CDOAN-DNP3

DNP3 Protocol Tester
Release 2.3.28
May 17, 2022

www.cdoancal.com

TPILB

Contents

Introduction

Features

CDOAN-DNP3 is a Windows-based program designed to generate, capture, and test communication with DNP3 protocol devices. Release 2.3.12 on 1-July-2021 supports the following functions:

Media
- Serial
- TCP/IP
- UDP/IP (options for broadcast only or all messages)
- Dual-Endpoint

Operational Modes
- Listen on communication between active master and outstation devices
- Operate as a master in communication to up to ten outstation devices
- Operate as one to ten outstations in communication to a master
- Interpret all data messages, correlating interpreted information with message octets
- Solicited and unsolicited operation

Subset Level
- Can constrain outstation operation to subset level 1, 2, 3 specifications
- Can operate as a single-frame response outstation that does not support events
- Or can remove all subset level restrictions

Transmission Errors
- Ability in inject selected DNP3 protocol errors into message transmission

DNP3 Protocol Support

DNP3 Protocol Support		
Data Link and Transport Layer Functions	All	
Application Function Codes	Data	Read, Write, Response, Unsolicited Response
	Counters	Freeze, Freeze and Clear, Freeze At Time (broadcast and not)
	Controls	Select, Operate, Direct (normal and no response)
	Time	Non-Lan and LAN time sync
	Unsolicited	Enabled and Disable, Unsolicited Response
	File	Open, Close, Delete, Read, Write, File Info
	Other	Assign Class
Object Groups	Information	Device attributes
	Data	Analog, Binary, Double, Counters, Frozen Counters (static and events), Class Data
	Control	Binary and analog outputs, binary output status, analog output status
	Time	Relative time for events, absolute time for synchronization
	Other	Analog deadbands, File controls
	Secure Authentication	Parsed for display only

Views

- *DNP3*
  - Checkboxes to control default DNP3 features (such as request and response variations)
  - Configuration control over automatic error generation
- *Master Configuration*
  - Support communication with up to 10 outstations
  - Configure messages for transmission
  - Set properties such as object group, variation, and qualifier
  - Ability to combine multiple requests in a single transmission (such a read analog and binary)
- *Outstation Configuration*
  - Define point configuration for up to 10 outstations
  - Point Modeling: analog and binary value changes, counter "counting"
  - Automatic event generation
- *Communication Messages*
  - Shows all master and outstation messages
  - Correlates interpreted data to message octet values
  - Complies communication statistics
  - Save to/restore from text files
  - Print
  - Load files generated by programs from other companies such as PCAP files (and others)
- *Point Tabular*
  - Display of input and output points, showing input data and control actions
  - Ability to add point names, binary point state names, and analog engineering units information
  - Ability to select point for trending
  - Print
- *Change Events* list of events objects reported from an outstation
- *Trend* (graph) of data for up to 4 selected points over a 1-hour period
- Ability to undock windows for personalized screen layout

Installation

CDOAN-DNP3 is installed from a single setup file called CDOAN-DNP3-setup.exe. it is digitally signed to CDOAN.

Licensing

CDOAN-DNP3 is licensed is two ways:

- License code installed on a PC based on hardware in the PC. This licensing form limits operation to the specific PC on which the license is installed. These licenses cannot be transferred to another computer.
- License code installed on a (customer provided) USB flash drive based on characteristics of that drive. Most (but not all) USB flash drives contain enough information to store a license file. A license installed on a USB drive enables operation on any PC in which the USB drive is installed. That is, a USB drive-based license allows operation on any PC, but only one at a time.

The CDOAN-DNP3 startup screen shows active license information and contains a target to request a license from CDOAN.

- If you want a USB flash drive-based license, insert that drive into a USB port before starting this process
- Select the **Request License** target
- The application searches for a USB flash drive that contains enough characteristics to store a license. If one is found, a prompt is issued asking if that drive should be used. If more than one USB drive is inserted, only the first applicable USB flash drive is presented. Trial licenses cannot be installed on a USB drive, only permanent licenses can.
- Enter all requested data including the license type. A trial, available for free, operates for two-weeks
- The resulting license request information is saved to a "txt" file
- Email this file to cdoancal@gmail.com
- A license "txt" file will be sent by return Email
- Restart CDOAN-DNP3 and select the **Load License From File** target. If the license is to be installed on a USB flash drive, remove all other flash drives and insert the target drive before loading the license.

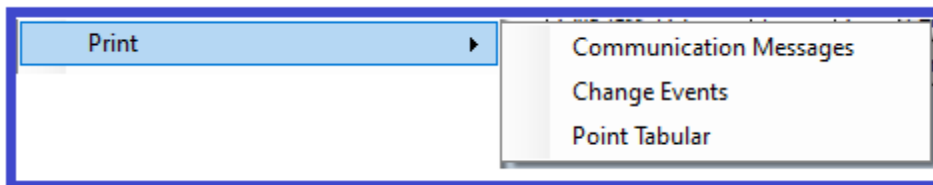# Menu

The main menu contains five pull-down lists.

File
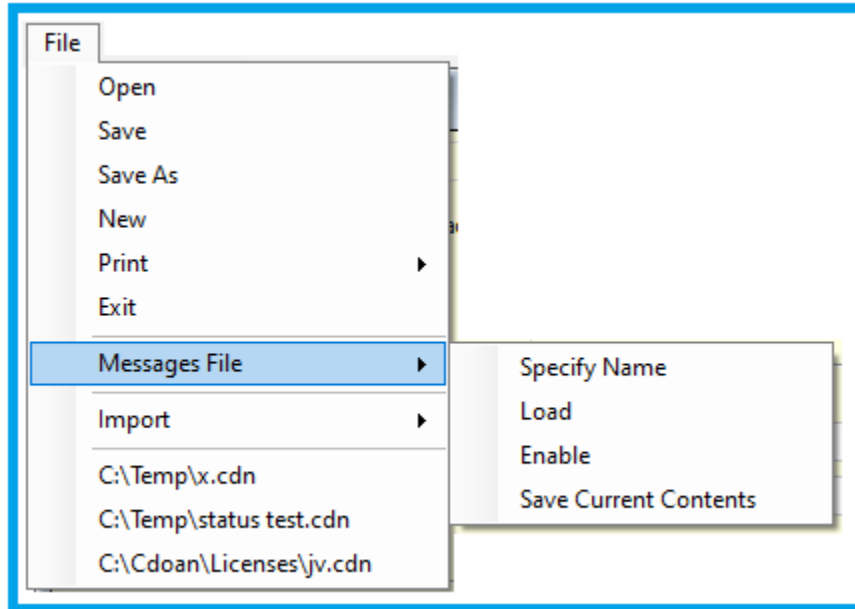
CDOAN Configuration File
- Save and Save-As to save a file
- Open to open any configuration file
- Any file name at the bottom to open one of the most recent three saved files

Print
- The print option allows printing of the Messages, Change Events, or Point Values view.

Messages File is used to save messages processed in an active communication session and reload them later
- **Specify name**
  Defines the name of a messages file. Saving can be enabled and disabled from the *Communication Messages* view. When enabled, messages are saved to the file name specified

- **Load**
  Loads messages from a previously saved file

- **Enable**
  Toggle to enable or disable CDOAN-DNP3 to write messages to the messages file. Writing is enabled automatically when a new name is specified. It can be disabled and reenabled here, or from the *Save Messages* check-box at the top of the Messages view.

- **Save Current Contents**
  Writes contents of the messages view to a CMSG file, the same as if saving was enabled during communication

Import

- Activates an external program, PCAP-TO-CDOAN, that converts files written by programs from other companies to CDOAN format. A converted file can be loaded via the **Messages File/Load** option described above. PCAP-TO-CDOAN is available for free at *www.cdoancal.com*. Conversion is supported for most PCAP files (Wireshark), most files created by Triangle Microworks, Inc. Test Harness and DNP Conformance Tool, as well as several generic binary and text files.

Views

The **Views** pull-down is used to request a view for display or close an already opened view.
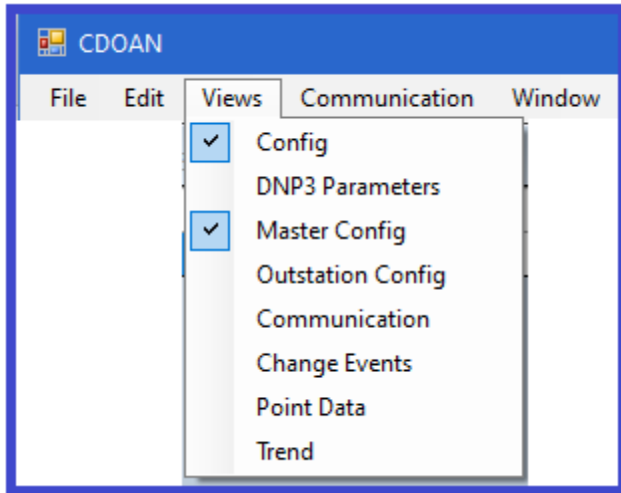
CDOAN-DNP3 supports eight views. Each is discussed in the Views section.

Views that are:

  Closed: are shown without a checkmark to the left. Selecting a closed view causes that view to be opened
  Opened: are shown with a checkmark to the left. Selecting an open view causes that view to be closed. An
             opened view can be selected from a list of open views at the bottom of the CDOAN-DNP3 window
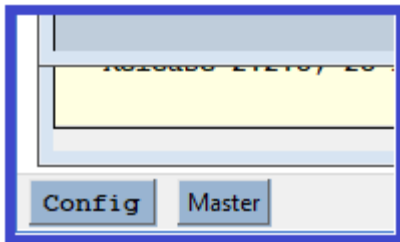
Communication
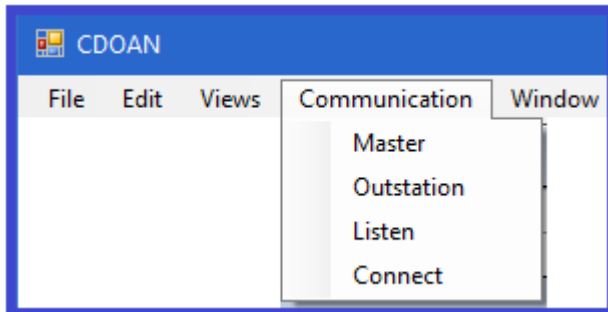
The **Communication** pull-down is used to starts active communication in either master or outstation simulation mode, or listening, and to stop an active communication session.

Window

The **Window** controls screen layout of open windows.
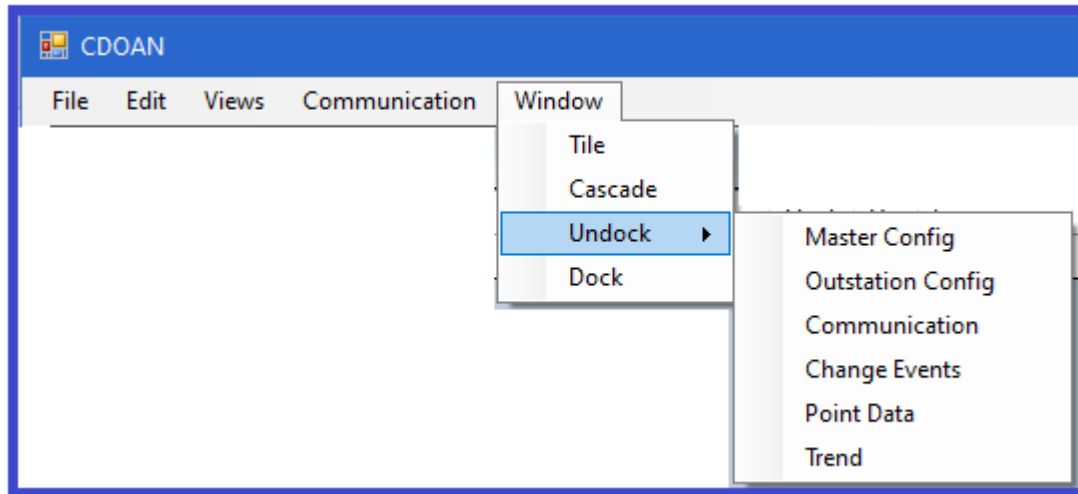

Tile   Tiles all active "Docked" views. As many as four views can be tiled. When more than four views
                are open and docked, the *Tile* commands reverts to *Cascade*
Cascade   Cascades all active "Docked" views

Undock and Dock

                Views are initially shown docked within the larger encompassing CDOAN program window. They
                can be moved and resized within that window only. Most views can be undocked. An undocked
                view is allowed to float and move anywhere in the computer monitor (or monitors) area.
                Undocked views can be re-docked.

Stop

A sixth **Stop** tollbar target appears when, and only when communication is active.

Selecting this **Stop** menu target causes communication to stop. It is identical to selecting **Stop** from the
Communication pull-down menu.

Views

This section discusses each of CDOAN-DNP3's seven views.

Config

The Config view supports entry of general operational parameters and license information.

Communication Mode

Serial	Uses serial communication
TCP Only	Uses TCP only
UDP Only	Uses UDP only

TCP (UDP Broadcast)
- Master: Sends broadcast requests with UDP; non-broadcast with TCP
- Outstation: Shows all messages received. Responds to TCP messages only

Dual Endpoint Uses TCP, plus
- Master: Listens for a connection; auto configures to the DNP address extracted from the unsolicited null startup message
- Outstation: Must be enabled for unsolicited mode; issues a connection request on startup

TCP and UDP
- Master: Sends all messages over TCP
- Outstation: Sends replies consistent with the request (UDP to UDP, TCP to TCP).

Master
 IP Address   Optional master IP address, used only in network listening mode. If provided, only message from the master or outstation IP addresses will be shown
 COM Port   The "IP address" column changes to a "COM Port" column for serial protocols. This is the COM port used to receive messages from, or send messages to, the master

Outstation
 IP address   Outstation IP address, required for master operation, optional for listening operation
 COM Port   The "IP address" column changes to a "COM Port" column for serial protocols. This is the COM port used to receive messages from, or send messages to, the outstations

Network Port   IP port used for network communication

Baud Rate   The "Network Port" field changes to a "Baud Rate" field for serial communication

Font Point Size   Changes the point size for the Master Config, Outstation Config, Change Events, Trend, and Point Data views. Point sizes between 8 and 12 are allowed. The default is 9.

Configure Sample Master   Creates a sample master station to obtain data from a single outstation. To start running as a master, select this option and Communication/Master. [Defaults will be set to communicate to a network outstation on the same processor, such as another copy of CDOAN-DNP3. To communicate to another device, modify the communicate type and IP address or COM port.]

Configure Sample Outstation   Creates a sample outstation with binary, analog, and counter input points, and binary and analog output points. To start running as an outstation, select this option and Communication/Outstation.

Date/Time Range   Communication messages can be saved to a text file and reloaded at a later date. Start and/or stop time ranges, if enabled, are used to limit the load process to only a section of a large saved file. These fields are applied when File/Messages File/Load is selected.

License Code Area   The CDOAN-DNP3 license consists of four 8-digit hex values, shown in the screen. A new license can be entered by filling in the four values and selecting *Save Manually*. Alternatively, data from a license file delivered from CDOAN can be loaded by selecting *Load license from file.*

    To request a new license, select the *Request License* and send the resulting text file created to cdoancal@gmail.com

Revision History   Displays CDOAN-DNP3 release dates and revision history

---

Note   To get a feeling for CDOAN-DNP3 operations:

- Start one copy of CDOAN-DNP3, select *Configure Sample Outstation* and *Communication/Outstation*
- Start a second copy of CDOAN-DNP3 on the same computer, select *Configure Sample Master* and *Communication/Master*
- You should be up and running

DNP3 Parameters

This view is used to set DNP3 protocol options. It is divided into four sections:
- Settings applicable when running in master simulation mode
- Settings applicable when running in outstation simulation mode
- Settings applicable in both modes
- Settings to generate transmission errors

General Settings

Time Base

> Can either be UTC or local time. The time base is used in all event generation, and to format the clock shown in the upper right corner of the program window.

Confirm User Data

> If checked, all user data messages are transmitted using **confirmed user data**
> If not checked, all user data messages are transmitted using **unconfirmed user data**

Use Serial Time Sync For LAN and WAN

> Time synchronization commands sent over a network normally use the LAN model starting with "Record Current Time". If this option is checked, network time synchronization commands use the serial model starting with "Delay Measurement". The serial model is always used for serial communication.

Keep Alive Timer

> Time, in seconds, to transmit a keep alive message, defined as a **Request Link Status**. If 0, a **Request Link Status** is not sent unless otherwise configured. If non-zero, it defines a time, in seconds:

> Outstation Mode
>> A **Request Link Status** message is sent whenever no message is received from the master in the specified time. The **Request Link Status** message is sent to the master DNP address entered under the Master Settings area on this view. For network operations, the **Request Link Status** message is not sent unless there is an active TCP connection.

Master Mode

A *Request Link Status* message is sent to any configured outstation whenever no message is received from it in the specified time. A user configured *Request Link Status* message (in the normal set of messages to be sent) overrides this keep alive message. That is, if the user has configured logic for transmission of a *Request Link Status* message, the program will not override that logic.

Connect Mode

Keep alive logic is not activated if master mode was started by selection Communication/Connect.

Master Settings

Selecting any option here propagates the selection as the default for all messages in the *Master Config* view.

Request/Variation General Defines a preference in variations to be used for object group reads.

Any	No preference (use variation 0, Any)
Flags	Use a specific variation that includes reporting of flags
No Flags	Use a specific variation that excludes reporting of flags
Time	Use a variation that requests time, when applicable
Relative Time	Use a variation that requests relative time for binary events, and normal time for other applicable events

Request/Variation Numeric Objects Defines a preference in variations to be used when reading object groups used to report numeric values

Any	No preference (use variation 0, Any)
16-bit	Request 16-bit values
32-bit	Request 32-bit values
Float	Request floating point values, when applicable

Source/Destination Addresses

Of Master	Address of master. Source address in messages sent in master simulation mode
Of Outstation	Address of outstation. Default destination address in messages sent in master simulation mode

Delay Between Select and Operate

Imposes a delay of 0 to 9 seconds between issuing the select and operate portions of a binary or analog command

Broadcast Addresses

Defines what address is used when a broadcast message is sent.

Outstation Settings

Input Objects

Static

Always with Flags
- If checked, a point's data value is always sent using a variation with flags
- If not checked, a data value is sent using a variation without flags if the point is in a normal state (online and no other flags set). The point value is sent using a variation with flags under any other condition.

Send in Class 0
- Includes points in the object group in class 0 responses

Format
- Numeric format variation for reporting analog and counters

With Time
- Use a variation with time for reporting static values (application for frozen counters only)

Output Status
- Options to include analog and binary output status points in a response to a class 0 poll

Events

Enabled
- Generate events for the associated object type

With Time
- Use a variation with time for reporting events

Class
- Class used for reporting events of this type

Output Objects

Allow SBO
- Allow SBO commands

Allow SBO
- Allow Direct Operate commands

Select/Operate Timeout
- The operate portion of an SBO sequence is rejected if the difference between reception of the select and the output command exceeds the time specified

Other

Send Reset Link at Startup
- If checked, a *reset link* command is sent (by each configured outstation) as soon as possible after startup. This may be useful using confirmed user data services. If unchecked, CDOAN-DNP3 still sends a reset link, if the link has not been previously reset, on reception of a message using confirmed user data services

Cold Restart Time (secs)

- Defines time, in seconds, required to process a Cold Restart command. The outstation will not respond to requests during this time

Counter Deadband
- Deadband for reporting [non-frozen] counter events. A value of 0 disables events based on value change

Analog Deadband
- Deadband for reporting analog change events

Subset Level Compliance

No Restrictions
Introduces no communication restrictions to meet requirements of any subset level

Level 1
Responds only to requests included in subset level 1, specifically, a level 1 outstation does not:
- Respond to polls for specific object groups
- Support frozen counters nor freeze operations
- Generate analog events with time
- Support assign class commands

Level 2
Removes restrictions imposed for subset level 1. A subset level 2 outstation will:
- Respond to polls for specific object groups specifying variation 0 and qualifier 6 (all)
- Respond to polls for binary input events specifying any valid variation 0 and qualifier 6 (all)
- Support frozen counters but not frozen counter events

Level 3
Removes restrictions imposed for subset level 2. A subset level 3 outstation will:
- Respond to polls for specific object groups specifying any valid variation
- Respond to polls for specific object groups specifying the all qualifier (6) or a start/stop qualifier (0 or 1)
- Support frozen counter events
- Support assign class

Single Frame
A single frame response outstation is a very small subset level 1 outstation. It conforms to subset level 1 standards, but, additionally, does not generate events.

Error Generation
Each error class can be configured to generate the corresponding error condition:
- Never
- Once – The error is generated on the next applicable response. Afterwards, the option is automat6ically changed to ***Never***
- Always
- Occasionally – The error to generated at random time, less than 50%

Error types are:
- CRC – generates a CRC error
- No Appl Con – Do not send an application confirm when requested
- No Inc SEQ – Do not increment the application sequence number for new requests

- Add IIN Flags – In outstation simulation mode, sets additional internal indication flags. This option cannot be used to "unset" flags that would normally be set based on the state of communication and the outstation. Select the additional flags you want to set first, and then select "Always", Once", or "Occasionally".

File Read/Write Location

File operations supported include:

- Open
- Delete
- Read
- Write
- Get status

Files are read from and written to the specified folder. Please note that, for outstation operations, file operations are only supported if the **No Restrictions** box is checked under Subset Compliance. File operations are not part of subset levels 1, 2, or 3.

Master Station Configuration

This view supports configuration of messages to transmit in master simulation mode. CDAON-DNP3 supports independent communication to up to ten outstations.

| Type	Request	Var	Dest	Peri	Frequency	Qualifier	Range	Range	Index	CROB	Val	Agair
CLASS	1/2/3/0	2341-Class 1230	0	2	Periodic ∨	All				∨		Send
CONTROL	Binary SBO	1-Command	0	2	Periodic ∨	Point Index	1		0	∨		Send

Fields

Each row defines one message to send. Multiple messages of the same request type are allowed.

Type   General type of message to send, such a *Read*, *Class*, and *Control*

Request   Clarification of request within *Type*, such as *Binary SBO* or *Analog SBO* within *Control*

Var   DNP3 variation

Dest   Destination (outstation) address

Period   Transmission time, in seconds. The first transmission occurs at this time after communication starts and, if enabled for periodic transmission, at each interval thereafter.

Frequency   How often the message is sent

Disabled	Never sent
Periodic	Sent initially at the time after startup specified in the "period" column, and periodically thereafter at the same frequency
Once	Sent once at the time after startup specified in the "period" column
On Demand	Send only on request by the user (See "Again" column description)

Qualifier   DNP3 qualifier code

Range1   DNP3 range1 value, as consistent with the qualifier code

Range2   DNP3 range2 value, as consistent with the qualifier code

Index   Point index, valid for binary and analog output commands only

CROB   Control relay output block type, valid for binary output commands only

Val   Value for analog output commands, or
                  Pulse-on time for binary output commands, or
                  File name for file read and write commands

Again   Any message (except those identified as disabled) is sent when specified by the *Frequency* field, and also whenever the *Again* button is selected. This is useful for (for example) sending control actions only when requested by the user
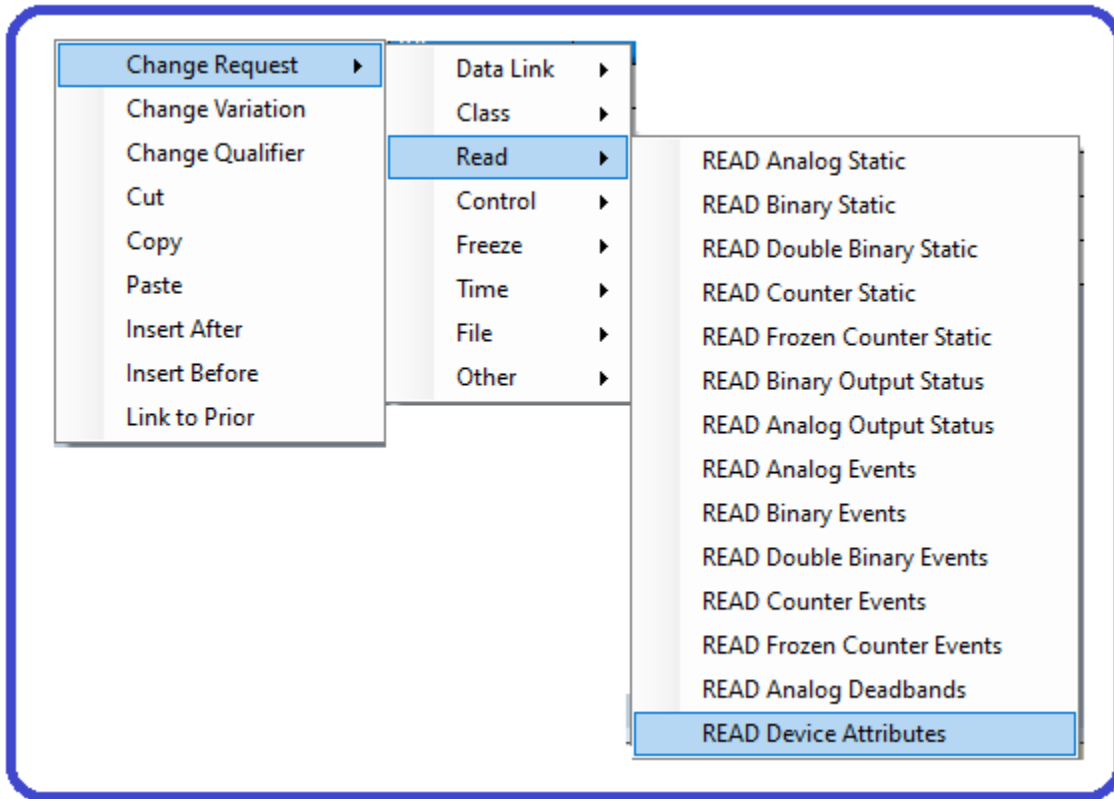
Editing Entries

Entries are created and edited from the *Edit* pull-down list, or by right-clicking on a row in the grid.
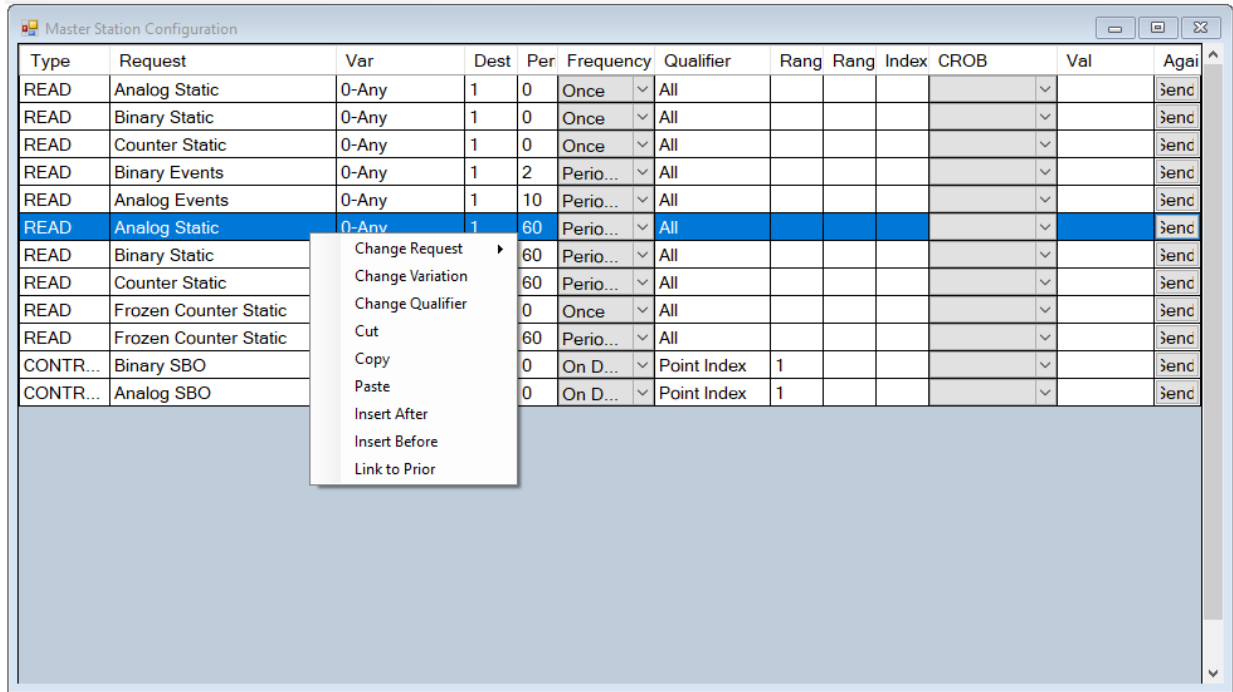

Fields of the edit pull-down menu are:

Change Request

Allows for selection of a new request and request type. Selecting a message causes the *Type* and *Request* columns to be filled in appropriately.
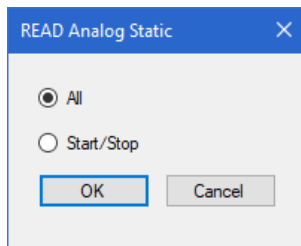
Change Variation

Presents options to enter a variation consistent with the *Type* and *Request*. For example, the following choices are presented for a *Read Analog Status* request.
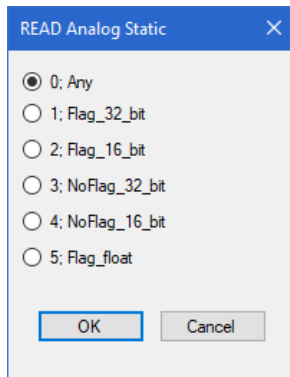
Change Qualifier

Presents options to enter a qualifier code consistent with the *Type* and *Request*. For example, the following choices are presented for a *Read Analog Status* request.

Cut, Copy, Paste

Has standard meanings and apply to a single operation on the entire row.
- Cut removes the row and moves it to a clipboard
- Copy moves a copy of the current row to the clipboard
- Paste inserts the item in the clipboard at the current row location, overwriting the row's current contents

Insert After and Insert Before

Inserts an [Unassigned] entry after or before the current row.

Link To Prior

If the message selected and the message above the selected message are the same type, they can be merged into a single request. For example, if both messages are "READ" or both are "CONTROL SBO" requests, then they can be as a single message by linking them. The *Link To Prior* option appears only if linkage is possible.

For example, consider the following:

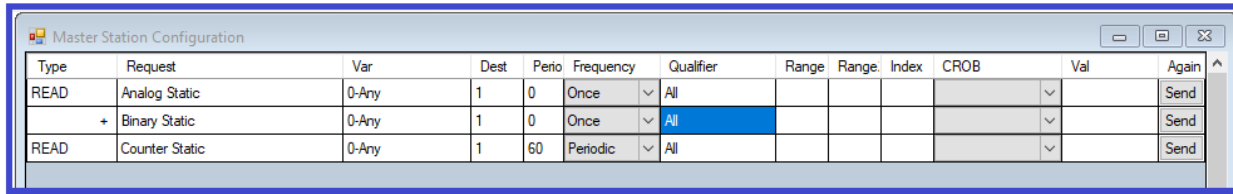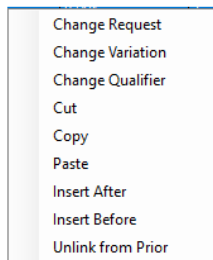| Type	Request	Var	Dest	Perio	Frequency	Qualifier	Range	Range.	Index	CROB	Val	Again
READ	Analog Static	0-Any	1	0	Once	All						Send
READ	Binary Static		1	0	Once	All						Send
READ	Counter Static		1	60	Periodic	All						Send

Change Request
Change Variation
Change Qualifier
Cut
Copy
Paste
Insert After
Insert Before
Link to Prior
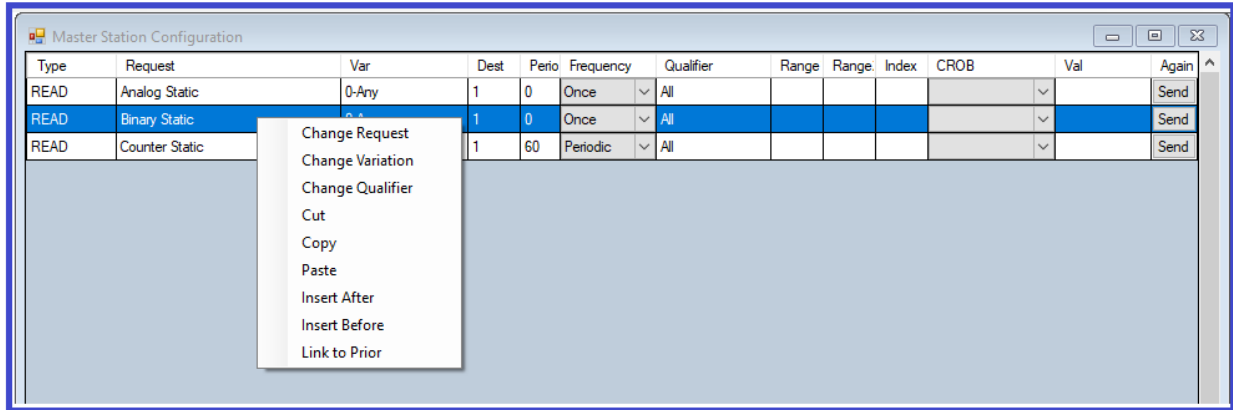
Selecting *Link To Prior* results in:

| Type	Request	Var	Dest	Perio	Frequency	Qualifier	Range	Range.	Index	CROB	Val	Again
READ	Analog Static	0-Any	1	0	Once	All						Send
+	Binary Static	0-Any	1	0	Once	All						Send
READ	Counter Static	0-Any	1	60	Periodic	All						Send

Note that the two messages are now joined. Sending this will issue a single message to read two objects: Analog Static and Binary Static. Also, the pull-down list (if requested) now shows as:

Change Request
Change Variation
Change Qualifier
Cut
Copy
Paste
Insert After
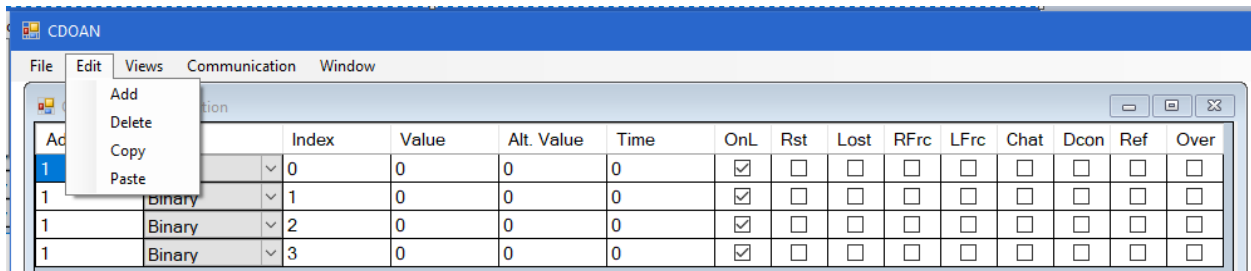Insert Before
Unlink from Prior

Outstation Configuration

Shows and allows editing of the point data base for outstation simulation mode.
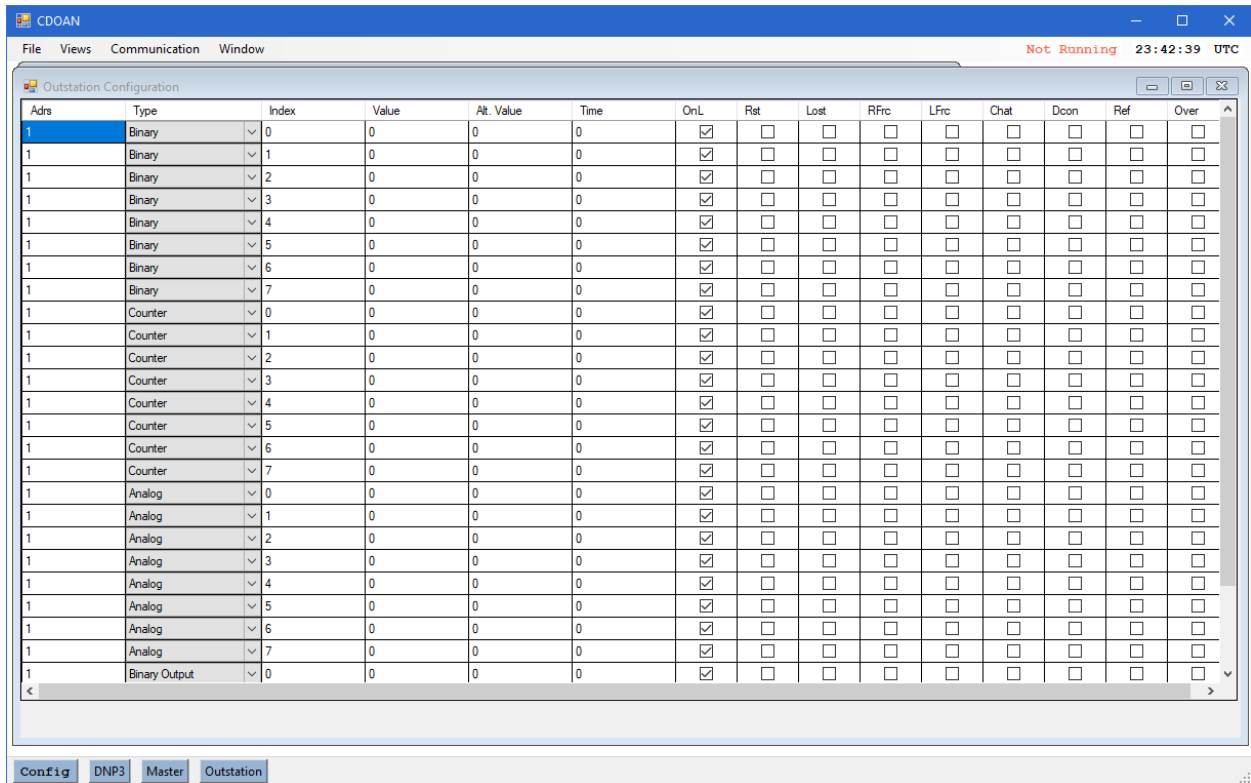

Adding and Deleting Points

Points are added to or deleted from the table by selecting the edit pull-down list or right-clicking a row in the table.

Selecting:
- **Add** generates the following dialog
- **Delete** deletes points in all selected rows
- **Copy** remembers contents of the current row for **Paste** operations
- **Paste** copies contents of the "Copied" row to all selected cells (excluding Adrs, Type, and Index). The target row and the source row must be of the same point type.
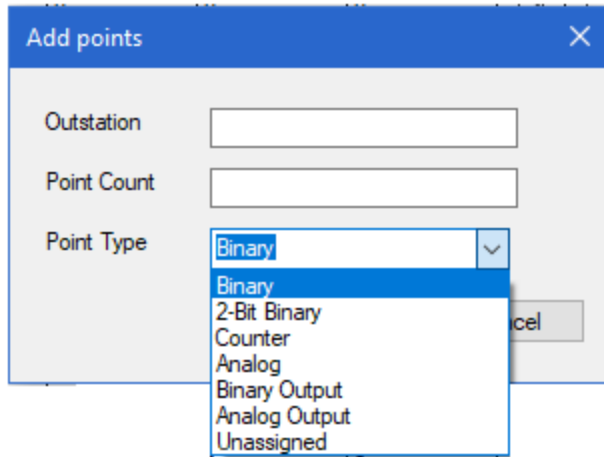
Enter the outstation address, the number of points to add, and the point type.

- Points are generated starting at index 0 within each point type at each outstation. Additional points are assigned incrementally increasing indices. There is no way to start point indices at any value other than 0, and there is no way to generate "gaps" in the address space. When a point is deleted from the middle (e.g., deleting point index 5 after creating indices 0 to 10), point indices are re-sequenced before an outstation simulation session is started.
- Both input and output points must be defined. A control action received for an undefined point results in an "undefined" control status response.
- Each counter point configures both an active running counter and a frozen counter consistent with the subset level being simulated. A frozen counter value represents the value of the same running counter that existed when the freeze operation was processed.

Point Properties

Properties define values and flags to report to the master when the point is polled. Any property may be changed while communication is active. The new value will be reported and events are generated when applicable.

Value   Value initially associated with the point

Alt. Value   Alternate point value
Time   The alternate value is processed at a frequency specified in the time column, in seconds. "Processing" depends on the point type.
 Analog Inputs   Alternates between alternate and initial values at every time interval. An event is generated if the difference between the values meets or exceeds the analog reporting deadband (specified in the DNP3 Protocol Settings View). Only one event per analog input is saved. Each new event overwrites any prior, non-reported event
 Binary Inputs   Alternates between and alternate and initial values at every time interval. A binary event is generated if the values differ. Multiple events per point are saved.
 Counter   Current value is incremented by the alternate values every period. An event is generated when the accumulated unreported change exceeds the counter deadband value in the DNP3 parameters page. No events based on a value change are reported if the counter event deadband value is 0.

Flags   The state of each point flag. Any change while communication is active generates an event. Changing an inconsistent flag, such as reference error for a binary input point, has no effect.

               The meaning of each flag is shown by mouseover in the flag title line.

Communication

Starting Communication

Active communication is started when by selecting either Master, Outstation, Listen, or Connect under the Communication pull-down list.
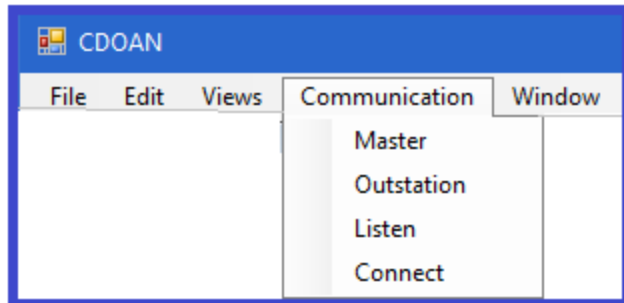
|	
Master	Starts communication as a master. Messages are transmitted as defined in the Master Config View.
Outstation	Starts communication as a set of 1 to 10 outstations, using point data defined in the Outstation Config view.
Listen	Listens to communication between active masters and outstations. Network listening can be filtered to specific masters or outstations by entering their IP addresses in the Config view.
Connect	An alternative way to start communication as a master. In this mode, CDOAN-DNP3 connects, but no messages are transmitted initially. Messages are transmitted manually, once for every time a message's **Again** box is checked in the Master Config view.

Other messages may be automatically sent to satisfy requirements for Data Link ACK, Application confirm, or on detecting the *Restart* or *Need Time* internal indication bits.

Showing Communication Messages

The **Communication Messages** view displays communication data collected from an active network or serial communication session, or loaded from a saved messages file. Options at the top of windows control how data is presented.
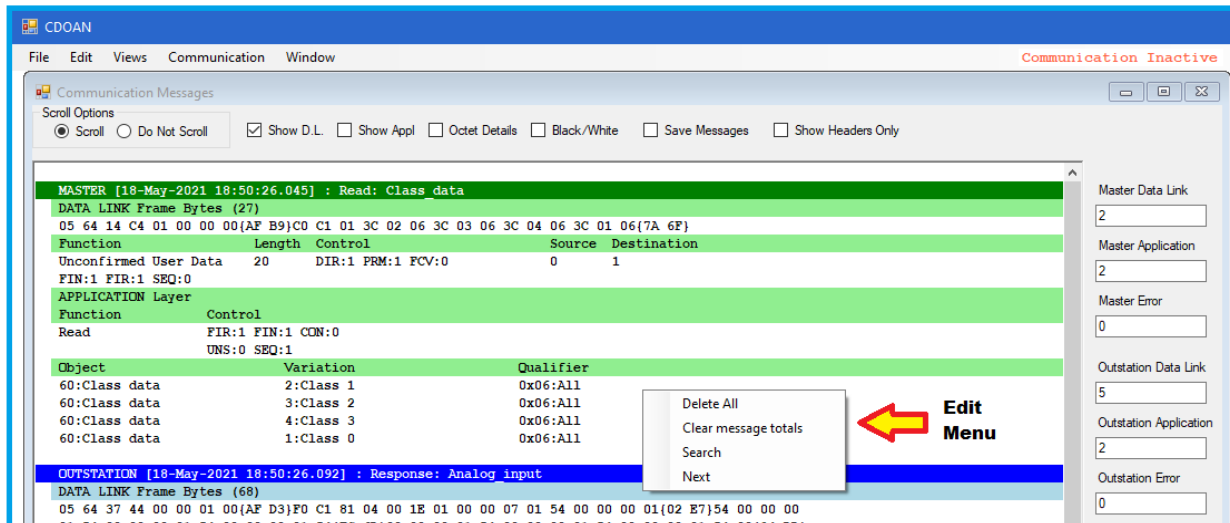
Scroll Options (radio buttons)

Scroll -   Normal scrolling

Do No Scroll -   New messages are still added at the bottom of the window, but lines do not scroll. The window remains focused at the current position. The view can be scrolled manually

Display Options (check boxes)

Show D.L.   Shows hex octets (bytes) in each data link frame. CRC security bytes are enclosed in braces "{ }" and are shown in red when in error.

Show Appl   Shows hex octets (bytes) in each application fragment, shown only when a complete fragment is received, which may require multiple data link frames. Application data omits CRC bytes

Octet Details   Data bytes for each interpreted application data item are shown in the margin to the right of the corresponding description

Black/White   Information in the "Active Comm" view can be shown in color, with different colors used for master and for outstation communication, or in black and white

Save Messages   When checked, data written to the "Active Comm" view is also written to a communication message file. File writing stops when the box is unchecked or when communication stops.

Show Headers Only - When checked, only summary information about each message is shown. This reduces processor utilization. Most processor time is used updating the screen.

All data processing still occurs and point values are updated on the *Point Data* view. The only change with this option set is that data presentation on the *Communication* view is compressed.

If enabled, the user is given an option (when communication is stopped) to regenerate the communication view with all messages shown in expanded format.

Sample Excerpt from Active Comm Data Presentation

Message Time and Type	[28-Feb-2020 21:59:54.066] FROM OUTSTATION: Response: Binary_input_event and Analog_input

```
                        Data Link Frame Bytes (71)
Data Link               05 64 3A 44 02 00 01 00{53 79}CA C0 81 00 00 02 02 17 03 00 01 F9 22 D0 8D 70{A5 AB}01 01 01 F9
Layer Octets            22 D0 8D 70 01 02 81 F9 22 D0 8D 70{8D F8}01 1E 02 00 00 04 01 32 FB 01 32 FB 01 32 FB 01{2F A3}
                        32 FB 01 32 FB{E1 BF}
```

CRC Octets in braces.
Shown in red if in error

	Function	Length	Control		Source	Destination
Data Link Layer	Unconfirmed User Data	58	DIR:0 PRM:1 FCV:0		1	2

Transport Layer	Transport Layer
	FIN:1 FIR:1 SEQ:10

```
                        Application Layer Bytes (52) - CRCs Removed
Application             C0 81 00 00 02 02 17 03 00 01 F9 22 D0 8D 70 01 01 01 F9 22 D0 8D 70 01 02 81 F9 22 D0 8D 70 01
Layer Octets            1E 02 00 00 04 01 32 FB 01 32 FB 01 32 FB 01 32 FB 01 32 FB
```

Application Octets
Corresponding to
Information
at the left :

	Function	Control	Internal Indications	
Application Header	Response	FIR:1 FIN:1 CON:0		C0 81 00 00
		UNS:0 SEQ:0		

	Object	Variation	Qualifier	
1st Object Header	2:Binary input event	2:With time	0x17:List of 3 points	02 02 17 03

	Index	Value	Flags	Time	
1st Object Data	> 0	0	Online	28-Feb-2020 09:59:52.825	00 01 F9 22 D0 8D 70 01
	> 1	0	Online	28-Feb-2020 09:59:52.825	01 01 F9 22 D0 8D 70 01
	> 2	1	Online	28-Feb-2020 09:59:52.825	02 81 F9 22 D0 8D 70 01

	Object	Variation	Qualifier	
2nd Object Header	30:Analog input	2:16 bit with flag	0x00:Start 0, Stop 4	1E 02 00 00 04

	Index	Value	Flags	Index	Value	Flags	
2nd Object Data	> 0	64306	Online	> 1	64306	Online	01 32 FB 01 32 FB
	> 2	64306	Online	> 3	64306	Online	01 32 FB 01 32 FB
	> 4	64306	Online				01 32 FB

Sample when "Show Headers Only" checked

```
Communication Messages                                                        [ _ ] [ □ ] [ X ]

Scroll Options
( • ) Scroll   ( ) Do Not Scroll    ☑ Show D.L.   ☐ Show Appl   ☐ Octet Details   ☐ Black/White   ☐ Save Messages   ☑ Show Headers Only

  MASTER [18-May-2021 19:01:50.925] : Read: Class_data                                    Master Data Link
--> Transport header:FIN:1 FIR:1 SEQ:0
60:Class data                2:Class 1                0x06:All                              6
60:Class data                3:Class 2                0x06:All                             Master Application
60:Class data                4:Class 3                0x06:All
60:Class data                1:Class 0                0x06:All                              6

  OUTSTATION [18-May-2021 19:01:51.030] : Response: Analog_input                          Master Error
--> Transport header:FIN:1 FIR:1 SEQ:0
--> Internal Indications:  Need_Time Restart                                               0
30:Analog input              4:16 bit, No flag        0x00:Start 0, Stop 7
                                                                                          Outstation Data Link
  MASTER [18-May-2021 19:01:52.034] : Write: Internal_indications
--> Transport header:FIN:1 FIR:1 SEQ:0                                                     6
80:Internal Indications      1:Packed                 0x00:Start 7, Stop 7
                                                                                          Outstation Application
  OUTSTATION [18-May-2021 19:01:52.111] : Response
--> Transport header:FIN:1 FIR:1 SEQ:0                                                     6
--> Internal Indications:  Need_Time
                                                                                          Outstation Error
  MASTER [18-May-2021 19:01:53.059] : Record_Current_Time
--> Transport header:FIN:1 FIR:1 SEQ:0                                                     0

  OUTSTATION [18-May-2021 19:01:53.136] : Response
--> Transport header:FIN:1 FIR:1 SEQ:0
```

Communication Statistics
Shown at the right edge of this view.

- Messages received from a master
  - Data Link

  - Application

  - With errors
- Messages received from an outstation
  - Data Link

  - Application

  - With errors

Edit Menu
The edit menu for the Communication View allows for:
- Deleting all messages
- Clearing message totals shown at the right potion of the view

When communication is inaction, the edit view contains extra entries
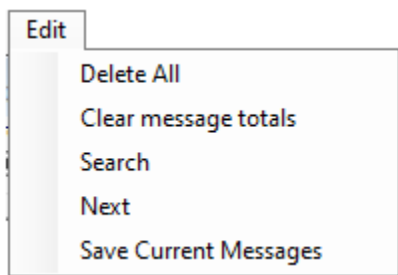
- Search allows entry of a search string for messages shown. Text is case insensitive
- Next finds the next entry
- Save Current Messages Writes contents of the messages view to a CMSG file, the same as if saving was enabled during communication

Point Data

Display

The points view shows values for all points from all devices detected during communication. Time stamps for input points are shown only if reported by the outstation.

In addition to input points, an entry is made for every analog and binary output control action detected. A time stamp is generated for these output actions indicating the time the control was detected.

Points are sorted by DNP3 address (address of the outstation), then by point type, and point index.

Edit Menu

The edit menu supports:

Edit Point Names and Value/State Descriptions
Addition of point name, binary state name, and analog engineering unit information (described in next section)

Trend
Adding an analog, binary, or double binary points point to the trend view. Counters cannot be trended.

Trend

Selecting the *Trend* target automatically starts trending on the selected point. The point will be shown in the color of the trend slot to which is was assigned. No further entry is needed.

Adding Point Names, Binary State Descriptions, and Analog Engineering Units Information

The product supports entry of:
- Point names for all input point types, and
- State names for binary and double binary input points, and
- Engineering unit descriptions and conversion information for analog input points

The entry process is started by selecting **Edit Point Names and Value/State Descriptions** in the edit pull-down list from the *Point Values* view. The selection generates the menu shown on the next page.

Show/Hide

The top targets in the view, identified with Show and Hide options, provide control over which columns to display in the main **Point Values** view. Once points names are included, the **Point Values** windows may be too small to show data for all columns. To make more space for applicable columns, other columns may be removed from that view by selecting "Hide". The may be reenabled by selecting "Show". As a default, all columns are shown.

Point Field Descriptions

Each entry defines one point and contains up to nine information fields.

Point Identification and Name

Four fields tell the program how to identify a point and the name of that point, and these four are the only required fields.

- Outstation is the DNP 2-octet address of the outstation device
- Point type is the DNP point type and is either Analog, Binary, Counter, and Double (Binary)
- Index is the DNP point index
- Name is the point name

Analog Specific Information

The next three fields are valid for analog inputs only.

- EngMin defines a floating-point number specifying the engineering-units value corresponding to a DNP3 value of -32768
- EngMax defines a floating-point number specifying the engineering-units value corresponding to a DNP3 value of 32767
- EU is the engineering units name, such as MVar

An entry made into any of these three fields for a non-analog point will eventually be erased.

Binary and Double Binary Specific Information

The final two fields are used only for binary, 1-bit and 2-bit, points.

- Name Off defines the state name for a binary state of '0' or a double binary state of '1' (i.e., 0-1)
- Name On defines the state name for a binary state of '1' or a double binary state of '2' (i.e., 1-0).

An entry made into any of these two fields for any non-binary type point will eventually be erased.

Buttons

Changes are made to the table through one or more of the buttons shown at the left of the menu

Finished

Select when done. The exit process may scan for and remove duplicates, and will remove invalid entries, such as engineering unit information for non-analog points.

Delete

Deletes all selected entries

Delete All

Deletes all entries

Adding and Editing Points

There are two ways to enter new point information:
- Add and Edit can be used to add or modify a single point
- Import can be used to import a list of points from a CSV (comma separated values) file

Any point information entered is used for display in the **Point Data** view. Point name information is not shown in the communication scrolling window.

Edit

Add

Used to add a new point, or edit an existing point. Selecting either target generates the following menu.

The name can be any ASCII string. However, '<', '>', and ':' are reserved characters and, if entered, will be removed.

Import

Importing point information from a set of comma delimited values is more involved. Selecting Import shows:

The CSV file to be imported can have 3 to 9 fields separated by commas. After import, the program must be able to assign an outstation address, point type, point index, and point name to each entry. Of these, the last three, point type, point index, and point name, must be in the CSV file. The first, outstation address, may also be in the file. If not, the outstation address contained in the entry field at the top of this menu is used.

There are five other fields that are not required, but will be processed if present. The meanings of all are described in a prior section.

- EngMin, EngMax, and EU are used for analog inputs, and
- NameOff and NameOn are used for binary inputs (1-bit and 2-bit)

Using the pull-down lists for each of the nine fields, enter the field contained in the corresponding position in the CSV file. If the CSV file has a field that is not used for this application, that field is skipped by selecting the "- - -" in the pull-down list for that field position.

Field syntax:
- Blanks are removed before and after all names. Blanks within a name are allowed.
- '<', '>', and ':' are reserved characters in all names and will be removed
- EngMin and EngMax are floating point numbers
- The point type is converted to "Analog", "Binary", "Counter", or "Double" according to the following rules
  - Analog is any name beginning with A or a, or DNP3 object group numbers 30 or 32
  - Binary is any name beginning with B or b, or DNP3 object group numbers 1 or 2
  - Counter is any name beginning with C or c, or DNP3 object group numbers from 20 to 23
  - Double binary is any name beginning with D or d, or DNP3 object group numbers 3 or 4

Once all columns have been configured, select the *Import* target to select the CSV file for import.

When the import process completes, the list of points imported is shown along with any errors detected during import of the CSV file. Any name found in the CSV file with the same outstation address, point type, and point index as one already existing in the point name list overwrites the previous entry. No error is logged for this.

All errors detected in any given CSV file line are shown at the bottom of the menu followed by the line from the CSV file where the error was detected. A line with any error is discarded. Lines without errors are processed.

Trend
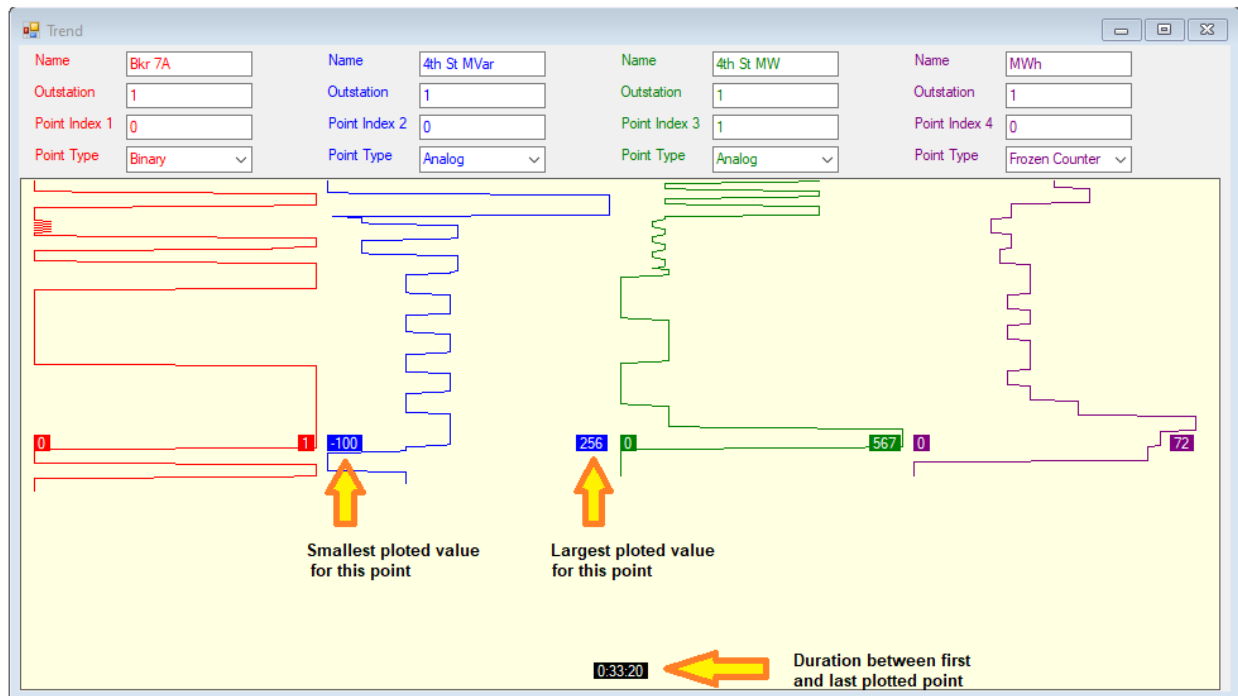
The Trend view plots values for up to four points. Each sample plotted represents the average value detected over a five-second period. Although value changes are processed as detected, the trend graph is only updated once every 15 seconds.

Each point is identified by name, outstation address, point index, and point type.

The name is entered by the user for informational purposes only

The Trend supports plotting of analog, binary (single and double inputs), and frozen counter points:
- Each analog value plotted represents the average over a 5-second period
- Each binary value is a weighted average, giving extra weight to brief momentary changes so that fast trip/close changes can be viewed. This is shown by a bump in the plot that may not show a complete transition from '0' to '1'. For an example, see the top of the red graph.
- Frozen counter values represent accumulations. The value plotted is the difference between successive readings. A new value is calculated when the reported value changes, or on the poll after a freeze is detected. An initial frozen counter value is not plotted until the second change (or freeze) occurs.

There are two ways to activate a point in one of the four columns:

1. Enter outstation, point index, and point type on the trend display. Then right-click one of the enterable fields. An inactive point is shown with at least one of the fields displayed with a gray background. Once active, all fields are shown with a white background
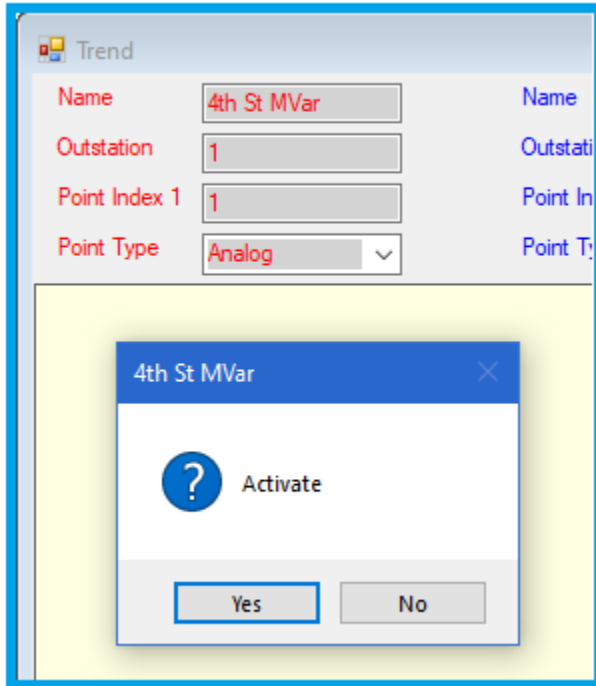

2. Right-click on a point in the point values view (as shown previously)

A point's background in the point view is shown in the color used to plot that point in the trend view. The background is white for all other (non-trending) points.
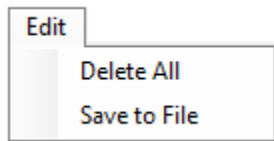
Change Events

Display

This view shows a list of all reported binary, analog, counter, and frozen counter events. Additionally, an "implied" binary event change is reported when a new state is detected for a 1-bit or 2-bit binary input point within a static object. That is, a change is detected in a static poll response that was not previously reported as an event.
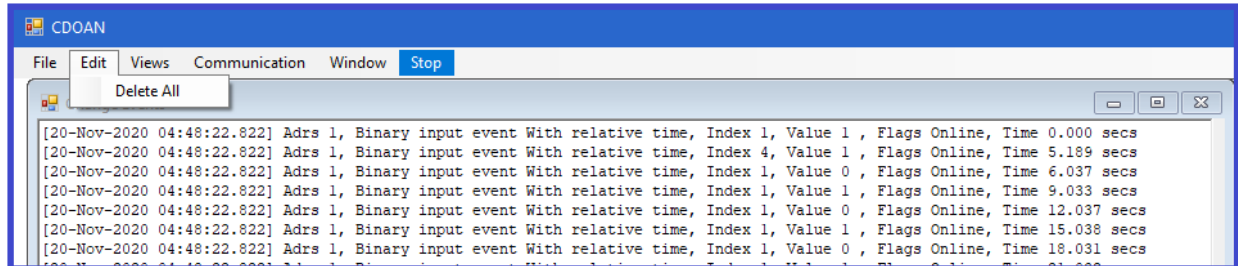
Edit Menu

Delete All deletes all events.
Save To File writes change events contents to a text file