MOTOROLA

Land Mobile Products Sector

Driver V2.00 of the DNP V3.00 (Master)

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User Guide

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Glossary

MDLC	Motorola Data Link Communication Protocol
DNP	Distributed Network Protocol
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
MOSCAD	Motorola SCADA
MOSCAD-L	Motorola SCADA-Light
DNP+	Distributed Network Protocol with a set of MDLC features
IED	Intelligent Equipment Device
IIN	Internal Indication

Applicable Documentation

The MOSCAD system includes the following manuals:

- MOSCAD Programming Toolbox for Windows - Getting Started, Motorola publication no. 68P02949C80
- MOSCAD Programming Toolbox for Windows - User Guide, Motorola publication no. 68P02949C85
- MOSCAD Programming Toolbox for Windows - Special Functions, Motorola publication no. 68P02949C90
- MOSCAD Programming Toolbox for Windows - Third Party Protocols Support, Modbus and Allen Bradley, Motorola publication no. 68P02952C50
- MOSCAD Programming Toolbox for Windows - AGA8 Gas Flow Calculations, Motorola publication no. 68P02946C25
- MOSCAD RTU Service manual, Motorola publication no. 68P02991G90
- MOSCAD RTU Owner's manual, Motorola publication no. 68P02994G10
- MCP/M User’s Manual, Motorola publication no. 68P02945C05-0.

References

The following is a list of abbreviations which refer to the titles of the different manuals which comprise the MOSCAD Programming Toolbox guide.

These abbreviations are used throughout the book. For a complete description, refer to the list below:

Abbreviation	Manual Title
User Guide	MOSCAD Programming Toolbox - User Guide - Motorola publication no. 68P02949C85
DNP Guide	DNP V3.00 Subset Definitions, Version 1.00 - The network protocol written by Harris Canada, Inc.

Terms and Conventions

The MOSCAD RTU is shipped in two versions, MOSCAD RTU and MOSCAD-L RTU. Most of the features described in this manual are common to MOSCAD and MOSCAD-L. Throughout the documentation, the terms "RTU" and "MOSCAD" refer to the "generic" system. Differences are indicated by specific references to MOSCAD-L.

Overview

This manual describes the Distributed Network Protocol (DNP) V3.00 as implemented in the DNP master driver for MOSCAD. The driver conforms to the Level 3 specifications provided in *DNP V3.00 Subset Definitions* by Harris Canada, Inc. (document number P009-0IG.SUB).

This manual covers the DNP implementation for both MOSCAD V3.70 or later and MOSCAD-L V1.00 or later. It explains how the DNP protocol functions in relation to reading from and writing to the RTU database. The manual is, therefore, intended for MOSCAD application programmers.

The driver described in this manual represents an implementation of DNP V3.00 Level 3 for communicating between a master and an Intelligent Equipment Device (IED), such as RTU. The driver satisfies the requirements of the DNP V3.00 Level 3.

Two drivers are supported: DNP and DNP+.

The DNP+ driver enhances the standard DNP 3.0 protocol with a set of features that are currently included only as a part of the MDLC protocol. Some of these features are: *Remote diagnostics* of the RTUs, efficient *time synchronization*, *remote monitoring* of applications, and *uploading* and *downloading* updated parameters. This allows the MOSCAD ToolBox user to communicate via MDLC-coded messages over the physical channel, with the MDLC-enabled capabilities of the MOSCAD. DNP-aware IEDs use that same physical channel to communicate with other DNP-aware devices. The DNP+ *time synchronization* is very accurate but in that DNP+ port, time synchronization can be done only via the DNP 3.0 protocol. The DNP+ driver implements the DNP 3.0 channel access mechanism, while the DNP driver does not.

The DNP+ protocol includes advanced features which are defined in the DNP 3.0 and MDLC protocols. To achieve seamless communication over the RF network, the combined system uses the DNP 3.0 type channel access mechanism and time synchronization for both the MOSCAD and the DNP 3.0 type components. Unique features such as remote diagnostics of RTUs, remote monitoring of applications, upload and download of updated parameters, use the MDLC protocol, and these features are available only for MOSCAD devices.

Since the DNP+ driver uses the DNP 3.0 type channel access, any MOSCAD in the DNP+ system should be loaded with the DNP+ driver, even if it uses the MDLC protocol only.

The DNP and the DNP+ drivers implement the DNP protocol standards in the same way. They differ only in the port declarations.

Unless otherwise indicated, this document applies to both DNP and DNP+. The term DNP stands for both DNP and DNP+ unless an express reference is made to the specific driver.

The DNP V3.00 Master Driver

This chapter covers the DNP driver for the master side. The driver is written as a ‘C’ block and is not part of the MOSCAD system; but it is incorporated into a new or existing MOSCAD application using the MOSCAD Toolbox software. The driver itself is downloaded as a ‘C’ block to the flash memory and is activated by a ladder process.

The User Interface

The DNP V3.00 master driver functionality is incorporated into the MOSCAD application using the regular MOSCAD Toolbox tools. The driver interfaces to the application via:

- Site configuration parameters
- Database tables
- Rungs

You will use the Site Configuration and Application Programmer tools to define the DNP port (Site Configuration) and the database and ladder rungs (Application Programmer) in order to merge driver functionality with the overall MOSCAD application. Therefore, you can easily incorporate the DNP master driver into new or existing MOSCAD applications, by simply defining a port, adding the DNP-specific tables, and developing the necessary ladder rungs.

DNP supports the following data types (“I/O points”):

- Binary Input
- Binary Output
- Analog Input
- Analog Output
- Counter
- Freeze counter
- Floating-point

Site Configuration Definitions

Site configuration is a two-step process: defining the ports and setting their advanced parameters.

Note that the DNP driver is implemented on RS-232/RS-485 ports. The DNP+ driver is implemented on RS-232(Radio Darcom or RS232 Multi-drop fiber optic)/RS-485 ports. Up to two ports of the RTU can be defined as master DNP ports. Each such port is handled by a different driver.

Defining the Port

To set the DNP port, start the Site Configuration module and define:

- Port 1 as RS-485 User Port (Ladder Controlled)

or

- Port 1, 2, or 3 as RS-232 User Port (Ladder Controlled)

To set the DNP+ port, start the Site Configuration module and define:

- Port 1 as RS-485 Multi-drop or as RS-232 Async RTU-to-RTU

or

- Port 2 or 3 as RS-232 External Modem Async (Multi-drop half-duplex without CD or Darcom) or as RS-232 Async RTU-to-RTU

Port 2 is applicable only to MOSCAD, and not to MOSCAD-L.

Up to two DNP master ports can function simultaneously.

The port's associated link name should be passed as a permanent parameter via the Permanent Configuration Parameters table discussed later in this manual.

For RS-485 the protocol does not support channel access functionality in user ports. This means that the slave's unsolicited ("burst" in MOSCAD terms) frames mechanism may work but data collision may occur if multiple RTUs try to communicate simultaneously.

Setting the Advanced Parameters

To implement DNP on the user port, you will set several advanced parameters to the values provided below.

- **Dynamic RAM size**

1. Open the Advanced menu.
2. Choose General System Parameters.
3. Choose System Values.

4. Set the value to 30.

   RAM size for dynamic allocation<0-4000>K-bytes.....[2]:**30**

30K is set aside to enable the driver to allocate the necessary RAM for managing a typical database and communications via the selected DNP port. For two drivers define 60K. For a larger database, you can increase the dynamic RAM size, depending on the memory available on the RTU. You can always add more memory to the RTU using a RAM expansion board.

- **Error Logger RAM Size**

1. Open the Advanced menu.
2. Choose General System Parameters.
3. Choose Buffers/Queues Size.
4. Set the value to 3000.

   Error logger buffer size <100-2000>bytes .....[300]:**3000**

- **User port buffer size**

1. Open the Advanced menu.
2. Choose MDLC and User Port Heaps.
3. Choose More.
4. For the RS232 port set the value to 400, and for RS485 set the value to 800.

   Ladder-Diagram user port buffer size<10-1000>bytes .....[50]:**400**

This parameter should be set according to the Ladder Main Process scan time. Eight 100-byte buffers are available for reception (each buffer has 16 bytes overhead). These buffers should be sufficient to store all characters received during one scan time. For example, under a baud rate of 9600, each character takes about 1 msec to arrive. If the scan time is greater than 8*84 msec, increase this parameter.

In DNP, these buffers are used for both the DNP port and the logger port. In DNP+, they are used only for the logger port. Therefore, it is recommended to define more buffers of 100 bytes each and to decrease them after debugging.

- **Unformatted (Adapter) buffer size**

1. Open the Advanced menu.
2. Choose MDLC and User Port Heaps.
3. For the RS232 port set the value to 300, and for RS485 set the value to 500.

   Unformatted (Adapter) buffer size<10-1000>bytes .....[50]:**300**

It should be set according to the Ladder Main Process scan time. Eight 100-byte buffers are available for reception (each buffer has 16 bytes overhead). These buffers should be sufficient to store all characters received during one scan time. For example, under a baud rate of 9600, each character takes about 1 msec to arrive. If the scan time is greater than 8*84 msec, increase this parameter. In addition, if you get the #1952 error or unexpected CRC errors, you should increase this value.

This parameter is applicable for DNP+ only.

- **Number of idle to announce 'End of RX'**

1. Open the Advanced menu.
2. Choose Ports.
3. Choose Port x (x stands for the port number).
4. Choose Advanced Physical Layer Parameters.
5. Set the value to 50.

Number of idle to announce 'End of RX' <1-200> .....[80]:**50**

Announce the end of reception after 50 idles. For example, under a baud rate of 9600 each character takes about 1 msec to arrive. Therefore, end of RX is announced after about 50 msec.

This parameter is applicable for DNP only.

- **User tasks for 'C' blocks**

See the note in section *Permanent Configuration Parameters Table* page *11*.

- **I2Phys function table size**

1. Open the Advanced menu.
2. Choose General System Parameters.
3. Choose System Values.
4. Choose More.
5. Choose More.
6. Set the value to 3 for one driver, 6 for two drivers.

Size of I2Phys function table <0-255> ..... [0]:**3**

This parameter is applicable for DNP+ only.

Application Programmer Definitions

At the application level you will configure the DNP by defining user tables and ladder processes.

You define the following DNP-specific user tables, per driver:

- Permanent Configuration Parameters table
- Variable Configuration Parameters table
- Devices Permanent Configuration Parameters tables (three consecutive tables)
- Devices Variable Configuration Parameters table
- Statistics table
- Device Statistics table
- I/O tables
- Read Requests table
- Operate Requests table

NOTE

The table and variable names provided here are arbitrary and have no impact on the application.

Permanent Configuration Parameters Table

The Permanent Configuration Parameters table is used to store values (common to all the devices handled by the master) that may not change during the lifetime of the application. For example, the DNP port number or the master address are permanent parameters.

It should be defined as a single-column table of Integer Parameter type and must contain at least 15 rows.

The following figures illustrate such a table.

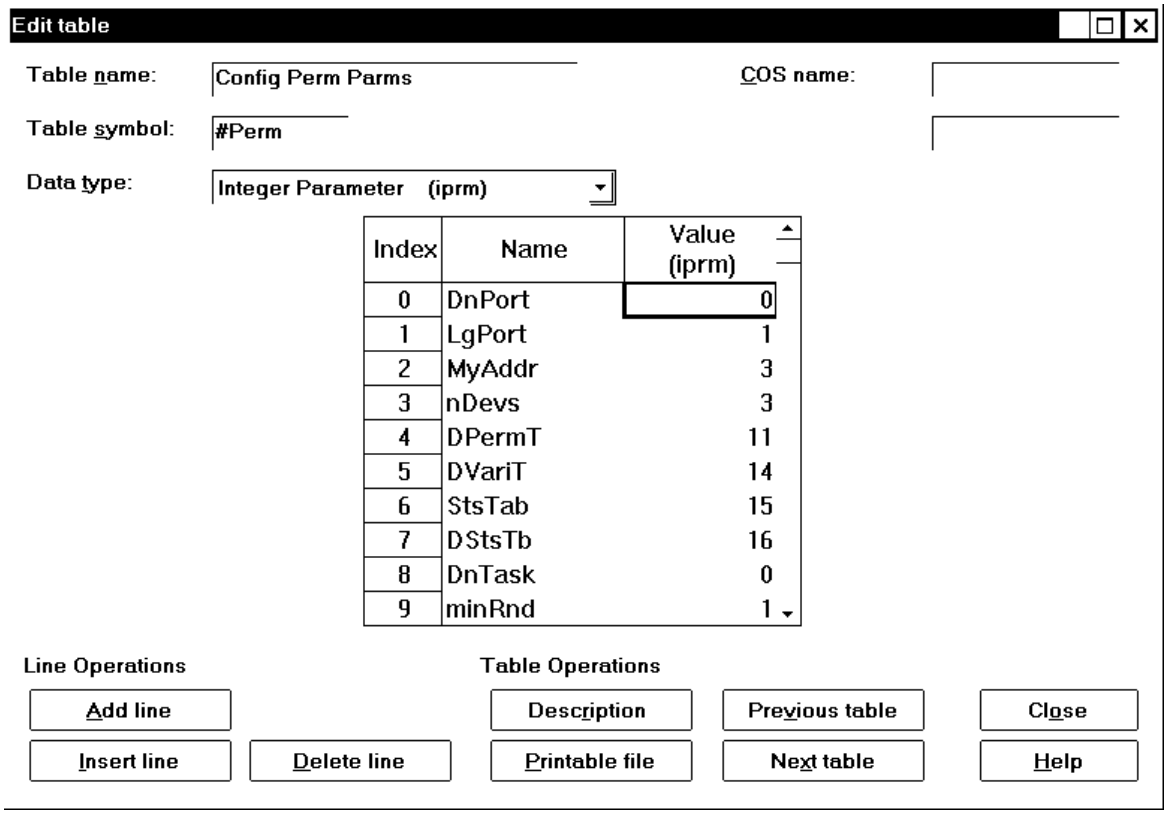

Figure 1: Permanent Configuration Parameters table

The Permanent Configuration parameters are as follows:

- **DnPort**

Port number or port's link ID, depend on the driver.

For the DNP driver, this is the communication port number that corresponds to the logical name defined in the Site Configuration. The following chart lists the valid values and their meanings.

Value	Meaning
0	User1
1	User2
2	User3

NOTE

It is highly recommended to work with ports 2 or 3, because they support flow control (define the port with the option of DTR/CTS). Working with port 1 requires enlarging the buffers or the baud rate.

For the DNP+ driver, this is the link ID that corresponds to the communication port as defined in the Site Configuration. The following chart lists the valid values and their meanings.

Value	Meaning
21 to 29	LINE 1 – LINE 9 respectively
51 to 69	RSLink 1 - RSLink 19 respectively
80 to 99	LINE 10 - LINE 29 respectively

- **LgPort**

Logger port number. The following chart lists the valid values and their meaning.

Value	Meaning
-1	No logger
0	User1
1	User2
2	User3

NOTE

1. If a logger is defined (0..2) and the port is not defined in the Site Configuration, the DNP driver performance may be impaired.
2. Use the log port for debugging purposes only. Writing to the log port delays the driver significantly. When data is sent to the logger port, the rate of data reception from the slave (device) decreases, and the task remains unavailable for handling more commands originating from the master.

- **MyAddr**

The DNP address of the master driver. The address can be a number from 0 to 65534.

The following chart lists the valid values and their meanings.

Value	Meaning
0	The DNP address is identical to the RTU's MOSCAD Site ID (SelfID).
1 to 65534	An address different from the RTU's actual Site ID

- **nDevs**

Number of devices + 1 device for broadcast address parameters (1..250).

- **DPermT**

Number of first Devices Permanent Parameters table (0..124; three consecutive tables).

- **DVariT**

Number of Devices Variable Parameters tables (0..126)

- **StsTab**

Number of Master Statistics table (0..126)

- **DStsTb**

Number of Devices Statistics table (0..126)

- **DnTask**

The internal driver task number. The following chart lists the valid values and their meanings.

Value	Meaning
0	Default value: Task Priority A for DNP, Task Priority E for DNP+.
1	Task Priority A (Applicable to DNP only)
2	Task Priority B (Applicable to DNP only)
3	Not used
4	Not used
5	Task Priority E
6	Task Priority F
7	Task Priority G

8	Task Priority H
9	Task Priority I
10	Task Priority J
11	Task Priority K
12	Task Priority L
13	Task Priority M
14	Task Priority N

NOTE

1. If two ports are defined as master DNP ports, they must have different DnTask values.
2. Do not build a process (in the ladder diagram) or other C Block applications with the same priority as DnTask.
3. Usage of Task Priority E - M requires changing the following advanced parameter in the Site Configuration:

- **Number of User tasks for 'C' blocks**

1. Open the Advanced menu.
2. Choose General System Parameters.
3. Choose System Values and click on the More button.
4. Set the value to 1 for task priority E, 2 for task priority F, etc.

Number of User tasks for 'C' blocks <0-10>..... [0]:**1**

- **minRnd**

Minimum random number for transmission. Applicable to the DNP+ driver only.

To avoid collisions, each station must wait a random quiet time. In this case, a collision may occur only if two stations decide to wait for the same amount of time. For each transmission, the driver uses a new random number. **minRnd** and **maxRnd** limit the minimum and the maximum values of this number.

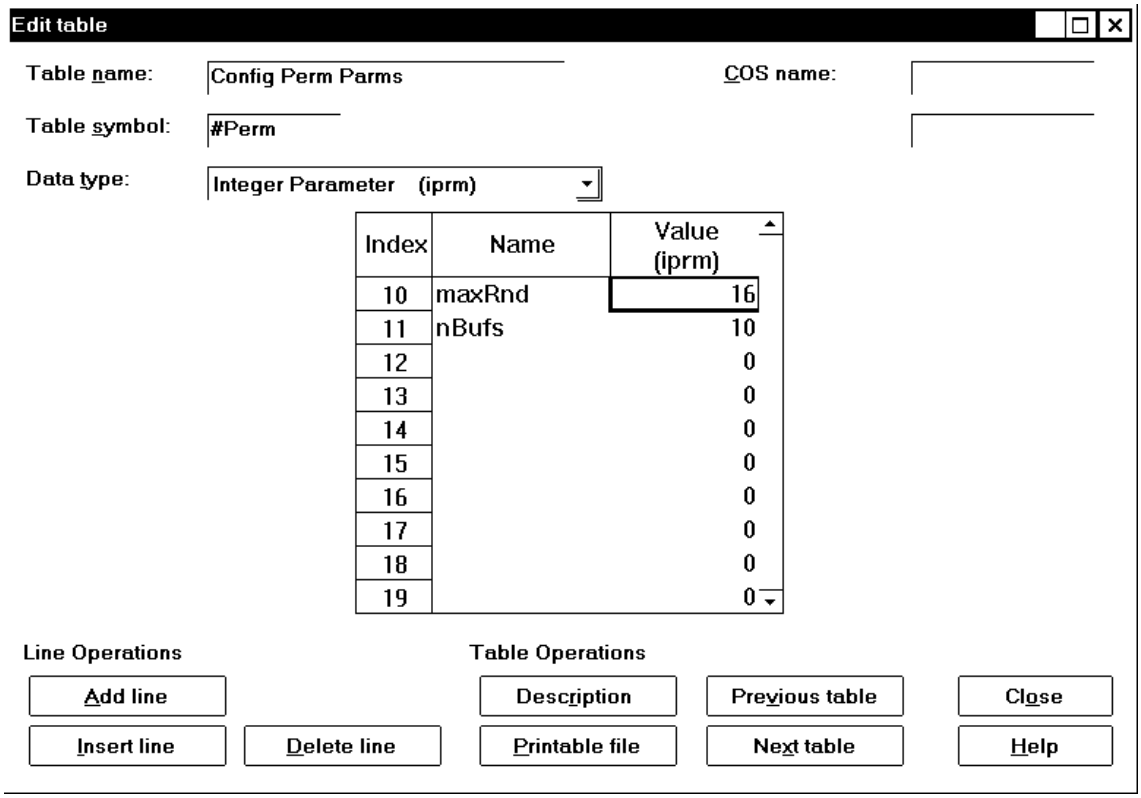

Figure 2: Permanent Configuration Parameters table (cont)

- **maxRnd**

Maximum random number for transmission. See explanation for **minRnd.** Applicable to the DNP+ driver only.

- **nBufs**

Number of formatted buffers that can be received and stored until the driver task handles them. Applicable to the DNP+ driver only.

It is recommended to use the default value (10), unless working with a radio

Variable Configuration Parameters Table

The Variable Configuration Parameters table stores the parameters (common to all the devices handled by the master) that you can modify during the lifetime of the application.

The table should be defined as single-column of Integer Parameter type. It must contain at least 12 rows. The following figure illustrates a Variable Configuration Parameters table.

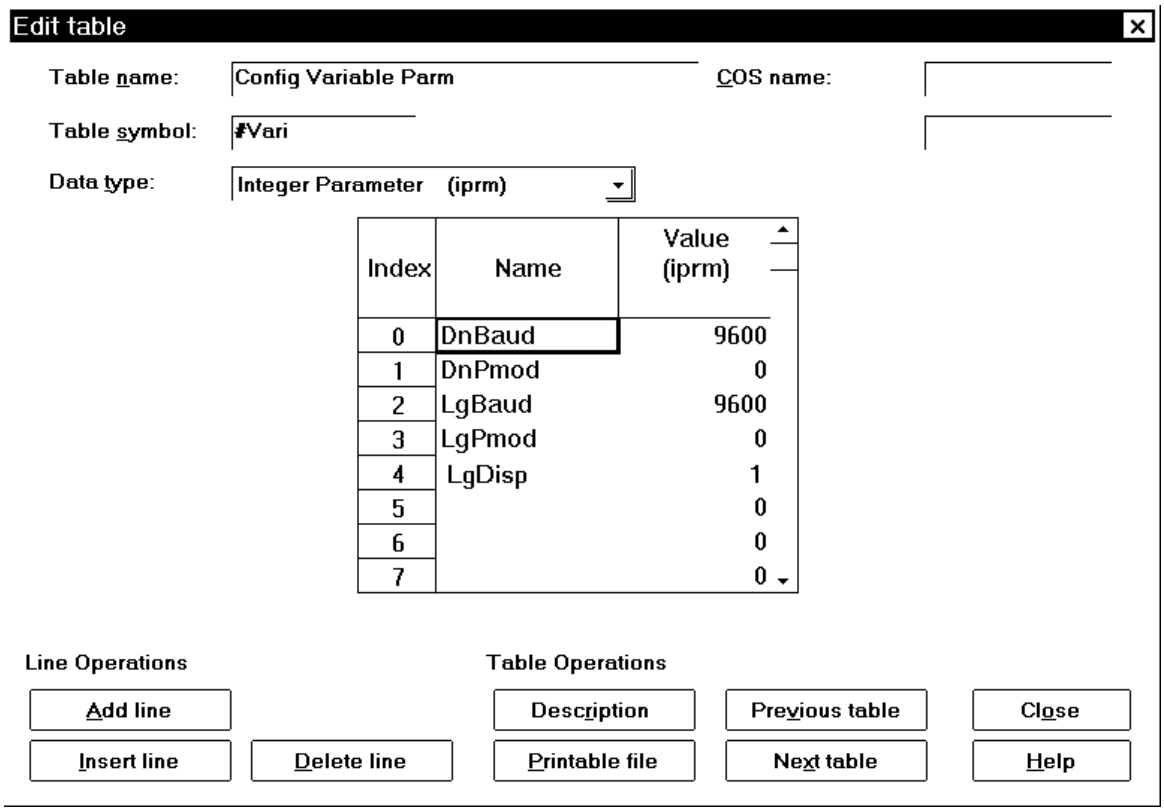

Figure 3: Variable Configuration Parameters table

The Variable Configuration parameters are as follows:

- **DnBaud**

DNP port baud rate (600, 1200, 2400, 4800, 9600, 19200, 38400, 57600). Applicable to DNP driver only.

- **DnPmod**

Communication port mode. Applicable to DNP driver only. The valid values are 0 through 7. The following chart lists the valid values and their meanings.

Value	Meaning
0	8 Bit, No parity, 1 Stop bit
1	7 Bit, Even parity, 2 Stop bits
2	7 Bit, Odd parity, 2 Stop bits
3	7 Bit, Even parity, 1 Stop bit
4	7 Bit, Odd parity, 1 Stop bit
5	8 Bit, No parity, 1 Stop bit

Value	Meaning
6	8 Bit, Even parity, 2 Stop bits
7	8 Bit, Odd parity, 1 Stop bit

- **LgBaud**

Logger port baud rate. See range in DnBaud.

- **LgPmod**

Logger port mode. See values in DnPmod.

- **LgDisp**

Logger port mask. The valid values are a combination of the bits. If the value is 0x0001, then there is no need to set the other bits. The following chart lists the valid bits and their meanings.

Value	Meaning
0x0000	Do not log any information
0x0001	Log all available information
0x0002	Log MMI information
0x0004	Log Database information
0x0008	Log Application level information
0x0010	Log Link level information
0x0010	Log User information
0x0020	Log Transport level information
0x0040	Log errors

Devices Permanent Configuration Parameters Tables

These three consecutive tables store the permanent parameters. Each row in the table refers to a different device, and each column represents a field in the structure. All tables must be multiple-column of Integer Parameter type. The first row of each table represents the broadcast address parameters. It must be filled in according data in the figures below.

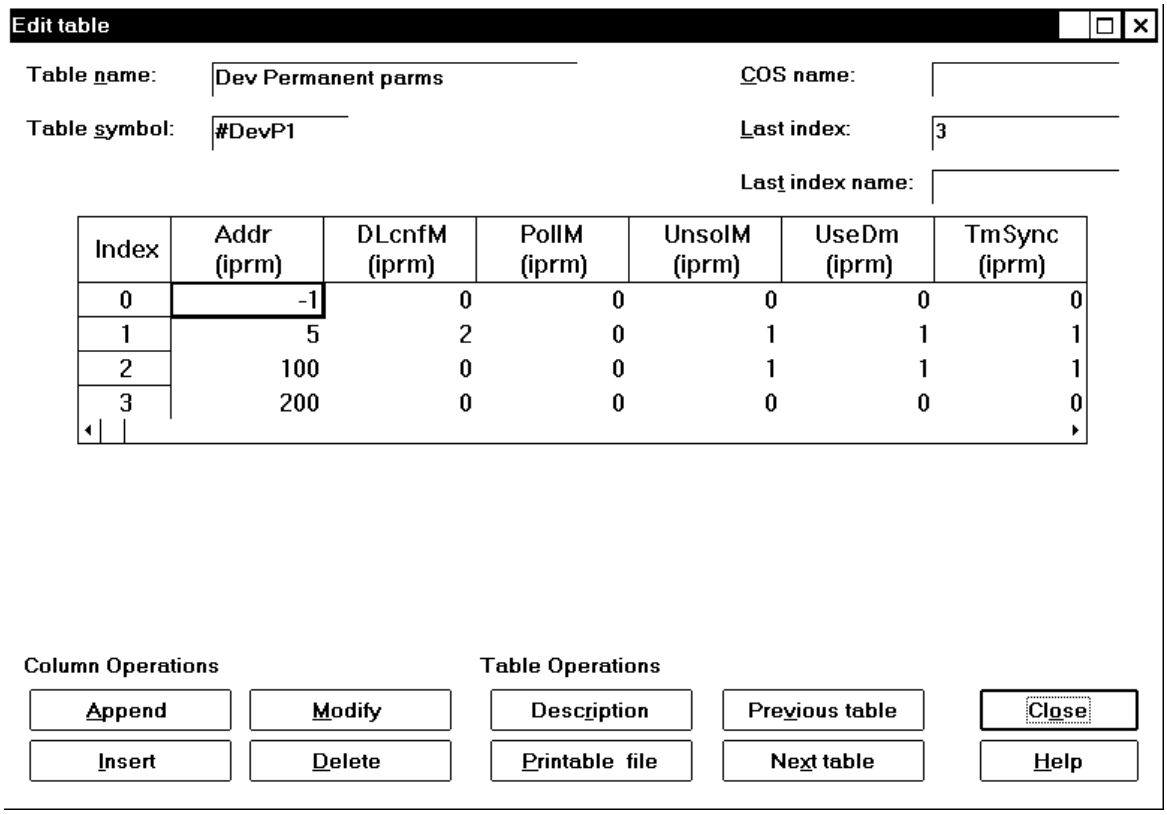

Figure 4: First Devices Permanent Configuration Parameters table

The First Devices Permanent Configuration parameters are as follows:

- **Addr**

The DNP address of the slave (device) driver. The address can be a number from -1 to 65534.

The following chart lists the valid values and their meanings.

Value	Meaning
-1	A broadcast address. This value should be filled in the first row.
0 to 65534	A DNP address of a slave device.

- **DLcnfM**

Device data link confirm mode. The following chart lists the valid values and their meanings.

Value	Meaning
0	Never
1	Only on multi-frame fragments.
2	Always

- **PollM**

Support poll mode (0..1)

- **UnsolM**

Support unsolicited response mode (0..1)

- **UseDm**

Send a delay measurement request before sending a write time request (0..1). The delay is measured starting from the queuing of the DNP frame in the user port queue. The time to be written is fixed according to the delay.

For DNP+, it is recommended to set this parameter to 0 and to send a delay measurement request, once for each device, during the initialization.

- **TmSync**

Perform time synchronization when time needed IIN is set (0..1)

- **RngQul**

Support qualifiers 00 and 01 (0..1)

The second table consists of at least 7 columns. It will look as follows:

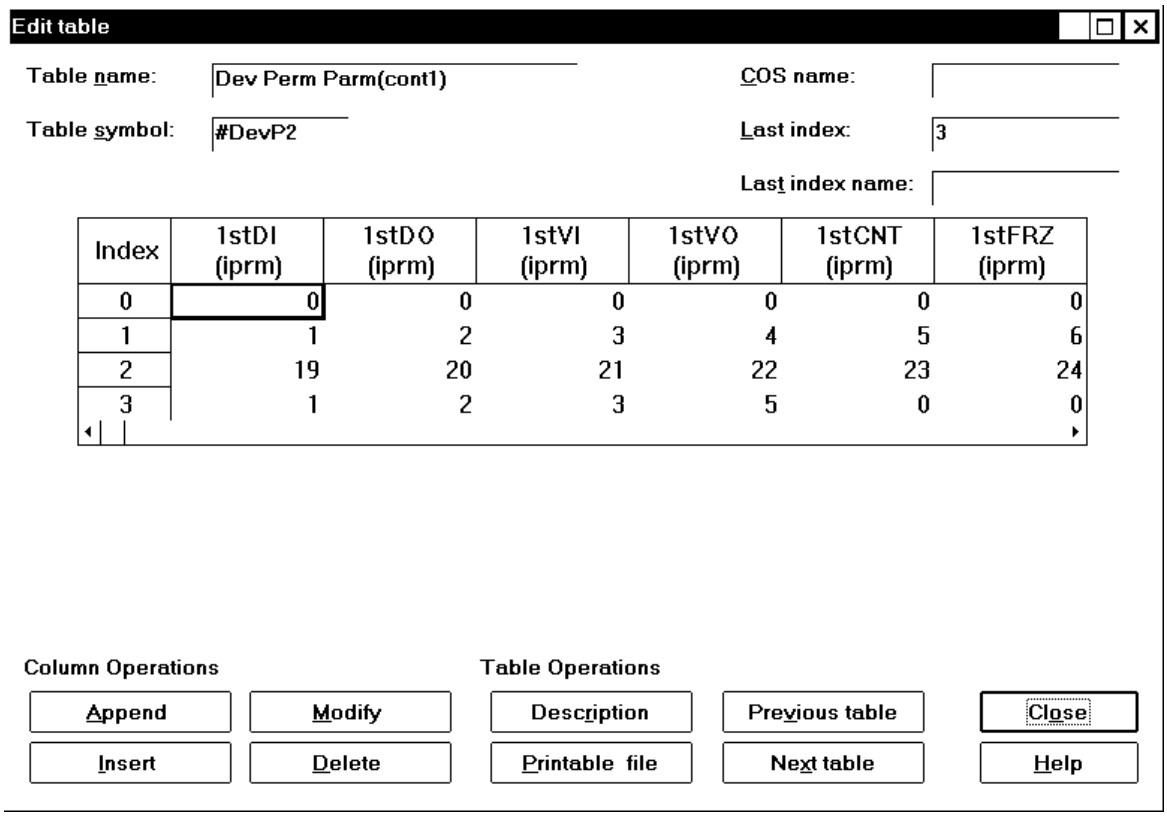

Figure 5: Second Devices Permanent Configuration Parameters table

The Second Devices Permanent Configuration parameters are as follows:

- **1stDI**

Index of the first Binary Inputs table of the device (0..126). All Binary Inputs tables must be defined in consecutive order.

- **1stDO**

Index of the first Binary Outputs table of the device (0..126). All Binary Outputs tables must be defined in consecutive order.

- **1stVI**

Index of the first Analog Inputs table of the device (0..126). All Analog Inputs tables must be defined in consecutive order.

- **1stVO**

Index of the first Analog Outputs table of the device (0..126). All Analog Outputs tables must be defined in consecutive order.

- **1stCNT**

Index of the first Counters table of the Device (0..126). All Counters tables must be defined in consecutive order.

- **1stFRZ**

Index of the first Freeze Counters table of the Device (0..126). All Freeze Counters tables must be defined in consecutive order.

- **1stFlt**

Index of first floating-points table (0..126). All the floating-point tables must be defined in consecutive order.

The third table consists of at least 7 columns. All of its columns must be filled in according the definitions in the device. Lack in symmetry might cause unexpected behavior.

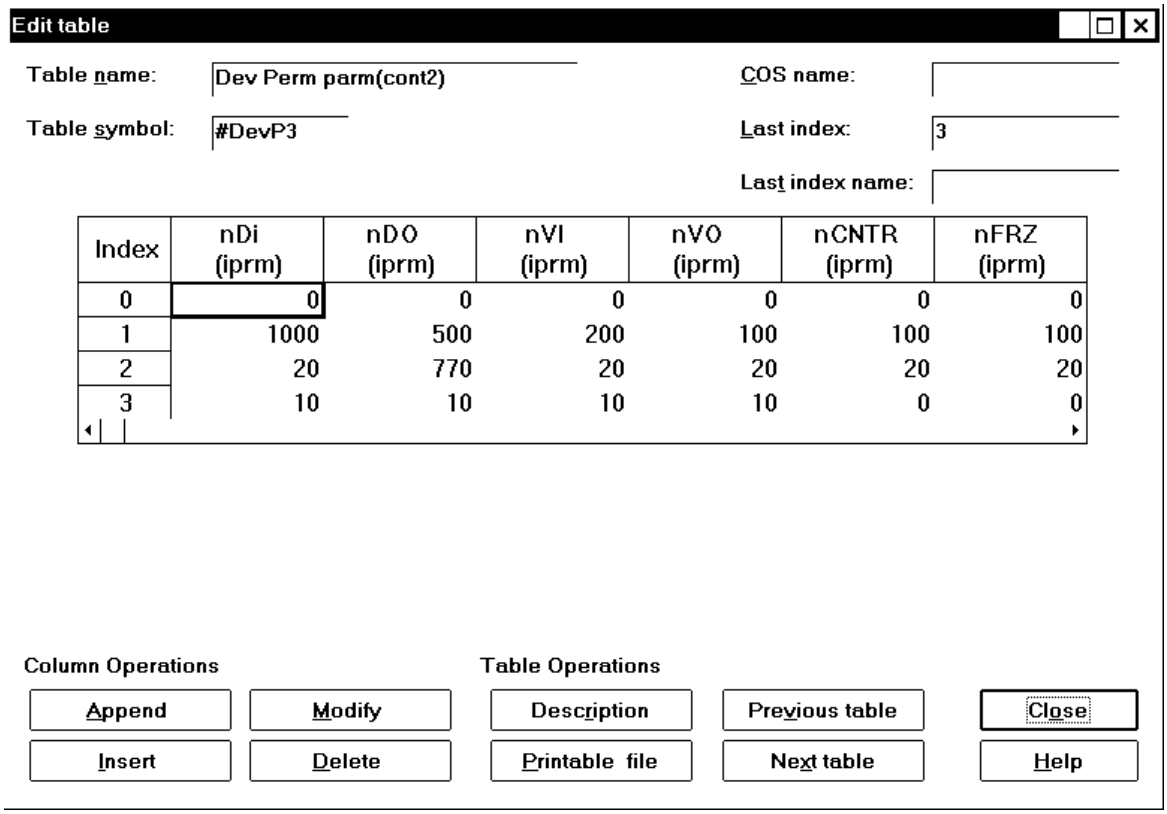

Figure 6: Third Devices Permanent Configuration Parameters table

The Third Devices Permanent Configuration parameters are as follows:

- **nDI**

Number of Binary Inputs points of the device (0..10000)

- **nDO**

Number of Binary Outputs points per device (0..10000)

- **nVI**

Number of Analog Inputs points per device (0..3000)

- **nVO**

Number of Analog Outputs points per device (0..3000)

- **nCNTR**

Number of Counters points per device (0..3000)

- **nFRZ**

Number of Freeze Counters points per device (0..3000).

- **nFLT**

Number of floating-point points per device (0..3000)

Devices Variable Configuration Parameters Table

The Devices Variable Configuration Parameters table stores the variable parameters per device (each row represents a device). It is mandatory to define this table. It should be a multiple-column table of "Integer Parameter" type which consists of 5 columns.

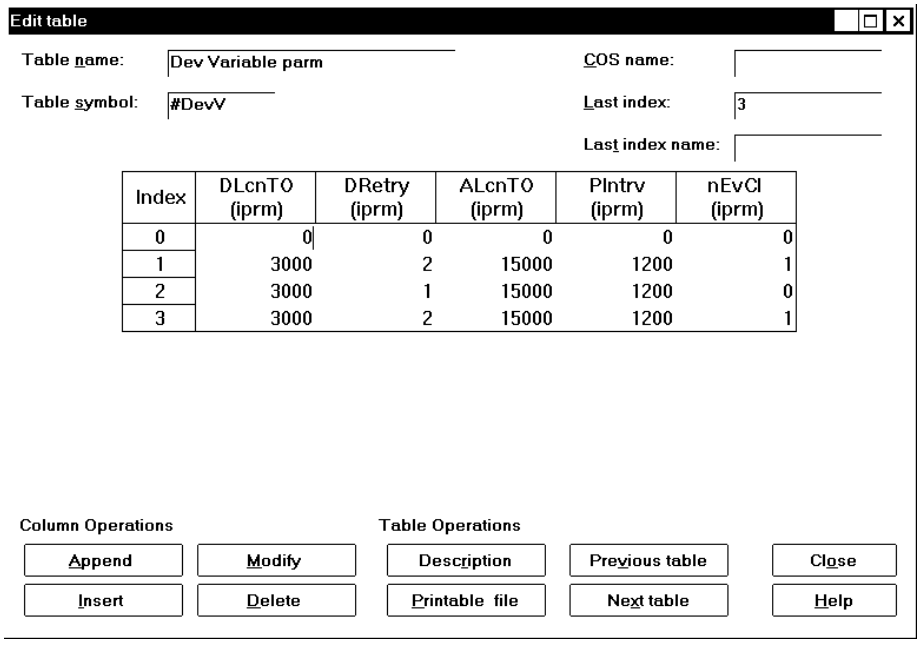

Figure 7: Devices Variable Configuration Parameters table

The Devices Variable Configuration parameters are as follows:

- **DLcnTO**

Data link confirm timeout, in milliseconds. This is the time the master RTU waits for the slave (device) RTU's data link layer to confirm the last frame sent before starting the retries.

Define a timeout greater than 0 if the permanent DLcnfM parameter was set to 1 or 2. Otherwise, set it to 0.

For DNP+, always define 0. The link level time-outs are part of the MDLC parameters.

Valid values are 0 through 65535.

- **DRetry**

Data Link retry. This is the number of times the master will retransmit a frame in the event that the slave (device) does not confirm it.

Define a value greater than 0 if the permanent DLcnfM parameter was set to 1 or 2. Otherwise, set it to 0.

Valid values are 0 through 255.

- **ALcnTO**

Application Layer confirm timeout, in milliseconds. This is the time the Application Layer waits for the confirmation to arrive. This time must be greater than the total retry time allocated to the Data Link layer.

Define a timeout greater than 0 if the permanent DLcnfM parameter was set to 1 or 2. Otherwise set it to 0.

Valid values are 0 through 65535.

- **PIntrv**

Time between Integrity Data Polls, in 100 milliseconds units (1..65535). Applicable only in Polled mode.

- **nEvCl**

Number of Event Class Polls between Integrity Data Polls (0..65535). Applicable only in Polled mode.

Statistics Table

The Statistics table stores valuable statistical and diagnostic data about the master driver behavior. You will use this table to obtain information about such unusual occurrences as too many framing errors which reduce efficiency.

To use the Statistics table, define the first index of the table via the permanent StsTab parameters.

The Statistics table should be defined as single-column of Integer Parameter type. It must contain at least 19 rows. Figure 8 illustrates the table.

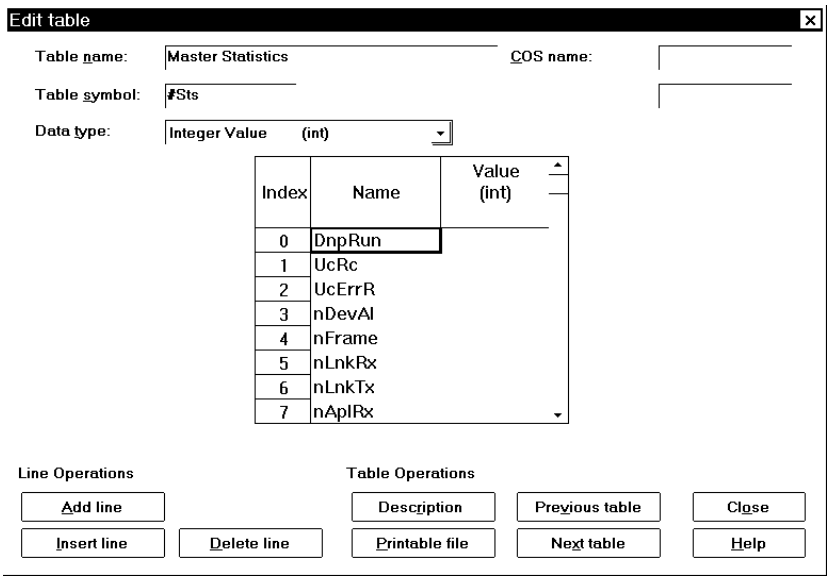

Figure 8: Statistics Table

The Statistics parameters are as follows:

- **DnpRun**

This flag indicates whether the DNP driver (task) is running (1) or not (0).

- **UcRc**

UCALLs Return code. The value is 0 for proper execution. Applicable for some UCALLs. See section *UCALLs Return Codesl.*

- **UcErrR**

The faulty error. Applicable only if UcRc is not equal to 0.

- **nDevAl**

Number of devices allocated.

- **nFrame**

Number of frame buffers currently allocated.

- **nLnkRx**

Number of Link receive data structures currently allocated.

- **nLnkTx**

Number of Link transmit data structures currently allocated.

- **nAplRx**

Number of Application receive data structures currently allocated.

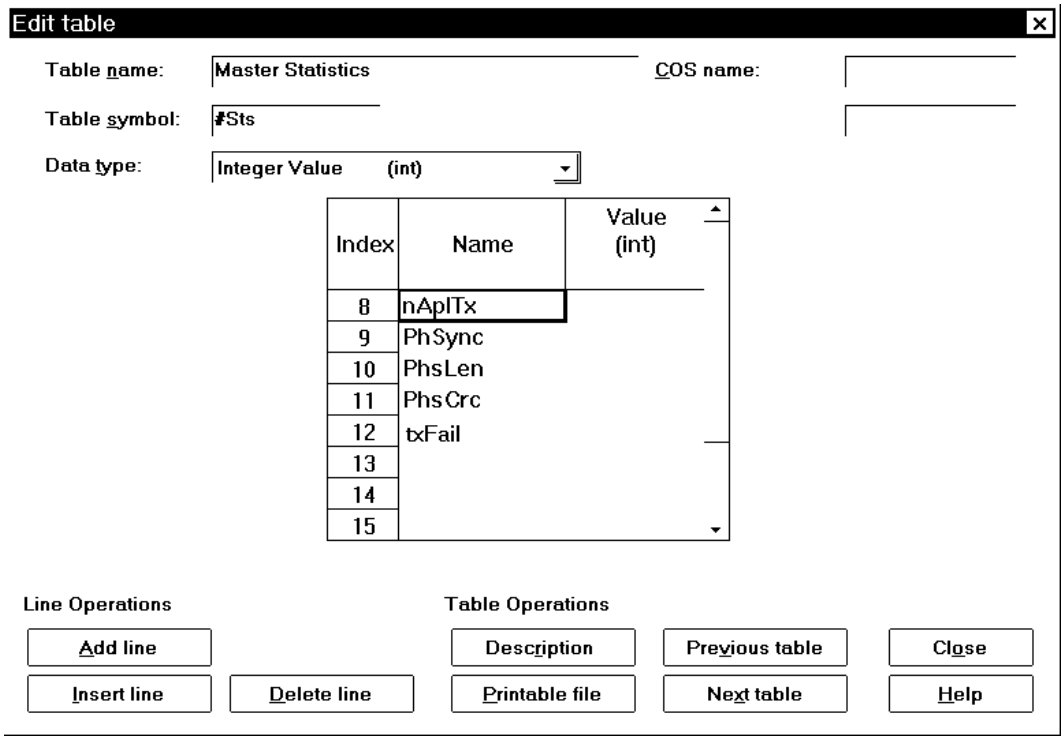

Figure 9: Statistics Table (cont.)

- **nAplTx**

Number of Application transmit data structures currently allocated.

- **PhSync**

Number of times that extra bytes were received before the start bytes (0x05 and 0x64) (Physical Layer).

- **PhsLen**

Number of times that an invalid length byte was received (Physical Layer).

- **PhsCrc**

Number of times that a CRC error in frame was received (Physical Layer).

- **txFail**

Number of times that transmission failed.

Devices Statistics Table

The Devices Statistics table stores valuable statistical and diagnostic information per device. The user must define this table and update the DStsTb field in the permanent parameters table (see *Permanent Configuration Parameters Table*).

The table must be multiple-column of Integer Parameter type with at least 6 columns. Each row in the tables represents the parameters of a certain device. Figure 10 illustrates the table.

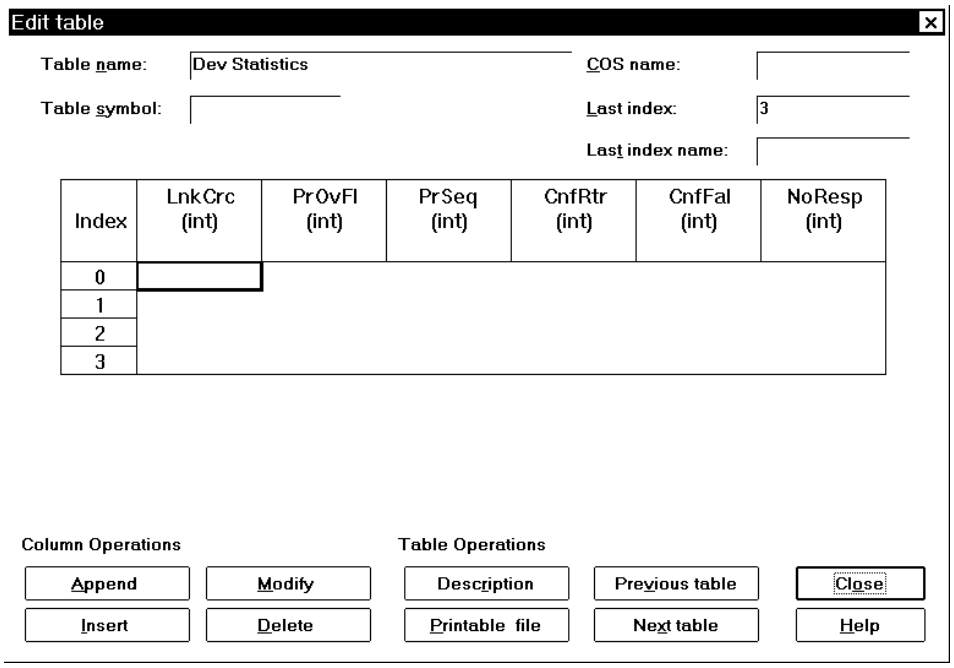

Figure 10: Device Statistics Table

The Device Statistics parameters are as follows:

- **LnkCrc**

Number of times that a CRC error in frame was received (Link Layer).

- **PrOvFl**

Number of times that the application layer receive fragment buffer was too small (Transport Layer).

- **PrSeq**

Number of times that the sequence numbers of multiple-frame request fragment has not incremented correctly (Transport Layer).

- **CnfRtr**

Number of frames retransmitted (Link Layer).

- **CnfFal**

Number of times retries failed to get confirm (Link Layer).

- **NoResp**

Number of times that an expected response was not received (Application layer).

I/O Tables

You must define at least one I/O table for each data type you use for DNP per device. If you need to define less than 250 entries, specify the exact number of rows. For example, if you need 50 entries, specify 49 as last index. If you need more than 250 entries, you must define multiples of 249 entries. If you need 260 entries, define two columns with 249 entries each.

The data type of the columns are determined according the I/O data type, as follows:

- For Binary Inputs and Binary Outputs tables, define Discrete (bit) columns (in fact, you can use any "bit" data type supported in the Database Builder and mix different bit types if this better serves your purpose).
- For Analog Inputs, Analog Outputs, Counters and Freeze Counters tables, define Integer Value (int) columns (or any other data type with the same size or integer value — 2 bytes).
- For Floating-Point tables, define Real Value (real) columns (or any other data type with the same size — 4 bytes).

Freeze Counter Tables

If you use counters, define Counter tables, set nCNTR to a value greater than 0, and define appropriate Freeze Counter tables. The Freeze Counter tables should have the same size as (or less than) the Counter tables. Each point in the Freeze Counter tables stores the frozen value of the corresponding (same order) counter.

The index of the first tables of each data type should be specified in the Devices Permanent Configuration Parameters table.

The following figures illustrate the required I/O tables.

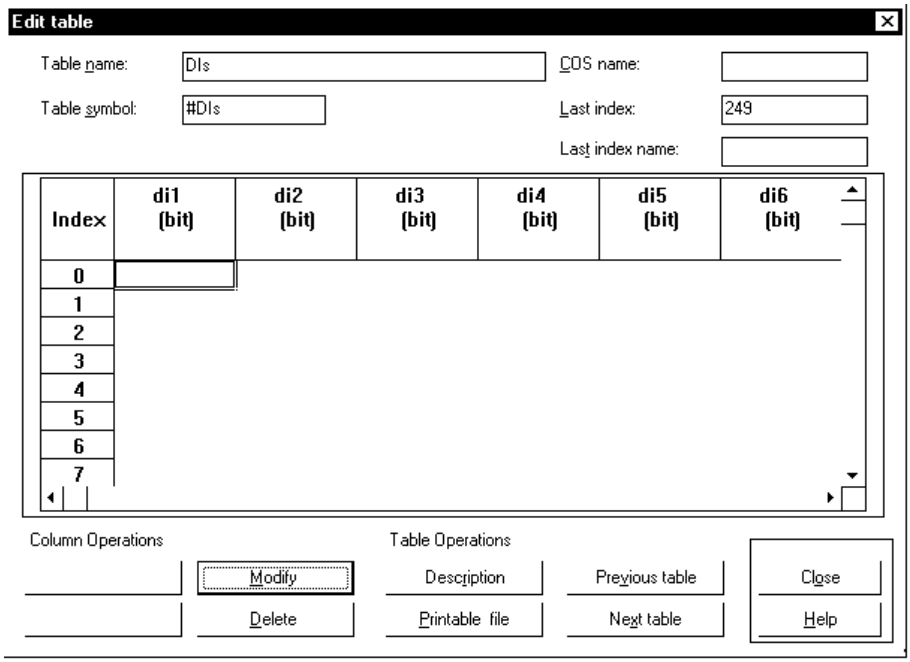

Figure 11: Binary Inputs table

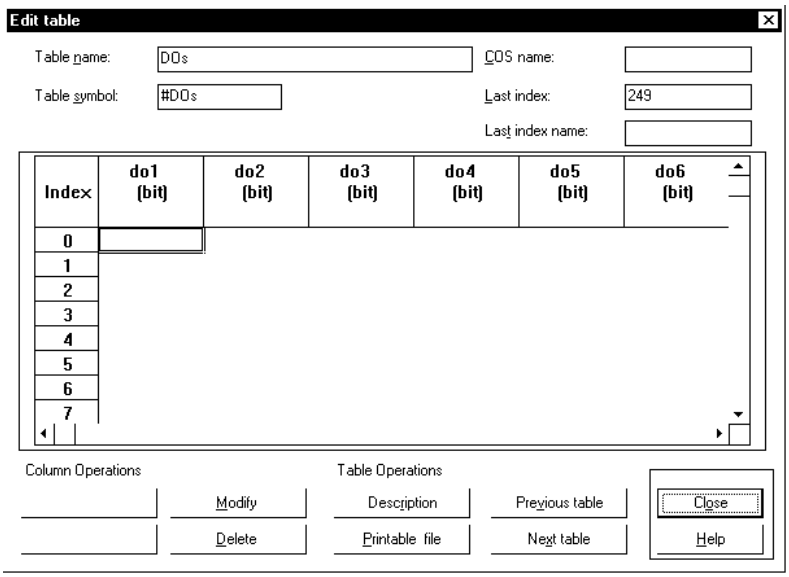

Figure 12: Binary Outputs table

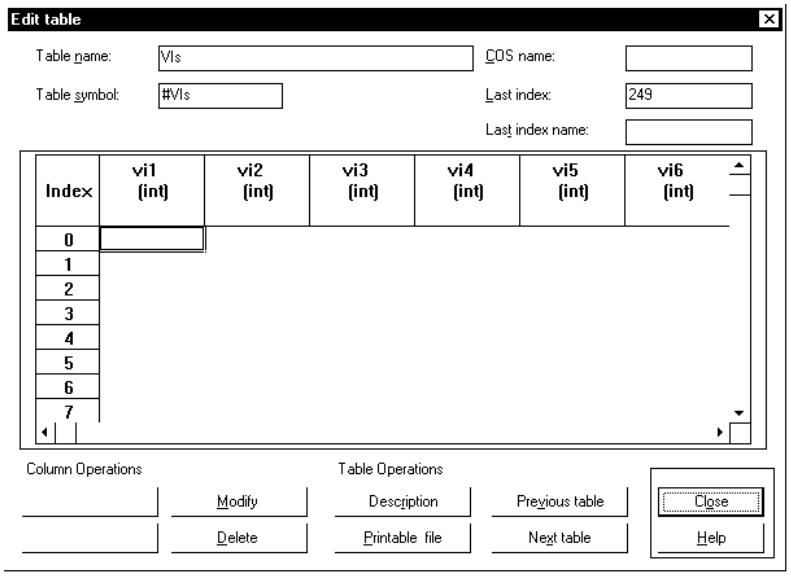

Figure 13: Analog Inputs table

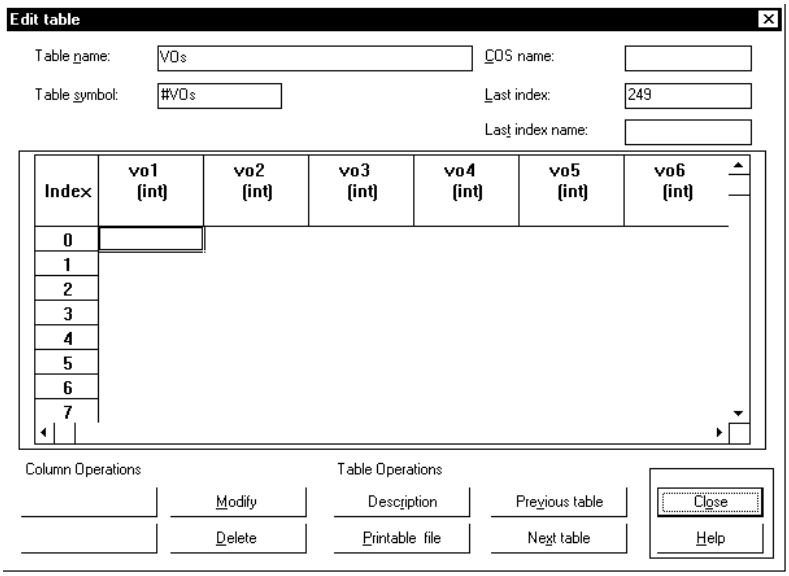

Figure 14: Analog Outputs table

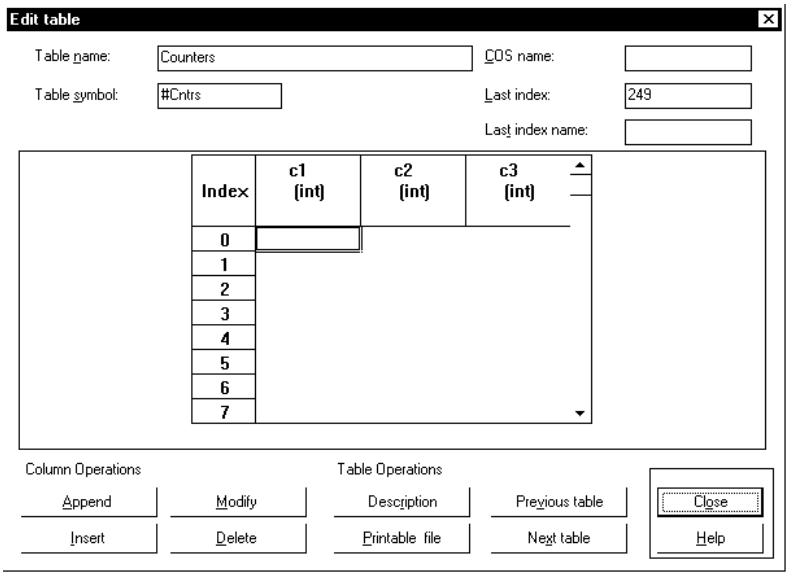

Figure 15:Counters table

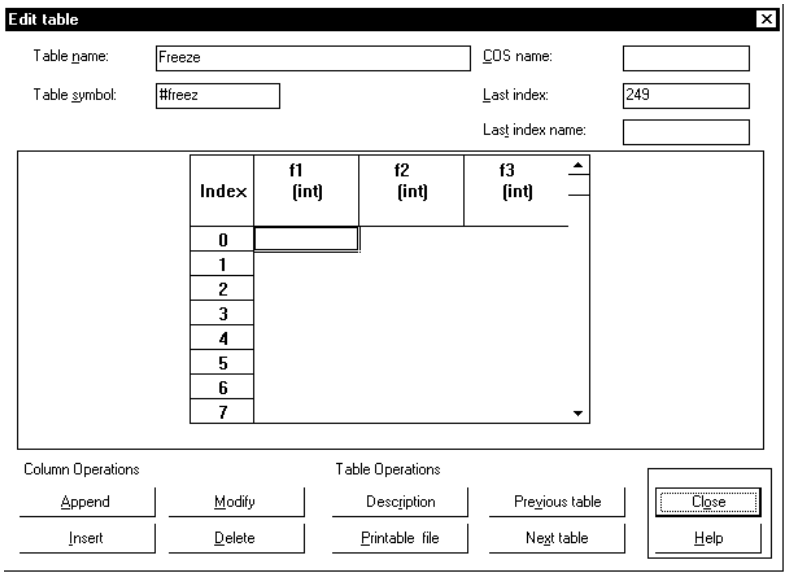

Figure 16: Freeze Counters table

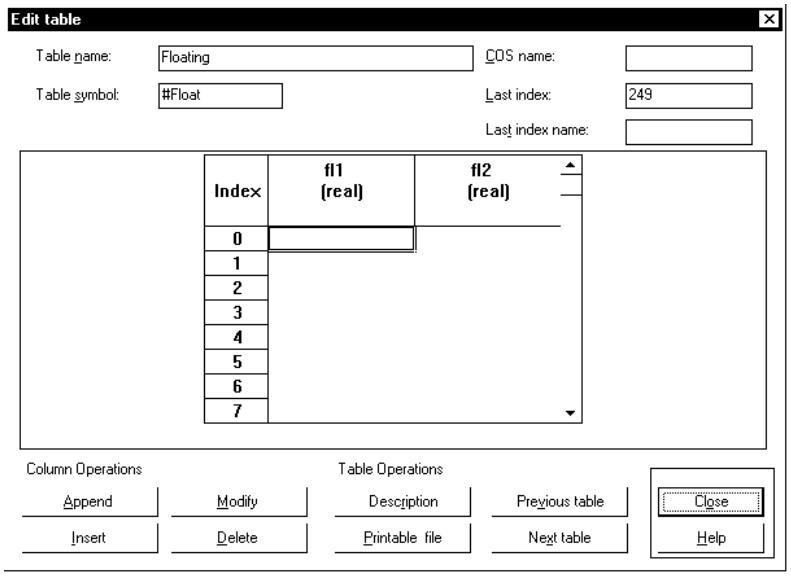

Figure 17: Floating-point table

Read Requests Table

The Read Requests table contains parameters for the DMread/DM2rd UCALL (see section *Dmread UCALL*). It should be a multiple-column table of "Integer Parameter" type with at least 4 columns. Each row contains full information about a READ request - object, variation and point range. The table structure is mandatory.

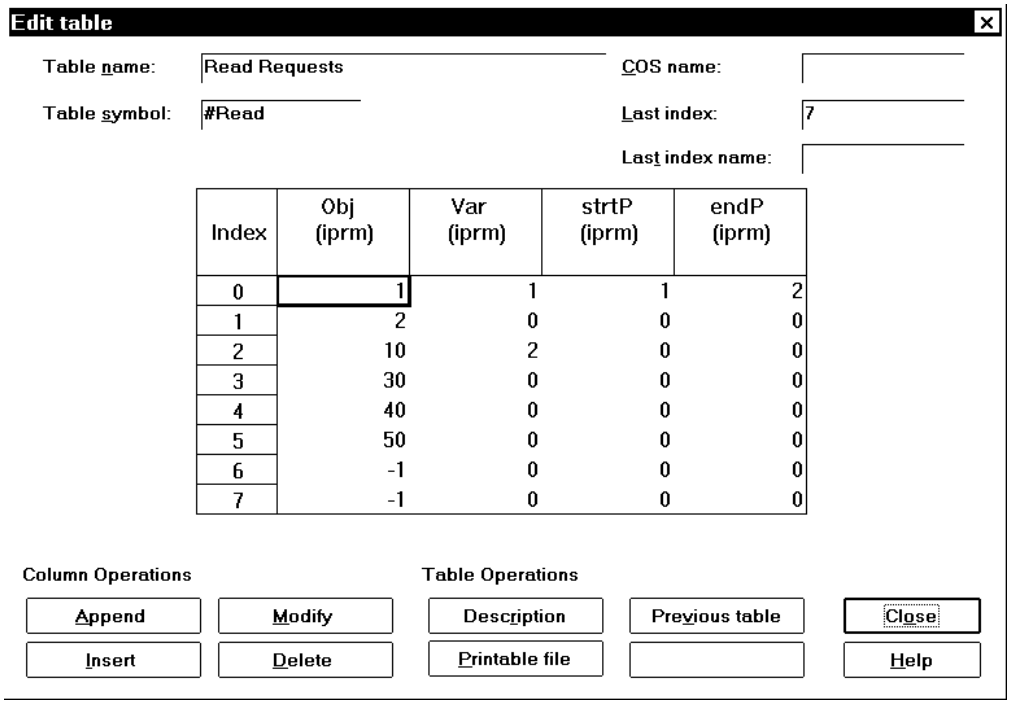

Figure 18: Read Requests table

The Read |Requests parameters are as follows:

- **Obj**

DNP object. All the objects and variations supported with the READ function are described in section *Supported Objects, Variations and Qualifiers*. Enter -1 for a row which is not applicable.

- **Var**

DNP variation. See 'Obj' for details.

- **strtP**

Starting point. (The point must fall within the range define for the data type, e.g. nDI, nDO, etc.)

- **endP**

End point. (The point must fall within the range define for the data type, e.g. nDI, nDO, etc.)

Operate Requests Table

The Operate Requests table contains parameters for the DMopr/DM2opr UCALLs (see section *Dmopr UCALL*). It should be a multiple-column table of Integer Parameter type with 8 columns. Each row contains full information for an OPERATE/SELECT request. The table structure is mandatory.

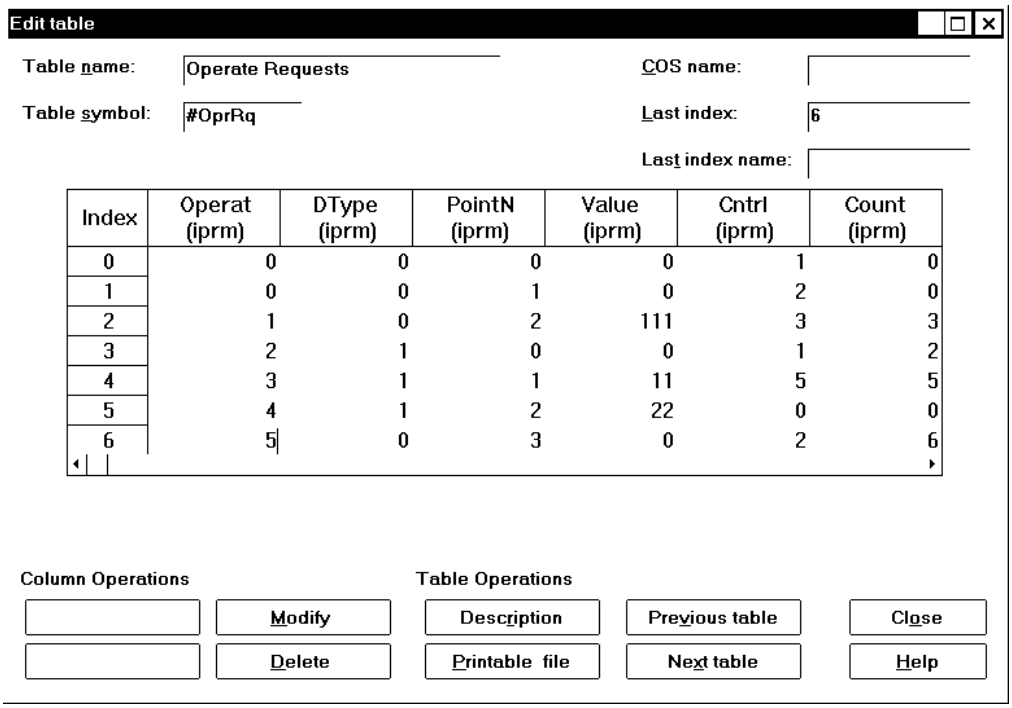

Figure 19 Operate Requests table

The Operate Requests parameters are as follows:

- **Operat**

The operation function.

The functions are divided into 2 groups:

- The "immediate" functions in which the value to write is taken from this table;
- The other functions in which the value is taken from the appropriate I/O table.

The following chart lists the valid values and their meanings.

Value	Meaning
0	Direct Operate. The value to write is taken from this table.
1	Direct Operate. The value to write is taken from the appropriate I/O table.

Value	Meaning
2	Direct Operate, no acknowledgment. The value to write is taken from this table.
3	Direct Operate, no acknowledgment. The value to write is taken from the appropriate I/O table.
4	Select before Operate. The value to write is taken from this table.
5	Select before Operate. The value to write is taken from the appropriate I/O table.

- **DType**

Type of point: 0 - Binary Output (Object 12), 1 - Analog Output (Object 41).

- **PointN**

Point number

The next columns are applicable only to the “immediate” functions. The Value column is applicable only to Analog Outputs. The remaining columns are applicable to Binary Outputs only.

- **Value**

Value to operate/select, only if Dtype is set to 1.

- **Cntrl**

Control byte, only if Dtype is set to 0. The valid values are:

Value	Meaning
0	No operation specified.
1	Pulse on. The point is turned on for the specified TimOn, and then turned off for the specified TimOff, as many as Count times. After Count times, it is left in off state.
2	Pulse off. The point is turned off for the specified TimOff, and then turned on for the specified TimOn, as many as Count times. After Count times it is left in on state.
3	Latch on.
4	Latch off.

- **Count**

Number of times to count, if Cntrl is set to 1 or 2.

- **TimOn**

On-Time, in 100 milliseconds units, if Cntrl is set to 1 or 2.

- **TimOff**

Off-Time, in 100 milliseconds units, if Cntrl is set to 1 or 2.

The Ladder Process

This section describes the UCALLs that should be used to run the DNP master driver in a MOSCAD application. If two ports are defined, use the UCALLs with "2" for the second port.

DMstrt/DM2str UCALL

The first DNP driver is launched by calling the DMstrt UCALL. The second DNP driver is launched by calling the DM2str UCALL.

This UCALL must be called from the **Main Process**, in each ladder scan. Actually, it should be called only after power-up or after the 'C' block has been downloaded. However, since there is no indication whether the DNP master driver 'C' block has been downloaded, call the function in each scan; an internal mechanism decides whether or not to run the DNP master driver task.

This function takes 2 constant parameters:

1. Number of the permanent DNP configuration parameters table. The table structure is described in *Permanent Configuration Parameters Table* on page 11.

2. Number of the variable DNP configuration parameters table. The table structure is described in section *Variable Configuration Parameters Table* on page 11.

NOTE

The default value of the qualifier in the Read request is 0 or 1. These values define a range of points. Use qualifier 6, that means "all points", if the object does not support qualifiers 0 and 1, or if the RngQul variable is set to 0.

DMparm/DM2prm UCALL

Modifies the variable DNP configuration parameters, including the unique device parameters.

This function expects 2 constant parameters:

1. The number of the variable DNP configuration parameters table. See *Variable Configuration Parameters Table* on page 16.

2. Number of the devices variable DNP configuration parameters table. See *Devices Variable Configuration Parameters Table* on page 23.

This UCALL may be called a few times. It is, however, recommended to use the variable parameters that were set when the task was run, and to avoid this UCALL.

DMread/DM2rd UCALL

Sends read requests initiated by the ladder. The requests are concentrated in a multiple-column table in which each row represents one request. -1 in the first column means that the row is not applicable. All requests are sent in consecutive order.

This function expects 2 parameters:

1. A variable parameter that represents the device index.
2. A constant parameter that corresponds to the index of the read request table containing the information for a list of read requests. See *Read Requests Table* on page 32. Different tables may be used for this UCALL, but using the same table saves run time.

DMopr/DM2opr UCALL

Send operate/select requests initiated by the ladder. The requests are concentrated in a multiple-column table in which each row represents one request. -1 in the first column means that the row is not applicable. All requests are sent in consecutive order.

This function expects 2 parameters:

1. A variable parameter that represents the device index.
2. A constant parameter that corresponds to the index of the operate request table, containing the information for a list of operate requests. See *Operate Requests Table* on page 34. Different tables may be used for this UCALL, but using the same table saves run time.

NOTE

In order to send an operate request to the slave, you must call the DMopr/DM2opr UCALLs. It is not enough to change the point's value in the I/O tables.

DMreq/DM2req UCALL

Sends a request initiated by the ladder.

This function expects 2 parameters:

1. A variable parameter that represents the device index.

2. A constant parameter that corresponds to the function code. The following chart lists the codes and their meanings:

Code	Meaning
0	Enable/disable unsolicited mode.
1	Send an Integrity Poll request.
2	Send an Event Class request.
3	Send a Freeze request.
4	Send a Freeze, No Acknowledgment request.
5	Send a Freeze and Clear request.
6	Send a Freeze and Clear request, No Acknowledgment request.
7	Send a Read Time request. In this command, qualifier 7 is used. You can read the time using DMread/DM2rd, but in this case, the qualifier will be 6.
8	Send a Write Time request. If the device is defined with the delay measurement mode (UseDm parameter), a delay measurement request should be sent before the write time request. Otherwise, consider the delay measured by the Delay Measurement request (code 11). Broadcast request will consider the last measured delay.
9	Send a Cold Restart request.
10	Send a Warm Restart request.
11	Send a Delay Measurement request. The delay is measured starting from the queuing of the DNP frame in the user port queue. The delay is kept per device. Applicable only to DNP+.

DMmod/DM2mod UCALL

Changes a working mode initiated by the ladder.

This function expects 2 parameters:

1. A variable parameter that represents the device index.

2. A constant parameter that corresponds to the function code. The valid value is 0 and represents Toggle the Polled mode.

DMclr/DM2clr UCALL

Clears the statistics table and the Devices Statistics table.

This function has no parameters.

UCALLs Return Codes

The UCALLs return codes are applicable to: DMreq/DM2req, DMread/DM2rd, DMopr/DM2opr and DMmod/DM2mod.

The following chart lists the possible return codes:

Code	Meaning
0	No error
1	Problem in getting table information
2	Device does not exist
3	Unknown function code
4	Point number out of range
5	Bad point range
6	Command buffer full
7	Unknown data type
8	Application transmit queue busy
9	Object variation not supported
10	Memory problem
11	READ function not supported for object variation
12	Duplicate request not placed in queue

Supported Functions

This section lists the supported DNP functions.

These are the supported request function codes:

1 - Read
2 - Write
3 - Select
4 - Operate
5 - Direct Operate
6 - Direct Operate, No Acknowledgment
7 - Immediate Freeze
8 - Immediate Freeze, No Acknowledgment
9 - Freeze and Clear
10 - Freeze and Clear, No Acknowledgment
13 - Cold Restart (Restart the RTU including the DNP driver)
14 - Warm Restart (Restart only the DNP driver)
20 - Enable Unsolicited Messages
21 - Disable Unsolicited Messages
23 - Delay Measurement

The following are the supported response function codes:

129 - Response
130 - Unsolicited Message

Supported Objects, Variations and Qualifiers

The following table lists all the objects, function codes and qualifiers supported by MOSCAD.

OBJECT			REQUEST (Master->Slave)		RESPONSE (Slave->Master)	
Obj	**Var**	**Description**	**Func Code (dec)**	**Qual Code (hex)**	**Func Code(dec)**	**Qual Code (hex)**
1	0	Binary Input - All Variations	1	00,01,06		
1	1	Binary Input	1	00,01,06	129,130	00,01
1	2	Binary Input with Status	1	00,01,06	129,130	00,01
2	0	Binary Input Change – All Variations	1	06,07,08		
2	1	Binary Input Change without Time	1	06,07,08	129,130	17,28
2	2	Binary Input Change with Time	1	06,07,08	129,130	17,28
2	3	Binary Input Change with Relative Time	1	06,07,08		
10	0	Binary Output - All Variations	1	00,01,06		
10	2	Binary Output Status	1	00,01,06	129,130	00,01
12	0	Control Block - All Variations				
12	1	Control Relay Output Block	3,4,5,6	17,28	129	echo of req
20	0	Binary Counter - All Variations	1,7,8,9, 10	00,01,06		
20	2	16-Bit Binary Counter with Flag	1	00,01,06	129,130	00,01
20	4	16-Bit Delta Counter with Flag	1	00,01,06	129,130	00,01
20	6	16-Bit Binary Counter without Flag	1	00,01,06	129,130	00,01
20	8	16-Bit Delta Counter without Flag	1	00,01,06	129,130	00,01
21	0	Frozen Counters - All Variations	1	00,01,06		
21	2	16-Bit Frozen Counter with Flag	1	00,01,06	129,130	00,01
21	10	16-Bit Frozen Counter without Flag	1	00,01,06	129,130	00,01
22	0	Counter Change Event – All Variations	1	06,07,08		
22	2	16-Bit Counter Change Event without Time	1	06,07,08	129,130	17,28
30	0	Analog Input - All Variations	1	00,01,06		
30	2	16-Bit Analog Input	1	00,01,06	129,130	00,01
30	4	16-Bit Analog Input without flag	1	00,01,06	129,130	00,01

OBJECT			REQUEST (Master->Slave)		RESPONSE (Slave->Master)	
Obj	**Var**	**Description**	**Func Code (dec)**	**Qual Code (hex)**	**Func Code(dec)**	**Qual Code (hex)**
32	0	Analog Change Event – All Variations	1	06,07,08		
32	2	16-Bit Analog Change Event without Time	1	06,07,08	129,130	17,28
32	4	16-Bit Analog Change Event with Time	1	06,07,08	129,130	17,28
40	0	Analog Output Status – All Variations	1	00,01,06		
40	2	16-Bit Analog Output Status	1	00,01,06	129,130	00,01
41	0	Analog Output Block – All Variations	3,4,5,6	17,28	129	echo of req
41	2	16-Bit Analog Output Block	3,4,5,6	17,28	129	echo of req
50	0	Time and Date - All Variations	1	06,07		
50	1	Time and Date	2	06,07		
			1	06,07	129	07
51	0	Time and Date CTO – All Variations	1	06		
51	1	Time and Date CTO	1	06	129, 130	07
51	2	Unsynchronized Time and Date CTO	1	06	129, 130	07
52	0	Time Delay - All Variations	1	06		
52	1	Time Delay Coarse	1	06	129	07
52	2	Time Delay Fine	1	06	129	07
60	1	Class 0 Data	1	06		
60	2	Class 1 Data	1	06,07,08		
			20,21	06		
60	3	Class 2 Data	1	06,07,08		
			20,21	06		
60	4	Class 3 Data	1	06,07,08		
			20,21	06		
100	1	Short Floating Point	1	00,01,06		
No Object			13			
No Object			23			

Some of the objects/variations have a status byte which indicates the status of the point. Other objects/variations have a flag byte which indicates the status of the point as well. These bytes are different in each case. Currently, the driver just logs them but does not keep them.