# CANopen Adapter User Manual

## FnIO S-Series

# NA-9161

List of revisions

| No. | Date | Version | Revision |
|---|---|---|---|
| 1 | 2007. . | 1.00 | created |
| 2 | 2007. 11. 27 | 1.01 | include FnBus communication register |
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# Contents

# 1. Product Specifications

## 1) General Specifications

| Item | | Specifications | Remarks |
|---|---|---|---|
| Temperature | Operating | -0℃ to +60℃ (32˚F to 140˚F) | |
| | Storage | -40℃ to +85℃ (-40˚F to 185˚F) | |
| Humidity | Operating | 5 to 95% RH (Non-condensing) | |
| | Storage | 5 to 95% RH (Non-condensing) | |
| Vibration immunity | | 10 TO 55Hz,double amplitude of 0.75mm,<br>10minutes on each of 3 axes (X,Y,Z) | |
| Shock Immunity | | Peak acceleration and duration 15g/11ms,<br>3 times on each of 3 axes (X,Y,Z) | |
| Capsuling | | Din rail or screw tightening | |

## 2) CANopen Communication Specification

| Item | Specification | Remarks |
|---|---|---|
| Network Protocol | 8 transmit PDOs<br>8 receive PDOs<br>1 standard SDO(server)<br>1 emergency object<br>1 SYNC<br>node guarding<br>NMT objects | |
| Network length | Depending on Baudrate | |
| Number of Nodes | 99 Node/Max | Rotary switch |
| Communication speed | 10Kbits ~ 1Mbits | Auto Baudrate selection |
| Number of Expansion I/O | Max. 32 Slots | |
| Isolation | Non-Isolation | |
| CANopen Power | Rate voltage: 24V DC nominal Voltage range: 11 to 28.8 V DC Current consumption: Max 1.5w | |

# 2. CANopen Setting

**CANopen setting include the following configurations:**

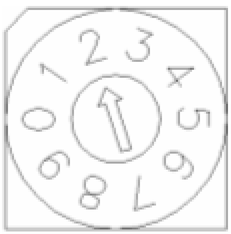
- **Communication parameter setting**
- **I/O allocation**
- **Default Identifier**
- **COMMUNICATION**

## 1) Communication Parameter Setting

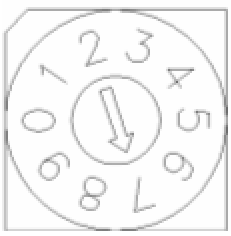
◆ **Node Address Setting**

- NA-9161 Node address is determined by the node address rotary switch on the front panel of adapter module.
- Set node address is recognized on the power-on of adapter module.

Ex) When node address is set as 27:
Device MAC ID Setting :( 2*10 + 1*7 )= 27



X 10 (MSD)



X 1 (LSD)

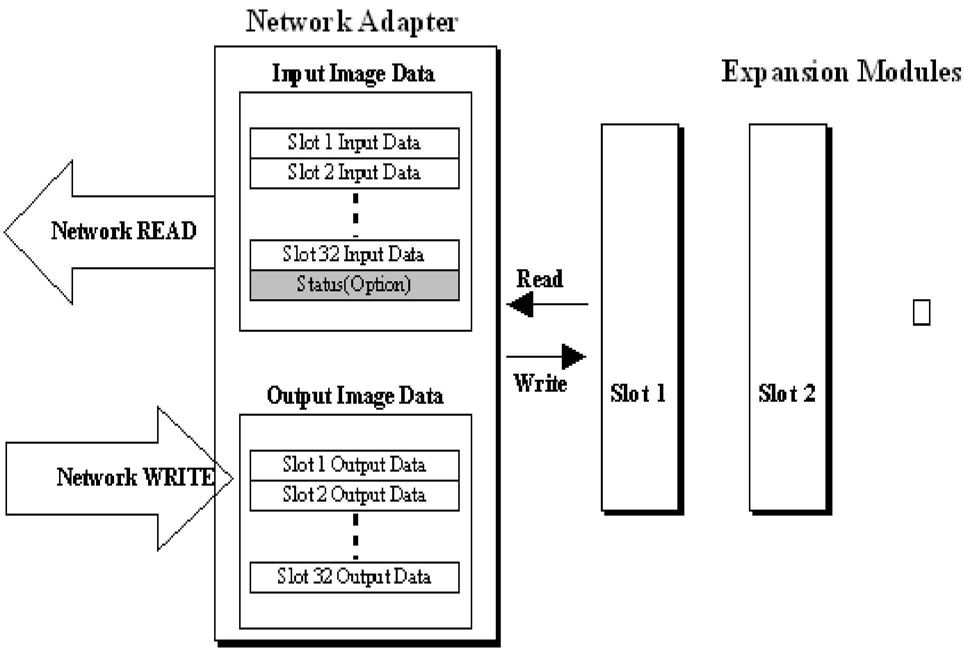
* Each CANopen Adaptor has MAC ID from no.0 to 99

◆ **Communication Speed Setting**

- See Master Setting about communication speed setting.

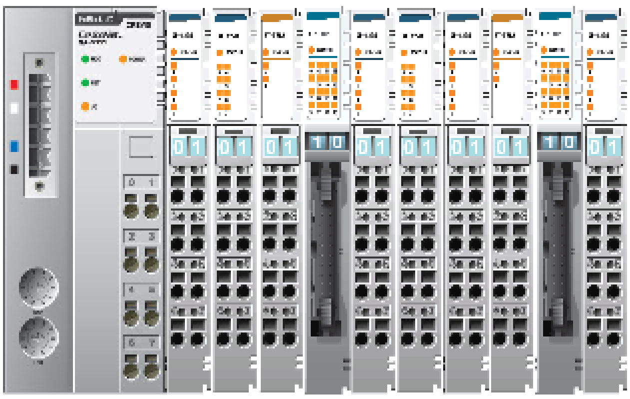
## 2) I/0 Allocation

The expansion Module connecting to Adaptor has 3 types of Data types (I/O Data, Configuration Parameters, Memory Resister) These data are exchanging I/O Process image Data via FnBus Protocol between Adaptor and Expansion Module as below ;




◆ **Input Image Data is determined by the position of Slot and Expansion Module.**

= **For Example**



| Slot Address | Module Description |
|---|---|
| 0 | CANopen Adaptor |
| 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 |

◆ **Compress mode data format**

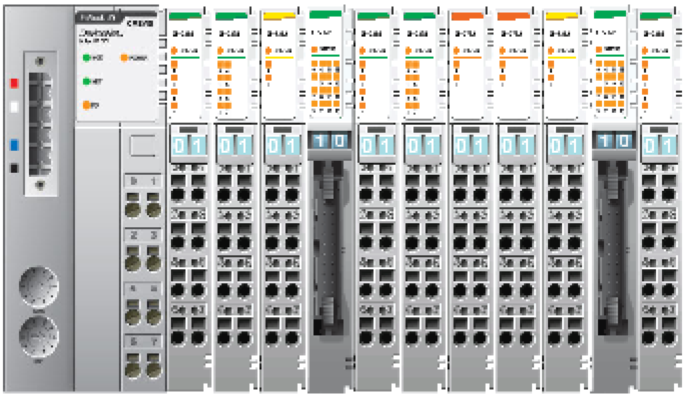
| Byte | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | Index | Sub-In. |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Analog Input Ch0 low byte (Slot#3) | | | | | | | | 0x6401 | 0x01 |
| 1 | Analog Input Ch0 High byte (Slot#3) | | | | | | | | 0x6401 | 0x01 |
| 2 | Analog Input 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 | Discrete Input 4pts(Slot#2) | | | | Discrete Input 4pts(Slot#1) | | | | 0x6000 | 0x01 |
| 9 | Discrete Input 4pts(Slot#4) | | | | Discrete Input 4pts(Slot#2) | | | | 0x6000 | 0x02 |
| 10 | Discrete Input 8pts(Slot#4) | | | | | | | | 0x6000 | 0x03 |
| 11 | Discrete Input 4pts(Slot#5) | | | | Discrete Input 4pts(Slot#4) | | | | 0x6000 | 0x04 |
| 12 | Discrete Input 8pts(Slot#6) | | | | | | | | 0x6000 | 0x05 |
| 13 | Discrete Input 4pts(Slot#9) | | | | Discrete Input 4pts(Slot#7) | | | | 0x6000 | 0x06 |
| 14 | Discrete Input 8pts(Slot#9) | | | | | | | | 0x6000 | 0x07 |
| 15 | | | | | Discrete Input 4pts(Slot#9) | | | | 0x6000 | 0x08 |
| 16 | HSC Input 0 byte(Slot#10) | | | | | | | | 0x3000 | 0x01 |
| 17 | HSC Input 1 byte(Slot#10) | | | | | | | | 0x3000 | 0x02 |
| 18 | HSC Input 2 byte(Slot#10) | | | | | | | | 0x3000 | 0x03 |
| 19 | HSC Input 3 byte(Slot#10) | | | | | | | | 0x3000 | 0x04 |
| 20 | HSC Input 4 byte(Slot#10) | | | | | | | | 0x3000 | 0x05 |
| 21 | HSC Input 5 byte(Slot#10) | | | | | | | | 0x3000 | 0x06 |

◆ **Non-compress mode data format**

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

◆ **Output Image Data is determined by the position of Slot and Expansion Module.**

**= For Example**



| Slot Address | Module Description |
|---|---|
| 0 | CANopen Adaptor |
| 1 | 4-Discrete Output |
| 2 | 8-Discrete Output |
| 3 | 2-Analog Output |
| 4 | 16-Discrete Output |
| 5 | 4-Discrete Output |
| 6 | 8-Discrete Output |
| 7 | 2-Relay Output |
| 8 | 2-Relay Output |
| 9 | 2-Analog Output |
| 10 | 16-Discrete Output |
| 11 | 1Ch, High speed counter |

◆ **Compress mode data format**

| Byte | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | Index | Sub-In. |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Analog Output Ch0 low byte (Slot#3) | | | | | | | | 0x6411 | 0x01 |
| 1 | Analog Output Ch0 High byte (Slot#3) | | | | | | | | 0x6411 | 0x01 |
| 2 | Analog Output Ch1 low byte (Slot#3) | | | | | | | | 0x6411 | 0x02 |
| 3 | Analog Output Ch1 High byte (Slot#3) | | | | | | | | 0x6411 | 0x02 |
| 4 | Analog Output Ch0 low byte (Slot#9) | | | | | | | | 0x6411 | 0x03 |
| 5 | Analog Output Ch0 High byte (Slot#9) | | | | | | | | 0x6411 | 0x03 |
| 6 | Analog Output Ch1 low byte (Slot#9) | | | | | | | | 0x6411 | 0x04 |
| 7 | Analog Output Ch1 High byte (Slot#9) | | | | | | | | 0x6411 | 0x04 |
| 8 | Discrete Output 4pts(Slot#2) | | | | Discrete Output 4pts(Slot#1) | | | | 0x6200 | 0x01 |
| 9 | Discrete Output 4pts(Slot#4) | | | | Discrete Output 4pts(Slot#2) | | | | 0x6200 | 0x02 |
| 10 | Discrete Output low 8pts(Slot#4) | | | | | | | | 0x6200 | 0x03 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 11 | Discrete Output 4pts(Slot#5) | | | | Discrete Output 4pts(Slot#4) | | | | 0x6200 | 0x04 |
| 12 | Discrete Output 8pts(Slot#6) | | | | | | | | 0x6200 | 0x05 |
| 13 | Discrete Output 4pts(Slot#10) | | | | Discrete Output | | Discrete Output | | 0x6200 | 0x06 |
| 14 | Discrete Output High 8pts(Slot#10) | | | | | | | | 0x6200 | 0x07 |
| 15 | Reserved | | | | Discrete Output 4pts(Slot#10) | | | | 0x6200 | 0x08 |
| 16 | HSC Output low byte(Slot#10) | | | | | | | | 0x3200 | 0x01 |
| 17 | HSC Output High byte(Slot#10) | | | | | | | | 0x3200 | 0x02 |

◆ **Non-compress mode data format**

| Byte | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | Index | Sub-In. |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Analog Output Ch0 low byte (Slot#3) | | | | | | | | 0x6411 | 0x01 |
| 1 | Analog Output Ch0 High byte (Slot#3) | | | | | | | | 0x6411 | 0x01 |
| 2 | Analog Output Ch1 low byte (Slot#3) | | | | | | | | 0x6411 | 0x02 |
| 3 | Analog Output Ch1 High byte (Slot#3) | | | | | | | | 0x6411 | 0x02 |
| 4 | Analog Output Ch0 low byte (Slot#9) | | | | | | | | 0x6411 | 0x03 |
| 5 | Analog Output Ch0 High byte (Slot#9) | | | | | | | | 0x6411 | 0x03 |
| 6 | Analog Output Ch1 low byte (Slot#9) | | | | | | | | 0x6411 | 0x04 |
| 7 | Analog Output Ch1 High byte (Slot#9) | | | | | | | | 0x6411 | 0x04 |
| 8 | Reserved | | | | Discrete Output 4pts(Slot#1) | | | | 0x6200 | 0x01 |
| 9 | Discrete Output 8pts(Slot#2) | | | | | | | | 0x6200 | 0x02 |
| 10 | Discrete Output low 8pts(Slot#4) | | | | | | | | 0x6200 | 0x03 |
| 11 | Discrete Output High 8pts(Slot#4) | | | | | | | | 0x6200 | 0x04 |
| 12 | Reserved | | | | Discrete Output 4pts(Slot#5) | | | | 0x6200 | 0x05 |
| 13 | Discrete Output 8pts(Slot#6) | | | | | | | | 0x6200 | 0x06 |
| 14 | Reserved | | | | | | Discrete Output 2pts(Slot#7) | | 0x6200 | 0x07 |
| 15 | Reserved | | | | | | Discrete Output 2pts(Slot#8) | | 0x6200 | 0x08 |
| 16 | Discrete Output low 8pts(Slot#10) | | | | | | | | 0x6200 | 0x09 |
| 17 | Discrete Output High 8pts(Slot#10) | | | | | | | | 0x6200 | 0x0A |
| 18 | Reserved | | | | Discrete Output 4pts(Slot#11) | | | | 0x6200 | 0x0B |
| 19 | HSC Output low byte(Slot#11) | | | | | | | | 0x3200 | 0x01 |
| 20 | HSC Output High byte(Slot#11) | | | | | | | | 0x3200 | 0x02 |

### 3) CANopen I/O Data Format Setting

I/O Data format of NA-9161 is able to be changed to CANopen Configuration Software Setting Data format by changing object value of Configuration software.

◆ **FnBus Communication register Format**

- The index 0x4500 are can be access via SDO.

FnBus Error monitor data format : This object are FnBus state.

| Index | Sub-Index | Decimal Byte | Data Type | Description |
|---|---|---|---|---|
| 0x4500 | 0x01 | Byte 00 | unsigned8 | FnBus Error Code |
| | | Byte 01 | unsigned32 | Error Slot number |
| | | Byte 02 | unsigned8 | Reserve |
| | | Byte 03 | unsigned32 | Field Power state<br>0x80: not supply, 0x00: supply |

Ex) Data Read : Id=RxSDO DLC=8; Data=40 00 45 01 xx xx xx xx

FnBus Data mode : The process image are can be changed via this object.

| Index | Sub-Index | Decimal Byte | Data Type | Description |
|---|---|---|---|---|
| 0x4500 | 0x02 | Byte 00 | unsigned8 | 0 : non-compress mode |
| | | | | 1 : compress mode |

Ex) Data Read : Id=RxSDO DLC=8; Data=40 00 45 02 xx xx xx xx
Data Write : Id=RxSDO DLC=8; Data=2F 00 45 02 01 xx xx xx(compress mode set)

Expansion module active flag data format : The IO slot are deactivated via the bit flag.

| Index | Sub-Index | Data Type | Data Type | Description |
|---|---|---|---|---|
| 0x4500 | 0x03 | unsigned32 | Bit 00 | Active/Deactiveate flag for slot position #1 (0:Active, 1:Deactivate) |
| | | | Bit 01 | Active/Deactiveate flag for slot position #2 (0:Active, 1:Deactivate) |
| | | | Bit 02 | Active/Deactiveate flag for slot position #3 (0:Active, 1:Deactivate) |
| | | | : | : |
| | | | Bit 30 | Active/Deactiveate flag for slot position #31 (0:Active, 1:Deactivate) |
| | | | Bit 31 | Active/Deactiveate flag for slot position #32 (0:Active, 1:Deactivate) |

### ◆ Digital Data Bit size Information

- The index is can be access via SDO.

Input bit size information : All digital input data are counted

| Index | Sub-Index | Decimal Byte | Data Type | Description |
|---|---|---|---|---|
| 0x2020 | 0x01 | Byte 00 | unsigned8 | All Digital input bit size |

Ex) Data Read : Id=RxSDO DLC=8; Data=40 20 20 00 xx xx xx xx

Output bit size information : All digital output data are counted

| Index | Sub-Index | Decimal Byte | Data Type | Description |
|---|---|---|---|---|
| 0x2220 | 0x01 | Byte 00 | unsigned8 | All Digital output bit size |

Ex) Data Read : Id=RxSDO DLC=8; Data=40 20 22 00 xx xx xx xx

### ◆ Special IO Data Block

Special Input Block

| Index | Sub-Index | Decimal Byte | Data Type | Description |
|---|---|---|---|---|
| 0x3000 | 0x01 | Byte 00 | unsigned8 | 0h~7h Special input data |
| | 0x02 | Byte 01 | unsigned8 | 8h~15h Special input data |
| | : | : | : | : |
| | 0x64 | Byte 64 | unsigned8 | 1F8h~1FFh Special input data |

Special Output Block

| Index | Sub-Index | Decimal Byte | Data Type | Description |
|---|---|---|---|---|
| 0x3200 | 0x01 | Byte 00 | unsigned8 | 0h~7h Special output data |
| | 0x02 | Byte 01 | unsigned8 | 8h~15h Special output data |
| | : | : | : | : |
| | 0x64 | Byte 64 | unsigned8 | 1F8h~1FFh Special output data |

## 4) Default Identifier

CANopen provides default identifiers for the most important communication objects, and these are derived from the 7-bit node address(the node ID) and a 4-bit function code in accordance with the following scheme:

11Bit Identifier

| 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Function | | | | Code Node ID | | | | | | |

The COB ID are given according to DS301. This gives rise to the following default identifiers:

| Object | Function | Function Code | COB ID(hex/dec) | Object for Communication parameter/mapping |
|---|---|---|---|---|
| NMT | Boot-up | 0000 | 0x00/0 | - |
| SYNC | Synch. | 0001 | 0x80/128 | 0x1500+0x1006 |
| EMERGENCY | Status/Error | 0001 | 0x81-0xFF/129-255 | - |
| PDO 1(Tx) | Digital Input | 0011 | 0x181-0x1FF/385-511 | 0x1800/0x1A00 |
| PDO 1(Rx) | Digital Output | 0100 | 0x201-0x27F/513-639 | 0x1400/0x1600 |
| PDO 2(Tx) | Analog Input | 0101 | 0x281-0x2FF/641-767 | 0x1801/0x1A01 |
| PDO 2(Rx) | Analog Output | 0110 | 0x301-0x37f/769-895 | 0x1401/0x1601 |
| SDO (Tx) | Parameter | 1011 | 0x581-0x5ff/1409-1535 | - |
| SDO (Rx) | Parameter | 1100 | 0x601-0x67F/1537-1663 | - |
| Nodeguard | Life/Nodeguard | 1110 | 0x701-0x77F/1793-1919 | 0x100C,0x100D,0x100E |

The COB ID can be changed vis SDO.
The PDOs 3-8 do not have default values in DeviceProfile 402. The COD ID of these PDOs have to be set by the user with regard to the COB ID which are already use by the network.

## 5) COMMUNICATION

**- Structure of the device model**

Communication. This function unit makes the communication data objects and the associated functionality for data exchange over the CANopen network available.
The network status machine is part of this.
Object directory. This contains all the data objects (application data + parameters) that are accessible from outside and that affect the behavior of communication, application and status machines. The object directory is organised as a twoimensional table in which the data are addressed by their index and sub-index.

The data exchange with CANopen devices takes place by means of data objects. In the CANopen communication profile, two types of standard object (PDO and SDO) and special objects (for network management etc.) are defined.

The NA-9161 support the following objects:

. 8 transmit PDOs

. 8 receive PDOs

. 1 standard SDO (server)

. 1 emergency object

. 1 synchronisation object ( SYNC, without time stamp )

. node guarding

. NMT objects

Every CANopen device possesses a CANopen object directory in which the parameters for all the CANopen objections are entered.

**- PDO (Process Data)**

In many fieldbus systems the entire process image is continuously transferred - usually in a more or less cyclic manner.
CANopen is not limited to this communication principle, since the multi-master bus access protocol allow CAN to offer other methods.

The process data in CANopen is divided into segments with a maximum of 8 bytes. These segments are known as process data objects(PDOs). The PDOs each correspond to a CAN telegram, whose specific CAN identifier is used to allocate them and to determine their their priority.

The PDOs are named from the point of view of the bus coupler: receive PDOs (RxPDOs) are received by the coupler and contain output data, while transmit PDOs (TxPDOs) are sent by the coupler and contain input data.

**- PDO Mapping**

CANopen specifies the data assignment for the first two PDOs in the device profile for input/output groups(DS401)("default mapping"). The first PDO is provided for digital inputs (TxPDO1) or outputs (RxPDO1). The first 4 analogue inputs or outputs are located in second PDO. These PDOs are accordingly occupied by the bus couplers - if , for instance, no digital output terminals are plugged in RxPDO1 remains empty.

Once the first PDOs have been occupied, the next PDOs are filled with process data in the following sequence :
1. Digital I/Os (1-byte)

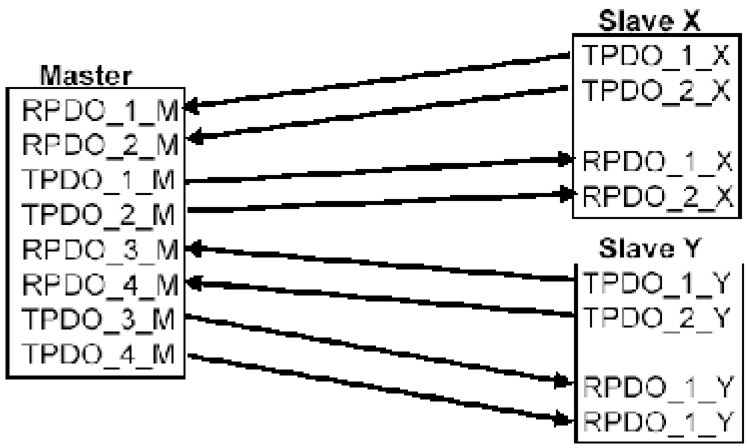
2. Digital I/Os (2-byte)
3. Analog I/Os

**- PDO Identifier**

For the first two PDOs(PDO1 + PDO2) CANopen provides default identifiers depending on the node address, but all other PDOs must have identifiers assigned to them.
The principle of the default identifiers is explained in the section on "Network Manangement", and there is a list of all the CANopen default identifiers in the appendix.

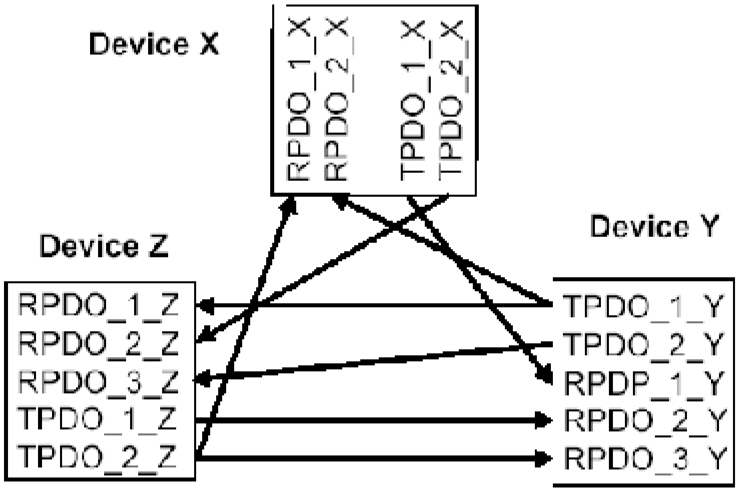
Pre-Define Connection Set

In the system of default identifiers all the nodes ( here : salves) communicate with one central station ( the master ) , since slave nodes do not listen by default to the send identifier of other slave nodes:




PDO Linking

If the consumer-producer model of CANopen PDOs is to be used for direct data exchange between nodes (without a master), the distribution of identifiers must be appropriately adapted, so that the TxPDO indentifier of the producer agrees with the RxPDO identifier of the consumer:




This procedure is known as PDO linking. It permits, for example, easy construction of electronics drives in which several slave axes simultaneously listen to the actual value in the master axis TxPDO.

**- PDO Communication Type (Event driven)**

The "event" is the alteration of an input value, the data being transmitted immediately after this change. The event-driven flow can make optimal use of the bus bandwidth, since instead of the whole process image it is only the changes in that are transmitted. A short reaction time is achieved at the same time, since when an input value changes it is not necessary to wait for the next interrogation from a master.

**Polling**

The PDOS can also be polled by data request telegrams ( remote frames). In this way It is possible to get the input process image of event-driven inputs onto the bus, even when the inputs have not changed, for instance by a monitoring or diagnostic device brought into the network while it is running.
The Crevis CANopen bus adaptor support the interrogation of PDOs by means of remote frames.

**Synchronized**

It is not only for drive applications that it is worthwhile to synchronize the determination of the input information and the setting the outputs. For this purpose CANopen provides the SYNC object, a CAN telegram of high priority but containing no user data, whose reception is used by the synchronized nodes as a trigger for reading the inputs or for setting the outputs:

**PDO transmission type**

The "PDO transmission type" parameter specifies how the transmission of the PDO is triggered, or how received PDOs handled:

| Transmission type | PDO transmission | | | | |
|---|---|---|---|---|---|
| | cyclic | acyclic | synchronous | asynchronous | RTR only |
| 0 | | X | X | | |
| 1-240 | X | | X | | |
| 241-251 | Reserved | | | | |
| 252 | | | X | | X |
| 253 | | | | X | X |
| 254 | | | | X | |
| 255 | | | | X | |

**Synchronous**

Transmission type 0 is only useful for RxPDOs: the PDO is only used when the next SYNC telegram is received. In transmission type 1-240 the PDO is cyclically transmitted or expected : after every "nth" SYNC(n=1...240).
since transmission types can be combined on a coupler as well as in the network, it is possible, for example, for a fast cycle to be agreed for digital inputs (n=1), whereas the data for analogue inputs is transmitted in a shower cycle (e.g.n=10).
The cycle time (SYNC rate) can be monitored (object 0x1006), so that if the SYNC fails the Adaptor switches its outputs into the fault state.

**Asynchronous**

The transmission types 254 + 255 are asynchronous, but may also be event-driven.
In transmission type 254, the event is specific to the manufacturer, whereas for type 255 it is defined in the device profile. Since the Beckoff CANopen bus couplers support device profile DS401 no distinction is made here between the two transmission type.

**Inhibit Time**

The "inhibit time" parameter can be used to implement a " transmit filter" that dose not increase the reaction time for relatively new input alterations, but is active for changes that follow immediately afterwards. The inhibit time(transmit delay time) specifies the minimum length of time that must be allowed to elapse between the transmission of two the same telegrams. If the inhibit time is used, the maximum bus loading can be determined, so that the worst case latency can then be found.

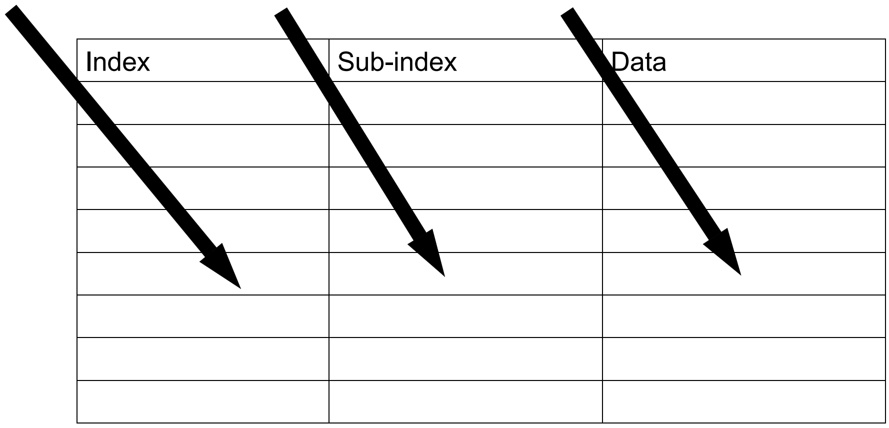
**SDO(Service Data)**

The parameters listed in the object direcory are read and written by means of service data objects. these SDOs are Multiplexed domains, i.e. structures of any size that have a multiplexer (address). The multiplxer consist of a 16-bit index and an 8-bit sub-index that that address the corresponding entries in the object directory.

**Byte0** **Byte1-3: data addressing** **Byte4-7: 1-4byte of data**

| Commnand Specifier | Index Low Byte | Index High Byte | Subindex | Data0 | Data1 | Data 2 | Data 3 |
|---|---|---|---|---|---|---|---|

-Upload
-Download
-Number of data byte
-Request
-Response




The CANopen bus couplers are servers for the SDO, which means that at the request of a client they make data available(upload), or they receive data from the client(downlad).

This involves a handshake between the client and the server. When the size of the parameter to be transferred is not more than 4 bytes, a single handshake is sufficient (one telegram pair).

For a download, the client sends the data together with its index and subindex, and the server confirms reception. for an upload, the client requests the data by transmitting the index and sub-index of the desired parameter, and the server sends the parameter (including index and sub-index) in its answer telegram. The same pair of identifiers is used for both upload and download. The telegrams, which are always 8 bytes long, encode the various services in the first data byte.
All parameters with the exception of objects 1008h, 1009h and 100Ah(device name, hardware and software versions) are only at most 4 bytes long, so this description is restricted to transmission in expedited transfer.

# 3. CANopen Network Installation

CANOpen Network Set up is like following figure1.

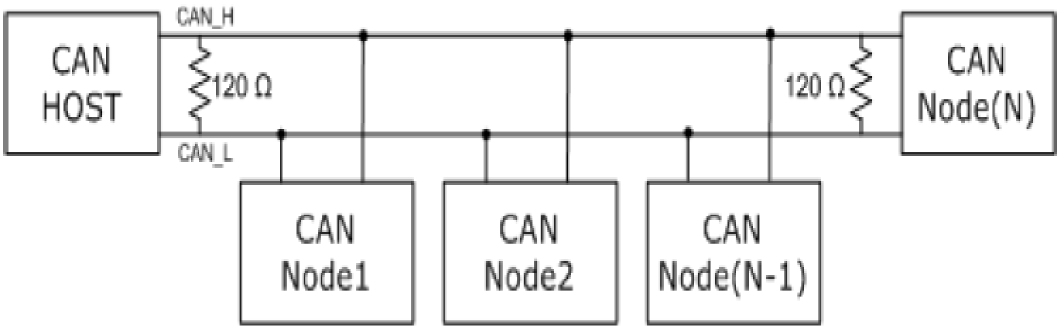



Figure 1. CANOpen Network Example

## 1) CANopen Network Start-up

CANopen defines a state machine that controls the functionality of a device. Transition between the individual states is initiated by internal events or services from the NMT master. These devcies states can be connected to application processes.

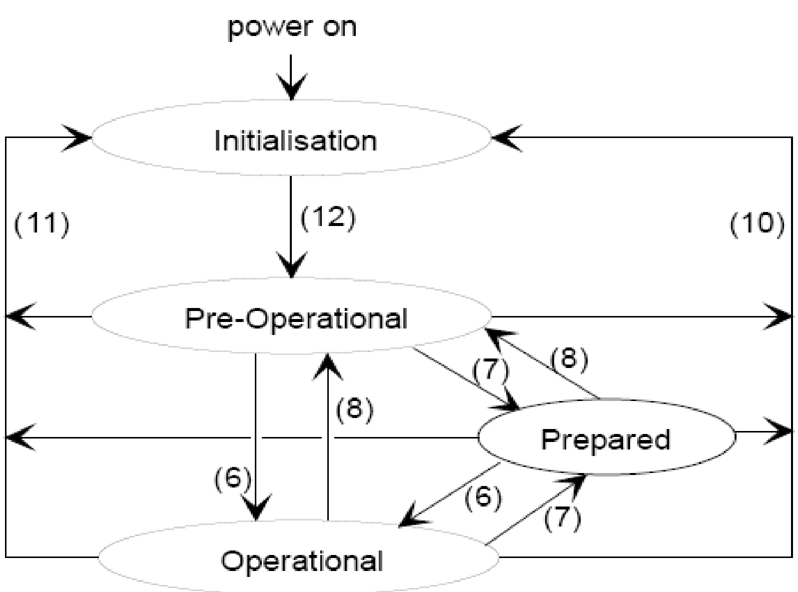



Figure 2. State diagram of a Simple CANopen Boot Up

In Initialization state, the CANopen data structures of a node are initialized by the application. The CIA DS-301 standard defines various mandatory OD entries for this task as well as specific communication objects required for that. In the minimum device configuration, the identifier for these communication objects must correspond to the so-called pre-Dfined

Connection-Set. The device profiles define further settings for the applicable device class. The pre-defined settings for identifier for emergency, PDOs and SDOs are calculated based on the node address(Node ID), that can be in the range from 1 to 99, added to a base identifier that determines the function of the individual object.
After Initialization is completed the node automatically switches into PRE-OPERATIONAL(12) states. The NMT master will be informed about this state change with the BOOT-UP message sent by the corresponding node. In this state it is not possible to communicate with the node using PDOs. However, the node can be configured over the CAN bus using SDOs PRE-OPERATIONAL state. NMT services and Life Guarding are also available in this state.
The application as well as the available resources of the CANopen device determine to what extend configuration over the CAN bus with the help of SDOs must take place.
For example, if the CANopen device dose not provide a non-volatile memory to store mapping and communication parameters for PDOs and these parameters differ from the default values, then these parameters must be transmitted to the node over the network after initialization is completed.
After the configuration of these parameters by the application or NMT master is completed, the NMT service start_Remote_Node(6) can be use to render the node from PRE-OPERATIONAL state into OPERATIONAL state. This state change also causes the initial transmission of all TPDO s independently of whether an event for it is present.
Each susequent transmission of PDOs then always takes place as a function of an event.
All CANopen devices also support the Stop_Remote_Node(7), Enter_PRE_OPERATIONAL_State(8), Reset_Node(10), Reset_Communication(11)services.
Reset_Node is used to reset the application-specific data and the communication parameter of the node. This state change is comparable with an initial operation of the node.
If the NMT service Reset_Communication is used to Change the state of a node, then loading initial values exclusive for the communication parameters in the CANopen stack takes place.
No communication via PDO and SDO is possible if the device is in STOPPED state. Only NMT services, Node Guarding, Life Guarding as well as Heartbeat are possible in this state

## 2) Boot-up Message

After the initialization phase and the self test, the bus coupler sends the boot-up message, a CAN message with no data bytes and with the identifier of the emergency message : CAN-ID = 0x80 + node ID.

## 3) Node Guarding

Node Guarding represents a means of node supervision that is initiated by the NMT master. This service is used to request the node's operational state and to determine whether the node is functioning correctly. The NMT master transmits a single
Node Guard message to the slave in the form of a remote frame with the CAN identifier 0x700 plus the node address of the NMT slave. As a response to this remote frame, the NMT slave sends a CAN message back containing its current NMT state and a one bit that toggles between two subsequent messages.
Response from the NMT Slave to a Node Guard Remote Frame:

| Identifier | DLC | Data |
|---|---|---|
| | | 0 |
| 0x700 + Node Address | 1 | Status Byte |

Node State of a CANopen Device

| Status Byte | Node State |
|---|---|
| 0x00 | BOOT-UP |
| 0x04 | STOPPED |
| 0x05 | OPERATIONAL |
| 0x7F | PRE-OPERATIONAL |

Bit 7 of the status byte always starts with a 0 and changes its value after each transmission. The application is responsible for actively toggling this bit. This ensures that the Node Guard response message from a slave is not just stored in one of the Full-CAN channels. Thus the NMT master will get the confirmation from the NMT slave node that the application is still running.

## 4) Life Guarding

As an alternative to Node Guarding node supervision can also be performed by Life Guarding services. In contrast to the Node Guarding the NMT master cyclically sends a Life Guard message to the slave in the form of a remote frame with the CAN identifier 0x700 plus the node address of the NMT slave. As a response to this remote frame, the NMT slave sends a CAN message back containing its current NMT state and a one bit that toggles between two subsequent messages. With being missing the answer or unexpected status of the slave the NMT masters application is informed. Further the slave can detect the loss of the masters. The Life Guarding is started with the transmission of the first Life Guard message of the masters.
Response from the NMT Slave to a Life Guard Remote Frame

| Identifier | DLC | Data |
|---|---|---|

| | | |
|---|---|---|
| | | 0 |
| 0x700 + Node Address | 1 | Status Byte |

Meaning of the status byte corresponds to that of he Node Guarding message. The Life Guarding supervision on the NMT slave node is deactivated, if the Life Guard time (object entry 0x100C in the object dictionary) or the Life time factor(object entry 0x100D in the object dictionary) are equal to zero.

# 4. Check Operation Status

When all installation and configuration processes are complete, the adaptor module status LED( RUN LED ) shall be lit in a green color. If not, it indicates that an error has occurred. See the following table for proper measures.

## 1) RUN : CAN-RUN LED

| State | LED is | Description |
|---|---|---|
| Not Powered Not On-line | Off | The Device is not on-line or may not be powered Not completed the Dup-Mac_ID test yet |
| On-line, STOPPED | Single Flash Green | The Device is in STOPPED state |
| On-line, PRE-OPERATIONAL | Blinking Green | The Device is in the PRE-OPERATIONAL state |
| On-line, OPERATIONAL | Green | The Device is in the OPERATIONAL state |

## 2) ERR : CAN-ERR LED

| State | LED is | Description |
|---|---|---|
| Not Powered Not On-line | Off | Device is in mode baud rate search or may not be powered. |
| Warning limit reached On-line | Single Flash Red | At least one of the error counters of the CAN controller has reached or exceeded the warning level(too many error frames). |
| Error Control Event On-line | Double Flash Red | The guarding monitor has asserted, guarding telegrams are no longer being received. The adapter is pre-operational state. |
| Sync Error On-line | Triple Flash Red | A sync error has occurred.<br>- The adapter is pre-operational(PDOs switch off). |
| Bus Off | Red | Device is in the cyclic data exchange mode with the parameterization master |

## 3) I/O : Expansion Module Status LED

| State | LED is | To Indicate |
|---|---|---|

| | | |
|---|---|---|
| Not Powered<br>No Expansion Module | Off | Device has no expansion module or may not be powered |
| FnBus On-line,<br>Do Not Exchanging I/O | Flash Green | Fn-Bus is on-line but does not exchanging I/O data<br>- Passed the expansion module configuration. |
| FnBus Connection<br>Run Exchanging I/O | Green | Expansion Slot is connected and run exchanging I/O data |
| FnBus connection fault during exchange IO | Red | One or more expansion module occurred in fault state.<br>- FnBus communication failure |
| Expansion Configuration Failed | Flash Red | Failed to initialize expansion module<br>- Detected invalid expansion module ID.<br>- Overflowed Input/Output Size<br>- Initial protocol failure |

### 4) Field Power : Field Power Status LED

| State | LED is | To Indicate |
|---|---|---|
| Not Supplied Field Power | Off | Not supplied 24Vdc field power |
| Supplied Field Power | Green | Supplied 24Vdc field power |

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