channel to non-blocking

Purpose: Set socket to non blocking mode for reading

Function Prototype:

```
GOAL_STATUS_T goal_maChanTcpSetNonBlocking(
    GOAL_MA_CHAN_TCP_T *pChanTcpHdl,        /**< pointer to store CHAN_TCP handler */
    GOAL_NET_CHAN_T *pChanHandle,           /**< channel handle */
    GOAL_BOOL_T flgOption                   /**< non blocking state */
);
```

Example:

```
/* set TCP channel to non-blocking */
res = goal_maChanTcpSetNonBlocking(pMaTcp, pChanTcp, GOAL_TRUE);
if (GOAL_OK != res) {
    goal_logErr("error while setting TCP channel to non-blocking");
    return;
}
```

6.7.5 goal_maChanTcpGetRemoteAddr - Get remote address of TCP channel

Purpose: Get the ip address of the remote end point of the TCP channel.

Function Prototype:

```
GOAL_STATUS_T goal_maChanTcpGetRemoteAddr(
    GOAL_MA_CHAN_TCP_T *pChanTcpHdl,        /**< pointer to store CHAN_TCP handler */
    GOAL_NET_CHAN_T *pChanHandle,           /**< channel handle */
    GOAL_NET_ADDR_T *pAddr                  /**< remote address */
);
```

Example:

```
/* get IP Address of remote node */
res = goal_maChanTcpGetRemoteAddr(pMaTcpHdl, pChan, &remote);
if (GOAL_RES_ERR(res)) {
    goal_logErr("Failed to get Remote Address for socket %p", (void *) pChan);
    return;
}
```

6.7.6 goal_maChanTcpSend - Send data through TCP channel

Purpose: Send data to a previously opened TCP channel.

Function Prototype:

```
GOAL_STATUS_T goal_maChanTcpSend(
    GOAL_MA_CHAN_TCP_T *pChanTcpHdl,        /**< pointer to store CHAN_TCP handler */
    GOAL_NET_CHAN_T *pChanHandle,           /**< channel handle */
    GOAL_BUFFER_T *pBuf                     /**< buffer with data to send */
);
```

Example:

```
/* echo message */
goal_maChanTcpSend(pMaTcpHdl, pChan, pBuf);
```

6.8 UDP Channel

6.8.1 goal_maChanUdpOpen - Open the UDP channel MA

Purpose:
Open the UDP channel ma. This needs to be done once at application startup.

Function Prototype:

```
GOAL_STATUS_T goal_maChanUdpOpen(
    uint32_t id,                                    /**< MA id */
    GOAL_MA_CHAN_UDP_T **ppHdlMaChanUdp             /**< CHAN_UDP handle ref ptr */
);
```

Example:

```
/* open UDP channel MA and create new channel */
res = goal_maChanUdpOpen(GOAL_NET_ID_DEFAULT, &pMaChanUdp);
if (GOAL_RES_OK(res)) {
    GOAL_MEMSET(&addr, 0, sizeof(GOAL_NET_ADDR_T));
    addr.localPort = MAIN_APPL_UDP_PORT_1;
    res = goal_maChanUdpNew(pMaChanUdp, &pChan1, NULL, &addr, GOAL_NET_UDP_SERVER,
                                        udpCallback);
}
```

6.8.2 goal_maChanUdpGetById - Get the UDP channel MA handle

Purpose: This function gets the handle of the UDP channel ma which was previously opened.

Function Prototype:

```
GOAL_STATUS_T goal_maChanUdpGetById(
    GOAL_MA_CHAN_UDP_T **ppHdlMaChanUdp,            /**< CHAN_UDP handle ref ptr */
    uint32_t id                                     /**< MA id */
);
```

6.8.3 goal_maChanUdpNew - Create a new UDP channel

Purpose: Create a new UDP channel.

Function Prototype:

```
GOAL_STATUS_T goal_maChanUdpNew(
    GOAL_MA_CHAN_UDP_T *pChanUdpHdl,        /**< pointer to store CHAN_UDP handler */
    GOAL_NET_CHAN_T **ppChanHandle,         /**< pointer to channel handle */
    GOAL_NET_CHAN_T *pChanOut,              /**< pointer to channel handle for output */
    GOAL_NET_ADDR_T *pAddr,                 /**< remote address */
    GOAL_NET_TYPE_T type,                   /**< connection type */
    GOAL_MA_CHAN_UDP_CB_T callback          /**< channel callback */
);
```

Example:

```
if (GOAL_RES_OK(res)) {
    GOAL_MEMSET(&addr, 0, sizeof(GOAL_NET_ADDR_T));
    addr.localPort = MAIN_APPL_UDP_PORT_1;
    res = goal_maChanUdpNew(pMaChanUdp, &pChan1, NULL, &addr, GOAL_NET_UDP_SERVER,
                            udpCallback);
}
```

6.8.4 goal_maChanUdpClose - Close the UDP channel MA

Purpose: Close an existing channel

Function Prototype:

```
GOAL_STATUS_T goal_maChanUdpClose(
    GOAL_MA_CHAN_UDP_T *pChanUdpHdl,        /**< pointer to store CHAN_UDP handler */
    GOAL_NET_CHAN_T *pChanHandle            /**< pointer to channel handle */
);
```

6.8.5 goal_maChanUdpSetNonBlocking - Set the opened channel to non-blocking access

Purpose: Set a channel to non blocking operation.

Function Prototype:

```
GOAL_STATUS_T goal_maChanUdpSetNonBlocking(
    GOAL_MA_CHAN_UDP_T *pChanUdpHdl,        /**< pointer to store CHAN_UDP handler */
    GOAL_NET_CHAN_T *pChanHandle,           /**< channel handle */
    GOAL_BOOL_T flgOption                   /**< option value */
);
```

Example:

```
res = goal_maChanUdpSetNonBlocking(pMaChanUdp, pChan2, GOAL_TRUE);
if (GOAL_OK != res) {
    goal_logErr("error while setting UDP channel to non-blocking");
    return res;
}
```

6.8.6 goal_maChanUdpSetBroadcast - Set the opened UDP channel to broadcast operation

Purpose: Set a channel to broadcast.

Function Prototype:

```
GOAL_STATUS_T goal_maChanUdpSetBroadcast(
    GOAL_MA_CHAN_UDP_T *pChanUdpHdl,        /**< pointer to store CHAN_UDP handler */
    GOAL_NET_CHAN_T *pChanHandle,           /**< channel handle */
    GOAL_BOOL_T flgOption                   /**< option value */
);
```

Example:

```
/* enable broadcast reception */
res = goal_maChanUdpSetBroadcast(pMaChanUdp, pChan1, GOAL_TRUE);
if (GOAL_RES_ERR(res)) {
    goal_logErr("error while setting UDP channel to receive broadcasts");
    return res;
}
```

6.8.7 goal_maChanUdpGetRemoteAddr - Get remote address of the UDP channel

Purpose: Get the remote address of a udp channel, and thus the address from which data were received.

Function Prototype:

```
GOAL_STATUS_T goal_maChanUdpGetRemoteAddr(
    GOAL_MA_CHAN_UDP_T *pChanUdpHdl,        /**< pointer to store CHAN_UDP handler */
    GOAL_NET_CHAN_T *pChanHandle,           /**< channel handle */
    GOAL_NET_ADDR_T *pAddr                  /**< remote address */
);
```

6.8.8 goal_maChanUdpActivate - Activate a UDP channel

Purpose: Activate a channel

Function Prototype:

```
GOAL_STATUS_T goal_maChanUdpActivate(
    GOAL_MA_CHAN_UDP_T *pChanUdpHdl,        /**< pointer to store CHAN_UDP handler */
    GOAL_NET_CHAN_T *pChanHandle            /**< channel handle */
);
```

Example:

```
res = goal_maChanUdpActivate(pMaChanUdp, pChan2);
if (GOAL_RES_ERR(res)) {
    goal_logErr("error while enabling UDP channel");
    return res;
}
```

6.8.9 goal_maChanUdpSend - Send data to the UDP channel

Purpose: Send data to a open UDP channel.

Function Prototype:

```
GOAL_STATUS_T goal_maChanUdpSend(
    GOAL_MA_CHAN_UDP_T *pChanUdpHdl,        /**< pointer to store CHAN_UDP handler */
    GOAL_NET_CHAN_T *pChanHandle,           /**< channel handle */
    GOAL_BUFFER_T *pBuf                     /**< buffer with data to send */
);
```

Example:

```
/* echo message */
goal_maChanUdpSend(pMaChanUdp, pChan, pBuf);
```

7. Webserver

7.1 General

GOAL provides a smart webserver for embedded systems. The webserver was designed:

- for file downloads and
- to get information about the current device state and properties.

The webserver supports the following properties:

transfer protocols: HTTP / HTTPS

request methods: GET / POST

One or more webpages can be assigned to one instance of the webserver. The webpages are part of the application and must be made available by the application. The web-server provides a callback function for this purpose, see cbHttpReqFunc() in section 8.5.

The current device state and properties can be read from CM-variables and application-specific variables. The application-specific variables can be organized as simple variables or as a one-dimensional list.

It is possible to store templates for webpages with placeholders for current values of application-specific variables. The text substitutions are described in section 8.3. Web-templates make the dynamic management of web-pages possible.

The access to the webserver can be limited by user levels. The application can specify, which user levels shall be supported by the device and which rights the user levels shall have. The authentication data consisting of username and the password for each user level are configurable by CM-variables. The GOAL webserver provides up to 4 user levels.

The user levels can be applied by all instances of the webserver. For each instance of the webserver the valid user level can be specified during registration. Web-requests are only transferred to the application after a successful authentication, i.e. the callback function cbHttpReqFunc() in section 8.5 is only called after a successful login. The transfer of the username and the password via a web-server instance using the HTTP transfer protocol is unsafe. We recommend a port on which the HTTPS transfer protocol is running.

HTTPS is activated by the compiler-define GOAL_CONFIG_HTTPS. HTTPS uses the external software component mbedTLS for encoding and authentication. The access to mbedTLS is realized with the media adapter for TLS. TLS for HTTPS is initialized and opened by function goal_httpsNew().

About the CM-variables for HTTPS it is possible to install a private key and one’s own X509-certificate. If no own certificate is stored, the webserver takes a default certificate provided by a port.

example:

- …\appl\goal_http\01_get*:

for upload of a webpage

- …\appl\goal_http\05_template_cm*:

for upload of a web-template with CM-variables and application-specific variables

- …\appl\goal_http\06_template_list*:

for upload of a web-template with lists

- …\appl\goal_http\04_auth*:

for authentication about user levels

- …\appl\goal_http\02_post*:

for file download

7.2 Configuration

7.2.1 Compiler-defines

The following compiler-defines are available to configure the webserver:

GOAL_CONFIG_HTTP:
0: Transfer protocol HTTP is not used (default)
1: Transfer protocol HTTP is used

GOAL_CONFIG_HTTPS:
0: Transfer protocol HTTPS is not used (default)
1: Transfer protocol HTTPS is used

7.2.2 CM-variables

The following CM-variables are available to configure the webserver:

CM-Module-ID	GOAL_ID_HTTP
CM-variable-ID	0
CM-variable name	HTTP_CHANNELS_MAX
Description	Maximal number of connections available for the HTTP transfer protocol
CM data type	UINT16
Size	2 bytes

Default value	From NVS or 0

CM-Module-ID	GOAL_ID_HTTP
CM-variable-ID	1
CM-variable name	HTTPS_CHANNELS_MAX
Description	Maximal number of connections available for the HTTPS transfer protocol
CM data type	UINT16
Size	2 bytes
Default value	From NVS or 0

CM-Module-ID	GOAL_ID_HTTP
CM-variable-ID	2
CM-variable name	USERLEVEL0
Description	Authentication data for level 0
CM data type	STRING
Size	32 bytes
Default value	From NVS or an empty string

CM-Module-ID	GOAL_ID_HTTP
CM-variable-ID	3
CM-variable name	USERLEVEL1
Description	Authentication data for level 1
CM data type	STRING
Size	32 bytes
Default value	From NVS or an empty string

CM-Module-ID	GOAL_ID_HTTP
CM-variable-ID	4
CM-variable name	USERLEVEL2
Description	Authentication data for level 2
CM data type	STRING
Size	32 bytes
Default value	From NVS or an empty string

CM-Module-ID	GOAL_ID_HTTP
CM-variable-ID	5
CM-variable name	USERLEVEL3
Description	Authentication data for level 3
CM data type	STRING
Size	32 bytes
Default value	From NVS or an empty string

The following CM-variables allow to configure the TLS layer used by HTTPS:

CM-Module-ID	GOAL_ID_HTTPS
CM-variable-ID	0
CM-variable name	TLS_SERVER_CERTIFICATE
Description	Certificate of the webserver
CM data type	GENERIC
Size	1024 bytes
Default value	From NVS or certificate from a port

CM-Module-ID	GOAL_ID_HTTPS
CM-variable-ID	1
CM-variable name	TLS_PRIVATE_KEY
Description	Private key of the webserver
CM data type	GENERIC
Size	1024 bytes
Default value	From NVS or an empty entry

CM-Module-ID	GOAL_ID_HTTPS
CM-variable-ID	2
CM-variable name	TLS_SRV_CERT_CA_CN
Description	Common name of the server of the certification authority
CM data type	STRING
Size	128 bytes
Default value	From NVS or an empty string

CM-Module-ID	GOAL_ID_HTTPS
CM-variable-ID	3
CM-variable name	TLS_SRV_CERT_CA_O
Description	Name of the certification authority organization, e.g. the company name
CM data type	STRING
Size	128 bytes
Default value	From NVS or an empty string

CM-Module-ID	GOAL_ID_HTTPS
CM-variable-ID	4
CM-variable name	TLS_SRV_CERT_CA_C
Description	Country, in which the certification authority organization is located
CM data type	STRING
Size	8 bytes
Default value	From NVS or an empty string

CM-Module-ID	GOAL_ID_HTTPS
CM-variable-ID	5
CM-variable name	TLS_SRV_CERT_CN
Description	Common name of the webserver
CM data type	STRING
Size	128 bytes
Default value	From NVS or an empty string

CM-Module-ID	GOAL_ID_HTTPS
CM-variable-ID	6
CM-variable name	TLS_SRV_CERT_O
Description	Name of the organization provided the webserver
CM data type	STRING
Size	128 bytes
Default value	From NVS or an empty string

CM-Module-ID	GOAL_ID_HTTPS
CM-variable-ID	7
CM-variable name	TLS_SRV_CERT_C
Description	Country, in which the organization provided the webserver is located
CM data type	STRING
Size	8 bytes
Default value	From NVS or an empty string

CM-Module-ID	GOAL_ID_HTTPS
CM-variable-ID	8
CM-variable name	TLS_SRV_CERT_NOT_BEFORE
Description	From what date and time the certificate is valid
CM data type	STRING
Size	20 bytes
Default value	From NVS or an empty string

CM-Module-ID	GOAL_ID_HTTPS
CM-variable-ID	9
CM-variable name	TLS_SRV_CERT_NOT_AFTER
Description	From what date and time the certificate is invalid
CM data type	STRING
Size	20 bytes
Default value	From NVS or an empty string

7.3 Web-templates

The GOAL webserver allows to implement templates for web-pages with placeholders for current information. The placeholders are substituted by the current values by the web-server during the upload process. The webserver provides placeholders for

- CM-variables,
- application-specific variables and
- lists.

7.3.1 CM-variables

The placeholder for CM-variables contains the CM-module-ID and the CM-variable-ID. The web-server executes the substitution of the placeholder by the CM-variable automatically.

syntax:

[CM:<modNum>, <cmVarNum>]

example:

[CM:0, 2]

7.3.2 Application-specific variables

The placeholder for application-specific variables contains the name of the variable in the application. The web-server requires the current value of the variable from the application to be obtained by calling a callback function (see cpHttpTemplateFunc() in section 8.5), and substitutes this for the placeholder on the web-page.

syntax:

[VAR:<applVarName>]

example:

[VAR:applVar]

7.3.3 Lists

The webserver provides an effective method to generate lists in HTML text. The HTML text for a single list entry can be enclosed in the placeholders FOREACH and /FOREACH in the web-template. FOREACH marks a one-dimensional list and the HTML text between the placeholders FOREACH and /FOREACH is executed for each list element. The place for the list entry is marked in the HTML text by the placeholder VAR with the desired variable name. After the substitution of the placeholder VAR the web-server changes to the next list entry automatically, i.e. it is not possible to substitute the same list entry twice. Therewith it is only necessary to describe the first list entry in the web-template.

The webserver only gets the ID and the name of the list and the number of list elements during the registration. The content of the list elements is managed by the application. The web-server calls a callback function to get the content of the next list element, see cpHttpTemplateFunc() in section 8.5.

Nested lists are allowed. The maximal supported nesting depth is 4.

syntax:

[FOREACH:<listName>] … [/FOREACH]

example for HTML listing:

```
<ul>
    [FOREACH:mainList]
    <li> main: [VAR:mainName] </li>
    <li> sub-lists:
            <ul>
                [FOREACH]
                <li> sub: [VAR:subName] </li>
                [/FOREACH]
            </ul>
    </li>
    [/FOREACH]
</ul>
```

Example …\appl\goal_http\06_template_list* generates a HTML listing. The indication in the web-browser is shown in Figure 8.1:

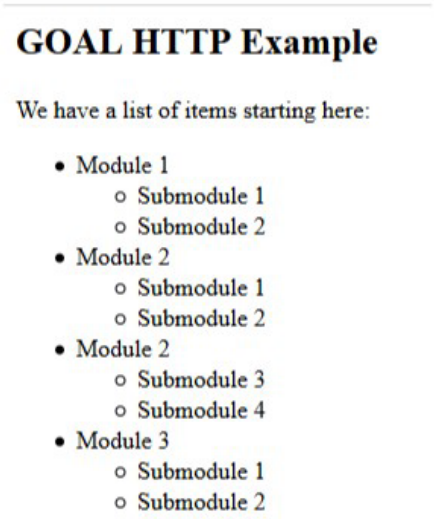

Figure 8.1 Web-page of Example 06_template_list

The placeholder [FOREACH] … [\FOREACH] can also be integrated in other HTML formatting like tables.

7.4 Characters

Square brackets: If the HTML text shall show square brackets, the square brackets must be written double, because placeholders in web-templates are bordered by square brackets.

Example: An array instruction shall be shown on a webpage.

HTML text: applArray[[5]]

Web-browser view: applArray[5]

Double quotes: Double quotes in the HTML-text must be protected by a backslash, because strings in the C code are enclosed by double quotes.

Example: uint8_t webPage[] = “<html><meta charset = ¥”utf-8¥”> … </html>”;

The rules for HTML text are valid for **all other characters**.

7.5 Callback Functions

Prototype	GOAL_STATUS_T cbHttpReqFunc(GOAL_HTTP_APPLCB_DATA_T *applData)	
Description	The received and valid web-request is passed to the application. The application has to process the web-request and to produce a web-response.	
Parameters	applData	Contains data for the application and data returned by the application.
Return values	GOAL return status	
Category	Optional	
Registration	During execution of the function goal_httpdResReg()	

Prototype	GOAL_STATUS_T cbHttpTemplateFunc(GOAL_HTTP_APPLCB_TEMPL_T *pWebTemplate)	
Description	About this callback function the application provides the current information for the specified placeholder. This callback function is called for each placeholder in the web-template. If there are multiple placeholders for the same information, this callback function is called for each placeholder.	
Parameters	pWebTemplate	Contains the information to specify a variable or list and the current return value of the specified variable.
Return values	GOAL return status	
Category	Optional	
Registration	During execution of the function	

7.6 Implementation Guideline

7.6.1 Upload a webpage

The webpage “device.html” shall be uploaded from the device to the web-browser. The content of the web-page is stored in variable webPage[] as string. No text substitutions on the webpage are necessary.

1. Initialize the webserver in state GOAL_FSA_INIT_APPL or GOAL_FSA_INIT_GOAL:

```
goal_httpInit();
```

2. Open 1 instance of the web-server using the TCP port 8081 in state GOAL_FSA_INIT_SETUP:

```
GOAL_HTTP_T *pWebInstanceHdl;      /* handle for the web-server instance */
goal_httpNew(&pWebInstanceHdl, 8081, 1);
```

3. Register the callback-functions and allowed methods for the opened web-server in state GOAL_FSA_INIT_SETUP: No callback function for text substitution is registered.

```
GOAL_HTTP_HDL_T webResourceHdl;
goal_httpResReg(pWebInstanceHdl, (uint8_t *) „/device.html“,
GOAL_HTTP_METHOD_ALLW_GET, applWebReqCb, NULL, &webResourceHdl);
```

4. Provide the web-page as string variable:

```
const uint8_t webPage[] = “<html><head><meta charset = \”utf-8\”>\
            <title> Device </title></head> \r\n\
            <body><h1>Device</h1> \r\n\
            <p>The device implementation bases on the GOAL middleware</p> \r\n\
            </body></html>”
```

5. Implement a callback function to process web-requests:

```
GOAL_STATUS_T applWebReqCb (GOAL_HTTP_APPLCB_DATA_T *pWebData) {
    GOAL_STATUS_T res;      /* GOAL return value */
     res = GOAL_ERROR;      /* no valid web-handle or request method not supported */

    if (webResourceHdl == pWebData->hdlRes) {
        if (GOAL_HTTP_FW_GET == pWebData->reqType) {
            GOAL_HTTP_GET_RETURN_HTML(pWebData, webPage,
                GOAL_STRLEN((const char*) webPage));
            res = GOAL_OK;
        }
    }
    return res;
}
```

6. The callback function applWebReqCb() is called by the web-server after a web-request is received.

7.6.2 Upload a webpage

The webpage “device.html” shall be uploaded from the device to the web-browser. The web-page bases on the template webPage[]. The template includes a placeholder for the CM-Variable DD_CM_VAR_MODULENAME with the CM-module-ID 34 and the CM-variable-ID 0. The webserver substitutes the placeholder by the current value of the CM-variable automatically. No text substitutions on the webpage are necessary.

1. Initialize the webserver in state GOAL_FSA_INIT_APPL or GOAL_FSA_INIT_GOAL:

```
goal_httpInit();
```

2. Open 1 instance of the webserver using the TCP port 8081 in state GOAL_FSA_INIT_SETUP:

```
GOAL_HTTP_T *pWebInstanceHdl;      /* handle for the web-server instance */
goal_httpNew(&pWebInstanceHdl, 8081, 1);
```

3. Register the callback-functions and allowed methods for the opened webserver in state

GOAL_FSA_INIT_SETUP: No callback function for text substitution is registered.

```
GOAL_HTTP_HDL_T webResourceHdl;
goal_httpResReg(pWebInstanceHdl, (uint8_t *) "/device.html",
GOAL_HTTP_METHOD_ALLW_GET, applWebReqCb, NULL, &webResourceHdl);
```

4. Provide a template for the webpage as string variable with placeholder for the CM-variable:

```
const uint8_t webPage[] = “<html><head><meta charset = \”utf-8\”>\
    <title> Device </title></head> \r\n\
    <body><h1>Device</h1> \r\n\
    <p>The device with the name [CM:34, 0] bases on the GOAL middleware</p> \r\n\
    </body></html>”
```

5. Implement a callback function to process web-requests:

```
GOAL_STATUS_T applWebReqCb (GOAL_HTTP_APPLCB_DATA_T *pWebData) {
    GOAL_STATUS_T res;      /* GOAL return value */
    res = GOAL_ERROR;       /* no valid web-handle or request method not supported */

    if (webResourceHdl == pWebData->hdlRes) {
        if (GOAL_HTTP_FW_GET == pWebData->reqType) {
            GOAL_HTTP_GET_RETURN_HTML(pWebData, webPage,
                GOAL_STRLEN((const char*) webPage));
            res = GOAL_OK;
        }
    }
    return res;
}
```

6. The callback function applWebReqCb() is called by the web-server after a web-request is received.

7.6.3 Read application specific variable

The webpage “device.html” shall be uploaded from the device to the web-browser. The webpage bases on the template webPage[]. The template includes a placeholder for the application-specific Variable applVar. The web-server calls the callback function applWebGetValCb() to provide the current value of the application-specific variable for the web-server. The webserver substitutes the placeholder by the current value of the application-specific variable.

1. Initialize the webserver in state GOAL_FSA_INIT_APPL or GOAL_FSA_INIT_GOAL:

```
goal_httpInit();
```

2. Open 1 instance of the webserver using the TCP port 8081 in state GOAL_FSA_INIT_SETUP:

```
GOAL_HTTP_T *pWebInstanceHdl;      /* handle for the web-server instance */
goal_httpNew(&pWebInstanceHdl, 8081, 1);
```

3. Register the callback-functions and allowed methods for the opened web-server in state GOAL_FSA_INIT_SETUP:

```
GOAL_HTTP_HDL_T webResourceHdl;
goal_httpResReg(pWebInstanceHdl, (uint8_t *) "/device.html",
GOAL_HTTP_METHOD_ALLW_GET, applWebReqCb, applWebGetValCb, &webResourceHdl);
```

4. Provide a template for the webpage as string variable with placeholder for the application-specific variable:

```
const uint8_t webPage[] = "<html><head><meta charset = \"utf-8\">\
        <title> Device </title></head> \r\n\
        <body><h1>Device</h1> \r\n\
        <p>The device with the name [VAR:applVar] bases on the GOAL middleware.</p> \r\n\
        </body></html>"
```

5. Implement a callback function to process web-requests:

```
GOAL_STATUS_T applWebReqCb (GOAL_HTTP_APPLCB_DATA_T *pWebData) {
    GOAL_STATUS_T res;      /* GOAL return value */
    res = GOAL_ERROR;       /* no valid web-handle or request method not supported */

    if (webResourceHdl == pWebData->hdlRes) {
        if (GOAL_HTTP_FW_GET == pWebData->reqType) {
            GOAL_HTTP_GET_RETURN_HTML(pWebData, webPage,
                GOAL_STRLEN((const char*) webPage));
            res = GOAL_OK;
        }
    }
    return res;
 }
```

6. Implement a callback function to get the current value of the application-specific variable from the application:

```
uint8_t deviceName[] = “Sample Gadget”;
GOAL_STATUS_T applWebGetValCb (GOAL_HTTP_APPLCB_TEMPL_T *pWebData) {
    if (0 == GOAL_MEMCMP(pWebData->in.name, “applVar”,
    GOAL_STRLEN(“applVar”))) {

        /* provide the complete device name */
        if (GOAL_STRLEN(deviceName) <= pWebData->in.retLenMax) {
            GOAL_MEMCPY(pWebData->out.strReturn, deviceName,
                GOAL_STRLEN(deviceName));
        }
        /* the device name is too long, cut the device name down
           * to the maximal allowed length */
        else {
            GOAL_MEMCPY(pWebData->out.strReturn, deviceName,
                pWebData->in.retLenMax);
        }
    }
    return GOAL_OK;
}
```

7. The callback function applWebReqCb() is called by the web-server after a web-request is received. The desired template for the web-page is made available for the web-server.

8. The callback function applWebGetValCb() is called for substitution.

7.6.4 Read a list

The webpage “device.html” shall be uploaded from the device to the web-browser. The web-page bases on the template webPage[]. The template includes a placeholder for the list of device components. The web-server calls the callback function applWebGetValCb() to provide the current value of the list entries. The webserver substitutes the placeholder by the current value of the application-specific variable.

1. Initialize the webserver in state GOAL_FSA_INIT_APPL or GOAL_FSA_INIT_GOAL:

```
goal_httpInit();
```

2. Open 1 instance of the webserver using the TCP port 8081 in state GOAL_FSA_INIT_SETUP:

```
GOAL_HTTP_T *pWebInstanceHdl;       /* handle for the webserver instance */
goal_httpNew(&pWebInstanceHdl, 8081, 1);
```

3. Register the callback-functions and allowed methods for the opened webserver in state GOAL_FSA_INIT_SETUP:

```
GOAL_HTTP_HDL_T webResourceHdl;
goal_httpResReg(pWebInstanceHdl, (uint8_t *) "/device.html",
GOAL_HTTP_METHOD_ALLW_GET, applWebReqCb, applWebGetValCb, &webResourceHdl);
```

4. Create the list information and register the list information for the webserver. The list information contains a list-ID, a list name and the number of list entries.

```
GOAL_HTTP_TEMPLATE_LIST_INIT_T webList;
GOAL_MEMSET(&webList, 0, sizeof(webList));
webList.listId = 1;
webList.cntMemb = 4;
GOAL_MEMCPY(webList.listName, "deviceComponents",
      sizeof("devcieComponents"));
goal_httpTmpMgrNewList(pWebInstanceHdl, &webList);
```

5. Provide a template for the webpage as string variable with placeholders for the list and list entries:

```
const uint8_t webPage[] = "<html><head><meta charset = \"utf-8\">\
                           <title> Device </title></head> \r\n\
                           <body><h1>Device</h1> \r\n\
                           <p> The device contains the following components: \r\n\
                               <ul> \r\n\
                                 [FOREACH:deviceComponents] \r\n\
                                 <li> [VAR:devComponent] </li> \r\n\
                             [/FOREACH]
                          </ul> \r\n\
                          </p> \r\n\
                          </body></html>"
```

6. Implement a callback function to process web-requests:

```
GOAL_STATUS_T applWebReqCb (GOAL_HTTP_APPLCB_DATA_T *pWebData) {
    GOAL_STATUS_T res;     /* GOAL return value */
    res = GOAL_ERROR;      /* no valid web-handle or request method not supported */

    if (webResourceHdl == pWebData->hdlRes) {
        if (GOAL_HTTP_FW_GET == pWebData->reqType) {
            GOAL_HTTP_GET_RETURN_HTML(pWebData, webPage,
                GOAL_STRLEN((const char*) webPage));
            res = GOAL_OK;
        }
    }
    return res;
}
```

7. Implement a callback function to get the current value of the list entries from the application:

```
GOAL_STATUS_T applWebGetValCb (GOAL_HTTP_APPLCB_TEMPL_T *pWebData) {
    GOAL_STATUS_T res;     /* GOAL return value */
    res = GOAL_ERR_NOT_FOUND;
    if (NULL != pWebData->in.pPath) {
        if (0 == GOAL_MEMCMP(pWebData->in.name, "devComponent",
        GOAL_STRLEN("devComponen"))) {

            switch ((pWebData->inPath)->path[0].index) {
                case 0:
                    GOAL_MEMCPY(pWebData->out.strReturn, "I/O module",
                        GOAL_STRLEN("I/O module"));
                    res = GOAL_OK;
                    break;
                case 1:
                    GOAL_MEMCPY(pWebData->out.strReturn, "drive",
                        GOAL_STRLEN("drive"));
                    res = GOAL_OK;
                    break;
                case 2:
                    GOAL_MEMCPY(pWebData->out.strReturn, "encoder",
                        GOAL_STRLEN("encoder"));
                    res = GOAL_OK;
                    break;
                case 3:
```

```
                    GOAL_MEMCPY(pWebData->out.strReturn, "power supply",
                        GOAL_STRLEN("power supply"));
                    res = GOAL_OK;
                    break;
                default:
                    break;
            }
        }
    }
    return res;
}
```

8. The callback function applWebReqCb() is called by the web-server after a web-request is received. The desired template for the web-page is made available for the web-server.

9. The callback function applWebGetValCb() is called for each substitution.

7.6.5 Set a user level

The upload of the webpage “admin.html” shall only be allowed for users with the USERLEVEL0. The login data for the USERLEVEL0 are:

- user name: admin
- password: a1b2c3:UL

The HTTPS transfer protocol is used.

The webpage “admin.html” does not contain any placeholder. No text substitutions on the webpage are necessary.

1. Initialize the webserver in state GOAL_FSA_INIT_APPL or GOAL_FSA_INIT_GOAL:

```
goal_httpInit();
```

2. Open 1 instance of the webserver using the TCP port 443 in state GOAL_FSA_INIT_SETUP:

```
GOAL_HTTP_T *pWebInstanceHdl; /* handle for the web-server instance */
goal_httpsNew(&pWebInstanceHdl, 443, 1);
```

3. Register the callback-functions and allowed methods for the opened webserver in state GOAL_FSA_INIT_SETUP:

```
GOAL_HTTP_HDL_T webResourceHdl;
goal_httpResReg(pWebInstanceHdl, (uint8_t *) "/admin.html",
GOAL_HTTP_METHOD_ALLW_GET | GOAL_HTTP_AUTH_USERLEVEL0, applWebReqCb,
NULL, &webResourceHdl);
```

4. Install the authentication for USERLEVEL0 in state GOAL_FSA_INIT_SETUP: The authentication data are written to the CM-variable USERLEVEL0.

```
goal_httpAuthBasSetUserInfo(pWebInstanceHdl, GOAL_HTTP_AUTH_USERLEVEL0,
    "admin", "a1b2c3:UL");
```

5. Provide a template for the webpage as string variable:

```
const uint8_t webPage[] = "<html><head><meta charset = \"utf-8\">\
                           <title> Administration </title></head> \r\n\
                           <body><h1>Administration</h1> \r\n\
                            <p> Internal information: … </p> \r\n\
                           </body></html>"
```

6. Implement a callback function to process web-requests:

```
GOAL_STATUS_T applWebReqCb (GOAL_HTTP_APPLCB_DATA_T *pWebData) {
    GOAL_STATUS_T res;      /* GOAL return value */
    res = GOAL_ERROR;       /* no valid web-handle or request method not supported */

    if (webResourceHdl == pWebData->hdlRes) {
        if (GOAL_HTTP_FW_GET == pWebData->reqType) {
            GOAL_HTTP_GET_RETURN_HTML(pWebData, webPage,
                GOAL_STRLEN((const char*) webPage));
            res = GOAL_OK;
        }
    }
    return res;
}
```

7. The callback function applWebReqCb() is called by the web-server after a web-request is received. This is only possible following successful login to the given web-server.

7.6.6 Download files

The webserver provides a download dialog. The received file is transferred to the application.

1. Initialize the webserver in state GOAL_FSA_INIT_APPL or GOAL_FSA_INIT_GOAL:

```
goal_httpInit();
```

2. Open 1 instance of the webserver using the TCP port 8081 in state GOAL_FSA_INIT_SETUP:

```
GOAL_HTTP_T *pWebInstanceHdl;      /* handle for the web-server instance */
goal_httpNew(&pWebInstanceHdl, 8081, 1);
```

3. Register the callback-functions and allowed methods for the opened webserver in state GOAL_FSA_INIT_SETUP:

```
GOAL_HTTP_HDL_T webResourceHdl;
goal_httpResReg(pWebInstanceHdl, (uint8_t *) "/download.html",
                GOAL_HTTP_METHOD_ALLW_GET |
GOAL_HTTP_METHOD_ALLW_POST,
                applWebReqCb, NULL, &webResourceHdl);
```

4. Provide a web-page as string variable:

```
const uint8_t webPage[] = "<html><head><meta charset = \"utf-8\">\
                           <title> Download dialog </title></head> \r\n\
                           <body><h1>Download dialog</h1> \r\n\
                           <form method = \"post\" enctype = \"multipart/form-data\"> \r\n\
                           <input type = \"file\" name = \"file\"> <br> \r\n\
                           <input type = \"submit\" value = \"POST\"> \r\n
                           </form> \r\n\
                           </body></html>"
```

5. Implement an application-specific function applDownload() to receive and install the new firmware.

6. Implement an application-specific function applDownloadFinished() to report the result of the web-request to the application.

7. Implement a callback function to process web-requests:

```
GOAL_STATUS_T applWebReqCb (GOAL_HTTP_APPLCB_DATA_T *pWebData) {
    GOAL_STATUS_T res;     /* GOAL return value */
    res = GOAL_ERROR;      /* no valid web-handle or request method not supported */

    if (webResourceHdl == pWebData->hdlRes) {
        switch (pWebData->reqType) {
            case GOAL_HTTP_FW_GET:
                GOAL_HTTP_GET_RETURN_HTML(pWebData, webPage,
                    GOAL_STRLEN((const char*) webpage));
                break;
            case GOAL_HTTP_FW_POST_START:
                res = applDownload(pWebData);
                GOAL_HTTP_RETURN_OK_204(pWebData);
                break;
            case GOAL_HTTP_FW_POST_DATA:
                res = applDownload(pWebData);
                GOAL_HTTP_RETURN_OK_204(pWebData);
                break;
            case GOAL_HTTP_FW_POST_END:
                res = applDownload(pWebData);
                GOAL_HTTP_RETURN_OK_204(pWebData);
                break;
            case GOAL_HTTP_FW_REQ_DONE_OK:
            case GOAL_HTTP_FW_REQ_DONE_ERR:
                res = applDownloadFinished(pWebData);
```

```
                    break;
                default:
                    break;
            }
        }
        return res;
    }
```

8. The callback function applWebReqCb() is called by the web-server after a web-request is received.

8. Trouble Shooting

This section lists common pitfalls which possibly occur when using the R-IN32M3 Module examples.

8.1 Start-up Issues

In case an example application is started but the expected application behavior is not shown, please check the log:

```
2019-01-18 09:44:45   GOAL_LOG_SEV_INFO   7   [I|goal_miDmPartRegInt:275] part added to 'Write to CC', pos: 1, len: 2
2019-01-18 09:44:45   GOAL_LOG_SEV_INFO   7   [I|appl_setup:798] TX: Slot 3 Subslot 1 DATA: 1
2019-01-18 09:44:45   GOAL_LOG_SEV_INFO   7   [I|appl_httpSetup:100] setup web server
2019-01-18 09:44:45   GOAL_LOG_SEV_INFO   7   [I|goal_httpNewAc:959] HTTP Application Core successfully started
2019-01-18 09:44:45   GOAL_LOG_SEV_INFO   7   [I|appl_httpSetup:178] web server setup done
2019-01-18 09:44:45   GOAL_LOG_SEV_INFO   7   [I|appl_setup:822] Device Version : 1.0.0.0
2019-01-18 09:44:45   GOAL_LOG_SEV_INFO   7   [I|appl_setup:823] Device Type : 1
2019-01-18 09:44:45   GOAL_LOG_SEV_INFO   7   [I|appl_setup:825] Serial Number : b4:e9:a3:00:75:39
2019-01-18 09:44:45   GOAL_LOG_SEV_INFO   7   [I|goal_miMctcRpcSyncLoop:1028] local setup done
2019-01-18 09:44:45   GOAL_LOG_SEV_INFO   7   fixed memory usage: 102096/262144 bytes
2019-01-18 09:44:45   GOAL_LOG_SEV_INFO   7   fixed memory usage: (39%)
2019-01-18 09:47:04   GOAL_LOG_SEV_ERROR   492   [CC_E|goal_miMctcMonitorRx:1250] data channel offline: MCTC SPI
2019-01-18 09:47:13   GOAL_LOG_SEV_INFO   501   [CC_I|goal_miMctcMonitorRx:1239] data channel online: MCTC SPI
2019-01-18 09:47:13   GOAL_LOG_SEV_ERROR   501   [CC_E|goal_miMctcRpcSyncLoop:956] sync needs local reset to proceed
```

If the last log entry regarding „sync needs local reset to proceed“ is shown, the communication controller (CC) needs a reset. This can be achieved using the „RST“ button on the R-IN32M3 Module board.

8.2 Connection Issues

If the SPI communication is not working at all, this can be seen on the following final log message:

```
2019-01-18 09:47:04   GOAL_LOG_SEV_ERROR   492   [CC_E|goal_miMctcMonitorRx:1250] data channel offline: MCTC SPI
```

Please check the board connection and the proper execution of the application on the application controller (AC).

8.3 IP Configuration

In the EtherNet/IP project, if the switch between static IP configuration and DHCP fails after reboot, please check the following CM variables using the management tool:

Table 9.1 IP Configuration

Module ID	Variable ID
GOAL_ID_NET	IP
GOAL_ID_NET	NETMASK
GOAL_ID_NET	GW
GOAL_ID_NET	VALID
GOAL_ID_NET	DHCP_ENABLED

To disable DHCP set the variable DHCP_ENABLED to 0. Make sure variable “VALID” is set to 1. Upload these settings to the CC and save those values permanently. After a reboot DHCP should be disabled.

Revision History		R-IN32M3 Module User's Manual: Software	
Rev.	**Date**	**Description**	
		Page	**Summary**
1.00	Aug 03, 2020	—	First Edition issued
2.00	Nov 06, 2020	18, 23, 86-90, 138-153	Added the EtherCAT function and new function.
		35	Added the chapter 4.10.1.2 Control interface
		97-103	Added the chapter 6.1.8 to 6.1.17
		137-137	Added the chapter 6.4.13, 6.4.14, 6.4.15
		164-164	Optimized Chapter 7
2.01	Jan 15, 2021	48, 73, 119, 120	Change default value
2.02	Jun 14, 2021	16	Add the chapter 1.1
		42	Delete the description of SPI speed range.
2.03	Oct 15, 2021	15	Added description of uGOAL
		16	Update features according to FW 2.1.0.0
		18, 19, 21	Added the wording of uGOAL
		25	Integrated the contents of Chapter 9.4 into Chapter 4.9
		48	Delete Chapter 5.4.1, moved up subsequent chapters
		57	Delete Chapter 5.4.46, moved up subsequent chapters
		59	Fixed a typo in the function name in Chapter 5.5.1
		66	Modify the chapter 5.5.19
		68	Modify the chapter 5.5.23
		77	Added cautions to the chapter 5.6.16
		80, 80	Added the chapter 5.6.23 and 5.6.24
		84, 85	Added the chapter 5.7.10 and 5.7.11
		86	Delete Chapter 5.8.1 – 5.8.6 to describe in Chapter 6.5, moved up subsequent chapters
		89	Overall change of Chapter 5.9 (change of description, addition of chapter)
		99	Added the chapter 6.1.12
		156	Added description of arguments in chapter 6.6.5
		—	Fixed typo (from goal_appl.h to goal_config.h)
		183	Move "Trouble Shooting" to Chapter 8
2.04	2022.06.10	—	Minor correction
2.05	2023.05.31	—	Removed description of Renesas Synergy sample software
		177	7.6.4 Correction: [VAR: deviceComponents] > [VAR:devComponent]
		177	7.6.4 Correction of callback function processing
		124	6.3.30 Add pnioRpcSubmodPlug() for RPC transfer
		132	6.4.5 Add goal_eipCreateAssemblyObjectRpc() for RPC transfer
		149	6.5.16 Add goal_ecatdynOdSubIndexRpcAdd() for RPC transfer

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