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Preface

This device profile describes a DeviceNet I/O module with four outputs, sixty-eight inputs, and two power sense inputs. It is related to the DN-400 family of devices described in Document #2200093. The major differences between the DN-TC468 and the other members of the DN-400 family are:

1. No support for serial link (RS-232) I/O.
2. Poll and COS/Cyclic productions use fragmented I/O.

References

1. CIP Common Specification Vol. 1
2. DeviceNet Adaptation of CIP Common Vol. 3
3. DN-400 Family Device Profile Document #2200093

1 Object Model

1.1 Objects Present in Device

Object	Class Id	Number of Instances
		DN-TC468
Identity	0x01	1
Message Router*	0x02	1
DeviceNet	0x03	1
Assembly	0x04	1 – Input Assembly, Instance #119 1 – Output Assembly, Instance #121
Connection	0x05	1 – Explicit Message Connection 1 – Poll I/O Connection 1 – COS/Cyclic Connection
Discrete Input Point	0x08	6
Discrete Output Point	0x09	4
Acknowledge Handler Object	0x2B	1
Power Sense	0x64	1
Non-Volatile Test Object	**	1
Vendor Specific Parameter	**	1
Factory Test Object	**	1

* Message Router attributes and services are optional. Message Router behavior is required.

** These objects are described in the Vendor Specific Object Library

1.2 Objects That Effect Behavior

Object	Class Id	Effect on Behavior
Identity	0x01	Supports the reset service
Message Router	0x02	No effect
DeviceNet	0x03	Configures port attributes
Assembly #119	0x04	Input Data Format – from Discrete Input Points
Assembly #121	0x04	Output Data Format – to Discrete Output Points
Connection	0x05	Establishes the number of connections
Discrete Input Point	0x08	Reports state of position sensing inputs and Aux supply monitors
Discrete Output Point	0x09	Defines behavior of solenoid output points
Acknowledge Handler Object	0x2B	Acknowledge Handling for COS/Cyclic IO Connections
Power Sense Object	0x64	Invert Value of Power Sense Inputs
Non-Volatile Test Object	**	Test Non-Volatile Memory
Vendor Specific Parameter Object	**	Vendor Specific Configuration
Factory Test Object	**	Vendor Specific Configuration

** These objects are described in the Vendor Specific Object Library

1.3 Object Interfaces

Object	Class Id	Interface
Identity	0x01	Message Router
Message Router	0x02	Explicit Message Connection Instance
DeviceNet	0x03	Message Router
Assembly	0x04	I/O Connection or Message Router
Connection	0x05	Message Router
Discrete Input Point	0x08	I/O Connection or Message Router
Discrete Output Point	0x09	I/O Connection or Message Router
Acknowledge Handler Object	0x2B	Message Router
Power Sense Object	0x64	Message Router
Non-Volatile Test Object	**	Message Router
Vendor Specific Parameter Object	**	Message Router
Factory Test Object	**	Message Router

** These objects are described in the Vendor Specific Object Library

2 Standard Objects

2.1 Identity Object (0x01)

There is a single instance of the identity object for the device.

2.1.1 Class Attributes

No class attributes or class services are supported.

2.1.2 Instance Attributes

Attribute ID	Access Rule	Name	Data Type	Attribute Values
				DN-TC468
1	Get	Vendor	UINT	0x0014
2	Get	Device Type	UINT	0x0000
3	Get	Product Code	UINT	0x001D
4	Get	Revision	STRUCT	03.03
5	Get	Status	WORD	0x0001
6	Get	Base Serial #	UDINT	0x00007400
7	Get	Product Name	SHORT_STRING	8, DN-TC468
8	Get	State	USINT	[0..5]
9	Get	CCV	UINT	[0..65535]
10	Get/Set	Heartbeat	USINT	[0.255]

2.1.3 Instance Services

Service Code	Service Name	Description of Service
05	Reset	Reset the device to power up configuration
0E	Get_Attribute_Single	Returns the contents of the specified Attribute
10	Set_Attribute_Single	Sets the contents of the specified attribute

2.1.4 Reset Service

Data Type	Value	Description of Service
UINT	0	Reset the device to power up configuration
	1	Return the device to Out-of-Box configuration

2.2 Message Router Objects (0x02)

There is a single instance of the Message Router Object. For this single instance of the Message Router Object there is no externally visible interface. There are no class attributes or services, and there are no instance attributes or services. This is consistent with the definition of the attributes and the services as optional, but the behavior of this object is required.

2.3 DeviceNet Object (0x03)

There is a single instance of the DeviceNet Object for the device

2.3.1 Class Attributes

Attribute ID	Access Rule	Name	Data Type	Value
1	Get	Revision	UINT	0x0002

2.3.2 Class Services

Service Code	Service Name	Description of Service
0E	Get_Attribute_Single	Returns the contents of the specified attribute

2.3.3 Instance Attributes

Attribute ID	Access Rule	Name	Data Type	Value
1	Get/Set	MACID Value	USINT	[0..63]
2	Get/Set	Baud Rate Value	USINT	[0..2]
3	Get/Set	BOI	BOOL	0x00 =Fault
4	Get/Set	Bus-Off Counter	USINT	0x00
5	Get	Allocation Information	STRUCT	Allocated Cnxns
6	Get	MAC ID Switch Changed	BOOL	0=No Change 1=Changed
7	Get	Baudrate Switch Changed	BOOL	0=No change 1=Changed
8	Get	MAC ID Switch Setting	USINT	[0..63]
9	Get	Baudrate Switch Setting	USINT	[0..3]
10	Get/Set	Quick Connect	USINT	0 = Disabled 1 = Enabled

2.3.4 Instance Services

Service Code	Service Name	Description of Service
0E	Get_Attribute_Single	Returns the contents of the specified attribute
10	Set_Attribute_Single	Sets the contents of the specified attribute
4B	Allocate	Creates predefined M/S connections
4C	Release	Deletes predefined M/S connections

2.4 Assembly Object (0x04)

There are four static assembly instances for each device, with instance numbers in the vendor specific range.

2.4.1 Class Attributes and Services

No class attributes or services are supported.

2.4.2 Instance Attributes

Attribute ID	Access Rule	Name	Data Type	Value
3	Get/Set	Value	array of bytes	see definitions

2.4.3 Instance Services

Service Code	Service Name	Description of Service
0E	Get_Attribute_Single	Returns the contents of the specified attribute
10	Set_Attribute_Single	Sets the contents of the specified attribute

2.4.4 Identification of I/O Assembly Instances

The assembly instances all come from the Vendor Specific Range, since the Device Profile for the Communications Adapter and the Generic Devices do not specify any assembly instances in the Open range.

Number	Static Assembly Type	Name
119	Input	Hardware Inputs
121	Output	Hardware Outputs

2.4.5 Format of I/O Assembly Data Attribute

2.4.5.1 Assembly #119 – Data Inputs

The Data Input Assembly contains ten(10) bytes. These ten(10) bytes appear on the wire, in an I/O message, as two fragments. The first fragment contains seven(7) bytes numbered below as zero(0) through six(6). The second fragment contains three(3) bytes numbered below as seven(7) through nine(9). These two fragments are sent with the minimum possible delay between fragments.

Byte\Bit	7	6	5	4	3	2	1	0
0	0	0	IN4	IN3	PS2	PS1	IN2	IN1
1	0	0	0	0	0	CP2	CP1	CP0
2	EX8	EX7	EX6	EX5	EX4	EX3	EX2	EX1
3	EX16	EX15	EX14	EX13	EX12	EX11	EX10	EX9
4	EX24	EX23	EX22	EX21	EX20	EX19	EX18	EX17
5	EX32	EX31	EX30	EX29	EX28	EX27	EX26	EX25
6	EX40	EX39	EX38	EX37	EX36	EX35	EX34	EX33
7	EX48	EX47	EX46	EX45	EX44	EX43	EX42	EX41
8	EX56	EX55	EX54	EX53	EX52	EX51	EX50	EX49
9	EX64	EX63	EX62	EX61	EX60	EX59	EX58	EX57

Bits IN1 through IN4 are general purpose inputs. PS2 and PS1 are connected to power sensors. The polarity of PS2 and PS1 may be programmed. These input bits correspond to the following positions on the connector.

IN1	J5.4
IN2	J5.2
PS1	J4.1
PS2	J4.3 & J4.4
IN3	J6.4
IN4	J6.2

Bits CP2 through CP0 are derived from a BCD Code Plug. Only three bits are available from the code plug and so only values in the range [0..7] are possible.

Bits EX64 through EX1 are the expanded general purpose input array.

Bit positions with a zero are unused and will always be returned as zero.

2.4.5.2 Mapping for Assembly Instance #119

Data Name	Class		Instance Number	Attribute	
	Name	Number		Name	Number
IN1	Discrete Input Point	0x08	1	Value	3
IN2	Discrete Input Point	0x08	2	Value	3
PS1	Discrete Input Point	0x08	3	Value	3
PS2	Discrete Input Point	0x08	4	Value	3
IN3	Discrete Input Point	0x08	6	Value	3
IN4	Discrete Input Point	0x08	7	Value	3

2.4.5.3 Assembly #121 – Data Outputs

Byte	7	6	5	4	3	2	1	0
0	0	0	0	0	OUT4	OUT3	OUT2	OUT1

The zeros in bit positions 4 through 7 indicate that those bits are unused and are ignored by the device.

2.4.5.4 Mapping for Assembly #121

Data Name	Class		Instance Number	Attribute	
	Name	Number		Name	Number
OUT1	Discrete Output Point	0x09	1	Value	3
OUT2	Discrete Output Point	0x09	2	Value	3
OUT3	Discrete Output Point	0x09	3	Value	3
OUT4	Discrete Output Point	0x09	4	Value	3

2.5 Connection Object (0x05)

2.5.1 Class Attributes

No class attributes or services are supported

2.5.2 Instance Attributes

There are three instances of the Connection Object in the device. Instance #1 is assigned to the Explicit Message Connection. Instance #2 is assigned to the Polled I/O Connection and supports COS/Cyclic consumption and ack production. Instance #4 handles COS I/O production and ack consumption. The tables below show the attributes and the predefined values where applicable. In order to have defined numeric values in the tables below, a slave MAC Id of sixty-three(63), and a master MAC Id of one(1) are assumed.

2.5.3 Instance Services

Service Code	Service Name	Description of Service
05	Reset	Reset the connection - restart timer transition from timed out state.
0E	Get_Attribute_Single	Returns the contents of the specified Attribute
10	Set_Attribute_Single	Sets the contents of the specified Attribute

Explicit Message Connection (Instance #1)

Attribute ID	Access Rule	Name	Data Type	Value
1	Get	State	USINT	0x03
2	Get	instance_type	USINT	0x00
3	Get	Xport Class Trigger	USINT	0x83
4	Get	produced connection ID	UINT	0x5FB for MAC ID 63
5	Get	consumed connection ID	UINT	0x5FC for MAC ID 63
6	Get	initial comm characteristics	USINT	0x21
7	Get	produced connection size	UINT	0x0019
8	Get	Consumed connection size	UINT	0x0019
9	Get/Set	expected packet rate	UINT	Application Dependent
10	N/A	N/A	N/A	Obsolete, no longer used
11	N/A	N/A	N/A	Obsolete, no longer used
12	Get/Set	watchdog timeout action	USINT	0x01 Auto Delete
13	Get	produced path length	UINT	0x0000
14	Get	Produced path	Array of USINT	<NULL>
15	Get	consumed path length	UINT	0x0000
16	Get	consumed path	Array of USINT	<NULL>
17	Get	production inhibit timer	UINT	0x0000*

* Server connection endpoints do not use this timer

Poll/COS/Cyc I/O Message Connection (Instance #2)

Attribute ID	Access Rule	Name	Data Type	Value
1	Get	State	USINT	0x03
2	Get	instance_type	USINT	0x01
3	Get	Xport Class Trigger	USINT	0x82 0x80 no poll, no ack
4	Get	produced connection ID	UINT	0x3FF 0xFFFF no Ack for MAC ID 63
5	Get	consumed connection ID	UINT	0x5FD for MAC ID 63
6	Get	initial comm characteristics	USINT	0x01 0xF1 no poll, no ack
7	Get	produced connection size	UINT	0x000A = 10
8	Get	consumed connection size	UINT	0x0001 = 1
9	Get/Set	expected packet rate	UINT	Application Dependent
10	N/A	N/A	N/A	Obsolete, no longer used
11	N/A	N/A	N/A	Obsolete, no longer used
12	Get/Set	watchdog timeout action	USINT	0x00 Time Out
13	Get	produced path length	UINT	0x0006 or 0x0000 no poll, no ack
14	Get	produced path	Array of USINT	20.04.24.77.30.03
15	Get	consumed path length	UINT	0x0006
16	Get	consumed path	Array of USINT	20.04.24.79.30.03
17	Get	production inhibit timer	UINT	0x0000 poll app dep. - COS/Cyc

COS/Cyc I/O Message Connection (Instance #4)

Attribute ID	Access Rule	Name	Data Type	Value
1	Get	state	USINT	0x03
2	Get	instance_type	USINT	0x01
3	Get	Xport Class trigger	USINT	0x12 COS 0x02 Cyc 0x10 COS, no Ack 0x00 Cyc, no Ack
4	Get	produced connection ID	UINT	0x37F for MAC ID 63
5	Get	consumed connection ID	UINT	0x5FA 0xFFFF no Ack for MAC ID 63
6	Get	initial comm characteristics	USINT	0x01 0x0F no Ack
7	Get	produced connection size	UINT	0x000A = 10
8	Get	consumed connection size	UINT	0x0000
9	Get/Set	expected packet rate	UINT	Application Dependent
10	N/A	N/A	N/A	Obsolete, no longer used
11	N/A	N/A	N/A	Obsolete, no longer used
12	Get/Set	watchdog timeout action	USINT	0x00 Time Out
13	Get	produced path length	UINT	0x0006
14	Get	produced path	Array of USINT	20.04.24.77.30.03
15	Get	consumed path length	UINT	0x0004 or 0x0000 no Ack
16	Get	Consumed path	Array of USINT	20.2B.24.01 <null> no Ack
17	Get/Set	production inhibit timer	UINT	app dependent

2.6 Discrete Input(0x08)

2.6.1 Class Attributes

Attribute ID	Access Rule	Name	Data Type	Description	Value
1	Get	Revision	UINT	Revision of this object	2

2.6.2 Class Services

Service Code	Service Name	Description of Service
0E	Get_Attribute_Single	Returns the contents of the specified attribute

2.6.3 Instance Attributes

Attribute ID	Access Rule	Name	Data Type	Description	Value
3	Get	Value	BOOL	Input Point Value	0=off 1=on

2.6.4 Instance Services

Service Code	Service Name	Description of Service
0E	Get_Attribute_Single	Returns the contents of the specified attribute

2.6.5 Input Point Mapping, DN-TC468

Data Name	Class		Instance Number	Attribute	
	Name	Number		Name	Number
IN1	Discrete Input Point	0x08	1	Value	3
IN2	Discrete Input Point	0x08	2	Value	3
PS1	Discrete Input Point	0x08	3	Value	3
PS2	Discrete Input Point	0x08	4	Value	3
IN3	Discrete Input Point	0x08	6	Value	3
IN4	Discrete Input Point	0x08	7	Value	3

2.7 Discrete Output (0x09)

2.7.1 Class Attributes

No class attributes or services are supported for this object.

2.7.2 Instance Attributes

Attribute ID	Access Rule	Name	Data Type	Description	Value
3	Get/Set	Value	BOOL	Output Point Value	0=off 1=on
5	Get/Set	Fault Action	BOOL	Action taken on output's value in Recoverable Fault State	0=Fault Value 1=Hold Last State
6	Get/Set	Fault Value	BOOL	Value to use for Fault Action	0=off 1=on
7	Get/Set	Idle Action	BOOL	Action taken on output's value in Idle State	0=Idle Value 1=Hold Last State
8	Get/Set	Idle Value	BOOL	Value to use for Idle Action	0=off 1=on

2.7.3 Instance Services

Service Code	Service Name	Description of Service
0E	Get_Attribute_Single	Returns the contents of the specified attribute
10	Set_Attribute_Single	Modifies an attribute value

2.7.4 Output Point Mapping

Data Name	Class		Instance Number	Attribute	
	Name	Number		Name	Number
OUT1	Discrete Output Point	0x09	1	Value	3
OUT2	Discrete Output Point	0x09	2	Value	3
OUT3	Discrete Output Point	0x09	3	Value	3
OUT4	Discrete Output Point	0x09	4	Value	3

2.8 Acknowledge Handler Object

The Acknowledge Handler Object is used to manage the reception of message acknowledgements.

2.8.1 Class Attributes

No class attributes are supported.

2.8.2 Class Services

No class services are supported.

2.8.3 Instance Attributes

Attribute ID	Access Rule	Name	Data Type	Description	Value
1	Set	Acknowledge Timer	UINT	Time to wait for acknowledge before resending	[1..65535] ms. 0 is invalid default = 16
2	Get/Set	Retry Limit	USINT	Number of Ack Timeouts before retry limit reached event	[0..255] default = 1
3	Get	COS Producing Connection Instance	UINT	Connection Instance which contains the path of the producing IO application	0x0004 Predefined COS Connection

2.8.4 Instance Services

Service Code	Service Name	Description of Service
0E	Get_Attribute_Single	Returns the contents of the specified attribute
10	Set_Attribute_Single	Modifies an attribute value

3 Vendor Specific Objects

3.1 Power Sense Object (0x64)

The Power Sense Object is used in conjunction with the Discrete Inputs for power sensing, PS2 and PS1. There is a single instance containing a single Boolean attribute.

3.1.1 Class Attributes

None

3.1.2 Class Services

None

3.1.3 Instance Attributes

Attribute ID	Access Rule	Name	Data Type	Description	Value
1	Get/Set	Value	BOOL	Ps_Polarity	0 = N Polarity 1 = P Polarity

3.1.4 Instance Services

Service Code	Service Name	Description of Service
0E	Get_Attribute_Single	Returns the contents of the specified attribute
10	Set_Attribute_Single	Modifies an attribute value

3.2 Non-Volatile Test Object

This object is used for diagnostic purposes, and factory configuration. This object allows control and manipulation of the non-volatile memory from DeviceNet and must be used with extraordinary care.

4 Configuration

4.1 Firmware

The firmware for the DN-TC468 family is stored in FLASH program memory inside the single chip processor (Atmel T89C51CC01). This memory may be electrically erased and reprogrammed multiple times. It is even possible to upgrade a device in the field. This is done with the six-pin serial cable. If pins 1 and 6 are shorted together the processor will enter the boot loader mode. A free software package from Atmel called FLIP can be used to download new firmware. On some newer versions of the Atmel processor it is necessary to make sure that the "Boot Loader Jump Bit" is cleared. Failure to do so will result in the repeated execution of the boot loader instead of the application.

4.2 Non-Volatile Data Configuration

All of the configuration parameters have default values defined in the firmware that are used when the processor is programmed for the first time. As various changes are made to these values in RAM they are updated in the Non-Volatile Data Memory. At some point in time a Factory Lock service is performed by the Factory Test Object. It saves all of the configuration parameters twice. Once to reflect the values that are currently being used and the second time to record the "As Shipped" value of each parameter so that a RESET service to the Identity Object can return the device as close as possible to the "Out of Box" configuration.