Chapter 6   DeviceNet

Overview   This chapter contains the description of the ELCO DeviceNet slave. The introduction to the system is followed by the description of the module. Another section of this chapter concerns the configuration by means of the *DeviceNet-Manager* of Allen - Bradley This section describes the configuration of the DeviceNet coupler and the FC200 modules.

A summary of the diagnostic messages and the technical data conclude the chapter.

Below follows a description of:

- DeviceNet basics
- Hardware description of the ELCO DeviceNet coupler FC2-GW-DN00
- Configuration by means of the *DeviceNet-Manager* inc. examples
- Diagnostics
- Technical data

Content

System overview

You can use the ELCO DeviceNet coupler to link-up up to 32 modules (of 40Byte each) of your System 200V periphery by means of DeviceNet.

The following DeviceNet components are currently available from ELCO.
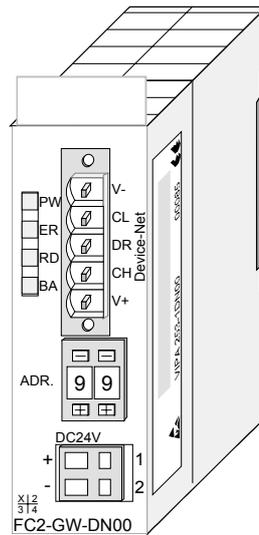
Order data DeviceNet	Type	Order number	Description
	IM 253DN	FC2-GW-DN00	DeviceNet coupler

Basics

General   DeviceNet is an open low-end network that is based upon the physical properties of CAN-Bus. The bus is also used to supply the devices with the required DC 24V power.

You can use DeviceNet to install direct connections between your control system and simple industrial devices like sensors and switches as well as technologically advanced devices like frequency converters and barcode readers.

Direct interfacing improves communications between the different devices and provides important diagnostic facilities at the device level.

DeviceNet   DeviceNet is an open device net standard that satisfies the user profile for industrial real-time system applications.

The DeviceNet protocol has an open specification that is the property of and administered by the independent vendor organization "Open DeviceNet Vendor Association" ODVA.

This is where standardized device profiles are created to provide compatibility and exchangeability on logical level for simple devices of the same type.

In contrast to the classical source–destination model, DeviceNet uses a modern producer/consumer model that requires data packets with identifier fields for the identification of the data.

This approach caters for multiple priority levels, more efficient transfers of I/O data and multiple consumers for the data.

A device that has data to send *produces* the data on the network together with an identifier. All devices requiring data listen for messages. When a device recognizes a suitable identifier, they act and *consume* the respective data.

DeviceNet carries two types of messages:

- *I/O messages*
  Messages that are subject to critical timing constraints and that are contain data for control purposes that can be exchanged by means of a single or multiple connections and that employ identifiers with a high priority.

- *explicit messages*
  These are used to establish multi-purpose point-to-point communication paths between two devices which are used for the configuration of network couplers and for diagnostic purposes. These functions usually employ identifiers of a low priority.

Messages that are longer than 8Byte are subject to the fragmentation service. A set of rules for master/slave, peer-to-peer- and multi-master connections is also available.

Communication medium

DeviceNet employs a master line/tap line topology with up to 64 network nodes. The maximum distance is either 500m at a rate of 125kBaud, 250m at a rate of 250kBaud or 100m at a rate of 500kBaud.

The length of the tap lines can be up to 6m while the total length of all spur lines depends on the baudrate.

Network nodes can be removed from or inserted into the network without interruption of the network operation. New stations and failed stations are detected automatically.

DeviceNet employs a screened five-core cable as data communication medium.

DeviceNet uses voltage differences and for this reason it exhibits less sensitivity to interference than a voltage or current based interface.

Signals and power supply conductors are included in the same network cable. It is therefore possible to connect devices that obtain the operating voltage via the network as well as devices with an integrated power supply. Furthermore it is possible to connect redundant power supplies to the network that guarantees the power supply when required.

Bus access method

DeviceNet operates according to the Carrier-Sense Multiple Access (CSMA) principle, i.e. every station on the network may access the bus when it is not occupied (random access).

The exchange of messages is message orientated and not station orientated. Each message is provided with a unique and priorizing identifier. At any time only one station is able to occupy the bus with its messages.

The DeviceNet bus access control is subject to non-destructive, bit-wise arbitration. In this case non-destructive means that the successful station participating in the arbitration doesn't need to re-send its message. The most important station is selected automatically when multiple stations access the bus simultaneously. If a station that is ready to send recognizes that the bus is occupied, its send request is delayed until the current transfer has been completed.

Addressing

All stations on the bus must be uniquely identified by means of an ID address. Every DeviceNet device has addressing facilities.

EDS file

The properties of the DeviceNet units are supplied in the form of an EDS file (**E**lectronic **D**ata **S**heet) to configure a slave interface by means of your configuration tool.

FC2-GW-DN00 - DeviceNet coupler - Structure

Properties   The DeviceNet coupler FC2-GW-DN00 provides a simple method of interfacing any decentral peripheral modules by means of the DeviceNet protocol.

- Group 2 only Device
  - employs the predefined connection set
- Poll only Device
  - no BIT STROBE mode support
  - no CHANGE OF STATE support
- supports all baudrates: 125, 250 and 500kBaud
- address selection by means of switches
- definition of the data rate by means of a special POWER ON procedure (start from address 90...92)
- LED status indicators
- a max. of 32 peripheral modules can be installed
- of these a max. of 8 may be configurable modules
- module configuration by means of the *DeviceNet-Manager*

Front view GW-DN00

[1]   LED status indicator
[2]   DeviceNet connector
[3]   Address selector
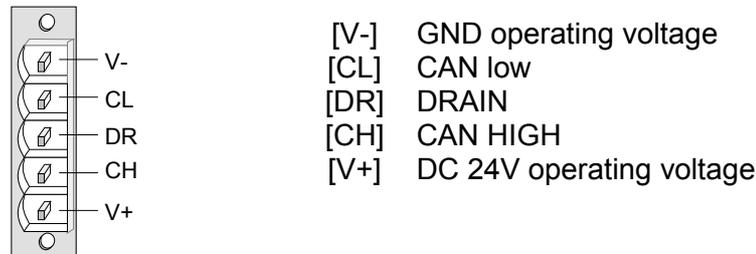[4]   DC 24V power supply connector
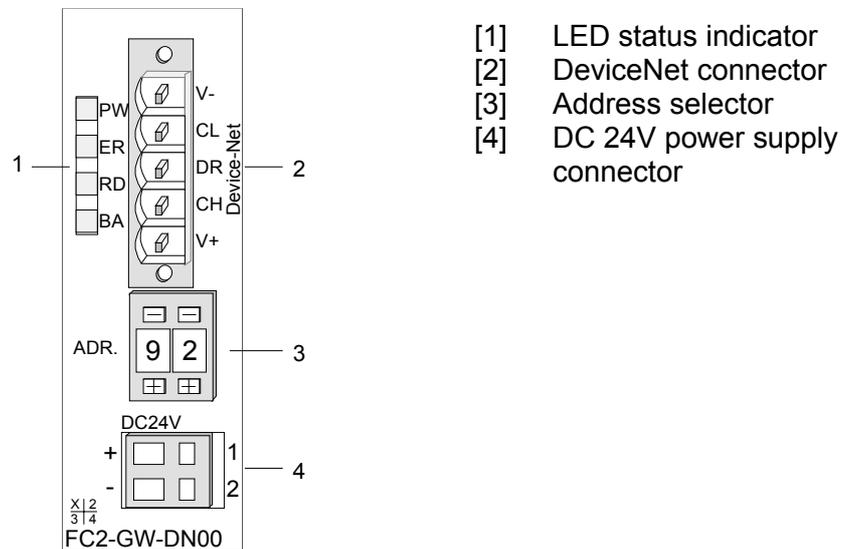
Components

LEDs

4 LEDs on the front show the current status of the module for the quick troubleshooting. A detailed description of the troubleshooting procedure by means of the LEDs and the backplane is available in a section of the chapter "diagnostics".

Label	Color	Description
PW	yellow	Power-LED: supply voltage available
ER	red	DeviceNet or backplane bus bus error
RD	green	Backplane bus status
BA	yellow	DeviceNet status

DeviceNet interfacing
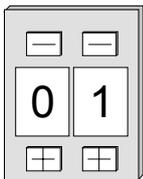
The DeviceNet connection is provided by a 5pin Open Style connector. The pin assignment is imprinted on the front of the module.

[V-]	GND operating voltage
[CL]	CAN low
[DR]	DRAIN
[CH]	CAN HIGH
[V+]	DC 24V operating voltage

V-
CL
DR
CH
V+

Address selector

The address selector is used for:

- the definition of the unique DeviceNet address
- programming of the baudrate

Addresses:

0...63: DeviceNet address

90, 91, 92: set communication rate to 125, 250, 500kBaud

Power supply

Every DeviceNet slave has an internal power supply. This power supply requires DC 24V. In addition to the electronics on the bus coupler, the supply voltage is also used to power any modules connected to the backplane bus. Please note that the maximum current that the integrated power supply can deliver to the backplane bus is 3.5A.

The power supply is protected against reverse polarity.

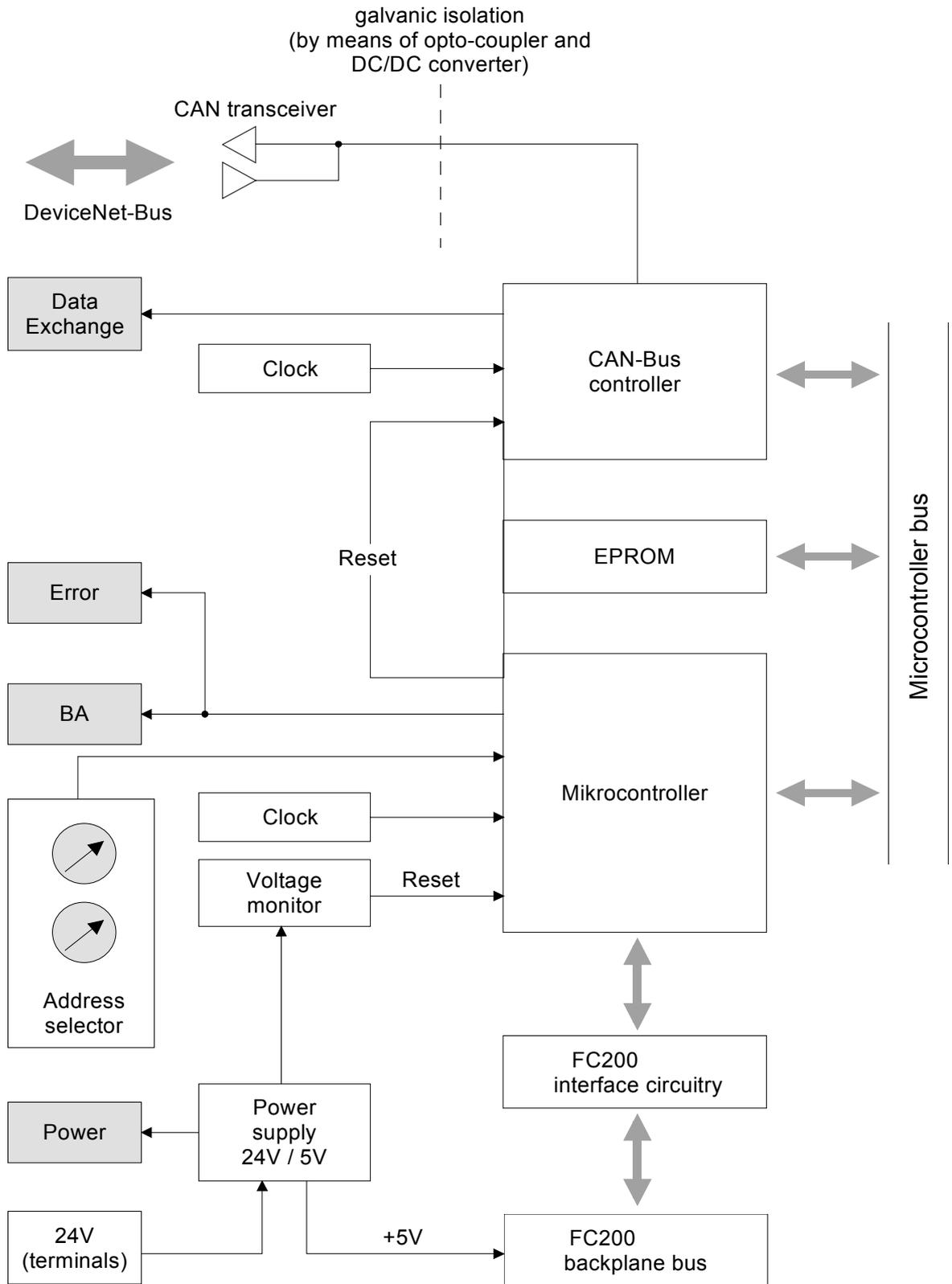DeviceNet and backplane bus are galvanically isolated from each other.

Note!

The DeviceNet coupler does not require any current from the power that is available via the DeviceNet.

Block diagram   The following block diagram shows the hardware structure of the bus coupler in principle as well as the internal communication:

galvanic isolation
(by means of opto-coupler and
DC/DC converter)

CAN transceiver

DeviceNet-Bus

Data
Exchange

Clock

CAN-Bus
controller

Reset

EPROM

Error

BA

Mikrocontroller

Clock

Voltage
monitor   Reset

Address
selector

Microcontroller bus

FC200
interface circuitry

Power

Power
supply
24V / 5V

24V
(terminals)   +5V   FC200
backplane bus

Configuration by means of the DeviceNet-Manager

Overview   The DeviceNet is configured by means of the *DeviceNet-Manager* software
                        from Allen - Bradley.

                        The following steps are necessary for the configuration:

                        • Configuration of the *DeviceNet-Manager*

                        • Set baudrate and DeviceNet address of the module

                        • Test the DeviceNet

                        • Module configuration

                        • I/O addressing of the DeviceNet scanner (master)

**Configuration of   During the configuration the module specific data of the ELCO DeviceNet
the DeviceNet-   coupler are defined and supplied to the *DeviceNet-Manager*.
Manager**   The following steps are required:

                        • Insert the supplied disc into your PC.

                        • Copy   the   file   **IM253DN.BMP**   to   your   PC   into   the   directory
                          /DNETMGR/RES of the *DeviceNet-Manager*

                        • The EDS file is located in a sub-directory of 501.VND on the disc. Copy
                          the file **1.EDS** into the directory **/DNETMGR/EDS/501.VND/0.TYP/-
                          1.COD**

                        You can also copy the entire tree

                                    501.vnd
                                        |-- 0.typ
                                            |--1.cod
                                                    |-- *1.eds*
                                                    |-- *device.bmp*

                        into the directory DNETMGR/EDS.

Specifying baudrate and DeviceNet address

You may set the baudrate as well as the DeviceNet address when the power has been turned off. These will be transferred into the module when you turn the respective power supply on.

Setting the baudrate

All stations connected to the bus communicate at the same baudrate. You may define the required rate by means of the address selector.

- Turn off the power supply
- Set the address selector to the wanted baudrate

Setting	baudrate in kBaud
90	125
91	250
92	500

- Turn on the power supply

  The selected transmission rate is saved to the EEPROM.

  At this point your DeviceNet coupler is set to the correct baudrate.

**LED-indicator
RD-LED
ER-LED**

When the baudrate has been saved successfully, the RD-LED (green) will be turned on.

When the baudrate was selected incorrectly, the ER-LED will be turned on.

Setting the DeviceNet address

All stations connected to the bus must have a unique DeviceNet address. The address can be defined by means of the address selector when the supply has been turned off.

- Turn off the power supply
- Set the address selector to the required address.
  Please ensure that the address is unique in the system and that it is located between 0 and 63.
- Turn on the power supply

  The selected addressis saved to the RAM.

Note!

Any changes to the addressing will only become effective after a POWER ON or an automatic reset. Changes to settings are not recognized during normal operations.

**LED indicator
ER-LED**

When the address is not valid or if it already exists the ER-LED (red) will be turned on after power on.

Test in conjunction with the DeviceNet

Approach
- Connect the PC containing the *DeviceNet-Manager* and the ELCO DeviceNet coupler to the DeviceNet.
- Define the baudrate and the node address at the coupler
- Turn on the power supply of the bus coupler
- Start the *DeviceNet-Manager*.
- Enter the same data rate into the manager that was selected at the bus coupler
- Start the function NETWORK WHO in the manager

  The following network windows is displayed:
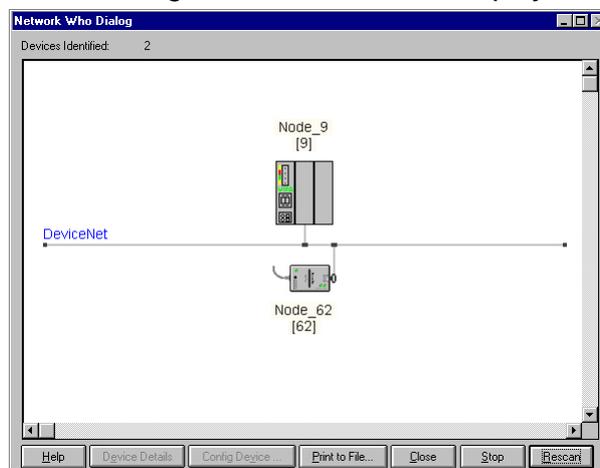
Device Details
- Right-click the bus coupler.
- Select the function DEVICE DETAILS in the context menu.

  The DEVICE DETAILS box is displayed on screen

Here you may display DeviceNet address (node address), the Vendor Code (in this case this is 501 for VIPA GmbH) and other internal information about every module on the bus.

Module configuration in the DeviceNet-Manager

The FC200 includes configurable modules like analog modules.
When you are using these modules in conjunction with a DeviceNet coupler the respective parameters have to be saved in the DeviceNet coupler.

Configuration in groups

The following conditions apply to the configuration:

- DeviceNet manages the parameter data in groups.
- Every DeviceNet coupler is able to process and store a maximum of 144Byte of parameter data.
- These 144Byte are divided into 8 groups of 18Byte each.
- Every group can contain the parameter data of 1 module.
- Groups are identified by a prefix-No. (1...8) in the parameter name.
- The number of parameter bytes is defined in the parameter "Len" (1st parameter) of a group. The number of parameter bytes is available from the technical data contained in the documentation on the peripheral modules.
- The group allocation for a module does not depend on the location or the installation sequence.
- The allocation of the plug-in location is defined by means of the "Slot"-parameter of a group (2nd parameter)
- The values may be entered as bit patterns by double-clicking a parameter
- Unused groups are identified by a "Value" 0000 0000.

Approach

Precondition: The IM 253DN coupler is active on the bus.

Below follows a description of how the parameter settings are defined in the *DeviceNet-Manager*.

- Execute the function WHO in the *DeviceNet-Manager*.

  This will open a network window that includes your coupler.

- Double-click the icon of the bus coupler where you want to modify the parameter data.

  The parameters are read from the coupler and displayed in the following window:
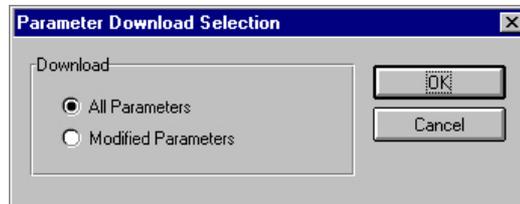
- Locate an unused group in the list of parameters (Value=0000 0000)

  You may display all 8 groups in the parameter list by choosing "All Parameters" in the selection field *Parameter Group.*
- Double click the "Len"-parameter

  The following dialog box is displayed:
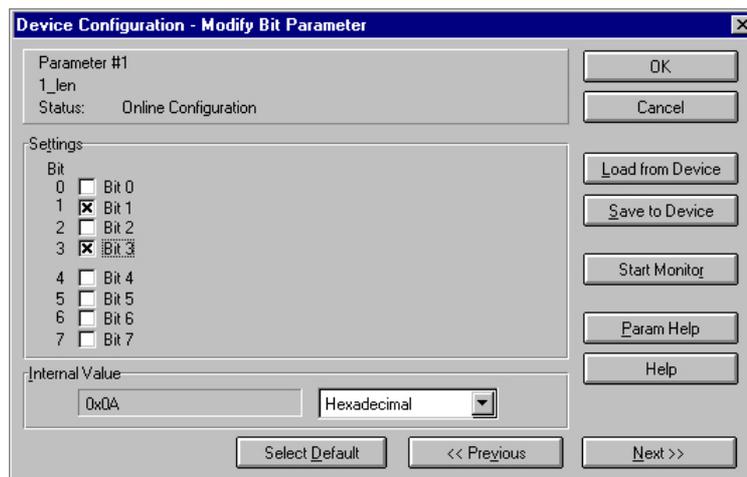
- Enter the number of parameter bytes (bit coded) of the module that you are configuring. You can obtain the number from the documentation for the peripheral module. Set or reset the respective bits by clicking the checkbox.
- Click [OK] to close the mask. The next parameter (slot) of the same group is displayed when you click the button [Next>>].
- Now you have to enter the plug-in location number of the module you are configuring as a bit-code in the same manner.

  You can retrieve the input range by means of the button [Param Help].
- At this point you can enter the parameter bytes for your module one after the other by clicking [Next >>].
- If you wish to configure other modules you have to select another unused group and proceed in the same manner.

- When you have entered all parameters into the different groups you transfer and save the parameters in the DeviceNet coupler by clicking the [Save to Device] button.

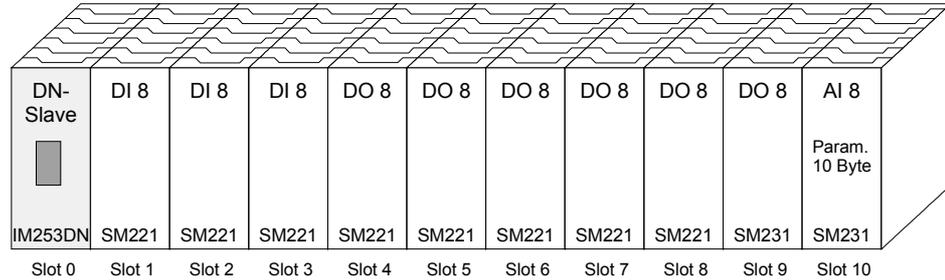 *The following selection window is opened:*

  Parameter Download Selection   ☒

  ┌─Download─────────────────────┐   ┌────────┐
  │ ⦿ All Parameters   │   │   OK   │
  │ ○ Modified Parameters   │   └────────┘
  │   │   ┌────────┐
  │   │   │ Cancel │
  └───────────────────────────────┘   └────────┘

  Here you may decide whether you want to transfer all the parameters or only the parameters that were modified.

- During the transfer the status text "Status: downloading" is displayed. When the transfer has completed, the status text changes to "Status: Device Values"

- If you were to request the "Device Details", you may see that the bit CONFIGURED is now also included in the status.

  When you have entered the parameter values and downloaded them into the DeviceNet coupler, the peripheral modules connected via the backplane bus have been configured accordingly.

Example   The following example is intended to show the configuration of the System 200V. Let us assume that the system has the following structure:


DN-Slave	DI 8	DI 8	DI 8	DO 8	DO 8	DO 8	DO 8	DO 8	DO 8	AI 8 Param. 10 Byte
IM253DN	SM221	SM221	SM221	SM221	SM221	SM221	SM221	SM221	SM231	SM231
Slot 0	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7	Slot 8	Slot 9	Slot 10

The example shows a DeviceNet coupler with 10 modules; however, the modules installed in plug-in locations 1 to 9 can not be configured.

Below follows the description of the configuration of the analog-module in location 10:

Precondition: - the hardware was assembled and is active on the bus.

                          - the Allen - Bradley *DeviceNet-Manager* was installed.

- Execute the function WHO in the *DeviceNet-Manager* and open the parameter window by double-clicking the DeviceNet coupler.

- Locate an unused group in the parameter list (Value=0000 0000)
- Double-click the "Len"-parameter.
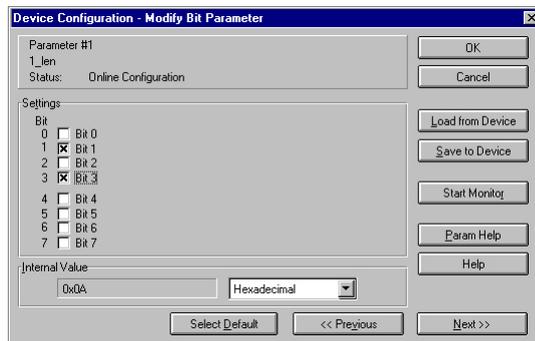
The analog module has 10Byte of parameter data. Enter this value as a bit-coded value.

- Click [Next>>] and enter the location 10 as the "slot".
- You may now enter the parameter bytes of your module by clicking [Next >>] repeatedly.

The analog input module has the following parameters:

Byte	Bit 7 ... Bit 0	Default
0	Diagnostic alarm byte:	00h
	Bit 0 ... 5: reserved	
	Bit 6: 0: Diagnostic alarm inhibited	
	1: Diagnostic alarm enabled	
	Bit 7: reserved	
1	reserved	00h
2	Function no. channel 0 (see module description)	2Dh
3	Function no. channel 1 (see module description)	2Dh
4	Function no. channel 2 (see module description)	2Dh
5	Function no. channel 3 (see module description)	2Dh
6	Option byte channel 0	00h
7	Option byte channel 1	00h
8	Option byte channel 2	00h
9	Option-byte channel 3	00h

- When all parameters have been entered into the group you transfer and save the parameters in the DeviceNet coupler by means of [Save to Device].

- During the transfer the status text is displayed as "Status: downloading". When the transfer has been completed the status text changes to "Status: Device Values"

Note!

Parameters may be changed at any time. For this purpose you have to click [Load from Device], then enter the required changes and save them by means of [Save to Device].

I/O addressing of the DeviceNet scanner

The DeviceNet coupler determines the modules installed on the backplane bus automatically and uses the result to generate the number of input and output bytes.

You have to determine these two values when you configure the input/output modules and enter them in the DeviceNet scanner (master):

- produced connection size (number of input bytes)
- consumed connection size (number of output bytes)

The addressing results from the sequence of the modules (plug-in location 1 to 32) and the base address that was defined in the DeviceNet scanner for the bus coupler.

DeviceNet scanner configuration

- Set the DeviceNet scanner to connection type POLL IO.
- Define the parameters:
  "Receive data size" = number of input bytes
  "Transmit data size" = number of output bytes
- Define the base address (mapping) of receive data and transmit data as required.
- Activate the DeviceNet coupler IM 253DN in the scan list.
- Start the DeviceNet scanner.

When the DeviceNet scanners have been configured, the input and output modules are accessible via the defined addresses.

Example

The following 6 modules have been installed into the backplane bus:

Plug-in location	Installed module	Input data	Output data
Slot 0	DeviceNet coupler	-	-
Slot 1	Digital Out SM 222		1Byte
Slot 2	Digital Out SM 222		1Byte
Slot 3	Digital In SM 221	1Byte	
Slot 4	Analog In SM 231	4Words	
Slot 5	Analog Out SM 232		4Words
Total:		1+4*2=9Byte	1+1+4*2=10Byte

The result is:

- produced connection size: 9Byte (sum of input bytes)
- consumed connection size: 10Byte (sum of output bytes)

Diagnostics

Overview   The LEDs installed to display the status allow extensive diagnostics during the POWER ON - procedure as well as during operation. The result of the diagnosis is determined by the combination of the different LEDs and the current operating mode.

Explanation:

LED	Description
☐ off	LED turned off
☐ on	LED is permanently on
☒ blinks	LED blinks

The following operating modes are available depending on the position of the address selector:

- DeviceNet mode (address selector in position 0...63)
- Configuration mode (address selector in position 90...92)

DeviceNet mode

POWER ON without DeviceNet

LED	Description
☐ PW on ☐ ER off ☒ RD blinks ☐ BA off	After POWER ON the PW-LED is turned on and indicates a properly operating power supply. The RD-LED blinks since the configuration data, stored in the EEPROM, was transferred successfully into the peripheral modules
☐ PW on ■ ER on ☐ RD off ☐ BA off	After POWER ON the PW-LED is turned on. The ER-LED is on due to errors on the backplane bus or when the configuration data could not be transferred into the peripheral modules.

POWER ON with DeviceNet without master

LED	Description
☐ PW on	After POWER ON the PW-LED is turned on.
☐ ER off	The RD-LED blinks because:
☒ RD blinks	• the backplane bus is operating properly
☒ BA blinks	• the configuration data was transferred successfully from the EEPROM into the configurable peripheral modules.
	The BA-LED blinks because:
	• at least one additional device is active on the DeviceNet,
	• and the address set up on the coupler is unique.
☐ PW on	After POWER ON the PW-LED is turned on. The ER-LED is on due to one of the following conditions on the DeviceNet coupler:
☐ ER on	
☐ RD off	• bad address or address occupied by another device
☐ BA off	• data transfer rate is bad.
☐ PW on	After POWER ON the PW-LED is on.
☐ ER on	The ER-LED is turned on when the configuration data could not be transferred into the configurable peripheral module.
☒ RD blinks	
☒ BA blinks	
	The RD-LED blinks because
	• the backplane bus is operating properly
	• the configuration data was not transferred into the configurable peripheral modules.
	The BA-LED blinks because
	• at least one other device is active on the DeviceNet,
	• the address set up on the coupler is unique.

POWER ON with DeviceNet and master

LED	Description
🟨 PW on 🟥 ER on ☒ RD blinks 🟨 BA on	After POWER ON the PW-LED is on. The ER-LED is turned on since the configuration data was not transferred into the configurable peripheral modules. The RD-LED blinks because • the backplane bus operates properly • the configuration data was not transferred into the configurable peripheral modules. The BA-LED is turned on • because the coupler IM 253DN has established a DeviceNet-connection to a master. Note! The IM 253DN coupler executes a reset after 30s. An error that occurs during POWER ON with DeviceNet and master displays the same combination of LEDs as a hardware error. It is possible to distinguish between these cases: • by interruption of the DeviceNet connection $\rightarrow$ ER-LED and RD are blinking! • with a network WHO in the *DeviceNet-Manager* $\rightarrow$ in case of a hardware error the IM253DN will not appear on the network Please call the VIPA hotline if a hardware error occurs!

Proper operation with DeviceNet and master

LED	Description
🟨 PW on ☐ ER off 🟩 RD on 🟨 BA on	After POWER ON the PW-LED is on. The RD-LED is turned on because the connection to the peripheral modules could be established via the backplane bus. The BA-LED is turned on because the coupler IM 253DN established a DeviceNet connection with a master.

Errors during the operation with DeviceNet and master

LED	Description
🟨 PW on 🟥 ER on ⬜ RD off 🟨 BA on	After POWER ON the PW-LED is on. The ER-LED is turned on because an error was detected on the backplane bus. The BA-LED is turned on because the IM 253DN coupler established a DeviceNet connection with a master. **Note!** The IM 253DN coupler will execute a reset after 30s.

Change of state from operational to module error status

LED	Description
🟨 PW on 🟥 ER on ⬜ RD off ⬜ BA off	The ER-LED is turned on for 1 second because a module error was detected. Subsequently the coupler IM 253DN will execute a reset. After the reset the coupler is re-started and it indicates the error by means of the respective LED combination.

Indicators after a re-start and a reset

LED	Description
🟨 PW on 🟥 ER on 🟩⊠ RD blinks 🟨 BA on	The ER-LED is turned on permanently and the RD-LED blinks because the quantity of I/O data was changed by the failure of the module. The configuration data could not be transferred. All Allen - Bradley scanners will display message #77.
🟨 PW on ⬜ ER off 🟩 RD on 🟨 BA on	The ER-LED is not turned on and the RD-LED is permanently on because the quantity of I/O data was modified by the failure of the module. The connection with the I/O modules was established. All Allen - Bradley scanners will display message #77.

Change of state from operational to connection error status

LED	Description
☐ PW on ☒ ER blinks ☒ RD blinks ☐ BA on	The ER-LED blinks because the timer of the I/O connection detected an error. The RD-LED blinks because the I/O-connection does not exist any longer. All inputs and outputs are set to zero. The BA-LED is turned on because the connection with the master is still established.

Configuration mode

POWER ON in configuration mode

LED	Description
☐ PW on ☐ ER off ☐ RD on ☐ BA off	After POWER ON the PW-LED is turned on and indicates that the power supply operates properly. The RD-LED is turned on after a short delay since the baudrate was transferred into the EEPROM.

Device error

LED	Description
☐ PW on ☐ ER on ☐ RD off ☐ BA off	The address that was set up on the coupler is not valid. Change the address to a valid setting: • 0...63 as DeviceNet address • 90...92 for the definition of the baudrate
☐ PW on ☐ ER on ☐ RD on ☐ BA on	When the coupler is not connected to the DeviceNet, an error was detected in the internal EEPROM or in RAM. When a DeviceNet connection exists, it is also possible that an error has occurred during the transfer of the configuration data into the peripheral modules. Note! Errors that occur during POWER ON with DeviceNet and master display the same combination of LEDs as a hardware error. It is possible to distinguish between these cases: • by interruption of the DeviceNet connection → ER-LED and RD are blinking! • with a network WHO in the *DeviceNet-Manager* → in case of a hardware error the IM 253DN will not appear on the network Please call the VIPA hotline if a hardware error occurs!

Technical data

DeviceNet coupler
IM 253DN

Electrical data	FC2-GW-DN00
Power supply	DC 24V (20.4 ... 28.8) via front from ext. power supply
Current consumption	Bus coupler: 50mA
	incl. supply to the peripheral modules: 800mA max.
Output current backplane bus	3.5A
Isolation	500V rms
between DeviceNet and backplane bus	
Function specific data	
Status indicator	by means of LEDs on the front
Physical connection to DeviceNet	5pin Open Style connector
Network topology	Linear bus, tap lines up to 6m length
Communication medium	Screened 5core cable
Communication rate	125, 250, 500kBaud
Overall length of the bus	up to 500m
Number of stations	max. 64
Combination with peripheral modules	
Number of modules	max. 32
Inputs	max. 256Byte
Outputs	max. 256Byte
Dimensions and Weight	
Dimensions (BxHxT)	25.4x76x78mm
Weight	80g