HITACHI
Inspire the Next

User Manual – CANopen Adapter

EH-RIO2 Series
RIO2-CAN
Version 1.00

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1. Important Notes

Solid state equipment has operational characteristics differing from those of electromechanical equipment.
Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls describes some important differences between solid state equipment and hard-wired electromechanical devices.
Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Hitachi be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.
The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Hitachi cannot assume responsibility or liability for actual use based on the examples and diagrams.

Warning!

- ✓ **If you don't follow the directions, it could cause a personal injury, damage to the equipment or explosion**
- Do not assemble the products and wire with power applied to the system. Else it may cause an electric arc, which can result into unexpected and potentially dangerous action by field devices. Arching is explosion risk in hazardous locations. Be sure that the area is non-hazardous or remove system power appropriately before assembling or wiring the modules.
- Do not touch any terminal blocks or IO modules when system is running. Else it may cause the unit to an electric shock or malfunction.
- Keep away from the strange metallic materials not related to the unit and wiring works should be controlled by the electric expert engineer. Else it may cause the unit to a fire, electric shock or malfunction.

Caution!

- ✓ **If you disobey the instructions, there may be possibility of personal injury, damage to equipment or explosion. Please follow below Instructions.**
- Check the rated voltage and terminal array before wiring. Avoid the circumstances over 55℃ of temperature. Avoid placing it directly in the sunlight.
- Avoid the place under circumstances over 85% of humidity.
- Do not place Modules near by the inflammable material. Else it may cause a fire.
- Do not permit any vibration approaching it directly.
- Go through module specification carefully, ensure inputs, output connections are made with the specifications. Use standard cables for wiring.
- Use Product under pollution degree 2 environment.

1.1 Safety Instruction

1.1.1 Symbols

DANGER 	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death property damage or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION 	Identifies information about practices or circumstances that can lead to personal injury, property damage, or economic loss. Attentions help you to identity a hazard, avoid a hazard, and recognize the consequences.

1.1.2 Safety Notes

DANGER 	The modules are equipped with electronic components that may be destroyed by electrostatic discharge. When handling the modules, ensure that the environment (persons, workplace and packing) is well grounded. Avoid touching conductive components, e.g. FnBUS Pin.

1.1.3 Certification (TBD)

c-UL-us UL Listed Industrial Control Equipment, certified for U.S. and Canada
See UL File E235505

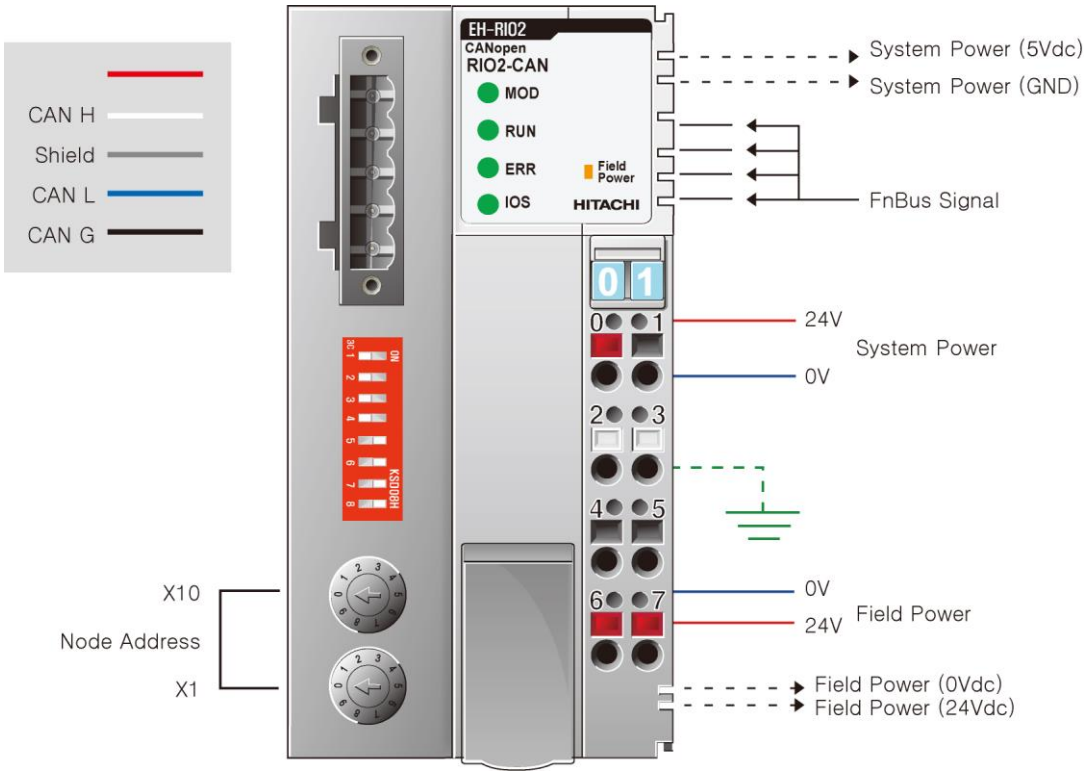
CE Certificate
EN 61000-6-2:2005
EN 61000-6-4/A11:2011

FCC
RoHS (EU, China)

2. Specification

2.1 The Interface

2.1.1 RIO2-CAN (CANopen)



Pin No.	Signal Description	Signal Description	Pin No.
0	System Power, 24V	System Power, Ground	1
2	F.G	F.G	3
4	Field Power, Ground	Field Power, Ground	5
6	Field Power, 24V	Field Power, 24V	7

2.2 Specification

2.2.1 Environment Specification

Environmental specification	
Operating Temperature	-20℃~55℃
Storage Temperature	-40℃~85℃
Relative Humidity	5% ~ 90% non-condensing
Operating Altitude	2000m
Mounting	DIN rail
General specification	
Shock Operating	IEC 60068-2-6
Vibration/shock resistance	Based on IEC 60068-2-6 Sine Vibration - 10 ~ 25 Hz : 0.5mm - 50 ~ 150 Hz : 5g - 150 ~ 1000 Hz : 2g - Sweep Rate : 1 Oct/min, 50 cycles Sine Vibration - 10 ~ 25 Hz : 0.03 g^2/Hz - 25 ~ 50 Hz : 0.05 g^2/Hz - 50 ~ 150 Hz : 0.15 g^2/Hz - 150 ~ 1000 Hz : 0.01 g^2/Hz - Test time : 5hrs for each test
EMC resistance burst/ESD	EN 61000-6-2 : 2005 EN 61000-6-4/ALL : 2011
Installation Pos. / Protect. Class	Variable/IP20
Product Certifications	TBD

2.2.2 General Specification

General Specification	
System Power	Supply voltage : 24Vdc nominal Supply voltage range : 11~28.8Vdc Protection : Output current limit (Min. 1.5A) Reverse polarity protection
Power Dissipation	40mA typical @ 24Vdc
Current for I/O Module	1.5A @ 5Vdc
Isolation	System power to internal logic : Non-isolation System power I/O driver : Isolation
Field Power	Supply voltage : 24Vdc nominal Supply voltage range : 11~28.8Vdc
Max. Current Field Power Contact	DC 10A Max
Weight	<167g
Module Size	54mm x 99mm x 70mm
Environment Condition	**Refer to '2.2.1. Environment Specification'**

2.2.3 Interface Specification

Interface Specification, RIO2-CAN	
Items	**Description**
Adapter Type	Slave node (CANopen, CiA 301)
Max. PDO Number	32 TPDO / 32 RPDO
PDO Mapping Method	Auto Mapping : CiA 301 (default), Sequential Manual Mapping (Reference to Index : 0x20F0, Sub Index : 6)
Max. Expansion Module	63 slots
Max. Input size	252 bytes
Max. Output size	252 bytes
Nodes	1~99
Baud rate	10, 20, 50, 100, 125, 250, 500, 800, 1000 Kbps (default 1000Kbps)
Interface Connector	5pin Open Connector
Other Serial Port	RS232 for MODBUS/RTU(Touch Panel, IOGuide ...)
Serial Configuration (RS232)	Node : 1 (Fixed) Baud Rate : 115200 (Fixed) Data bit : 8 (Fixed) Parity bit : No parity (Fixed) Stop bit : 1 (Fixed)
Indicator	5 LEDs 1 Green/Red, Module Status (MOD) 1 Green, Network Status (RUN) 1 Red, Error Status (ERROR) 1 Green/Red, Expansion I/O Module Status (I/O) 1 Green, Field Bus Power Status
Module Location	Left side of S-Series system
Field Power Detection	About 11Vdc

2.3 LED Indicator

2.3.1 Module Status LED (MOD)

State	LED is :	To indicate :
No Power	Off	No power is supplied to the unit.
Normal operation	Green	The unit is operating in normal condition.
Unrecoverable Fault	Red	The device has an unrecoverable fault. − Memory error or CPU watchdog error.

2.3.2 CANopen status LED (RUN)

State	LED is :	To indicate :
Not Powered	OFF	Module is either not getting power, or it is NOT_ACTIVE status. Module is initializing.
Stopped	Single flash Green	Module is stopped
PreOperational	Blinking Green	Module is in PRE_OPERATIONAL
Operational	Green	Module is in OPENRATIONAL

2.3.3 CANopen Error LED (ERR)

State	LED is :	To indicate :
Not Powered	OFF	Module is not getting powered or No error.
Warning limit reached	Single flash	At least one of the error counters of the CAN controller has reached or exceeded the warning limit.
Error control Event	Double flash	A guard event (NMT-Slave or NMT-Master) or a Heartbeat event has occurred.
Sync. Error	Triple flash	The SYNC message has not been received within then configured communication cycle period time out (see index 0x1006)
Event-timer Error	Quadruple flash	An expected PDO has not been received before the event-timer elapsed.
Bus Off	ON	The CAN controller is bus off.

2.3.4 Expansion Module Status LED (I/O)

State	LED is :	To indicate :
Not Powered No Expansion Module	OFF	Device has no expansion module or may not be powered.
Internal Bus On-line, Do not Exchanging I/O	Flashing Green	Internal Bus is normal but does not exchanging I/O data. (Passed the expansion module configuration)
Internal Bus Connection, Run Exchanging I/O	Green	Exchanging I/O data.
Internal Bus Connection Fault during Exchanging I/O	Flashing Red	One or more expansion module occurred in fault state. - Changed expansion module configuration. - Internal Bus communication failure.
Expansion Configuration Failed	Red	Failed to initialize expansion module. - Detect invalid expansion module ID. - Overflow Input/Output size. - Too many expansion module. - Initial protocol failure. - Mismatch vendor code between adapter and expansion module.

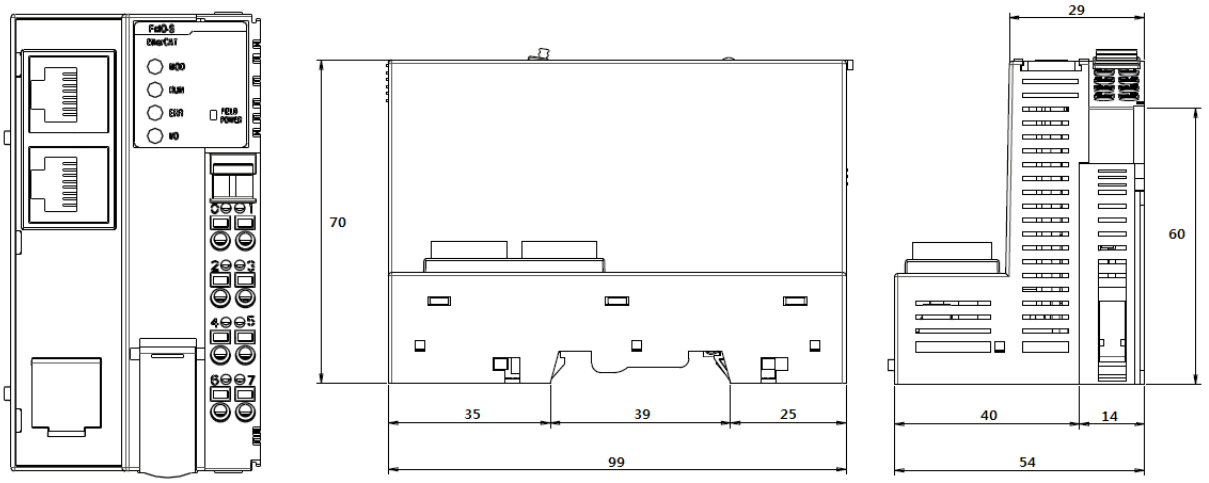
2.3.5 Field Power Status LED

State	LED is :	To indicate :
Not Supplied Field Power	Off	Not supplied 24V dc field power
Supplied Field Power	Green	Supplied 24V dc field power

3. Dimension

3.1 RIO2-CAN

(mm)

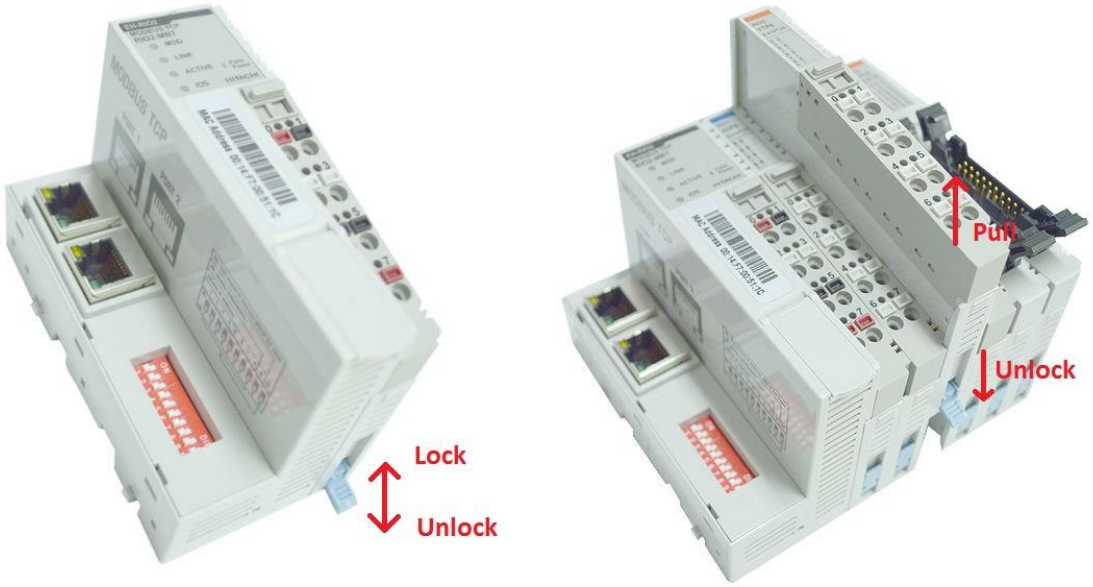


4. Mechanical Setup

4.1 Total Expansion

The number of the module assembly that can be connected is 63. So the maximum length is 426mm Exception. RIO2-YR8 is excepted to calculate maximum length because that is double width module.

4.2 Plugging and Removal of the Components.

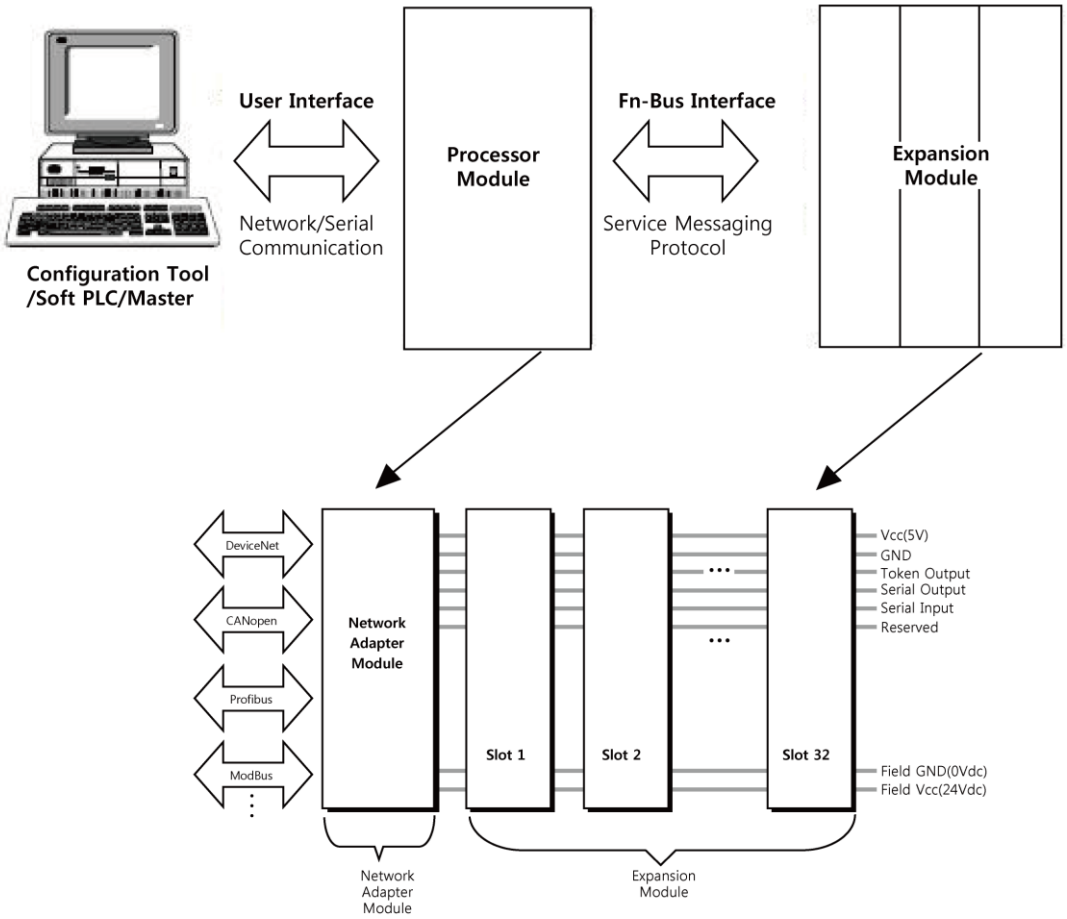


As above figure in order to safeguard the FnIO module from jamming, it should be fixed onto the DIN rail with locking level. To do so, fold on the upper of the locking lever.
To pull out the FnIO module, unfold the locking lever as below figure.

DANGER 	Before work is done on the components, the voltage supply must be turned off.

5. Electrical Interface

5.1 FnBus System



• Network Adapter Module

The Network Adapter Module forms the link between the field bus and the field devices with the Expansion Modules.

The connection to different field bus systems can be established by each of the corresponding Network Adapter Module, e.g. for SyncNet, PROFIBUS, CANopen, DeviceNet, Ethernet/IP, EtherCAT, CC-Link, MODBUS/Serial, MODBUS/TCP etc.

• Expansion Module

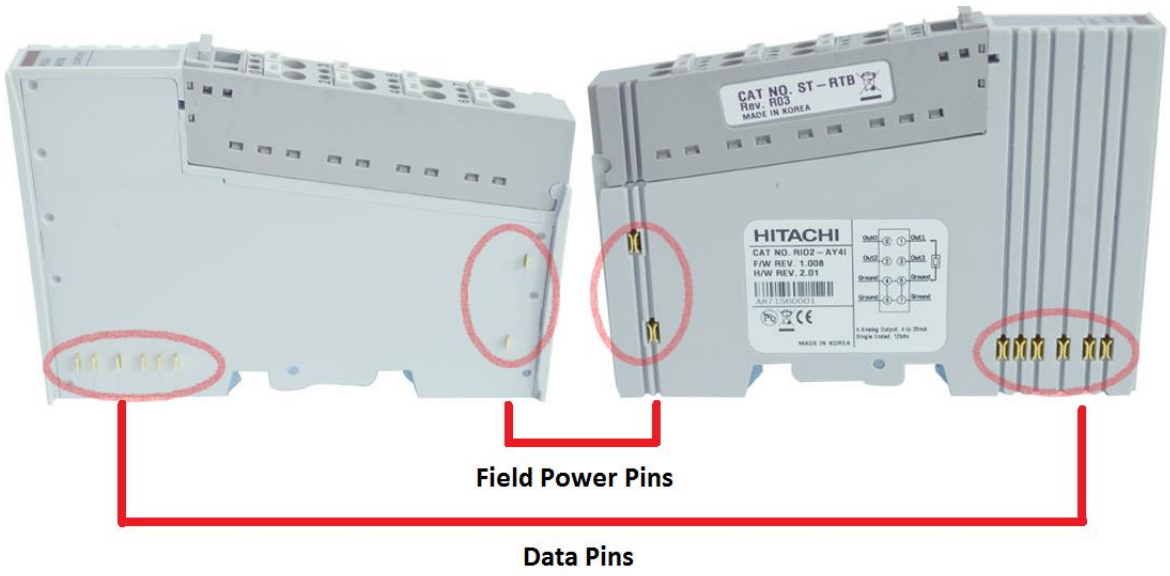
The Expansion Modules are supported a variety of input and output field devices.
There are digital and analog input/output modules and special function modules.

• Two types of FnBus Message

- Service Messaging
- I/O Messaging

5.1.1 FnBus Pin Description

Communication between the NA series and the expansion module as well as system / field power supply of the bus modules is carried out via the internal bus. It is comprised of 6 data pin and 2 field power pin.

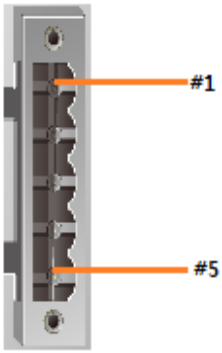


No.	Name	Description
1	Vcc	System supply voltage (5V dc).
2	GND	System Ground.
3	Token Output	Token output port of Processor module.
4	Serial Output	Transmitter output port of Processor module.
5	Serial Input	Receiver input port of Processor module.
6	Reserved	Reserved for bypass Token.
7	Field GND	Field Ground.
8	Field Vcc	Field supply voltage (24Vdc).

DANGER 	Do not touch data and field power pins in order to avoid soiling and damage by ESD noise.

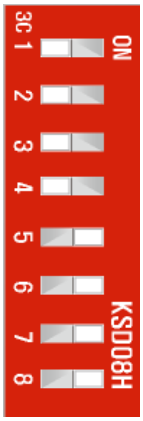
5.2 CANopen Electrical Interface

5.2.1 RIO2-CAN 5pin open connector



No.	Signal Name	Description
1	-	
2	CAN H	CAN High
3	Shield	F.G
4	CAN L	CAN Low
5	CAN G	CAN GND

5.2.2 Dip Switch



DIP Pole#	Description	
1	Terminal Resister	On : Terminal Resister On
2	Reserved	
3		
4		
5	Baudrate #4	Default : 0 (1000kbps) **5 6 7 8 (ex.)** 0 0 0 1 : 10Kbps 1 0 0 1 : 1000Kbps
6	Baudrate #3	
7	Baudrate #2	
8	Baudrate #1	

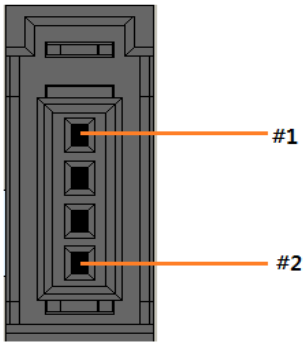
5.2.3 Address switch

x 10

x 1

Each Adapter could have an unique address (from 1 to 99) so that it can be addressed independently from other nodes. The address 0 is reserved.

5.2.4 RS232 Port for Modbus-RTU, IOGuide



RS232 (37204-64A3-004PL/3M		
Pin#	**Signal Name**	**Description**
1	Reserved	----
2	TXD	RS-232C TXD
3	RXD	RS-232C RXD
4	GND	RS-232C GND

5.3 Example

5.3.1 Example of Input Process Image (Input Register) Map

Input image data depends on slot position and expansion slot data type. Input process image data is only ordered by expansion slot position when input image mode is uncompressed (mode 0). But, when input image mode is compressed (mode 1), input process image data is ordered by expansion slot position and slot data type. Input process image mode can be set by Object Index 0x4500

For example slot configuration

Slot Address	Module Description
0	CANopen Adapter
1	4-discrete input
2	8-discrete input
3	2-analog input
4	16-discrete input
5	4-discrete input
6	8-discrete input
7	4-discrete input
8	2-analog input
9	16-discrete input
10	1ch, high speed counter

Non-compress mode data format

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Index	Sub-Index
0	Analog Input Ch0 low byte (Slot#3)								0x6401	0x01
1	Analog Input Ch0 high byte (Slot#3)								0x6401	0x01
2	Analog Input Ch1 low byte (Slot#3)								0x6401	0x02
3	Analog Input Ch1 high byte (Slot#3)								0x6401	0x02
4	Analog Input Ch0 low byte (Slot#8)								0x6401	0x03
5	Analog Input Ch0 high byte (Slot#8)								0x6401	0x03
6	Analog Input Ch1 low byte (Slot#8)								0x6401	0x04
7	Analog Input Ch1 high byte (Slot#8)								0x6401	0x04
8	Reserved				Discrete Input 4 pts. (Slot#1)				0x6000	0x01
9	Discrete Input 8 pts. (Slot#2)								0x6000	0x02
10	Discrete Input low 8 pts. (Slot#4)								0x6000	0x03
11	Discrete Input high 8 pts. (Slot#4)								0x6000	0x04
12	Reserved				Discrete Input 4 pts. (Slot#5)				0x6000	0x05
13	Discrete Input 8 pts. (Slot#6)								0x6000	0x06
14	Reserved				Discrete Input 4 pts. (Slot#7)				0x6000	0x07
15	Discrete Input low 8 pts. (Slot#9)								0x6000	0x08
16	Discrete Input high 8 pts. (Slot#9)								0x6000	0x09
17	Reserved				Discrete Input 4 pts. (Slot#10)				0x6000	0x0A
18	HSC Input 0byte(Slot#10)								0x3000	0x01
19	HSC Input 1byte(Slot#10)								0x3000	0x02
20	HSC Input 2byte(Slot#10)								0x3000	0x03
21	HSC Input 3byte(Slot#10)								0x3000	0x04
22	HSC Input 4byte(Slot#10)								0x3000	0x05
23	HSC Input 5byte(Slot#10)								0x3000	0x06
24	HSC Output 0byte(Slot#10)								0x3200	0x01
25	HSC Output 1byte(Slot#10)								0x3200	0x02

6. Object directory

All the CANopen objects relevant for the Network Adaptor are entered into the CANopen object directory. Th e object directory is divided into three different regions:

1) communication-specific profile region (index 0x1000 – 0x1FFF)
2) manufacturer-specific profile region (index 0x2000 – 0x5FFF)
3) standardized device profile region (0x6000 – 0x9FFF)

Region 1 thus contains the description of all the parameters particular to communication, the manufacturer-spe cific entries are described in region 2, and region 3 stores the objects for the device profile according to DS-401. Every entry in the object directory is identified by a 16 bit index.

6.1 Communication Profile Area

The following table contains all objects of the communication profile supported by the Network adaptor

Index	Sub-Index	Name	Type	Attribute	Default	Meaning
0x1000	0x00	Device type	unsigned32	ro		Statement of device type
0x1001	0x00	Error register	unsgined8	ro		Error register
0x1003	0x00	Predefine error field	unsgined8	rw	0	Number of error states stored
	0x01	Standard error filed	unsigned32	ro	0	Error state are stored
0x1005	0x00	COB-ID sync message	unsigned32	rw	0x80000080	Identifier of the Sync message
0x1006	0x00	Communication cycle period	unsigned32	rw	0	Communication cycle period in. '0' if not used
0x1007	0x00	Synchronous Window Length	unsigned32	rw	0	Synchronous Window Length
0x1008	0x00	Manufacturer device name	visible string	ro	RIO2-CAN	Device name of the Adapter
0x1009	0x00	Manufacturer hardware version	visible string	ro	100	H/W version description
0x100A	0x00	Manufacturer software version	visible string	ro	100	Software version number
0x100C	0x00	Guard time	unsigned16	rw	0x00C8	Interval between two guard telegrams. Is set by the NMTmaster.(mS)
0x100D	0x00	Life time factor	unsgined8	rw	2	Life time factor * guard time = life time(watchdog for life guarding)
0x1010	0x00	Largest sub index supported	unsigned32	ro	1	Number of store options
	0x01	Save all parameters	unsigned32	rw	1	Store all parameters 0x65766173(ASCII : save)
0x1011	0x00	Restore default parameters	unsgined8	ro	1	Number of restore options
	0x01	Restore all default	unsigned32	rw	1	Restore all default parameters 0x64616F6C(ASCII : load)
0x1012	0x00	COB-ID Time Stamp	unsigned32	rw	100	COB-ID Time Stamp
0x1014	0x00	COB-ID emergency message	unsigned32	ro	0x80+node ID	COB-ID of the emergency object
0x1015	0x00	Inhibit time EMCY	unsigned16	rw	0	COB-ID SYNC
0x1016	0x00	Number of entries	unsgined8	ro	5	
	0x01	Consumer Heartbeat time1	unsigned32	rw	0	
	0x02	Consumer Heartbeat time2	unsigned32	rw	0	
	...	...	...	...	...	
	0x05	Consumer Heartbeat time5	unsigned32	rw	0	Heartbeat time value
0x1017	0x00	Producer Heartbeat time	unsigned16	rw		Producer Heartbeat time (0~127)
0x1018	0x00	Identity object	unsgined8	ro	4	
	0x01	Manufacturer ID	unsigned32	ro	0x000002E5	
	0x02	Product code	unsigned32	ro	0x00001060	Identity Object
	0x03	Revision number	unsigned32	ro	0x00000100	
	0x04	Serial number	unsigned32	ro		
0x1019	0x00	Synchronous counter overflow value	unsigned16	rw	0	Synchronous counter overflow value
0x1029	0x00	Number of error	unsgined8	ro	1	
	0x01	Communication Error	unsgined8	rw	0	Error Behavior
0x1400	0x00	Number of entries	unsgined8	ro	5	
	0x01	COB-ID used by PDO	unsigned32	rw	0x200+nodeID	
	0x02	Transfer type	unsgined8	rw	0xFE	
…	…	…				
0x141F	0x00	Number of entries	unsgined8	ro	5	
	0x01	COB-ID used by PDO	unsigned32	rw		Receive PDO Communication
	0x02	Transfer type	unsgined8	rw	0xFE	Parameter 1-32

0x1600	0x00	Number of entries	unsgined8	rw	8	Receive PDO Mapping Parameter 1-32
	0x01	1. Mapping Entry 1	unsigned32	rw		
	…	…				
	0x08	8. Mapping Entry 8	unsigned32	rw		
…	…	…				
0x161F	0x00	Number of entries	unsgined8	rw	8	
	0x01	1. Mapping Entry 1	unsigned32	rw		
	…	…				
	0x08	8. Mapping Entry 8	unsigned32	rw		
0x1800	0x00	Number of entries	unsgined8	ro	5	Transmit PDO Communication Parameter 1-32
	0x01	COB-ID used by PDO	unsigned32	rw	0x180+nodeID	
	0x02	Transfer type	unsgined8	rw	0xFE	
…	…	…				
0x181F	0x00	Number of entries	unsgined8	ro	5	
	0x01	COB-ID used by PDO	unsigned32	rw		
	0x02	Transfer type	unsgined8	rw	0xFE	
0x1A00	0x00	Number of entries	unsgined8	rw	8	Transmit PDO Mapping Parameter 1-32
	0x01	1. Mapping Entry 1	unsigned32	rw		
	…	…				
	0x08	8. Mapping Entry 8	unsigned32	rw		
…	…	…				
0x1A1F	0x00	Number of entries	unsgined8	rw	8	
	0x01	1. Mapping Entry 1	unsigned32	rw		
	…	…				
	0x08	8. Mapping Entry 8	unsigned32	rw		

- **Object 0x1000, Device Type**

The object indicates the implemented device profile. The CANopen Network Adaptor has implemented the Device Profile for Generic I/O Modules" (device profile No. 401). Moreover, in the index 0x1000 the value informs about the type of modules connected.

Format:

MSB LSB

4 byte	3 byte	2 byte	1 byte	0 byte
0x00	0x00	0000.4321 (bit)	0x01	0x91
		Device connect Number	Device Profile Number	

Bit	**Meaning**
1	1 = 1, if at least one digital input is connected.
2	2 = 1, if at least one digital output is connected.
3	3 = 1, if at least one analog input is connected.
4	4 = 1, if at least one analog output is connected.

- **Object 0x1001, Error Register**

This register contains internal errors. This register is also part of the emergency message

Format:

Bit	**Meaning**
0	General Error
1	Reserved
2	Reserved
3	Reserved
4	Communication
5	Device profile specific
6	Reserved
7	Manufacturer specific

In the event of an error, bit 0 is always set. Additional bits used specify the error in more detail.

- **Object 0x1003, Pre-defined Error Field**

The sub-index 0 contains the errors currently stored in the field. If a new error occurs, it will be entered in sub-index 1, and all errors already existing moved down by one sub-index. A max. Of 20 error entries are supported. Should more than 20 errors occur, each time the error contained in sub-index 20 is written over?

Format:

Bit31	Bit16	Bit15	Bit0
Additional Information		Error code	

The additional information corresponds to the first 2 bytes of the additional code of the Emergency telegram. The error code coincides with the error code in the Emergency telegram.
The complete error memory is deleted by writing a .0" in sub-index 0.

- **Object 0x1005, COB-ID SYNC message**

The object defines the COB ID for the synchronization message.

Bit31	Bit11	Bit10	Bit0
Reserved (always 0)		COB-ID	

- **Object 0x1006, Communication Cycle Period**

The object defines the max. Time in µs for two subsequent SYNC messages.
The internal resolution is 2ms. If the value is 0, no SYNC monitoring is performed.

- **Object 0x1008, Manufacturer Device Name**

The object indicates the device name of the Network Adaptor.

- **Object 0x1008, Manufacturer Device Name**

The object contains the length of the time window for synchronous PDOs in us. It is 0 if not used.

- **Object 0x1009, Manufacturer Hardware Version**

The object indicates the current hardware version of the Network Adaptor

- **Object 0x100A, Manufacturer Software Version**

The object indicates the current software version of the Network Adaptor

- **Object 0x100C, Guard Time**

The object indicates the Guarding Time in milli-seconds. An NMT master cyclically interrogates the NMT slave for its status. The time between two interrogations is termed Guard Time.

- **Object 0x100D, Life Time Factor**

The life Time Factor is part of the Node Guarding Protocol. The NMT slave checks if it was interrogated within the Node Life Time (Guard time multiplied with the life time factor). If not, the slave works on the basis that the NMT master is no longer in its normal operation. It then triggers a Life Guarding Event.
If the node life time is zero, no monitoring will take place.

- **Object 0x1010, Store Parameters**

This object allows to permanently storing the settings made by the user. For this purpose, the signature .save" (lower case letters ASCII - MSB. 0x65 76 61 73 - LSB) must be written into the index 0x1010 sub index 1. The storing process runs in the background and takes approx. 2-3 seconds. When the storing process is finished, the SDO reply telegram is sent. Communication remains possible during storage by means of SDOs. An error message as a result of a new storage attempt only occurs, when the previous one was not yet finished.
It is also not possible to trigger the storage function for as long as .Restore" is active.
As soon as a setting is stored, the Emergency .Changed HW configuration. Is not sent any longer if the Network Adaptor is started up again without changing the module configuration.

> **Attention :**
> If following the storage of a configuration only the module ID is changed via the DIP switch, the saved configuration is continued to be used. In other words, all module ID specific entries in the object directory (objects that are module ID dependent and have the .rw" attribute) signal with the old values.

- **Object 0x1011, Restore default Parameters**

This object allows resetting the user stored parameters to the original default values.
Sub-indexes 2 and 3 are not supported.
The load command is processed in the background and takes approx. 2-3 seconds. When the performance is finished, the SDO reply message is sent. Communication can be continued during performance using SDOs. An error message is only tripped with another attempt to send a load command, if the previous one is not yet completed. It is also not possible to trigger a load command for as long as .Save" is active.
Sub-index 1 - Permanent entry of default parameters:
Writing the signature .load" (lower case letters ASCII - MSB 0x64 0x61 0x6F 0x6C LSB) into the index 0x1011 sub-index 1 entails loading of the standard factory settings after the following Power ON and each further Power On (until the next SAVE command is given).

- **Object 0x1014, COB-ID Emergency Object**

The object defines the COB ID for the EMCY message.

Bit31	Bit30 ... Bit11	Bit10 ... Bit0
0/1 valid/invalid	reserved (always 0)	COB-ID

If a new COB ID is to be entered, set bit 31 to 1 first, because standard DS301 does not allow to change a valid COB ID (Bit31=0).

- **Object 0x1015, Inhibit Time Emergency Object**

This object indicates the time in minutes which must be allowed to elapse prior to another Emergency to be sent.
An entry of zero deactivates the delayed transmission.
Due to the fact that with delayed transmission the entries are entered in a queue, the max. number of Emergencies in quick succession is limited to the queue size (20 entries). If this number is exceeded, an Emergency is sent immediately indicating the overflow.
One time unit is 100µs.

- **Object 0x1016, Consumer Heartbeat Time**

This entry allows the monitoring of a maximum of 1modules. The system checks whether each module defined in this object has created a Heartbeat within the set time. If the set time was exceeded, a Heartbeat-Event is triggered. The Heartbeat-Time is entered in milli-seconds. The monitoring is deactivated, if the time value is 0.

Format:

	MSB		LSB
Bit	31-24	23-16	15-0
Value	Reserved	Node-ID	Heartbeat Time
Data Type	-	Unsigned8	Unsigned16

- **Object 0x1017, Producer Heartbeat Time**

The object defines the time between two Heartbeat messages sent in milliseconds. If the time is 0, no Heartbeat is sent. The Heartbeat transmission starts as soon as a value other than 0 is entered.

- **Object 0x1018, Identity Object**

The object specifies the device used.

- **Object 0x1029, Error behavior**

The object specifies to which state an I/O module shall be set, when a communication error, output error or input error is detected.

- **Object 0x1400 ~ 0x141F Receive PDO Communication Parameter**

This object is used to set the communication parameters of the RxPDOs. 8 RxPDOs are supported. The default COB IDs of the first four PDOs is reassigned according to the DS301 standard. All further PDOs are deactivated. If not all default PDOs are used (i.e. a smaller number of modules is connected), also the default PDOs not used are deactivated.

Format COB-ID:

Bit31	Bit30	Bit29 Bit11	Bit10 Bit0
0/1 valid/invalid	0/1 RTR allowed / not allowed	reserved (always 0)	COB-ID

If a new COB ID is to be entered, bit 31 must be set to 1 first, because the DS301 standard does not permit to change a valid COB ID (Bit31=0).

- **Object 0x1600 ~ 0x161F, Receive PDO Mapping Parameter**

This object is used to define the data, which is to be transmitted by means of the PDO.
Sub-index 0 contains the number of objects valid for the PDO.

Design 1. to 8. Object:

Bit31 Bit16	Bit15 Bit8	Bit7 Bit0
Index (Unsigned16)	Sub-Index (Unsigned8)	Size (Unsigned8)

Index: Index of the object to be transmitted
Sub-Index: Sub-index of the object to be transmitted
Size: Object size in bits Due to the fact that max. 32 bytes can be transmitted in a PDO, the sum of the valid object lengths must not exceed 252 (32Byte*8Bit = 256 but, Fnbus specification is Max.252bytes)

- **Object 0x1800 ~ 0x181F, Transmit PDO Communication Parameter**

This object is used to set the communication parameters of the TxPDOs. 8 TxPDOs are supported. The default COB IDs of the first four PDOs is reassigned according to the DS301 standard. All other PDOs are de-activated. If not all default PDOs are used (i.e. a smaller number of modules is connected), also the default PDOs not used are de-activated.

Attention :

An object entry can only be mapped in a **max. of 3 different** PDOs.

- **Object 0x1A00 ~ 0x1A1F, Transmit PDO Mapping Parameter**

This object is used to define the data, which is transmitted using the PDO. Sub-index 0 contains the number of objects valid for the PDO.

Design 1. to 8. Object:

Bit31 Bit16	Bit15 Bit8	Bit7 Bit0
Index (Unsigned16)	Sub-Index (Unsigned8)	Size (Unsigned8)

Index: Index of the object to be transmitted
Sub-Index: Sub-index of the object to be transmitted
Size: Object size in bits Due to the fact that max. 8 bytes can be transmitted in a PDO, the sum of the valid object lengths must not exceed 252

6.2 Manufacturer Specific Profile Area

The following table contains all objects of the communication profile supported by the Network adaptor

*0x2100(Slot#0=NA), 0x2101(Slot#1), 0x2102(Slot#2)...

Index	Sub-Index	Name	Type	Attribute	Default	Meaning
0x20F0	0x00	Number of entries	unsigned8	ro	0x4F	
	0x01	Node id current switch value	unsigned8	ro		Node ID value
	0x02	Number of module	unsigned16	ro		Number of Module
	0x03	Run command 0 : IO_Available 1 : IO_Ready 2 : IO_Idle 3 : IO_Run 4 : IO_Timeout 5 : IO_Minorfault 6 : IO_Unrecoveryfault 7 : Reset	unsigned16	ro	0	
	0x04	All module id	unsigned16*n	ro		All module name
	0x05	Baudrate	unsigned16	ro		Baudrate Setting value 0x03E8 : 1000(default)
	0x06	PDO Mapping Mathod 0 : DS301(Auto) (default) 2 : Manual	unsigned8	rw	0	
	0x0C	Status, error information	unsigned32	ro	0x00000003	
	0x0E	All size of output bit	unsigned16	ro		
	0x0F	All size of input bit	unsigned16	ro		
	0x10	All size of output byte	unsigned16	ro		
	0x11	All size of input byte	unsigned16	ro		
0x21xx	0x04	Module ID	unsigned16	ro		
	0x08	Address of output byte	unsigned16	ro		
	0x09	Address of input byte	unsigned32	ro		
	0x0C	Fnbus Status, error information	unsigned32	ro		
	0x0E	Size of output bit	unsigned16	ro		
	0x0F	Size of input bit	unsigned16	ro		
	0x12	IO Data output#0	unsigned8*n	rw		
	0x13	IO Data input#0	unsigned8*n	ro		
	0x16	Parameter length	unsigned16	ro		
	0x17	Parameter data	unsigned8*n	rw		
	0x18	Hardware Rev	unsigned32	ro		
	0x19	Firmware Rev	unsigned32	ro		
	0x1A	Firmware release date	unsigned32	ro		
	0x1B	Inspection date	unsigned16	ro		
	0x20	String, Module description	unsigned8*n	ro		
0x3000	0x00	Read special input data	unsigned8	ro	0xFE	
	0x1	8-bit special input 1	unsigned8	ro		
	…	…	...	...	...	
	0xFE	8-bit special input 254	unsigned8	ro		Read Special Input 8 bit
0x3005	0x00	Enable special input interrupts	unsigned8	rw	1	
0x3006	0x00	Number of entries	unsigned8	ro	0xFE	
	0x01	Special input interrupt mask any change for special input 1	unsigned8	rw	0xFF	Special input Interrupt Mask any change for Special Inputs
	...	...	...	...	...	

	0xFE	Special input interrupt mask any change for special input 254	unsigned8	rw	0xFF	
0x3200	0x00	Number of entries	unsigned8	ro	0xFE	number of entries
	0x01	8-bit special output 1	unsigned8	rw	0	1st special output block
	…	…	...	...	...	
	0xFE	8-bit special output 254	unsigned8	rw	0	64st special output block
0x3206	0x00	Number of entries	unsigned8	ro	0xFE	
	0x01	Faultmode for special output 1	unsigned8	rw	0xFF	
	...	...	...	...	...	
	0xFE	Faultmode for special output 254	unsigned8	rw	0xFF	Error Mode 8 Special output
0x3207	0x00	Number of entries	unsigned8	ro	0xFE	
	0x01	Fault state for special output 1	unsigned8	rw	0	
	...	...	...	...	...	
	0xFE	Fault state for special output 254	unsigned8	rw	0	Fault State 8 output lines

- **Object 0x2100(Slot#0=NA), Manufacture Information.**

Index	Sub	Name	Type	Attribute	Default	Meaning
0x2100	0x00	number of entries	unsigned8	ro	0x4F	number of entries(slot number)
	0x04	module id	unsigned16	ro	0	

- **Object 0x2101(Slot#1=IO), ... , 0x213F(Slot#63=IO), IO Module Information.**

Index	Sub	Name	Type	Attribute	Default	Meaning
0x213F	0x00	number of entries	unsigned8	ro	0x4F	number of entries(slot number)
	0x04	module id	unsigned16	ro	0	

- **Object 0x20F0, Network Adapter Status.**

This object contains the Network Adapter status.
- Sub-index 2 contains rotary switch value set Node ID from NA.
- Sub-index 5 contains Dip switch value set baudrate from NA. If you write 5(125), you can read 7Dh.
- Sub-index 6 set Master's PDO mapping method. By default, DS301 Auto mapping. PDO1 is digital IO, PDO2 analog IO and PDO3~4 additional analog IO. If no additional analog IO, remap digital IO and special IO in slot order. Sequential mapping set all digital IO, in second analog IO and Special IO lastly. Manual is not mapping. So you need separate master.

- **Object 0x3000, Special Modules, Inputs.**

This object contains the process data of the special input modules. Sub-index 1 contains the first 8 special input channels from the left to the right, counted from starting with the Network Adaptor. Sub-index 2 the next etc.

- **Object 0x3005, Special Inputs Interrupt.**

This object shall enable and disable special module the interrupt behavior without changing the interrupt mask. By default, special input activates an interrupt.

- **Object 0x3005, Special Inputs Interrupt.**

This object determines, which input port lines shall activate an interrupt by positive or/and negative edge detection.

- **Object 0x3200, Special Modules, Outputs.**

This object contains the process data of the special output modules. Sub-index 1 contains the first 8 special output channels from the left to the right, counted from starting with the Network Adaptor. Sub-index 2 the next etc.

- **Object 0x3206, Special Output Error Mode**

This object is used to define whether the outputs change to a pre-defined error status (see object 0x3207) in the event of an error (i.e. Adapter changes to the Stopped status, Node guarding has failed,). Once the error is remedied, the outputs retain their momentary status, i, e. the set error status of the output channels remains unchanged.
All analog outputs that are not covered by the object 0x3207 are always set to 0 in the event of an error.
0 = The output remains unchanged
1 = The output changes to a pre-defined error status

- **Object 0x3207, Special Output Error Value integer**

This object is used to define values that they are to assume in the event of an error. Prerequisite being that the corresponding bit is set in object 0x3206

6.3 Standard Device Profile Area – DS401

Index	Sub-Index	Name	Type	Attribute	Default	Meaning
0x6000	0x00	Number of entries	unsgined8	ro	0xFE	
	0x01	Digital input 1-8	unsgined8	ro	0	
	…	…	…	…	…	
	0xFE	Digital input 2025-2032	unsgined8	ro	0	Read State 8 Input lines
0x6005	0x00	Enable digital input interrupts	unsgined8	rw	1	enable digital input interrupts
0x6006	0x00	Number of entries	unsgined8	ro	0xFE	
	0x01	Input interrupt mask any change for digital input 1-8	unsgined8	rw	0xFF	
	…	…	…	…	…	
	0xFE	Input interrupt mask any change for digital input 2025-2032	unsgined8	rw	0xFF	Input Interrupt Mask 8 - any change
0x6007	0x00	Number of entries	unsgined8	ro	0xFE	
	0x01	Input interrupt mask low to high for digital input 1-8	unsgined8	rw	0	
	...	...	...	...	...	
	0xFE	Input interrupt mask low to high for digital input 2025-2032	unsgined8	rw	0	Input Interrupt Mask 8 - low to high
0x6008	0x00	Number of entries	unsgined8	ro	0xFE	
	0x01	Input interrupt mask high to low for digital input 1-8	unsgined8	...	0	
	…	…	…	…	…	
	0xFE	Input interrupt mask high to low for digital input 2025-2032	unsgined8	rw	0	Input Interrupt Mask 8 - high to low
0x6200	0	Digital 1byte outputs	unsgined8	ro	0xFE	
	1	Digital output 1-8	unsgined8	rw	0	
	…	…	…	…	…	
	0xFE	Digital output 2025-2032	unsgined8	rw	0	Write State 8 Ouput lines
0x6206	0	Number of entries	unsgined8	ro	0xFE	
	1	Faultmode for digital output 1-8	unsgined8	rw	0xFF	
	…	…	…	…	…	Error Mode 8 Ouput lines
	0xFE	Faultmode for digital output 2025-2032	unsgined8	rw	0xFF	
0x6207	0	Number of entries	unsgined8	ro	0xFE	
	1	Faultstate for digital output 1-8	unsgined8	rw	0	
	…	…	…	…	…	Fault State 8 Ouput lines
	0xFE	Faultstate for digital output 2025-2032	unsgined8	rw	0	
0x6401	0	Number of entries	unsgined8	ro	0x7F	
	1	16-bit analog input 1	unsgined16	ro	0	
	…	…	…	…	…	
	0x7F	16-bit analog input 127	unsgined16	ro	0	Read Analog Input 16 bit
0x6411	0	Number of entries	unsgined8	ro	0x7F	
	1	16-bit analog output 1	unsgined16	rw	0	
	…	…	…	…	…	
	0x7F	16-bit analog output 127	unsgined16	rw	0	Write Analog Input 16 bit
0x6421	0	number of entries	unsgined8	ro	0x7F	
	1	trigger selection analog input 1	unsgined8	rw	7	
	…	…	…	…	…	Trigger Selection Analog Input
	0x7F	trigger selection analog input 127	unsgined8	rw	7	

0x6423	0x00	enable analog input interrupts	unsgined8	rw	1	enalbe analog input interrupts
0x6424	0	number of entries	unsgined8	ro	0x7F	Analog Input Interrupt Upper Limit
	1	upper limit analog input 1	unsgined16	rw	0	
	…	…	…	…	…	
	0x7F	upper limit analog input 127	unsgined16	rw	0	
0x6425	0	number of entries	unsgined8	ro	0x7F	Analog Input Interrupt lower Limit
	1	lower limit analog input 1	unsgined16	rw	0	
	…	…	…	…	…	
	0x7F	lower limit analog input 127	unsgined16	rw	0	
0x6426	0	number of entries	unsgined8	ro	0x7F	Analog Input Interrupt Delta Limit
	1	delta limit analog input 1	unsgined16	rw	0	
	…	…	…	…	…	
	0x7F	delta limit analog input 127	unsgined16	rw	0	
0x6427	0	number of entries	unsgined8	ro	0x7F	Analog Input Interrupt Negative Delta Limit
	1	negative delta limit analog input 1	unsgined16	rw	0	
	…	…	…	…	…	
	0x7F	negative delta limit analog input 127	unsgined16	rw	0	
0x6428	0	number of entries	unsgined8	ro	0x7F	Analog Input Interrupt Positive Delta Limit
	1	positive delta limit analog input 1	unsgined16	rw	0	
	…	…	…	…	…	
	0x7F	positive delta limit analog input 127	unsgined16	rw	0	
0x6443	0	number of entries	unsgined8	ro	0x7F	Analog Ouput Falut Mode
	1	fault mode analog output 1	unsgined8	rw	1	
	…	…	…	…	…	
	0x7F	fault mode analog output 127	unsgined8	rw	1	
0x6444	0	number of entries	unsgined8	ro	0x7F	Default Analog output Fault State unconverted
	1	Default Analog Output 1	unsgined16	rw	0	
	…	…	…	…	…	
	0x7F	Default Analog Output 127	unsgined16	rw	0	

- **Object 0x6000, Digital Inputs**

This object contains the process data of the digital input modules. Sub-index 1 contains the first 8 digital input channels from the left to the right, counted from starting with the Network Adaptor. Sub-index 2 the next etc.

- **Object 0x6005, Global Interrupt Enable Digital 8-bit**

This object shall enable and disable globally the interrupt behavior without changing the interrupt masks. In event-driven mode the device transmits the input values depending on the interrupt masks in objects 6006_h, 6007_h, and 6008. If the object is not supported, the device shall behave accordingly to the default value.

- **Object 0x6006, Interrupt Mask Any Change 8-bit**

This object determines, which input port lines shall activate an interrupt by positive or/and negative edge detection. If the object is not supported the device shall behave accordingly to the default value.

- **Object 0x6007, Interrupt Mask Low-to-High 8-bit**

This object determines, which input port lines shall activate an interrupt by positive edge detection (logical 0 to 1). Done for groups of 8 lines. The values shall be in an ”OR” connection to the values of 6006_h object (Interrupt mask any change 8-bit). If inputs are inverted by 6002_h object (polarity input 8-bit), the positive logical edge shall correspond to negative physical edge.

0 = Interrupt Disabled

1 = Interrupt Enabled

- **Object 0x6008, Interrupt Mask High-to-Low 8-bit**

This object determines, which input port lines shall activate an interrupt by negative edge detection (logical 1 to 0). Done for groups of 8 lines. The values shall be in an ”OR” connection to the values of 6006h object (Interrupt mask any change 8-bit). If inputs are inverted by 6002h object (polarity input 8-bit), the negative logical edge shall correspond to positive physical edge.
0 = Interrupt Disabled
1 = Interrupt Enabled

- **Object 0x6200, Digital Outputs**

This object contains the process data of the digital output modules. Sub-index 1 contains the first 8 digital output channels from left to right, counting starting from the Network Adaptor. Sub-index 2 the next etc.

- **Object 0x6206, Error Mode Output 8-Bit**

This object defines whether the outputs change to a pre-defined error status in the event of an error (i.e. adaptor changes to the Stopped status, Node guarding has failed,) (see object 0x6207). If the error is remedied, the outputs remain in their momentary status, i.e. the set error status of the output channels remains unchanged.
0 = Outputs remain unchanged (per channel)
1 = Outputs change to a pre-defined error status (per channel)

- **Object 0x6207, Error Value Output 8-Bit**

This object is used to define the values, which the outputs should assume in the event of an error. Prerequisite being that the corresponding bit in object 0x6206 is set.
0 = Output to 0 (per channel)
1 = Output to 1 (per channel)
Example: Index 0x6206 sub-index 0 = 1, sub-index 1 = 65 = 0x41
Index 0x6207 sub-index 0 = 1 sub-index 1 = 33 = 0x21
Channel 1 is set to 1, channel 7 is set to 0, and all other output channels remain unchanged in the event of an error

- **Object 0x6401, Analog Inputs 16 Bit**

This object contains the process data of the analog input modules. Sub-index 1 contains the first analog input channel from left to right, counting starting with the Network Adaptor. Sub-index 2 the second, etc.

- **Object 0x6411, Analog Outputs 16 Bit**

This object contains the process data of the analog output modules. Sub-index 1 contains the first analog output channel from left to right, counting starting with the Network Adaptor. Sub-index 2 the second, etc.

- **Object 0x6421, Analog Input Interrupt Trigger Selection**

This object determines, which events shall cause an interrupt for a specific channel. All bits set to 1_b shall trigger the corresponding analogue input. If the object is not supported, the device shall behave accordingly to the default value.

Format:

Bit	**Value**	**Meaning**
0	0_b	Upper limit not exceeded
	1_b	Upper limit exceeded
1	0_b	Input not below lower limit
	1_b	Input below lower limit
2	0_b	Input not changed by more than delta
	1_b	Input changed by more than delta
3	0_b	Input not reduced by more than negative delta
	1_b	Input reduced by more than negative delta
4	0_b	Input not increased by more than positive delta
	1_b	Input increased by more than positive delta
reversed	0_b	Reserved for future use

- **Object 0x6423, Analog Input Global Interrupt Enable**

This object shall enable and disable globally the interrupt behavior without changing the interrupt mask. By default, no analogue input activates an interrupt.

0 = global interrupt disabled
1 = global interrupt enabled

- **Object 0x6424, Analog Input Interrupt Upper Limit Integer**

If enabled (see 6423h object), an interrupt is triggered when the analogue input is equal or rises above the given value. The value shall be always left adjusted. As long as the trigger condition is met, every change of the analogue input data generates a new interrupt, if there is no additional trigger condition, e.g. an input interrupt delta (6426h).

- **Object 0x6425, Analog Input Interrupt Lower Limit Integer**

If enabled (see 6423h object), an interrupt is triggered when the analogue input falls below the given value. The value shall be always left adjusted. As long as the trigger condition is met, every change of the analogue input data generates a new interrupt, if there is no additional trigger condition, e.g. an input interrupt delta (6426h).

- **Object 0x6426, Analog Input Interrupt Lower Limit Integer**

This object shall set the delta value (rising or falling above or below the last communicated value) for interrupt-enabled analogue inputs (see 6423h object).

- **Object 0x6427, Analog Input Interrupt Negative Delta Unsigned**

This object shall set the negative delta value (falling below the last communicated value) for interrupt-enabled analogue inputs (see 6423h object).

- **Object 0x6428, Analog Input Interrupt Positive Delta Unsigned**

This object shall set the negative delta value (rising below the last communicated value) for interrupt-enabled analogue inputs (see 6423h object).

- **Object 0x6443, Analog Output Error Mode**

This object is used to define whether the outputs change to a pre-defined error status (see object 0x6444) in the event of an error (i.e. adaptor changes to the Stopped status, Node guarding has failed,). Once the error is remedied, the outputs retain their momentary status, i, e. the set error status of the output channels remains unchanged.
All analog outputs that are not covered by the object 0x6444 are always set to 0 in the event of an error.
0 = The output remains unchanged
1 = The output changes to a pre-defined error status

- **Object 0x6444, Analog Output Error Value Integer**

This object is used to define values that they are to assume in the event of an error. Prerequisite being that the corresponding bit is set in object 0x6443

7. Modbus Interface

7.1 MODBUS Interface Register/Bit Map

- **Register Map**

Start Address	Read/Write	Description	Func. Code
0x0000 ~ 0x007E	Read	Process input image registers (Real Input Register)	3,4,23
0x0800 ~ 0x087E	Read/Write	Process output image registers (Real Output Register)	3,16,23
0x1000 *	Read	Adapter Identification special registers.	3,4,23
0x1020 *	Read/Write	Adapter Watchdog, other time special register.	3,4,6,16,23
0x1100 *	Read/Write	Adapter Information special registers.	3,4,6,16,23
0x2000 *	Read/Write	Expansion Slot Information special registers.	3,4,6,16,23

* The special register map must be accessed by read/write of every each address (one address).

- **Register Bit Map**

Start Address	Read/Write	Description	Func. Code
0x0000~	Read	Process input image bits All input registers area are addressable by bit address. Size of input image bit is size of input image register * 16.	2
0x1000~	Read/Write	Process output image bits All output registers area are addressable by bit address. Size of output image bit is size of output image register * 16.	1,5,15

7.2 Supported MODBUS Function Codes

Function Code	Function	Description
1(0x01)	Read Coils (Read output bit)	This function code is used to read from 1 to 2000 contiguous status of coils in a remote device. The Request PDU specifies the starting address, i.e. the address of the first coil specified, and the number of coils. In the PDU Coils are addressed starting at zero. Therefore coils numbered 1-16 are addressed as 0-15. The coils in the response message are packed as one coil per bit of the data field. Status is indicated as 1= ON and 0= OFF.
2(0x02)	Read Discrete Inputs (Read input bit)	This function code is used to read from 1 to 2000 contiguous status of discrete inputs in a remote device. The Request PDU specifies the starting address, i.e. the address of the first input specified, and the number of inputs. In the PDU Discrete Inputs are addressed starting at zero. Therefore Discrete inputs numbered 1-16 are addressed as 0-15. The discrete inputs in the response message are packed as one input per bit of the data field. Status is indicated as 1= ON; 0= OFF.
3(0x03)	Read Holding Registers (Read output word)	This function code is used to read the contents of a contiguous block of holding registers in a remote device. The Request PDU specifies the starting register address and the number of registers. The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

7.2.1 8(0x08)Diagnostics

Sub-function 0x0000(0) Return Query Data
The data passed in the request data field is to be returned (looped back) in the response.
The entire response message should be identical to the request.

Sub-function	Data Field (Request)	Data Field (Response)	Description
0x0000(0)	Any	Echo Request Data	

Sub-function 0x0001(1) Restart Communications Option
The remote device could be initialized and restarted, and all of its communications event counters are cleared.
Especially, data field 0x55AA make the remote device to restart with factory default setup of EEPROM.

Sub-function	Data Field (Request)	Data Field (Response)	Description
0x0001(1)	0x0000, 0xFF00	Echo Request Data	Reset Only

Sub-function 0x000B(11) Return Bus Message Count
The response data field returns the quantity of messages that the remote device has detected on the communications system since its last restart, clear counters operation, or power–up.

Sub-function	Data Field (Request)	Data Field (Response)	Description
0x000B(11)	0x0000	Total Message Count	

Sub-function 0x000C(12) Return Bus Communication Error Count
The response data field returns the quantity of CRC errors encountered by the remote device since its last restart, clear counters operation, or power–up.

Sub-function	Data Field (Request)	Data Field (Response)	Description
0x000C(12)	0x0000	CRC Error Count	

Sub-function 0x000D(13) Return Bus Exception Error Count
The response data field returns the quantity of MODBUS exception responses returned by the remote device since its last restart, clear counters operation, or power–up.
Exception responses are described and listed in section 3.2.11.

Sub-function	Data Field (Request)	Data Field (Response)	Description
0x000D(13)	0x0000	Exception Error Count	

Sub-function 0x000E(14) Return Slave Message Count
The response data field returns the quantity of messages addressed to the remote device, or broadcast, that the remote device has processed since its last restart, clear counters operation, or power–up.

Sub-function	Data Field (Request)	Data Field (Response)	Description
0x000E(14)	0x0000	Slave Message Count	

Sub-function 0x000F(15) Return Slave No Response Count
The response data field returns the quantity of messages addressed to the remote device for which it has returned no response (neither a normal response nor an exception response), since its last restart, clear counters operation, or power–up.

Sub-function	Data Field (Request)	Data Field (Response)	Description
0x000F(15)	0x0000	Slave No Response Count	

Sub-function 0x0064(100) Return Slave ModBus, Internal Status
The response data field returns the status of ModBus and Internal addressed to the remote device.
This status values are identical with status 1word of input process image.

Sub-function	Data Field (Request)	Data Field (Response)	Description
0x0064(100)	0x0000	ModBus, Internal Status	Same as status 1word

7.2.2 Error Response

In an exception response, the server sets the MSB of the function code to 1. This makes the function code value in an exception response exactly 80 hexadecimal higher than the value would be for a normal response.

Exception Codes

Exception Code	Name	Description
01	Illegal Function	The function code received in the query is not an allowable action for the server (or slave).
02	Illegal Data Address	The data address received in the query is not an allowable address for the server (or slave).
03	Illegal Data Value	A value contained in the query data field is not an allowable value for server (or slave).
04	Slave Device Failure	An unrecoverable error occurred while the server (or slave) was attempting to perform the requested action.
05	Acknowledge	The server (or slave) has accepted the request and is processing it, but a long duration of time will be required to do so.
06	Slave Device Busy	Specialized use in conjunction with programming commands. The server (or slave) is engaged in processing a long–duration program command. The client (or master) should retransmit the message later when the server (or slave) is free.
08	Memory Parity Error	The server (or slave) attempted to read record file, but detected a parity error in the memory. The client (or master) can retry the request, but service may be required on the server (or slave) device.
0A	Gateway Path Unavailable	Specialized use in conjunction with gateways, indicates that the gateway was unable to allocate an internal communication path from the input port to the output port for processing the request.

7.3 MODBUS Special Register Map

The special register map can be accessed by function code 3, 4, 6 and 16. Also the special register map must be accessed by read/write of every each address (one address).

7.3.1 Adapter Identification Special Register (0x1000, 4096)

Address	Access	Type, Size	Description
0x1000(4096)	Read	1word	Vendor ID = 0x06D0 (741), Hitachi Europe GmbH.
0x1001(4097)	Read	1word	Device type = 0x000C, Network Adapter
0x1002(4098)	Read	1word	Product code = 0x1060(NA-9261)
0x1003(4099)	Read	1word	Firmware revision, if 0x0101, revision 1.01
0x1004(4100)	Read	2word	Product unique serial number
0x1005(4101)	Read	String up to 34byte	Product name string (ASCII) "NA-9261,CANopen Adapter,FnBUS"
0x1010(4112)	Read	2word	Firmware release date
0x1013(4115)	Read	1word	Firmware Code = 0x9261
0x101E(4126)	Read	7word - 1word - 1word - 1word - 1word - 1word - 2word	Composite Id of following address 0x1100(4352), Modbus RS232 Node. (Fixed 0x0001) 0x1000(4096), Vendor ID 0x1001(4097), Device type 0x1002(4098), Product code 0x1003(4099), Firmware revision 0x1004(4100), Product serial number

- String Type consist of valid string length (first 1word) and array of characters

7.3.2 Adapter Identification Special Register (0x1100, 4352)

Address	Access	Type, Size	Description
0x1102(4354)	Read	1word	Start address of input image word register. =0x0000
0x1103(4355)	Read	1word	Start address of output image word register. =0x0800
0x1104(4356)	Read	1word	Size of input image word register.
0x1105(4357)	Read	1word	Size of output image word register.
0x1106(4358)	Read	1word	Start address of input image bit. = 0x0000
0x1107(4359)	Read	1word	Start address of output image bit. =0x1000
0x1108(4360)	Read	1word	Size of input image bit.
0x1109(4361)	Read	1word	Size of output image bit.
0x110A(4362)	Read	1word	Update time for cyclic data change (same as 0x1028)
0x110C(4364)	Read	1word	Field power status
0x110D(4365)	Read	1word	Current Rotary Switch State and Dip Switch Status (MSB) ex) Dip SW(0x01), Rotary SW(0x02) = 0x0102
0x110E(4366)	Read	up to 33word	Expansion slot's ST-number including NA First 1word is adapter's number, if NA-9289, then 0x9289
0x1110(4368)	Read	1word	Number of expansion slot
0x1113(4371)	Read	up to 33word	Expansion slot Module Id. Refer to Appendix A.1 Product List. First 1word is adapter's module id.
0x1119(4377)	Read	1word	Hi byte is ModBus status, low byte is internal status. Zero value means 'no error'.
0x111D(4381)	Read	1word	Adapter S-Series Revision. If 0x013C, S-Series Revision is 1.60

*After the system is reset, the new "Set Value" action is applied.

** If the slot location is changed, set default value automatically (all expansion slot are live).

7.3.3 Expansion Slot Information Special Register (0x2000, 8192)

Each expansion slot has 0x20(32) address offset and same information structure.

Slot#1 0x2000(8192)~0x201F(8223) Slot#2 0x2020(8224)~0x203F(8255)
Slot#3 0x2040(8256)~0x205F(8287) Slot#4 0x2060(8288)~0x207F(8319)
Slot#5 0x2080(8320)~0x209F(8351) Slot#6 0x20A0(8352)~0x20BF(8383)
Slot#7 0x20C0(8384)~0x20DF(8415) Slot#8 0x20E0(8416)~0x20FF(8447)
Slot#9 0x2100(8448)~0x211F(8479) Slot#10 0x2120(8480)~0x213F(8511)
Slot#11 0x2140(8512)~0x215F(8543) Slot#12 0x2160(8544)~0x217F(8575)
Slot#13 0x2180(8576)~0x219F(8607) Slot#14 0x21A0(8608)~0x21BF(8639)
Slot#15 0x21C0(8640)~0x21DF(8671) Slot#16 0x21E0(8672)~0x21FF(8703)
Slot#17 0x2200(8704)~0x221F(8735) Slot#18 0x2220(8736)~0x223F(8767)
Slot#19 0x2240(8768)~0x225F(8799) Slot#20 0x2260(8800)~0x227F(8831)
Slot#21 0x2280(8832)~0x229F(8863) Slot#22 0x22A0(8864)~0x22BF(8895)
Slot#23 0x22C0(8896)~0x22DF(8927) Slot#24 0x22E0(8928)~0x22FF(8959)
…..
Slot#63 0x27C0(10176)~0x27DF(10207)

Address Offset	Expansion Slot#1	Expansion Slot#2	Expansion Slot#3	Expansion Slot#4	……..	Expansion Slot#63
+ 0x00(+0)	0x2000(8192)	0x2020(8224)	0x2040(8256)	0x2060(8288)	…….	0x27C0(10176)
+ 0x01(+1)	0x2001(8193)	0x2021(8225)	0x2041(8257)	0x2061(8289)	…….	0x27C1(10177)
+ 0x02(+2)	0x2002(8194)	0x2022(8226)	0x2042(8258)	0x2062(8290)	…….	0x27C2(10178)
+ 0x03(+3)	0x2003(8195)	0x2023(8227)	0x2043(8259)	0x2063(8291)	…….	0x27C3(10179)
+ 0x04(+4)	0x2004(8196)	0x2024(8228)	0x2044(8260)	0x2064(8292)	…….	0x27C4(10180)
+ 0x05(+5)	0x2005(8197)	0x2025(8229)	0x2045(8261)	0x2065(8293)	…….	0x27C5(10181)
+ 0x06(+6)	0x2006(8198)	0x2026(8230)	0x2046(8262)	0x2066(8294)	…….	0x27C6(10182)
+ 0x07(+7)	0x2007(8199)	0x2027(8231)	0x2047(8263)	0x2067(8295)	…….	0x27C7(10183)
+ 0x08(+8)	0x2008(8200)	0x2028(8232)	0x2048(8264)	0x2068(8296)	…….	0x27C8(10184)
+ 0x09(+9)	0x2009(8201)	0x2029(8233)	0x2049(8265)	0x2069(8297)	…….	0x27C9(10185)
+ 0x0A(+10)	0x200A(8202)	0x202A(8234)	0x204A(8266)	0x206A(8298)	…….	0x27CA(10186)
+ 0x0B(+11)	0x200B(8203)	0x202B(8235)	0x204B(8267)	0x206B(8299)	…….	0x27CB(10187)
+ 0x0C(+12)	0x200C(8204)	0x202C(8236)	0x204C(8268)	0x206C(8300)	…….	0x27CC(10188)
+ 0x0D(+13)	0x200D(8205)	0x202D(8237)	0x204D(8269)	0x206D(8301)	…….	0x27CD(10189)
+ 0x0E(+14)	0x200E(8206)	0x202E(8238)	0x204E(8270)	0x206E(8302)	…….	0x27CE(10190)
+ 0x0F(+15)	0x200F(8207)	0x202F(8239)	0x204F(8271)	0x206F(8303)	…….	0x27CF(10191)
+ 0x10(+16)	0x2010(8208)	0x2030(8240)	0x2050(8272)	0x2070(8304)	…….	0x27D0(10192)
+ 0x11(+17)	0x2011(8209)	0x2031(8241)	0x2051(8273)	0x2071(8305)	…….	0x27D1(10193)
+ 0x12(+18)	0x2012(8210)	0x2032(8242)	0x2052(8274)	0x2072(8306)	…….	0x27D2(10194)
+ 0x13(+19)	0x2013(8211)	0x2033(8243)	0x2053(8275)	0x2073(8307)	…….	0x27D3(10195)
+ 0x14(+20)	0x2014(8212)	0x2034(8244)	0x2054(8276)	0x2074(8308)	…….	0x27D4(10196)
+ 0x15(+21)	0x2015(8213)	0x2035(8245)	0x2055(8277)	0x2075(8309)	…….	0x27D5(10197)
+ 0x16(+22)	0x2016(8214)	0x2036(8246)	0x2056(8278)	0x2076(8310)	…….	0x27D6(10198)
+ 0x17(+23)	0x2017(8215)	0x2037(8247)	0x2057(8279)	0x2077(8311)	…….	0x27D7(10199)
+ 0x18(+24)	0x2018(8216)	0x2038(8248)	0x2058(8280)	0x2078(8312)	…….	0x27D8(10200)
+ 0x19(+25)	0x2018(8217)	0x2038(8249)	0x2058(8281)	0x2078(8313)	…….	0x27D9(10201)
+ 0x1A(+26)	0x201A(8218)	0x203A(8250)	0x205A(8282)	0x207A(8314)	…….	0x27DA(10202)
+ 0x1B(+27)	0x201B(8219)	0x203B(8251)	0x205B(8283)	0x207B(8315)	…….	0x27DB(10203)
+ 0x1C(+28)	0x201C(8220)	0x203C(8252)	0x205C(8284)	0x207C(8316)	…….	0x27DC(10204)
+ 0x1D(+29)	0x201D(8221)	0x203D(8253)	0x205D(8285)	0x207D(8317)	…….	0x27DD(10205)
+ 0x1E(+30)	0x201E(8222)	0x203E(8254)	0x205E(8286)	0x207E(8318)	…….	0x27DE(10206)
+ 0x1F(+31)	0x201F(8223)	0x203F(8255)	0x205F(8287)	0x207F(8319)	…….	0x27DF(10207)

Address Offset	Access	Type, Size	Description
+ 0x02(+2) **	Read	1word	Input start register address of input image word this slot.
+ 0x03(+3) **	Read	1word	Input word's bit offset of input image word this slot.
+ 0x04(+4) **	Read	1word	Output start register address of output image word this slot.
+ 0x05(+5) **	Read	1word	Output word's bit offset of output image word this slot.
+ 0x06(+6) **	Read	1word	Input bit start address of input image bit this slot.
+ 0x07(+7) **	Read	1word	Output bit start address of output image bit this slot.
+ 0x08(+8) **	Read	1word	Size of input bit this slot
+ 0x09(+9) **	Read	1word	Size of output bit this slot
+ 0x0A(+10)**	Read	n word	Read input data this slot
+ 0x0B(+11)**	Read/Write	n word	Read/write output data this slot
+ 0x0E(+14)	Read	1word	GT-number, if GT-1238, returns 0x1238
+ 0x0F(+15)	Read	String up to 72byte	First 1word is length of valid character string. If GT-1238, returns "00 1E 52 54 2D 31 32 33 38 2C 20 38 44 49 2C 20 32 34 56 64 63 2C 20 55 6E 69 76 65 72 73 61 6C 00 00" Valid character size = 0x001E =30 characters, "GT-1238, 8DI, 24Vdc, Universal"
+ 0x10(+16)	Read	1word	Size of configuration parameter byte
+ 0x11(+17)**	Read/Write	n word	Read/write Configuration parameter data, up to 8byte. Refer to A.2 ***
+ 0x17(+23)	Read	1word	Firmware Revision ex) 0x0001 (Major revision 0 /Minor revision 1)

* After the system is reset, the new "Set Value" action is applied.

** Nothing of output, input, memory or configuration parameter corresponding slot returns Exception 02.

8. Appendix

A.1. Product List

No.	ST-Number	Description	ID(hex)	Production Status
Digital Input Module				
	RIO2-XDP4	4 Points, Sink(Positive), 12V/24Vdc,	41 00 03	Active
	RIO2-XDP8	8 Points, Sink(Positive), 12V/24Vdc,	41 00 07	Active
	RIO2-XDP16	16 Points, Sink(Positive), 12V/24Vdc,	41 01 13	Active
	RIO2-XAH4	4 Points, 220Vac,	41 00 0A	Active
Digital Output Module				
	RIO2-YTP16	16 Points Source(Positive Logic), 24Vdc/0.5A,	81 01 16	Active
	RIO2-YTP4	4 Points Source(Positive Logic), 24Vdc/0.5A,	81 00 10	Active
	RIO2-YTP8	8 Points Source(Positive Logic), 24Vdc/0.5A,	81 00 12	Active
	RIO2-YTP4C	4 Points Source(Positive Logic), 24Vdc/2A,	81 00 3C	Active
	RIO2-YR8	8 Points, 230Vac/2A, 24Vdc/2A, Relay	81 00 50	Active
Analog Input Module				
	RIO2-AX4I	4 Channels, Current, 4~20mA, 12bit	41 43 1D	Active
	RIO2-AX8I	8 Channels, Current, 4~20mA, 12bit	41 47 83	Active
	RIO2-AX4V	4 Channels, Voltage, 0~10Vdc, 12bit	41 43 20	Active
	RIO2-AX8V	8 Channels, Voltage, 0~10Vdc, 12bit	41 47 22	Active
	RIO2-AX4H	4 Channels, Voltage, -10Vdc~10Vdc, 12bit	41 43 21	Active
	RIO2-RTD2	2 Channels, RTD, Status	41 41 28	Active
	RIO2-RTD4	4 Channels, RTD, Status	41 43 64	Active
	RIO2-RTD8	8 Channels, RTD, Status	41 47 65	Active
	RIO2-TC2	2 Channels, TC	41 41 2A	Active
	RIO2-TC4	4 Channels, TC	41 43 66	Active
Analog Output Module				
	RIO2-AY2I	2 Channels, Current, 4~20mA, 12bit	81 41 2D	Active
	RIO2-AY4I	4 Channels, Current, 4~20mA, 12bit	81 43 6E	Active
	RIO2-AY2V	2 Channels, Voltage, 0~10Vdc, 12bit	81 41 2E	Active
	RIO2-AY4V	4 Channels, Voltage, 0~10Vdc, 12bit	81 43 6A	Active
	RIO2-AY2H	2 Channels, Voltage, -10~10Vdc, 12bit	81 41 2F	Active

No.	ST-Number	Description	ID(hex)	Production Status
Special Module				
	RIO2-CU24	1 Channel, High Speed Counter, 24V Input	C1 01 05 39	Active
	RIO2-CU24L	2 Channel, High Speed Counter, 24V Sink Input	C1 01 07 4D	Active
	RIO2-RS232	RS232 Communication, 1Channel, RTS/CTS Flow Control	C1 05 05 42	Active
	RIO2-RS485	RS485 Communication, 1Channel	C1 05 05 45	Active
	RIO2-PWM2	2 CH PWM output, 0.5A/24Vdc, source	C1 05 01 56	Active
	RIO2-PO2	2 CH Pulse output, 0.5A/24Vdc, source	C1 09 07 90	Active

A.2. Glossary

- System Power: The power for starting up CPU.
- Field Power: The power for input and output line.
- Terminator Resistor: Resistor for prevention reflected wave.
- EDS: Electronic Data Sheet.
- sinking: The method of input and output what device does not have power source.
- sourcing: The method of input and output what device have power source.

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