

RDIO 8/24-0,5

Digital remote I/O modul

V.1.1

User Handbook

A u t o m a t i o n S y s t e m

CANtrol[®] //

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General Information on this Manual

Content:

This manual describes the module RDIO 8/24-0,5 and its modifications. The product-related information contained herein was up to date at the time of publication of this manual.

Completeness:

This manual is complete only in conjunction with the user manual entitled

'Introduction
to CANtrol Automation System'

and the product-related hardware or software user manuals required for the particular application.

Standards:

The CANtrol automation system, its components and its use are based on International Standard IEC 61131 Parts 1 to 4 (EN 61131 Parts 1 to 3 and Supplementary Sheet 1).
Supplementary Sheet 1 of EN 61131 (IEC 61131-4) entitled 'User Guidelines' is of particular importance for the user.

Order numbers:

Please see the relevant product overview in the 'Introduction to CANtrol Automation System' manual for a list of available products and their order numbers.

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Contents

- 1. GENERAL INSTRUCTIONS..... 7**
- 1.1. Hazard Categories and Indications7
- 1.2. Qualified users7
- 1.3. Use as Prescribed8

- 2. DIGITAL REMOTE I/O MODULE 8/24-0,5..... 9**
- 2.1. Overview9
- 2.2. Technical Data10
- 2.3. Block Diagram11
- 2.4. Module Diagram and Connection Assignment12
 - 2.4.1. Function Selection, Displays, Diagnostics13
 - 2.4.2. Assembly Operation.....14
 - 2.4.3. Commissioning.....14

- 3. DIGITAL INPUTS/OUTPUTS 15**
- 3.1. Grouping of Inputs/Outputs15
 - 3.1.1. Schematic Diagram of Input/Output Grouping, positive switching.....16
 - 3.1.2. Without Grouping, positive switching17
- 3.2. Digital Inputs, positive switching18
 - 3.2.1. Block diagram of input, positive switching18
 - 3.2.1. Digital Inputs Data, positive switching19
- 3.3. Isolated input for alternating voltage21
 - 3.3.1. Block diagram of isolated input for alternating voltage21
- 3.4. Digital Outputs, positive switching22
 - 3.4.1. Block diagram of output, positive switching22
 - 3.4.2. Digital Outputs Data, positive switching.....23

- 4. CONFIGURATION AND PROGRAMMING TOOL 25**
- 4.1. Programming Tool25
- 4.2. Configuration of Cell Controller with the CNW Tool26
- 4.3. Setting the Node ID27
- 4.4. CAN Baud Rate.....27

- 5. CANOPEN SOFTWARE OVERVIEW 29**
- 5.1. Basic Services - Communication Profile29
- 5.2. Service Data Objects (SDO)30
- 5.3. Process Data Objects (PDO)31

5.4.	Access to I/O Data	32
5.4.1.	Digital Mode	32
5.4.2.	Analog Mode	32
5.4.3.	Line Frequency Synchronisation.....	36
5.5.	Emergency Objects	37
5.6.	NMT Network Management	38
6.	DIGITAL REMOTE I/O MODULE 8/24 OBJECT DICTIONARY	41
6.1.	Object Dictionary - DS301	41
6.1.1.	Data Types	42
6.1.2.	PDO Mapping.....	43
6.2.	Object Dictionary - DS401	44
6.2.1.	Digital Input Module	44
6.2.2.	Digital Output Module.....	45
6.2.3.	Analog Output Module	46
6.2.4.	I/O Module Assignment.....	47
6.3.	Manufacturer-Specific Object Dictionary	48
6.3.1.	Enhancement to Manufacturer-Specific Profile.....	48
7.	ANNEX	51
7.1.	Environmental Protection	51
7.1.1.	Emission.....	51
7.1.2.	Disposal.....	51
7.2.	Maintenance/Upkeep	51
7.3.	Repairs/Service	51
7.3.1.	Warranty.....	51
7.4.	Nameplate	52
7.5.	Addresses and Bibliography	54
7.5.1.	Addresses	54
7.5.2.	Standards/Bibliography	54

1. General Instructions

1.1. Hazard Categories and Indications

The indications described below are used in connection with safety instructions you will need to observe for your own personal safety and the avoidance of damage to property.

These instructions are emphasised by bordering and/or shading and a bold-printed indication, their meaning being as follows:



DANGER ! means that death, severe physical injury or substantial damage to property will occur on failure to take the appropriate precautions.



Warning ! means that death, severe physical injury or substantial damage to property may occur on failure to take the appropriate precautions.



Caution means that minor physical injury or damage to property may occur on failure to take the appropriate precautions.



Note: provides important information on the product or refers to a section of the documentation which is to be particularly noted.

1.2. Qualified users

Qualified users within the meaning of the safety instructions in this documentation are trained specialists who are authorised to commission, earth and mark equipment, systems and circuits in accordance with safety engineering standards and who as project planners and designers are familiar with the safety concepts of automation engineering.

1.3. Use as Prescribed

This is a modular automation system based on the CANbus, intended for industrial control applications within the medium to high performance range.

The automation system is designed for use within Overvoltage Category I (IEC 364-4-443) for the controlling and regulating of machinery and industrial processes in low-voltage installations in which the rated supply voltage does not exceed 1,000 VAC (50/60 Hz) or 1,500 VDC.

Qualified project planning and design, proper transport, storage, installation, use and careful maintenance are essential to the flawless and safe operation of the automation system.

The automation system may only be used within the scope of the data and applications specified in the present documentation and associated user manuals.

The automation system is to be used only as follows:

- as prescribed,
- in technically flawless condition,
- without arbitrary or unauthorised changes and
- exclusively by qualified users

The regulations of the German professional and trade associations, the German technical supervisory board (TÜV), the VDE (Association of German electricians) or other corresponding national bodies are to be observed.

Safety-oriented (fail-safe) systems

Particular measures are required in connection with the use of SPC in safety-oriented systems. If an SPC is to be used in a safety-oriented system, the user ought to seek the full advice of the SPC manufacturer in addition to observing any standards or guidelines on safety installations which may be available.



Warning !

As with any electronic control system, the failure of particular components may result in uncontrolled and/or unpredictable operation. All types of failure and the associated fuse systems are to be taken into account at system level. The advice of the SPC manufacturer should be sought if necessary

2. Digital Remote I/O Module 8/24-0,5

2.1. Overview

Order number	The order/item No. required for acquiring a replacement is to be found on the nameplate of the module.
Function	<p>The Digital Remote I/O Module 8/24-0,5 is a CANopen-capable remote module with digital I/Os and fixed functionality. The module is a CANopen slave device complying with CiA Draft Standard DS401.</p> <p>The Digital Remote I/O Module comprises 8 digital inputs and 24 digital outputs and an isolated input. Output triggering in digital mode complies with the CiA specifications. User-specific modes have also been implemented, which contain a “pulse packet control with phase synchronisation” and a “noise shape mode”. These modes require synchronisation with the line frequency. The isolated input automatically recognises the line frequency of 50 or 60 Hz.</p>
Features	<ul style="list-style-type: none">• 8 digital inputs and 1 isolated input and 24 digital inputs/outputs; outputs may be supplied with power in groups.• Configurations are stored in a non-volatile memory• Minimal space requirement and mounting depth• Maintenance-free, having no buffer battery
Material supplied	<p>The material supplied comprises:</p> <ul style="list-style-type: none">• Digital Remote I/O Module 8/24-0,5



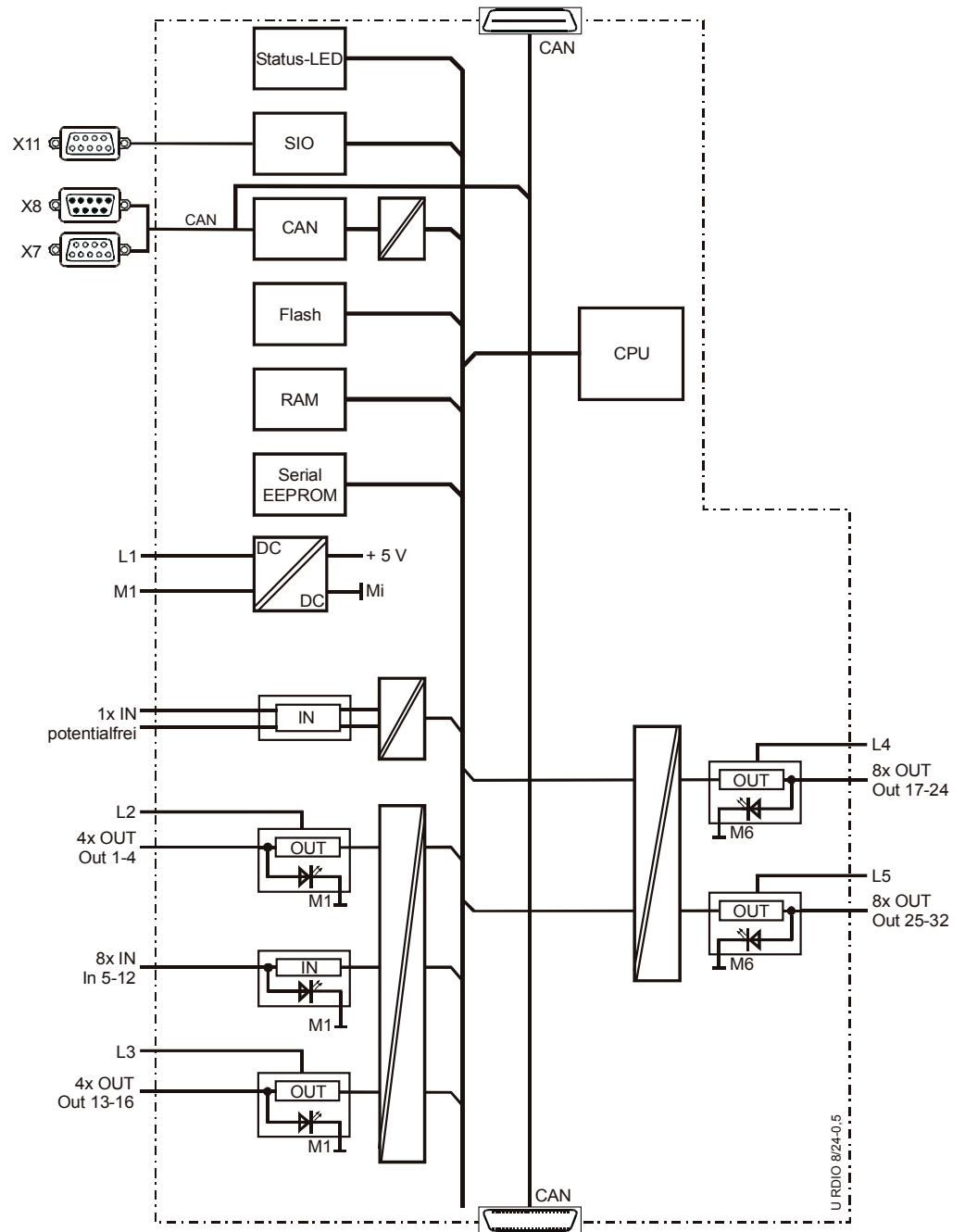
Note:

See section entitled ‘Digital Inputs/Outputs, positive switching’ for information on the digital I/Os and on how to create I/O groups.

2.2. Technical Data

Module data	
Name	Digital Remote I/O Module 8/24-0,5
Item No.	2030000
Dimensions W × H × D [mm]	124 x 170 x 85,5 (modular dimension W=113/118.5)
Weight	approx. 700 g
Mounting	NS 35/7.5 EN 50022 mounting rail
Working temperature range	5°C to 50°C (no moisture condensation) convection cooling provided
EMC, class of protection, insulation testing, degree of protection	
Emitted interference	EN 50081-2, industrial sector
Noise immunity	EN 50082-2, industrial sector
Class of protection	EN 61131-2
Insulation resistance	EN 6 1131-2; 500 VDC
Degree of protection	IP 20
Supply voltage, power consumption	
Module electronics power supply (supply voltage)	SELV DC +24 V max. 0.4 A (EN 61131-2)
Power supply, digital I/Os	+24 VDC (EN 61131-2) subdivided into 5 groups
Power consumption	at $U_e = +24$ VDC no-load max. 300 mA; all digital I/Os active approx. 12 A
Electrical isolation	yes, between CANbus and digital I/Os
Digital inputs/outputs	
Number of inputs	8
Number of inputs/outputs	24
Short circuit or polarity reversal protection	yes in both cases, all digital outputs
Connection method	vertical three-wire front wiring with push-on terminal strips for screw, spring or crimp connection
Operation and display	
LEDs	2 status LEDs; 1 status LED per input/output
Interfaces	
Type of interfaces	CANbus
Parameterisation	via CANbus or RS 232 interface

2.3. Block Diagram



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2.4.1. Function Selection, Displays, Diagnostics

I/O status

Each digital input and output has a yellow I/O status LED assigned to it to indicate the logic state of the input or output in question.



Note:

The isolated input (Sync) has no LED.

Operating status

2 operating status LEDs indicate the current state of the power supply and the module mode. Error messages are also displayed by these status LEDs.

I/O status

LED status	Logic state
input LED yellow ON	1 (HIGH, activated)
input LED yellow OFF	0 (LOW)
output LED yellow ON	1 (HIGH, activated)
output LED yellow OFF	0 (LOW)

Operating status

LED	Logical status
1 L1+ (green)	ON = correct supply voltage for module electronics
2 Status (bicolour green / red)	green = device is in "operational" status red = device is in "preoperational" status

3. Digital Inputs/Outputs

Outputs may also be connected to inputs without additional external load.

3.1. Grouping of Inputs/Outputs

The grouping facility permits formation of groups, separate power circuits, emergency off circuits, etc. as and when required.

Inputs/outputs can be supplied in groups as

- 1 input group and
- 4 output groups

Modular electronic

The **modular electronic circuit** is supplied together with input group 2 (Group 2) over connection terminals 1 (L1+) and 2 (M1).

The modular electronic circuit must be supplied with power in **any** cases, otherwise the modules will be inoperable.

Supply must be provided directly (unswitched) from the supply unit.

Inputs

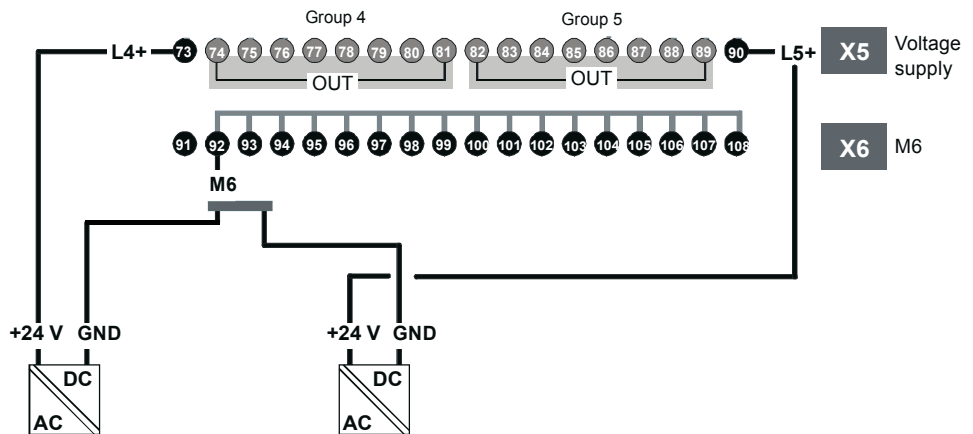
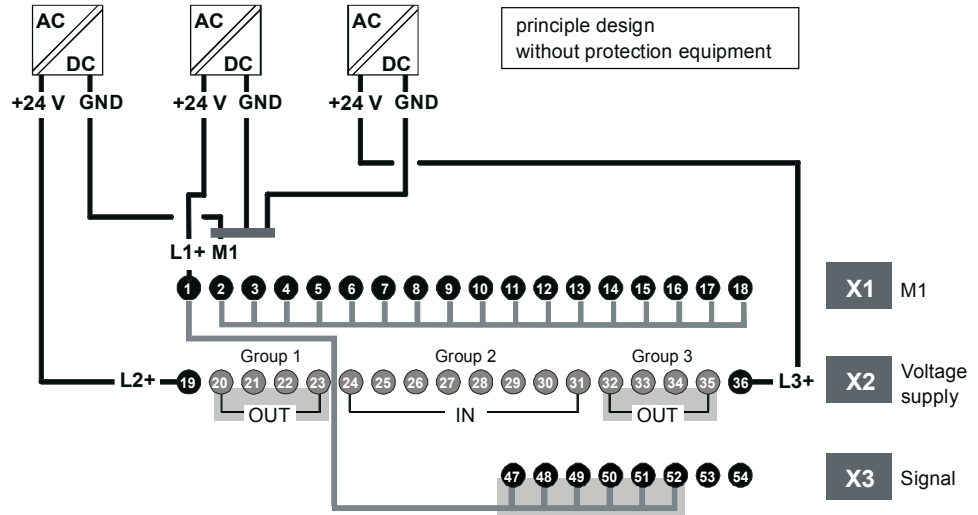
Inputs (sensors) must be supplied directly from the supply unit.

Do not conduct the sensor supply through switched circuits.

Outputs

Output groups may be supplied through upstream switch elements (emergency off, manual switches, etc.).

3.1.1. Schematic Diagram of Input/Output Grouping, positive switching

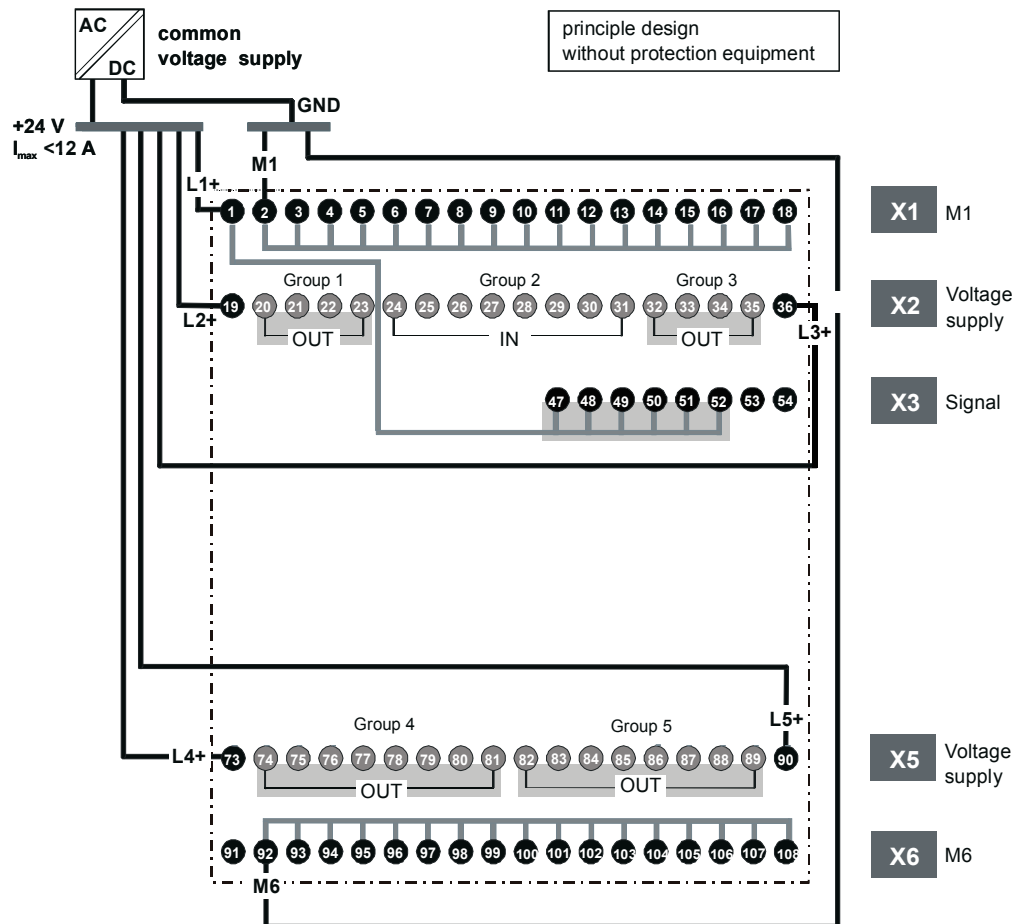


Group 1	OUT 1-4	<i>Bemessungsspannung für erhöhte Isolation nach</i> <i>Rated voltage for ncreased isolation defined by</i> EN 61131-2 0 ... 50 V
Group 2	IN 5-12	
Group 3	OUT 13-16	
Group 4	OUT 17-24	
Group 5	OUT 25-32	

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3.1.2. Without Grouping, positive switching

Wird auf die Gruppenbildung bei der Spannungsversorgung verzichtet, sind vom Anwender die im folgenden Bild dargestellten Verbindungen herzustellen.
 Without grouping of the voltage supply, the user has to build the following connection.



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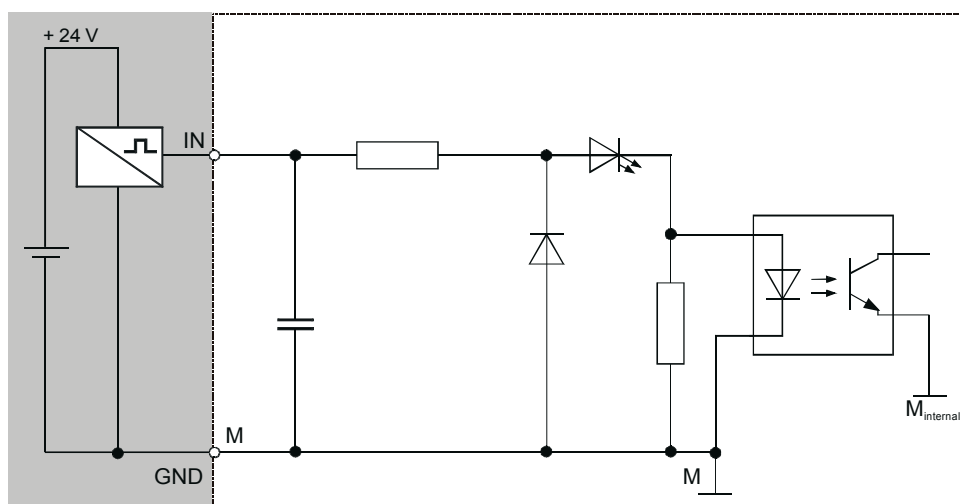
3.2. Digital Inputs, positive switching

The digital inputs are positive switching type 1 inputs for 2-conductor sensors. They are designed for input voltages of 24 V nominal. The inputs are transmitted cyclically to the CPU. An open input is interpreted as static 0 (LOW).

Operating status

The status of each input is indicated by a yellow operating status LED on the front panel of the module. The LEDs are spatially assigned to the supply terminals. An LED lights when its associated input is activated (logical 1 / HIGH).

3.2.1. Block diagram of input, positive switching

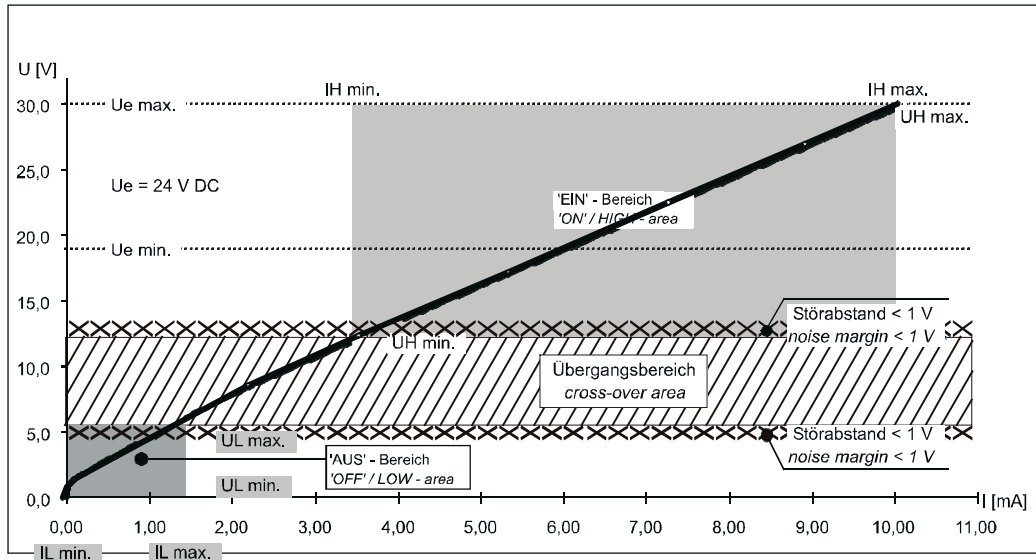


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3.2.2. Digital Inputs Data, positive switching

Module data	
Number of inputs	8
Line lengths: <div style="text-align: right; padding-right: 20px;">in switchgear cabinet</div> <div style="text-align: right; padding-right: 20px;">dedicated I.v. wiring</div>	<p>Allow for voltage drop when choosing conductor cross-section, otherwise no restrictions in practice.</p> <p>Observe all relevant local regulations and the requirements of EN 61131-3. Please consult manufacturer regarding lightning hazard</p>
Rated load voltage L+ Reverse voltage protection	24 VDC (SELV) yes
Electrical isolation	yes (optical isolator) in groups
Status display	yes, yellow LED for each input
Alarms	definable according to software
Input capacitance	< 10 nF

Digital-input operating areas, positive switching



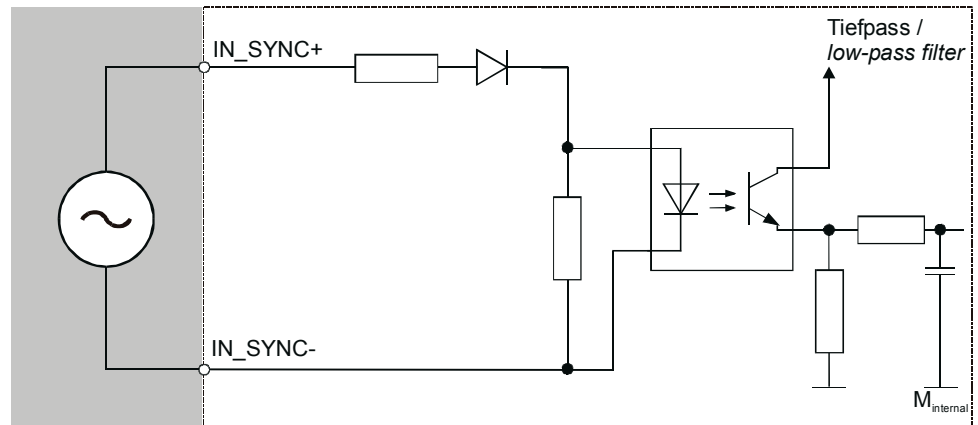
Eingangsspannung (DC) der externen Stromversorgung <i>Input voltage (DC) of extern power supply</i>		
U_e	24 V	Bemessungsspannung / <i>rated voltage</i>
$U_{e \text{ max.}}$	30 V	oberer Grenzwert / <i>upper limit</i>
$U_{e \text{ min.}}$	19,2 V	unterer Grenzwert / <i>lower limit</i>
Grenzwerte für '1' Signal für die 'EIN'-Bedingung <i>Limit for '1' signal for the 'ON'-condition</i>		
$U_{H \text{ max.}}$	30,0 V	obere Spannungsgrenze / <i>upper voltage limit</i>
$I_{H \text{ max.}}$	10,0 mA	obere Stromgrenze / <i>upper current limit</i>
$U_{H \text{ min.}}$	13,5 V	untere Spannungsgrenze / <i>lower voltage limit</i>
$I_{H \text{ min.}}$	3,5 mA	untere Stromgrenze / <i>lower current limit</i>
Grenzwerte für '0' Signal für die 'AUS'-Bedingung <i>Limit for '0' signal of the 'OUT'-condition</i>		
$U_{L \text{ max.}}$	5,5 V	obere Spannungsgrenze / <i>upper voltage limit</i>
$I_{L \text{ max.}}$	1,5 mA	obere Stromgrenze / <i>upper current limit</i>
$U_{L \text{ min.}}$	0 V	untere Spannungsgrenze / <i>lower voltage limit</i>
$I_{L \text{ min.}}$	0 mA	untere Stromgrenze / <i>lower current limit</i>

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3.3. Isolated input for alternating voltage

The isolated input is designed as alternating voltage input. Its task is to recognise the zero crossing and to route this as an internal signal. The inputs are transmitted cyclically to the CPU. An open input is interpreted as static 0 (LOW).

3.3.1. Block diagram of isolated input for alternating voltage



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Operating areas of isolated input for alternating voltage

Eingangsspannung (DC) der externen Stromversorgung <i>Input voltage (DC) of extern power supply</i>		
U_e	24 V	Bemessungsspannung / <i>rated voltage</i>
$U_{e \text{ max.}}$	30 V	oberer Grenzwert / <i>upper limit</i>
$U_{e \text{ min.}}$	19,2 V	unterer Grenzwert / <i>lower limit</i>
Grenzwerte für '1' Signal für die 'EIN'-Bedingung <i>Limit for '1' signal for the 'ON'-condition</i>		
$U_{H \text{ max.}}$	+ 40,0 V	obere Spannungsgrenze / <i>upper voltage limit</i>
$I_{H \text{ max.}}$	39 mA	obere Stromgrenze / <i>upper current limit</i>
$U_{H \text{ min.}}$	3,1 V	untere Spannungsgrenze / <i>lower voltage limit</i>
$I_{H \text{ min.}}$	1 mA	untere Stromgrenze / <i>lower current limit</i>
Grenzwerte für '0' Signal für die 'AUS'-Bedingung <i>Limit for '0' signal of the 'OUT'-condition</i>		
$U_{L \text{ max.}}$	2,4 V	obere Spannungsgrenze / <i>upper voltage limit</i>
$I_{L \text{ max.}}$	1 mA	obere Stromgrenze / <i>upper current limit</i>
$U_{L \text{ min.}}$	- 40,0 V	untere Spannungsgrenze / <i>lower voltage limit</i>
$I_{L \text{ min.}}$	0 mA	untere Stromgrenze / <i>lower current limit</i>

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3.4. Digital Outputs, positive switching



Warning ! The module can be destroyed by overvoltages > 32 V.
Risk of **fire!**

Outputs

The outputs are of positive switching 24 volt type (two-conductor). Maximum output current per output is 500 mA. The outputs have a common earth (GND) when operating in groups. Power is supplied separately from the supply for the modular electronic circuit (see 'Connection Assignment'). The outputs switch automatically to '0' (LOW) if there is no available data link to the CPU (Life Guarding) or if the module's internal supply is insufficient.

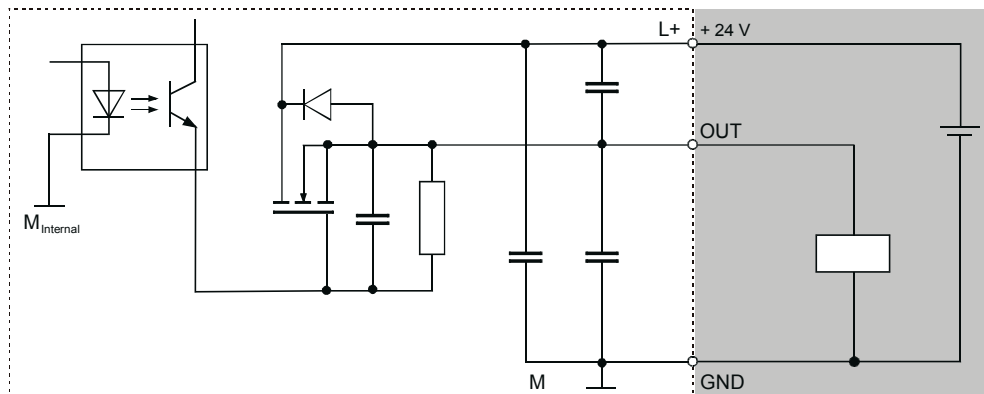
Protected output

All outputs are protected by an incorporated current-limiting circuit and a thermal overload protection circuit. If overloaded, the affected output switches off. The output can be re-activated by program on elimination of the overload and thermal cooling. A high-speed de-excitation feature having a terminal voltage of 50 V, related to L+, protects all outputs against induced voltage peaks under inductive loads. The overload protection of non-involved outputs may also respond prematurely if feedback or high-speed de-excitation give rise to thermal loads.

Operating status

The status of each output is indicated by a yellow operating status LED on the front panel of the module. The LEDs are spatially assigned to the supply terminals. A LED lights when its associated output is activated, logical '1' (HIGH).

3.4.1. Block diagram of output, positive switching



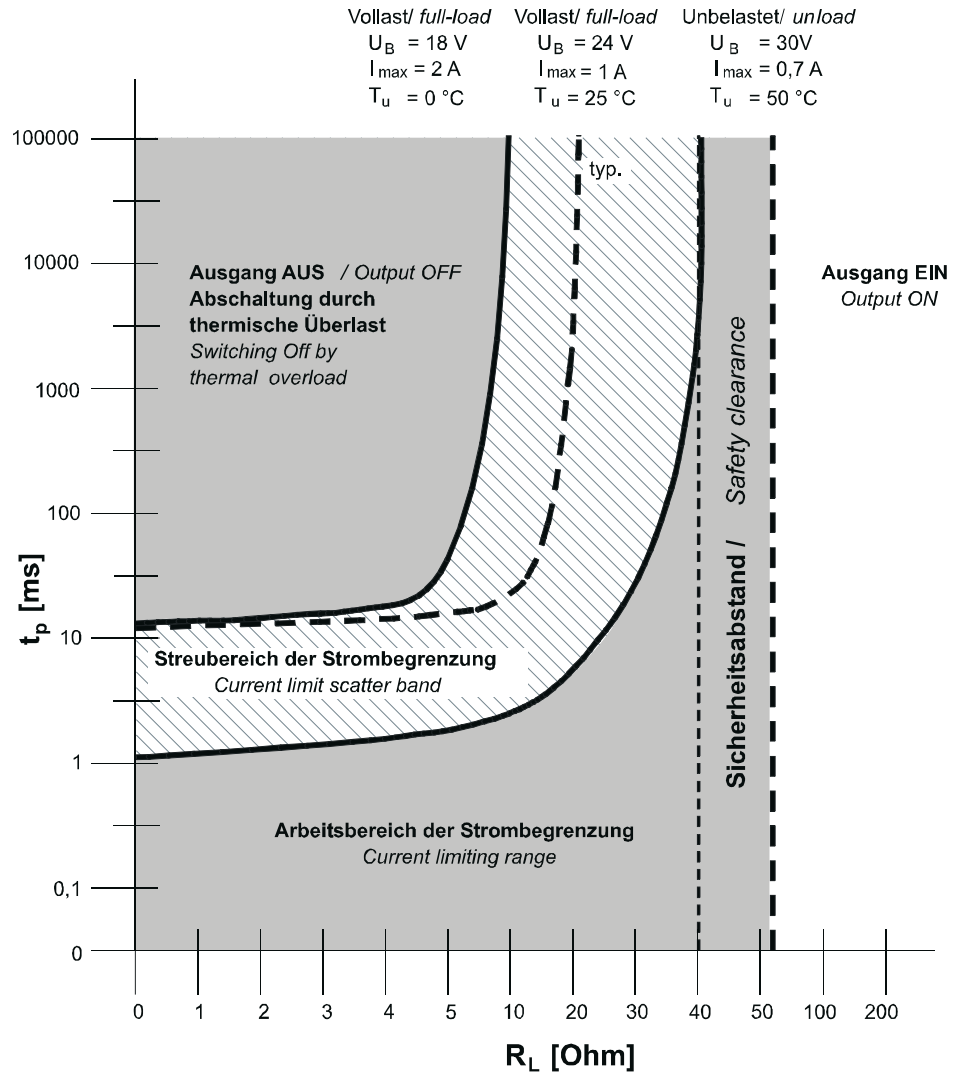
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3.4.2. Digital Outputs Data, positive switching

Module data	
Number of outputs	24 semiconductor outputs in 4 groups
Type of outputs	semiconductor, non-holding
Suppressor circuit for inductive loads	high-speed de-excitation 50 V terminal voltage (typical) to + 24 V
Power loss due to de-excitation	max. 0.5 watts per output max. 4 watts per module
Status display	yes, yellow LED for each output
Load connection	
Total loading (100%)	12 A (24 x 0.5 A)
Overload protection	yes, in event of thermal overload Responding of thermal overload protection may influence adjoining outputs
Short-circuit protection ¹⁾ response threshold	yes, electronic current-limiting feature, min. 0.5 A, typically 0.9 A
<small>1) Current is limited electronically. Responding of the short-circuit protection feature produces thermal overload and trips the thermal overload protection circuit..</small>	
Output delay for '0' to '1' for '1' to '0'	max. 0.5 ms max. 0.5 ms
Output capacitance	< 20 nF
Rated voltage	+24 VDC
Voltage drop (at rated current)	< 0.5 V
Rated current for '1' signal	0.5 A
Leakage current for '0' signal	max. 0.1 mA
Total current of all outputs	max. 12 A (24 x 0.5)
Total current per group (horizontal mounting on vertical mounting plate)	max. 4 A (8 x 0.5)
Lamp load (+24 VDC)	max. 6 watts
Connection of two outputs in parallel to provide logic operation to increase performance	allowed not allowed
Insulation resistance	
Rated voltage	0 V <U _e <50 V
Test voltage up to 2,000 m altitude	500 VDC

Overload Reaction of Digital Outputs

Überlast-Verhalten der digitalen Ausgänge
Overload-reaction of digital output



Innerhalb des Streubereichs der Strombegrenzung ist das Verhalten der Strombegrenzung undefiniert.

Within the current-limit scatter band the reaction of current limiting is undefined.

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Note:

It is not possible to know for certain within the current limit scatter band whether the response will be to disconnect or to return to the working range. As a result, this state should be avoided!

The output is ready for operation by elimination of the overload and thermal cooling.

4. Configuration and Programming Tool

4.1. Programming Tool

The most commonly-used programming and diagnostic tool (PADT) for automation systems is a personal computer provided by the user.

The features of this peripheral strongly determine how safe and reliable the operation of the automation system with a connected PADT will be.

Commercially available PCs are in general not suitable for use under the operating conditions defined for automation systems (industrial environment).

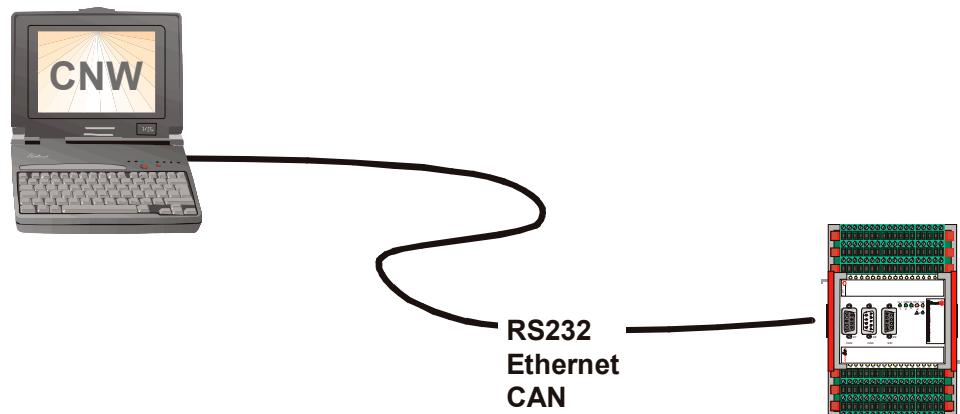
**Caution**

The user should specially ensure that the conditions necessary for safe operation as a PADT are fulfilled by the user's chosen PC.

The PADT can be connected to the automation system via

- the CANbus
- the serial module interface
- the Ethernet interface (via Cell controller...)

Konfiguration von Node ID und Baudrate mit Peer-to-Peer Verbindung *Configuration of the node-ID and baudrate with peer-to-peer connection*



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4.2. Configuration of Cell Controller with the CNW Tool

New or replaced cell controllers have to be configured before they are used in an application. This procedure can be compared with setting selector switches in other systems. Such switches were deliberately omitted when the automation system was being designed, since these do not allow the array of configuration data currently needed to be represented conveniently and neatly.

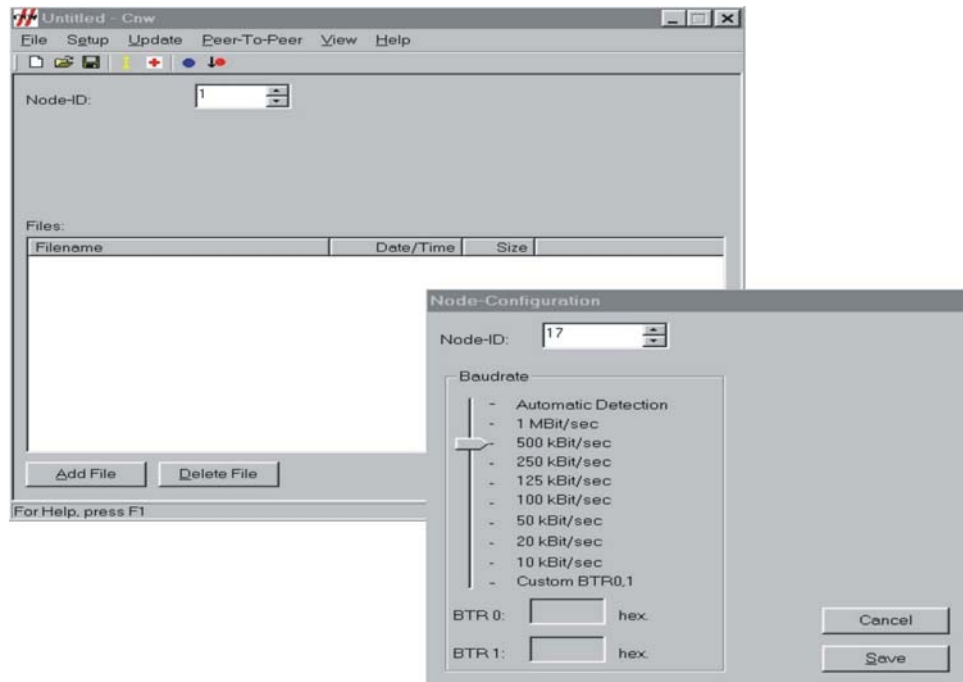
In place of this, the automation system uses the user-friendly CNW tool (CANtrol Node Wizard), which guides you through the configuration process. The familiarisation and documentation requirements usually involved with setting configurations are thus reduced to a minimum.

A single module is connected to the PADT (PC) for configuration.

The module has to be put into configuration mode after the supply voltage has been applied, or, depending on previous use, it may already be ready for configuration.

The elementary parameters 'node ID' (identification number) and 'CAN baud rate' are then configured using the menu item 'peer-to-peer'. The data are validated in the module by deactivating / activating the module and operation is then possible on a correspondingly set-up CANbus.

Example:



2VF100052DG01.jpg

Other functions of the CNW tool

- Query firmware information:
Enter the node ID of the required cell controller and the CAN baud rate in the main window.
Then select *Firmware Information* in the 'Update' menu.

This allows the firmware information for all cell controllers connected to CAN channel 0 to be queried. This function also allows communication via the CANbus to be tested at the same time.
- Update firmware.

4.3. Setting the Node ID

The individual CANbus users are identified within the automation system communications by an unambiguous node ID.
The node ID numbers from 1 to 127 are permitted.
These numbers can be allocated at will, however, they do affect individual CAN user priorities (*do not confuse with CAN message identifiers*).



Note:

Users of **the same** physical CAN line **must always** be allocated an unambiguous node ID.

4.4. CAN Baud Rate

In order to ensure successful CAN communication, there should be a uniform baud rate setting for all bus users. The values chosen should be selected in accordance with the maximum line length, but should not be unnecessarily high (extra safety factor).



Note:

There is always a uniform baud rate for a physical CAN line.
For this reason, baud rate settings **have to be** identical for all users located in the same line, both during configuration (with the CNW) and in the application programs.
Different lines may have different baud rates.

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5. CANopen Software Overview

The 'digital remote I/O module' is a CANopen slave device with a device profile for I/O modules conforming to Draft Standard (DS) 401 published by the CAN-users' association, 'CAN in Automation - CiA'. All device-profile and communication profile (DS301) parameters are filed in the one object dictionary. This dictionary also contains user-specific entries, an added feature required for the pulse interval characteristic of the module outputs.

5.1. Basic Services - Communication Profile

NMT	The NMT function comprises node guarding and minimum boot-up.
Node Guarding	A CANopen master operating in the CAN network can address the module by transmitting node guarding telegrams. The module responds in conformity with the Node Guarding Protocol Specification by transmitting the prevailing operating condition with toggle bit. The extended Node Guarding Function has also been implemented (life-time master monitoring), and the form of reaction to absence of a Guarding Telegram can be configured as well.
Boot UP	The module performs a boot up process to CiA DS301 - Minimum Capability Device - when the power supply is switched on. The change in status from "Initialising" to "Preoperational" is indicated by an emergency telegram containing no data. This telegram's CAN Identifier (CobId) is calculated from 128 + Node Number (NodId). The module then changes to preoperational state and can be operated by CANopen SDO accesses. The I/O status LEDs for the digital outputs illuminate during the boot up. The outputs are set to 0 (low) when the module electronic circuit is switched on or off, and then remain in that state until the next switching command. There are no short switching-peaks in the process.
I/O Access	All digital I/O channels can be addressed either by SDO telegram or by PDO telegram, analog values being accessible only by SDO. All inputs are also capable of producing edge-triggered event telegrams.
SDO Telegrams	An SDO channel provides full access to the entries in the object dictionary. Individual objects are selected by an index and a subordinate sub-index when accessing the object dictionary by SDO. The index is represented as a 16-bit value and the sub-index as an 8-bit value.
PDO Telegrams	The appropriate NMT Command (Start Node) must be used to switch the module to Operational State so that it can be operated by PDOs (Process Data Object). The module supports one PDO telegram at a time in transmit and receive direction. The PDO transmit-and-receive pair is not activated until the module goes into "operational" status. The 'pair' can be deactivated by suitable SDO accesses (Service Data Object) during runtime. PDOs are implemented as <u>asynchronous</u> Event PDOs in the basic setting, but a synchronous mode of operation can also be configured if required.



N.B.:

Please note that all data is transmitted in Intel 'Little Endian' format.

5.2. Service Data Objects (SDO)

SDO telegrams can be used to access all entries in the object dictionary. Exclusive use is made here of the so-called "expedited" protocol, which can contain up to four bytes of user data. Correspondingly, all entries in the object dictionary are less than or equal to four bytes in length.

The "expedited" protocol comprises a Request Telegram - sent by a CANopen master - and a corresponding Response Telegram from the CANopen slave module. Digital remote I/O modules are unable to initiate a request telegram and simply respond to requests.

The module supports one SDO channel. The CAN Identifiers (CobId) of the request telegram and the response telegram are derived from the node number (NodeId) set up by CNW software, duly using the standard identifiers specified in the CiA DS301 CANopen Communication Profile.

Identifier - Request Telegram (Master -> Slave): 1536 + NodeId

Identifier - Response Telegram (Slave -> Master): 1408 + NodeId

The make-up of the "expedited" protocol is outlined schematically in the following graphic.

The first byte in the "expedited" protocol (CMD) contains code indicating whether data is to be downloaded to or uploaded from the slave module's object dictionary. The object in question is identified by an index and a sub-index. The user data (up to four bytes) is contained in the request telegram when downloading data, and in the response telegram when uploading.

Example: Downloading data to the remote I/O module (Download)

	0	1	2	3	4	5	6	7
Request	CMD	Index	Sub-index	Data				
	0	1	2	3	4	5	6	7
Response	CMD	Index	Sub-index	reserved				

Example: Uploading data from the digital remote I/O module (Upload)

	0	1	2	3	4	5	6	7
Request	CMD	Index	Sub-index	reserved				
	0	1	2	3	4	5	6	7
Response	CMD	Index	Sub-index	Data				

5.3. Process Data Objects (PDO)

Process Data Objects (PDO) are defined as individual, unconfirmed CAN Telegrams that can be sent by all subscribers in the network. Accordingly, a PDO always has one transmitter, and can be processed by one or more receivers.

The CiA DS301 Communication Profile defines various object dictionary entries specifying the communication behaviour and data format of PDOs. All PDOs supported by the digital remote I/O module are set up exclusively as asynchronous Event PDOs, but are also suitable for synchronous operation. The data format of individual PDOs is unchangeably predetermined.

The first transmit-and-receive PDO pair is switched to active in the module's initial state. One PDO can address up to 8 digital inputs and up to 32 digital outputs.

An event interrupt mask must be activated before the module can transmit its Event PDO. The 'input events' causing transmission of a PDO are coded in corresponding bits of this mask. The '*Any Change*' mask is set by default when the module starts, so that a PDO can be sent to coincide with every edge-change at an input.

Make sure, when using event interrupt masks, that the individual interrupt masks are in logical OR-relationship with one another. A mask that may be set for rising edges will not then be affected by deleting the '*Any Change*' mask.

Telegram Identifiers

The PDO transmit-and-receive pair (PDO 1) is defined in conformity with CiA Device Profile DS401, while the telegram identifiers employed are derived in conformity with CiA DS301 from the node number (NodId) of the module.

Receive PDO 1 : 512 + Node Number

Transmit PDO 1 : 384 + Node Number

The predefined Identifiers can be changed during runtime, by SDO accesses to object dictionary entries 0x1400, 0x1402 and 0x1800, 0x1802.



N.B.:

The digital remote I/O module does not support the second PDO pair predefined in CiA DS301, because Device Profile DS401 reserves this pair for analog I/Os.

Operational State

The module must be switched to Operational State by the NMT 'START NODE' command before it can be operated by PDOs.

Outputs can then be switched by PDO and the module can use PDO telegrams to signal appropriately programmed 'edge events'.

In 'initial state', 'edge events' are active for rising and falling edges at all inputs.

5.4. Access to I/O Data

The module has 8 digital inputs and 24 digital output-ports. Access to the I/Os is always arranged through the object dictionary, where the I/Os are distributed over 8-bit, 16-bit or 32-bit I/O Groups.

The inputs have two objects (Index 0x6000) for the 8-bit group and one object (Index 0x6100) for the 16-bit group, and the outputs have one object (Index 0x6320) for the 32-bit group. The user can read off the values by SDO telegram. Sub-index 0 contains the number of objects available in the particular group.

The outputs are selected in digital mode as required by CiA specifications. Additional analog, user-specific modes have also been implemented to provide "Pulse-Packet Control with Phase Synchronisation" and a so-called "Noise Shaper Mode", these modes being synchronised over a purpose-designed isolated input.

Read Access A 'read access' reports the current state of a connection, whether it is being used as an input or as an output.

Write Access When performing a 'write access', the system masks the respective input-bits.

5.4.1. Digital Mode

An output is used purely as 'digital output' in this mode of operation.

5.4.2. Analog Mode

Pulse-Packet Mode

In Pulse-Packet Mode, channels are switched within a predetermined time frame of three seconds, with optional choice of duty cycle between 0.0 and 100.0%. One channel remains switched on for at least 20ms (16ms) - one full wave - when operating at 50Hz (60Hz) a.c.

Over CANopen, the module receives the value for the desired manipulated variable as a percentage. The resolution of the manipulated variable is 1/10% and is valid for the whole range from 0.0 to 100.0%. The percentile variable is represented by an integer between 0 and 1000, for example 50.5% = > 505. The time base for manipulated-variable output is three seconds, so a manipulated variable of, say, 50%, would correspond to a control pulse of 1.5 seconds.

The duration of the control pulse (the time during which an output should be set) is determined by converting the transmitted percentile value into a multiple of a full wave of the line frequency.

The 'pulse' period is calculated as follows:

$$\text{Pulse duration} = \text{Round}(S * n / 100) * d$$

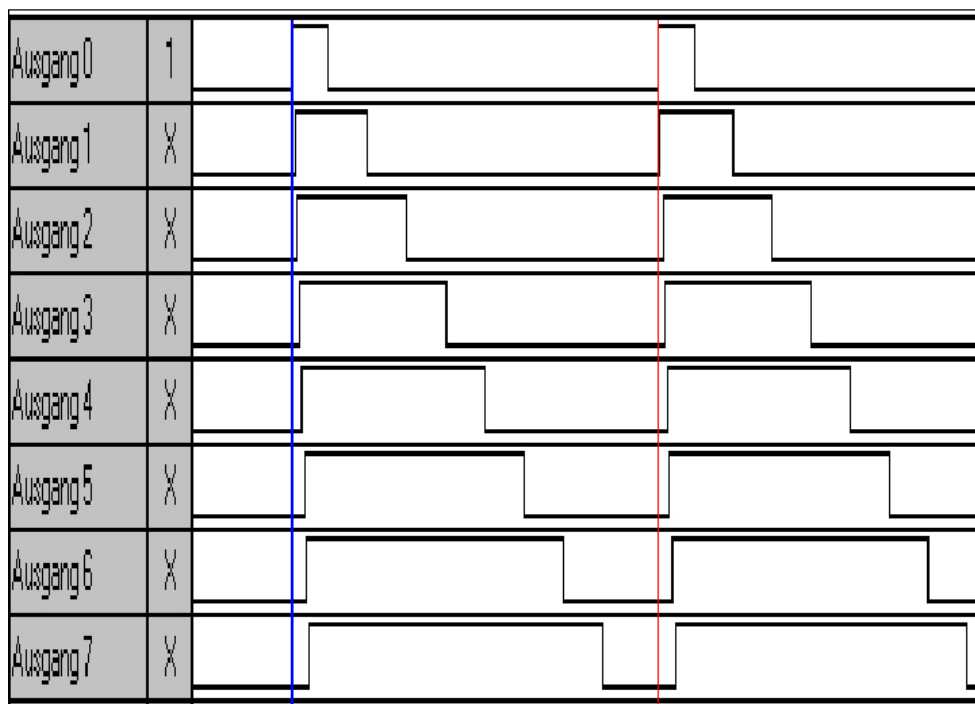
S = manipulated variable as %

n = number of full waves in three seconds (50Hz: n=150; 60Hz: n=180)

d = period of a full wave (50Hz: d=20ms; 60Hz: d=16.66)

To prevent the full output power from being selected all at once in the one phase-zero-crossing when operating in Pulse-Packet Mode, the beginnings of the control pulses of the module outputs configured in this mode are each delayed by 20ms in relation to one another.

Pulse-Packet Mode with delayed beginning of pulse and 10.. 80% manipulated variable at Output 0...7



2VF100096DG00.jpg

Ausgang = output

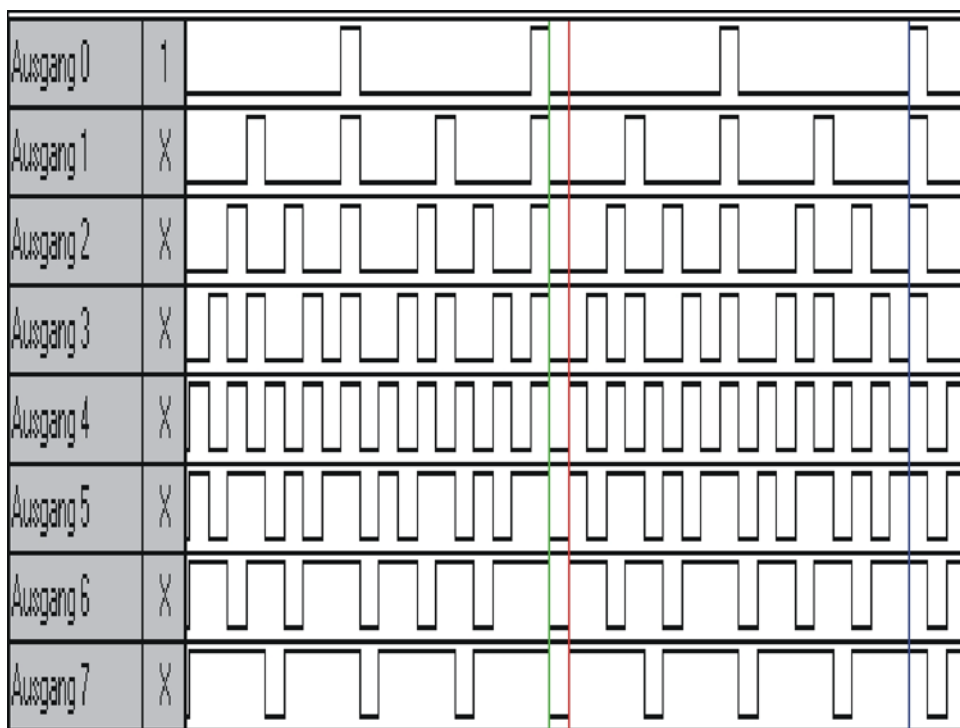
Noise-Shaper Mode

In this operating mode, the manipulated variable is spread over the full waves (half waves) of the line frequency so as to provide an averagely uniform distribution throughout a cycle period of three seconds.

Over CANopen, the digital remote I/O module receives the value for the desired manipulated variable as a percentage. The resolution of the manipulated variable is 1/10% and is valid over the whole range from 0.0 to 100.0%.

This operating mode is particularly suitable for controlling very rapidly responding heating elements, avoiding the "flickering" which is otherwise perceptible here in Pulse Interval Mode. The duty cycle of between 0 and 100% is communicated for each channel here in the same way as in Pulse-Packet Mode.

Pulse-Packet Mode with delayed beginning of pulse and 10.. 80% manipulated variable at Output 0...7



2VF100097DG00.jpg

Ausgang = output

Noise-Shaper Algorithm

```
Dim y As Integer `manipulated variable as %
Dim xAs Integer `integer - dummy variable
Dim yp As Boolean`integer - dummy variable
Dim rest As Integer `integer - dummy variable

n = 150           `number of periods in 3 seconds
`(in full-wave operation - 50Hz: n=150; 60Hz: n=180)
`(in half-wave operation - 50Hz: n=300; 60Hz: n=360)

Do
    y = CANget(manipulated variable) `read in manipulated
variable
rest = 0

`this loop runs in a cycle of one period (PD)
`until the cycle period of 3 seconds has run out
`in full-wave operation - 50Hz: PD=20ms; 60Hz: PD=16.66ms
`in half-wave operation - 50Hz: PD=10ms; 60Hz: PD=8.33ms
For i = 0 To n - 1
    x = y + rest
    If rest >= n Then
        yp = True /* set output to high here */
        rest = x - n
    else
        yp = False /* set output to low here */
        rest = x
    End If
Next
Loop
```

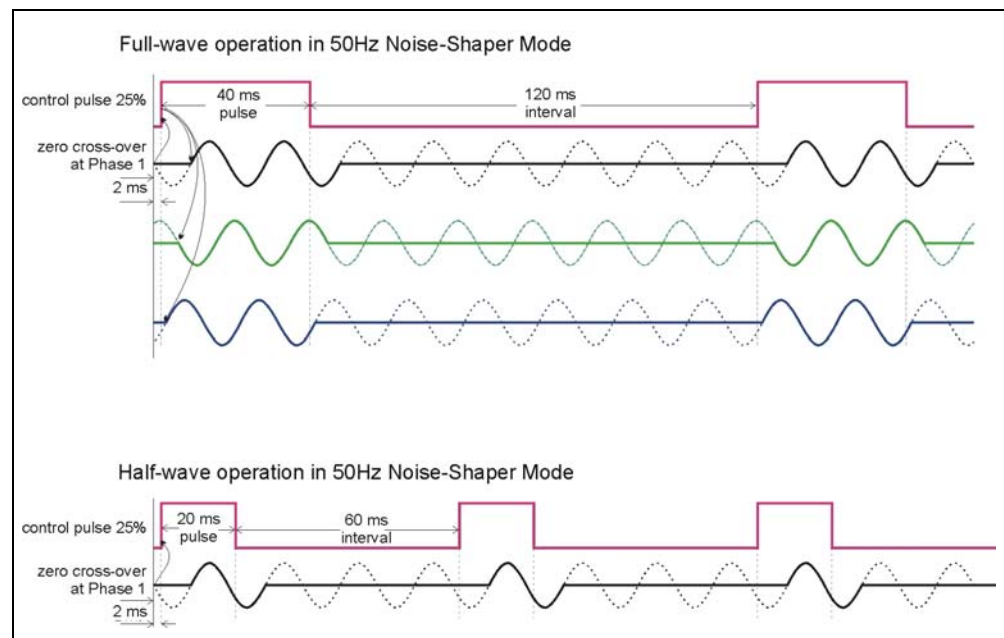
5.4.3. Line Frequency Synchronisation

The isolated input at terminals 53/54 is used to synchronise control pulses with the zero-crossings of the supply voltage.

This synchronisation of the line frequency only affects 'Noise Shaper' operating mode.

The control pulse for all phases is started about 2 ms (1.6 ms) after the zero cross-over at Phase 1 when operating at 50Hz (60Hz). The control pulses are the same length in all phases, being calculated from the number of full-waves to be controlled, multiplied by 20 ms (16.66ms). The 'Noise Shaper' algorithm is used to calculate the actual number of full-waves to be controlled.

25% control pulse in 'Noise-Shaper' mode for three-phase alternating current 50Hz, full-wave and half-wave operation



2VF100098DG00.jpg

5.5. Emergency Objects

Any error situation occurring in the CANopen slave is recorded in the Error Register. An emergency telegram is sent each time this register is changed.

Identifier

The CANopen slave transmits the emergency object with an Identifier = 128 + NodeId.

Format

Byte	0	1	2	3	4	5	6	7
Data	Error Code		Error Register	Reserved			Reserved	

Error Codes

to DS 301

5.6. NMT Network Management



Warning!

The CANopen slave may fail to receive any further commands where errors or failures occur in the CAN network. Resultant malfunctioning (for instance, failure to reset outputs) may result in damage to machinery or injury to persons. The CANopen Life Guarding feature allows the user to configure the CANopen slave so that network failures are duly detected and outputs automatically switched to an operationally safe state.

Node Guarding

The Node Guarding function is performed by the CANopen master, which transmits a monitoring telegram at configurable intervals of time. On receiving this telegram, the addressed CANopen slave must transmit a response telegram indicating its present state.

Where no response is received, the CANopen master can assume that the slave is no longer operational and can then react accordingly.

Life Guarding

When a Life Guarding function is also activated in the CANopen slave, it too can react to absence of node guarding telegrams.

This means that the module can still restore its outputs to a safe state should the CANopen master break down. The default setting switches the outputs off.

The user can change this setting by selecting an appropriate object.

Life Time

The 'Life Time' is the period within which a node guarding telegram must be received. Where none is received, the module behaves as described under Node Guarding. This 'life time' is determined by multiplying the Object Guard Time (0x100C) by the Life Time Factor (0x000D).

For example: Guard Time 1000 ms x Life Time Factor 3 = Life Time 3,000 ms.

The Life Guarding function just goes on standby when neither value reads 0, and is not actually activated until the first node guarding telegram is received. The Life Guarding function is switched off again when either one of these two objects is set to zero during operation.



N.B.:

The 'Life Time' must never be shorter than the Node Guard Time of the associated master.

Life Guarding Event

A Life Guarding Event occurs whenever the 'Life Time' is exceeded.

The following actions are then performed in the module:

The module switches into PRE-OPERATIONAL mode.

The outputs go into a defined state which can be configured by the objects 'Fault Mode (0x6326) / Fault State(0x6327)' and 'Set Mode of Outputlines (0x2000)'.

The Life Guarding Event is duly noted in the Error Register.

An Emergency Telegram is sent by the digital remote I/O module.

The Status LED signals red, meaning Preoperational.

Restart

Whenever a Life Guarding Event occurs, the associated state remains unchanged until the next node guarding telegram is received, on which the module must also be restored to "operational" state again.

Life Guarding Objects

0x100C	Guard Time in milliseconds
0x100D	Life Time Factor
0x6326	Fault Mode 32 bit, outputs whose value is changed by a fault
0x 6327	Fault State 32 bit, state assumed by outputs when a fault occurs
0x2000	Set Mode of Outputlines, state and value of outputs when a fault occurs

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6. Digital Remote I/O Module 8/24 Object Dictionary

This chapter describes all the objects supported by the digital remote I/O module. The objects originate from the DS301 Communication Profile and the DS401 "Device Profile for I/O Modules", supplemented by a manufacturer-specific section.

6.1. Object Dictionary - DS301

This section describes the CiA DS301 Communication Profile Objects supported by the digital remote I/O module.

Index	Object	Name	Type	Acc.
0x1000	VAR	Device type	unsigned32	ro
0x1001	VAR	Error register	unsigned8	ro
0x1004	ARRAY	Number of PDOs supported	unsigned32	ro
0x1008	VAR	Manufacturer device name	Vis-String	ro
0x1009	VAR	Manufacturer hardware version	Vis-String	ro
0x100A	VAR	Manufacturer software version	Vis-String	ro
0x100C	VAR	Guard Time	unsigned16	rw
0x100D	VAR	Life Time Factor	unsigned8	rw
0x100E	VAR	Cobld guarding protocol	unsigned32	rw
0x100F	VAR	Number of SDOs supported	unsigned32	ro

Receive PDO Communication Parameter

0x1400	RECORD	1 st receive PDO parameter	PDOCommPar	rw
--------	--------	---------------------------------------	------------	----

Receive PDO Mapping Parameter

0x1600	RECORD	1 st receive PDO mapping	PDOMapping	ro
--------	--------	-------------------------------------	------------	----

Transmit PDO Communication Parameter

0x1800	RECORD	1 st transmit PDO parameter	PDOCommPar	rw
--------	--------	----------------------------------------	------------	----

Transmit PDO Mapping Parameter

0x1A00	RECORD	1 st transmit PDO mapping	PDOMapping	ro
--------	--------	--------------------------------------	------------	----

6.1.1. Data Types

Data Type: PdoCommPar (DS301)

Index (hex)	Sub-index	Field in Pdo Communication Record	Data Type
0x0020	0	Number of supported entries in the record	Unsigned 8
	1	CobId used by PDO	Unsigned 32
	2	Transmission Type	Unsigned 8

Data Type *PDOCommPar* specifies the communication parameters of the individual PDOs.

This data type can be used during the run time of the digital remote I/O module to activate or de-activate individual PDOs and to change preset Identifiers.

The *CobId* entry is defined as follows

	MSB				LSB
bits	31	30	29	28 - 11	10 - 0
11-bit-ID	0/1	0/1	0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	11 bit Identifier
29-bit-ID	0/1	0/1	1	29 bit Identifier	

bit number	Value	Meaning
31 (MSB)	0	PDO valid
	1	PDO not valid
30	0	RTR allowed on this PDO
	1	no RTR allowed on this PDO
29	0	11-bit ID (CAN 2.0A)
	1	29 bit ID (CAN 2.0B)
28 - 11	0	if bit 29 = 0
	X	if bit 29 = 1; bits 28 - 11 of 29 bit Cob ID
10 - 0 (LSB)	X	bits 10 - 0 of CobId



N.B.:

It is not possible to use 29-bit Identifiers with the digital remote I/O module.

6.1.2. PDO Mapping

Receive PDO 1 (Default)

Index	Sub-Index	Comment	Name	Value
0x1600	0	Number of mapped objects		0x04
	1	1 st object to be mapped	Write_8_Outputs_1H-8H	0x6200 0x01
	2	2 nd object to be mapped	Write_8_Outputs_9H-10H	0x6200 0x02
	3	3 rd object to be mapped	Write_8_Outputs_11H-18H	0x6200 0x03
	4	4 th object to be mapped	Write_8_Outputs_19H-20H	0x6200 0x04

Transmit PDO 1 (Default)

Index	Sub-Index	Comment	Name	Value
0x1A00	0	Number of mapped objects		0x02
	1	1 st object to be mapped	Read_8_Inputs_1H-8H	0x6000 0x01
	2	2 nd object to be mapped	Read_8_Inputs_9H-10H	0x6000 0x02

6.2. Object Dictionary - DS401

This section describes all CiA DS401 "Device Profile for I/O Modules" objects supported by the digital remote I/O module.

6.2.1. Digital Input Module

Index	Object	Name	Type	Acc.
0x6000	ARRAY	Read State 8 Input Lines	unsigned 8	ro
0x6005	VARIABLE	Enable Digital Input Interrupts	BOOLEAN	rw
0x6100	RECORD	Read State 16 Input Lines	unsigned 16	ro
0x6106	RECORD	Input Interrupt Mask 16 Input Lines any change	unsigned 16	rw
0x6107	RECORD	Input Interrupt Mask 16 Input Lines low to high	unsigned 16	rw
0x6108	RECORD	Input Interrupt Mask 16 Input Lines high to low	unsigned 16	rw

BIT Access

The 8/24 digital remote I/O module has 8 inputs, arranged at physical addresses 5 to 12 on the top part of the module. As a result, software cannot fully represent this input region in one byte. Index 0x6000 is therefore made up of three sub-indices, sub-index 0x01 mapping inputs 5 to 8 and sub-index 0x02 doing the same for inputs 9 to 12.

Index 0x6000 is needed to write standard PDOs.

WORD Access

Index 0x6100 and sub-index 0x01 can be used to perform a WORD access (16-bit) where it is intended to check the states of all inputs by means of one telegram.

Like index 0x6100, the other indices relating to the inputs (16-bit access) also just contain sub-indices 0x00 and 0x01.

See "I/O Module Assignment" table for further information.

6.2.2. Digital Output Module

Index	Object	Name	Type	Acc.
0x6200	RECORD	Write State 8 Output Lines	unsigned 8	rw
0x6320	RECORD	Write State 32 Output Lines	unsigned 32	rw
0x6326	RECORD	Fault Mode 32 Output Lines	unsigned 32	rw
0x6327	RECORD	Fault State 32 Output Lines	unsigned 32	rw

The 8/24 digital remote I/O module has up to 24 outputs capable of operating in digital mode. These outputs are arranged at physical addresses 1 to 4 and 13 to 16 on the top of the module, and at 17 to 32 on the underside. As a result, software is unable to represent this output region in full in one byte, so index 0x6200 is made up of five sub-indices.

Index 0x6200 is needed to describe standard PDOs.

DWORD Access

Index 0x6320 and sub-index 0x01 can be used to perform a DWORD access (32-bit) where it is intended to change the states of all outputs by means of the one telegram.

Objects 0x6326 and 0x6327 take effect when the module detects a fault state, for instance where CAN communication ceases to operate.

0x6326 (Fault Mode) indicates if a default value is applied to the digital output when a fault occurs. If so, 0x6327 (Fault State) is used to determine the default value. Fault states are configured with DWORD in conformity with the output pattern shown above.

See "I/O Module Assignment" table for further information.



N.B.:

The module's outputs can be operated in all three described modes. Three access masks are used inside the module to make sure the data assigned to the outputs conforms to the mode currently set up. For example, digital values should not be written to a pulse interval output.


6.2.3. Analog Output Module

Index	Object	Name	Type	Acc.
0x6411	RECORD	Write Analog Output 16	unsigned 16	rw

The digital remote I/O module has up to 24 outputs that can be operated in analog mode. Determined by the unit's design, these outputs are disposed at physical addresses 1 to 4 and 13 to 16 on the top of the module, and at 17 to 32 on the underside of the module. A 16-bit value can be written directly to each output operating in this mode via its own sub-index (0x01-0x20). The value itself can vary within the limits 0 to 1000.

See "I/O Module Assignment" table for further information.

6.2.4. I/O Module Assignment



Signal	Digital Input Mode				Digital Output Mode				Analog Output Mode		
	BYTE		WORD		BYTE		DWORD		WORD values ranging from 0 to 1000		
	Index 0x6000		Index 0x6100		Index 0x6200		Index 0x6320		Index 0x6411		
OUT1		Sub-Index 0x01		Sub-Index 0x01	0	Sub-Index 0x01	0	Sub-Index 0x01	0x01		
OUT2							1			1	0x02
OUT3							2			2	0x03
OUT4							3			3	0x04
IN5	4	Sub-Index 0x02	4	Sub-Index 0x02	Usable only as input		Usable only as input		Usable only as input		
IN6	5		5								
IN7	6		6								
IN8	7		7								
IN9	0		8								
IN10	1		9								
IN11	2		10								
IN12	3		11								
OUT13		Sub-Index 0x03		Sub-Index 0x03	4	Sub-Index 0x04	12	Sub-Index 0x01	0x0D		
OUT14							5			13	0x0E
OUT15							6			14	0x0F
OUT16							7			15	0x10
OUT17		Sub-Index 0x04		Sub-Index 0x04	0	Sub-Index 0x04	16	Sub-Index 0x01	0x11		
OUT18							1			17	0x12
OUT19							2			18	0x13
OUT20							3			19	0x14
OUT21							4			20	0x15
OUT22							5			21	0x16
OUT23							6			22	0x17
OUT24							7			23	0x18
OUT25		Sub-Index 0x04		Sub-Index 0x04	0	Sub-Index 0x04	24	Sub-Index 0x01	0x19		
OUT26							1			25	0x1A
OUT27							2			26	0x1B
OUT28							3			27	0x1C
OUT29							4			28	0x1D
OUT30							5			29	0x1E
OUT31							6			30	0x1F
OUT32							7			31	0x20

6.3. Manufacturer-Specific Object Dictionary

This Section describes objects needed in addition to DS401 objects.

Index	Object	Name	Type	Acc
0x2000	RECORD	Set Mode of Outputlines	unsigned 32	rw
0x2001	VAR	Set Time Base	unsigned 16	rw
0x2002	VAR	Analog Synchronisation	unsigned 8	w

6.3.1. Enhancement to Manufacturer-Specific Profile

0x2000 Set Mode of Outputlines

The 8/24 digital remote I/O module has up to 24 outputs which can be operated in different modes. These outputs are disposed at physical addresses 1 to 4 and 13 to 16 on the top of the module, and at 17 to 32 on the underside. A set of parameters can be written to each output. A 32-bit value can be written directly to this parameter set via a sub-index (0x01-0x20) of its own.

	MSB			LSB
bits	25-31	24	23 - 16	15 - 0
	R	M	Output mode	16 bit default value

R: reserved bits

M: Fault Mode

- 0: Current value retained in event of a fault
- 1: Default value sent to output in event of a fault.

Output Mode:

The digital outputs can be operated in four different modes:

- 0: Pulse Packet Mode
- 1: Noise Shaper Mode - Half-Wave Operation
- 2: Noise Shaper Mode - Full-Wave Operation
- 3: Digital Mode

16 bit default value:

Where a fault occurs, this value is applied to the output in question provided the Fault Mode bit (M) has been set beforehand. Values here can range from 0 to 1000 in Output Modes 0 to 2. Mode 3 (digital mode) provides two valid values:

- 0: interpreted as FALSE, output reset
- 1: interpreted as TRUE, output set

0x2001 Set Time Base

The default time-base for calculation of control pulses in Pulse Packet and Noise Shaper modes is three seconds. This object can be used to change the default value in units of one second within the range 1 to 10.

0x2002 Analog Synchronisation

The values of the analog outputs are written with Object 0x6411 - Write Analog Output 16. However, the values are not deemed valid and are not sent to the outputs until the 'Analog Synchronisation' telegram is received. The value of the byte variable transmitted with this object is set to 1.

Precise function:

- When Telegram 0x2002 is received by the digital remote I/O module, the cycle currently in progress (3 seconds) is interrupted and then re-started with the most recently transmitted analog values, the intention being to guarantee synchronisation between controller and actuator.
- If synchronisation fails to arrive before the (3-second) cycle time runs out, a new cycle is started with the old analog values even if new analog values have in fact been received.

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7. Annex

7.1. Environmental Protection

7.1.1. Emission

When used correctly, our modules do not produce any harmful emissions.

7.1.2. Disposal

At the end of their service life, modules may be returned to the manufacturer against payment of an all-inclusive charge to cover costs. The manufacturer will then arrange for the modules to be recycled.

7.2. Maintenance/Upkeep



Warning !

Do not insert, apply, detach or touch connections while in operation – risk of destruction or malfunction.
Disconnect all incoming power supplies before working on our modules; this also applies to connected peripheral equipment such as externally powered sensors, programming devices, etc.
All ventilation openings must always be kept free of any obstruction.

The modules are maintenance-free when used correctly.
Clean only with a dry, non-fluffing cloth.
Do not use detergents.

7.3. Repairs/Service



Warning !

Repair work may only be carried out by the manufacturer or its authorised service engineers.

7.3.1. Warranty

Sold under statutory warranty conditions. Warranty lapses in the event of unauthorised attempts to repair the equipment and/or product, or in the event of any other form of intervention.

7.4. Nameplate

Erklärungen zu den Typenschildern (Beispiel)

nameplate descriptions (example)

Barcode ①
Identifizierungs-Nr.
identification-no.

Modul-Typ ②
module type

Identifizierungs-Nr. ③
identification-no.

Modell / Bestell-Nr. ④
model / order-number

Version ⑤

Versorgungsspannung ⑥
supply voltage

Datum / Date ⑦

CE Kennzeichnung ⑧
CE mark

① Barcode
② CDIO 16/16-0,5 -1131
③ Num. : 20110300300329
④ Modell : 2011030
⑤ Version: 03
⑥ SELV 24V DC; 12A max.
⑦ Date: 966
⑧ CE mark

① Barcode
② CDIO 16/16-0,5-1131
③ Num. : 20122302000001
④ Modell : 2012230
⑤ Version: 20
⑥ SELV 24V DC; 12 A max.
⑦ Date: 182

① Barcode
② KS800-CAN
③ 00836400001073
④ Typ:9407 481 60001
⑦ Nr. :8346
⑤ Version: 2.1
⑥ 24V DC; 5W intern
Made in Germany
⑧ CE mark

2VF100080DG01.cdr

- ① **Barcode**
same as identification number.
- ② **Module type**
plain-text name of module.
- ③ **Identification no.**
module's identification number.
- ④ **Model/order no.**
You only need to give this number when ordering a module. The module will be supplied in its current hardware and software version.
- ⑤ **Version**
defines the design-level of the module as supplied ex-works.
- ⑥ **Supply voltage**
- ⑦ **Date**
internal code.
- ⑧ **CE mark**



Note:

The 'Version' (supply version) panel specifies the design-level of the module as supplied ex-works. When replacing a module, users, with the CNW (Control Node Wizard) tool, can read off the current software version of the newly supplied module, and then reload their 'own' software version for a particular project if necessary.

With the latter in mind, before the download you should always keep a record of the existing software levels in your project documentation (software version, node IDs, baud rate, etc.)

7.5. Addresses and Bibliography

7.5.1. Addresses

CiA 'CAN in Automation', international manufacturers and users organisation for CAN users in the field of automation:

CiA - CAN in Automation e.V.
Am Weichselgarten 26
D-91058 Erlangen /Germany
e-mail: headquarters@can-cia.de
<http://www.can-cia.de>

DIN-EN Standards Beuth Verlag GmbH or VDE-Verlag GmbH
10772 Berlin 10625 Berlin

IEC Standards VDE Verlag GmbH or Internet search
10625 Berlin <http://www.iec.ch/>

7.5.2. Standards/Bibliography

IEC61131-1/EN61131-1	Programmable controllers Part 1: General information
IEC61131-2/EN61131-2	Programmable controllers Part 2: Equipment requirements and tests
IEC61131-3/EN61131-3	Programmable controllers Part 3: Programming languages
IEC61131-4/EN61131B1	Programmable logic controllers Supplementary Sheet 1: User guidelines
EN 50081 Parts 1+2	German EMC Act: Emitted interference
EN 50082 Parts 1+2	German EMC Act: Noise immunity
ISO/DIS 11898	Draft International Standard: Road vehicles - Interchange of digital information - Controller Area Network (CAN) for high-speed communication
EN 954-1	Safety of machinery: Safety-related parts of control systems (Part 1)
Bibliography	A variety of specialist publications on the CANbus is available from specialist bookshops, or can be obtained through the CiA users' organisation.



Note:

Our Technical Support team will be glad to provide other literature references on request.
