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User's Guide to

CoPilot 1553

Version 1.5

Ballard Technology, Inc.

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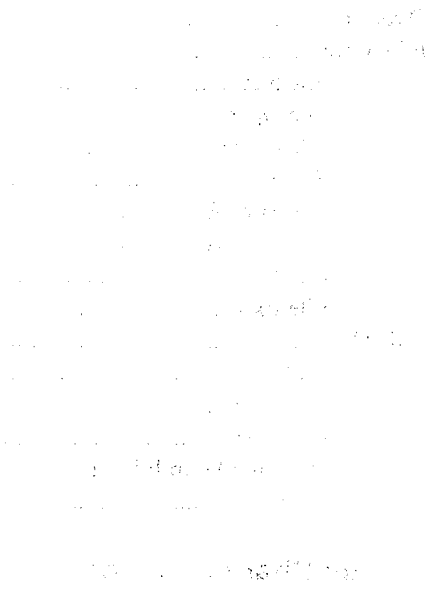
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Introduction

CoPilot

Capabilities

CoPilot 1553 is the Windows based software developed by Ballard Technology, Inc. to simplify the simulation and testing of a MIL-STD-1553 databus. It provides a consistent interface to our ISA, PCI, cPCI and PCMCIA family of products.

CoPilot supports the development of:

- Bus Controller schedule and data.
- RT subaddress and data definition.
- Monitor capture and analysis of bus traffic.
- Error Injection.

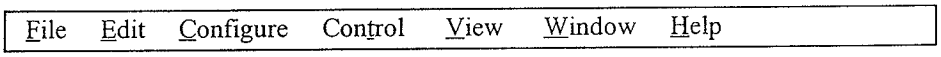
Note: Since the models within PC1553-3 (ISA), LP1553-3 (PCI), LC1553-3 (cPCI) and CM1553-3 (PCMCIA) family of boards are the same, individual models are referenced in this document without the PC, LP, LC or CM prefix (e.g. 1553-3A).

Two Versions

CoPilot 1553 is available in two versions: the Single Terminal version for our 1553-3A, CM1553-1 and CM1553-3 boards and the Multiple Terminal version for 1553-3B_4, 1553-B_{32} and 1553-C boards.

Accessing Features

CoPilot capabilities are accessible through the **Toolbar** and the **Menu Bar**. These capabilities are also accessed by clicking Alt + the underlined letter or through the Shortcut Keys. Information regarding CoPilot states is highlighted in the **Status Bar**.



CoPilot 1553 operates under Windows 95, Windows 98 or Windows NT.

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Getting Acquainted with CoPilot

A Few Clicks of the Mouse

CoPilot simplifies tasks associated with simulation and test on a MIL-STD-1553 bus. You can setup and run **Bus Controller Schedules, Simulate RTs** or engage the **Bus Monitor** with a few clicks of the mouse. You can also observe and change data while the bus is running. The tools and filters built into the CoPilot monitor assist you in locating and analyzing bus activity. With CoPilot there is no need to write programs to access capabilities built into the five product familes.

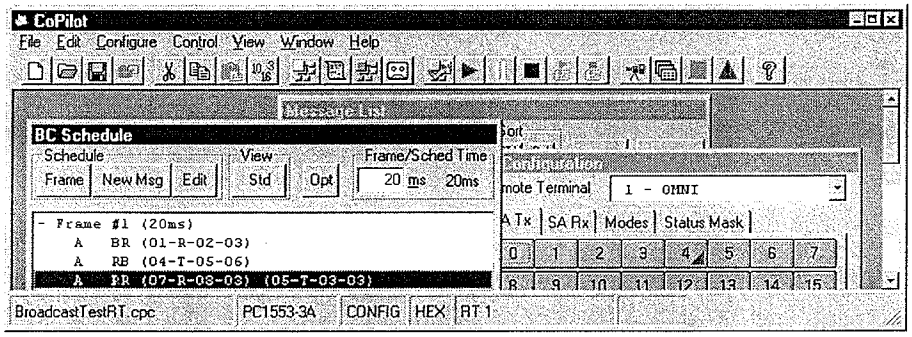
The Progressive Order of Capabilities

CoPilot capabilities are organized under the Menu Bar in the same order in which they are commonly used:

- File management.
- Edit tools.
- Configuration specifications (defining terminal characteristics).
- Loading and Controlling the 1553 board.
- Viewing and changing data while the bus is active.

The CoPilot Desktop

CoPilot features are contained in a series of special purpose windows. You may keep several of them active on the CoPilot desktop at one time.



To establish focus on one of these open windows, click on that window or select it from the list of active windows under the **Windows** menu item. Most windows are linked to help files through the Help button.

CoPilot Initialization

CoPilot is initialized each time you begin a terminal session and each time you select the New File option. Based on these settings, you can simulate one or more RTs or act as a Bus Monitor with a few clicks of the mouse.. The on-screen keyboard and special functions available through CoPilot windows simplifies the tasks associated with defining a unique configuration.

OK and Close Buttons

CoPilot windows and dialog boxes are closed through an "OK" or "Close" button. When the "OK" button appears, it is typically accompanied by a "Cancel" button. Click OK to accept the change and close the window or "Cancel" to discard the changes and close the window.

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The Close button is used on windows through which multiple commands or attributes are defined. The BC Schedule and RT Configuration window are examples. Since these definitions are added to the configuration record immediately as they are defined, they may not be eliminated through a "Cancel" button.

Loading the Board

When you are ready to run a MIL-STD-1553 simulation, the information defined within CoPilot must be transferred to the 1553 board. The transfer is triggered by the Start command based on Terminal Simulation Assignments made through the **TSA** window. Open the TSA window or simply click Control \ Start and the TSA window is opened automatically.

Configuration Data and the TSA

CoPilot allows you to define BC, RT, and Monitor specifications for a simulation more complex than your board can support. For example, you can define a Bus Controller Schedule, several RTs, Bus Monitor's capture attributes, and Error Injection. Then simulate (only) one of those terminals through a one-terminal CM1553-1 board. However, you can not define a more complex simulation through the TSA window than your 1553 board can support.

This flexibility may at first be confusing but there are several advantages to this approach. For example:

- You may begin simulating many terminals, then replace some with external devices as the simulation progresses without removing specifications from the configuration .CPC file.
- You may use a common set of specifications (saved in a single .CPC file) and assign these tasks to more than one 1553 board.
- If you have a variety of boards in an organization (e.g., 1553-3B$_4$ and a 1553-3C), you can use a common file to support a simulation up to the capacity of each board.

Learning through Examples

Sometimes the easiest way to learn is by example. You may want to look through one or more of the following:

- The Use of Defaults
- Defining a Multi-Terminal Simulation

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Toolbar

CoPilot provides access to menu items through toolbar buttons. The title of each toolbar button is displayed when the mouse cursor is positioned over the button. The CoPilot toolbar can be displayed or suppressed through the **View Menu**.

File Menu

 New File

 Open File

 Save File

Edit Menu

 Cut (remove and copy to Clipboard)

 Copy (to Clipboard)

 Paste (from Clipboard)

 Radix

Configure Menu

 Bus Schedule

 Message List

 RT Configuration

 Monitor Initialization

Control Menu

 Terminal Simulation Assignment

 Start Simulation

 Pause / Continue Simulation

 Stop Simulation

 Start Monitor

 Pause Monitor

 Error Injection

View Menu

 Data Selection

 View Message

Help

 Help

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Menu Bar

The following commands are available through the CoPilot Menu:

File Menu

- File New (CTRL+N)
- File Open (CTRL+O)
- File Close
- File Save (CTRL+S)
- File Save As (CTRL+A)
- File Save As ASCII (CTRL+I)
- Exit

Edit Menu

- Edit Cut (CTRL+X)
- Edit Copy (CTRL+C)
- Edit Paste (CTRL+V)
- Radix

Configure Menu

- Board Setup
- CoPilot Options
- Broadcast RT 31
- Mode Code Initialization
- Message Retry Initialization
- RT Labels
- BC Schedule (CTRL+B)
- BC Message List (CTRL+L)
- RT Configuration (CTRL+R)
- Monitor Initialization (CTRL+M)

Control Menu

- Start Simulation (F5)
- Pause Simulation (CTRL+F5)
- Stop Simulation (SHIFT+F5)
- Start Monitor (F6)
- Pause Monitor (CTRL+F6)
- Terminal Simulation Assignments (CTRL+T)
- Error Injection (CTRL+E)

View Menu

- Data Selection (CTRL+D)
- View Messages
- View Memory
- Toolbar
- Status Bar

Window Menu

- Data View Cascade

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Status Bar

The CoPilot status bar provides information regarding the MIL-STD-1553 board currently defined, active files and operating status.



The status bar display can be suppressed by clicking Status Bar under **View Menu**.

Shortcut Keys

CoPilot windows are available through menu selection, the CoPilot Toolbar and Shortcut Keys. These are highlighted on the right-hand side of each Menu Screen.

Window

The Active Window

When two or more CoPilot windows are open, the one lying on top is the active window and has what is called the focus. Keystrokes and application of special functions (e.g., edit commands) are always associated with the focused window.

Changing the Window Focus

The Window menu contains a list of open windows. This includes windows that were opened and minimized through the "-" button. Clicking the window title under the Window menu screen changes the focus.

Data View Windows

When Data View windows are active, clicking the Data View Cascade entry under the menu repositions these windows into an orderly sequence.

Help

Windows Help

Most CoPilot windows are supported through help commands. These may be accessed through the contents or index under the Help menu or through the help button (or F1 key) on most windows.

Context Sensitive Help is noted by an "?" in the upper right corner of the window. Click the "?" button, then click a feature on the window for a description of that option or text box.

Jump and Glossary

You may click on any underlined word shown in green to jump to a help description on that subject. Clicking on words underlined with a dashed line brings up a glossary definition.

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Board Capabilities

During the configuration process, you are allowed to define the BC, 32 RTs and the Bus Monitor but your 1553 board may not be able to run all of those at one time.

Capabilities of Standard Boards

The capabilities of standard Ballard 1553 boards are summarized in the table below

1553 Board Capabilities

Board	BC	RT	Mon	BC/RT	B/R/M	Err Inj
CM1553-1	yes	1	yes			
1553-3A	yes	1	yes			
1553-$3B_4$	yes	4	yes	4		
1553-$3B_{32}$	yes	32	yes	33		
1553-3C	yes	32	yes	33	yes	yes

The 1553-3A for example, is capable of simulating the BC or 1 RT or the Monitor. The 1553-3C can do all of those simultaneously, plus Error Injection. In addition, **Error Detection** is standard on the CM1553-1, CM1553-3, PC1553-3, LP1553-3 and LC1553-3 family of boards.

If you have questions about the capabilities of the boards installed in your computer or you would like to upgrade those capabilities, call Ballard Technology, Inc. at (425) 339-0281 or 1-800-829-1553.

Error Detection

Errors detected through the 1553 board are reported in **Message View** and **Monitor** records.

- Message View Windows: When an error is detected, an Error button appears on the bottom right corner of the Message View window, accompanied by an Error Code (in red). To clear the error display, click the Error Button.
- Monitor Records: The word Error appears in red on the left side of all monitor records on which an error is detected. It may also be followed by a letter, indicating the type of error.
- Error Codes:
  - D Data Count
  - E Message Error
  - I Illegal Command
  - M Manchester Error
  - N No Response
  - P Parity Error
  - R Retry Failure
  - S Sync Error
  - T Time-out
  - W Word Error
  - Y System Error

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MIL-STD-1553

A DOD Standard

The MIL-STD-1553 multiplex databus defines a high speed digital transmission system for the interchange of status and data between equipment internal to a vehicle. This standard, defined by the U.S. Department of Defense, has been in use since 1973. The 1553 standard was updated and released in 1975 as MIL-STD-1553A through the joint efforts of industry, Air Force, Army and Navy.

MIL-STD-1553B

MIL-STD-1553B was released in 1978 to correct difficulties encountered in the application of 1553A, and was further refined in 1980 and 1986 with the release of Notice 1 and Notice 2.

CoPilot initialization settings are based on 1553B, Notice 2.

Broadcast Commands

Special use of RT 31

A broadcast command is a BC command that is sent simultaneously to multiple RTs. When broadcast messages are legalized, they are addressed to RT 31.

Based on Notice 2

Under Notice 2 to MIL-STD-1553B, broadcast commands are illegal except for a limited set of Mode Codes. Legal broadcast mode codes are:

4 "Transmitter Shutdown"

5 "Override Transmitter Shutdown"

8 "Reset Remote Terminal"

CoPilot initialization is based on the standards established under Notice 2. You may alter the broadcast mode code settings through the **Mode Code Initialization** window.

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Windows Basics

Overview

Most of the tools used for defining a 1553 bus are grouped under the first three titles in the Menu Bar.

File Menu

The File Menu allows you to access and preserve configuration and monitor files from one session to another.

Edit Menu

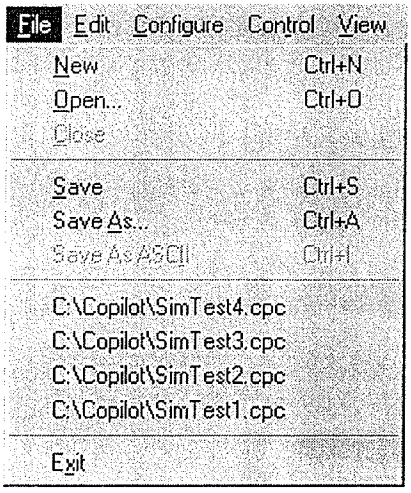
The Edit Menu provides access to the common windows tools to cut, copy, and paste data within and between CoPilot windows.

Configure Menu

The Configure Menu is the heart of the system, through which you may define the terminal and hardware environment that describes the MIL-STD-1553 configuration.

File Menu

The File Menu provides a variety of ways to load and save CoPilot Configuration (.CPC), Monitor (.CPM) and Monitor ASCII (.TXT) files.



NEW clears existing Configuration Specifications and initializes Configuration Data based on CoPilot defaults.

OPEN, SAVE, SAVE AS and SAVE AS ASCII provide access and management of named Configuration (.CPC) and Monitor (.CPM) files.

File LIST entries provide an alternate method to OPEN one of four recently used files.

EXIT closes the CoPilot application.

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File New

Initializing Configuration Data

The NEW command clears existing configuration data and initializes configuration data based on the standard CoPilot default settings. These initialization settings are sufficiently defined so that in many cases you can **Start** the Bus Monitor or an RT Simulation without defining additional configuration data.

If configuration data have been changed since your last SAVE, a dialog box appears asking whether or not you wish to save the existing configuration data.
A New Configuration File can be created by:

- Clicking  button on the CoPilot Toolbar.
- Selecting FILE | NEW on the CoPilot Menu bar.
- Pressing the CTRL+N shortcut key.

File Open

Opening an existing file

The file open command opens and translates an existing CoPilot configuration (.CPC) file or CoPilot Monitor (.CPM) file. You may have several monitor files open concurrently but only one configuration open at a time.

The File Open dialog box may be accessed by:

- Clicking  button on the CoPilot Toolbar.
- Selecting FILE | OPEN on the CoPilot Menu bar.
- Pressing the CTRL+O shortcut key.

File Close

This command closes a monitor file. This menu item is not accessible unless a Monitor file is active.

File Close is not required for .CPC configuration files.

File Save

Updating an existing CoPilot file

This command saves the active configuration data to a .CPC file or saves the CoPilot monitor data to a .CPM file. To save monitor records, you must be in the Monitor window.

The File Save command may be activated by:

- Clicking  button on the CoPilot Toolbar.
- Selecting FILE | SAVE on the CoPilot Menu bar.
- Pressing the CTRL+S shortcut key.

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File Save As

The File Save As command allows you to save all definitions within the active bus configuration window to the .CPC or .CPM file name of your choice.

The File Save As dialog box may be activated by:

- Selecting FILE | SAVE AS on the CoPilot Menu bar.
- Pressing the CTRL+A shortcut key.

File Save As ASCII

Monitor Data may be saved in ASCII format, then loaded into another application program. The resulting ASCII file is designed to load easily into Microsoft Word, Excel, or Access. Monitor files saved in ASCII format carry an extension of .TXT.

The File Save As ASCII dialog box may be activated by:

- Selecting FILE | SAVE AS ASCII on the CoPilot Menu bar.
- Pressing the (CTRL + I) shortcut keys.

Monitor data saved in ASCII cannot be reloaded into the CoPilot Monitor, therefore if you wish examine monitor data again through CoPilot, you should save the monitor data in a binary (.CPM) format.

File List

Accessing recently used files

The four most recently accessed configuration or monitor files are listed near the bottom of the File Menu list box. Click on any one of these filenames to open the file.

File Exit

Saving Configuration Data

The File Exit command closes the CoPilot session. A warning message appears if changes have been made to any of the configuration definitions and you are given a choice to close those windows with or without saving the changes.

Exiting CoPilot while the Board is Running

You may exit CoPilot and leave the board running or armed.

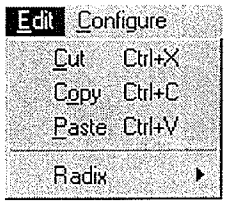
- If you attempt to exit while the board is running, a warning message appears. You may cancel the request or exit leaving the board in an active state.
- To stop the simulation at a later time, re-enter CoPilot, click the  button or use the shortcut keys Shift + F5.

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Edit Menu

Adapted to CoPilot

The Cut, Copy, Paste and Drag and Drop functions are typical of Windows applications except they have been augmented to simplify CoPilot operations.



For example:

- If a message is purged from a Message List through the Edit | Cut command, all references to that message in the **BC Schedule** is automatically removed.
- You can create a second copy of a frame including all the attached messages by copying and pasting the frame title.
- If a named frame exists more than once in a schedule, changing any one of them, automatically update all the others.

The Radix command allows you to define and display data values in hexadecimal, decimal or octal.

Edit Cut

The Edit Cut function removes the highlighted text in the active window and saves it on the Windows clipboard.

Removing a highlighted message

A highlighted frame or message within the Message List or BC Schedule can be cut by:

- Clicking the  button on the CoPilot toolbar.
- Clicking the EDIT | CUT menu selection.
- Pressing the CTRL+X shortcut keys.

Edit Copy

Copy creates a copy of the highlighted message or frame title in the active BC Schedule or Message List window on the Windows clipboard.

Copy is available through:

- The  button on the CoPilot toolbar,
- The EDIT | COPY menu selection,
- or the CTRL+C shortcut keys.

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Edit Paste

Paste inserts the contents of the Windows clipboard into a Message List or BC Schedule window. If the clipboard is empty or the clipboard information came from another application, paste is not available.

Paste is available through:

- The  button on the CoPilot toolbar.
- The EDIT | PASTE menu selection.
- Pressing the CTRL+V shortcut keys.

Drag and Drop Editing

Moving Messages

To move messages within the Schedule or Message List:

1. Click on the message you want to move.
2. While continuing to hold down the left button, move the pointer to the row immediately preceding the target location. Release the mouse button and the message will be inserted.

Single messages or frames may be

- Moved within the BC Schedule.
- Moved within the Message List windows.
- Copied from the Message List to the BC Schedule window.

The latter functions as a combination of COPY and PASTE commands.

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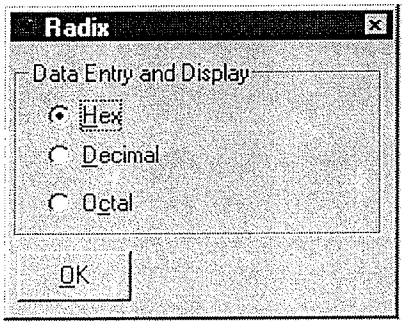
Radix

The radix option allows you to enter and display BC and RT data values in Hexadecimal, Decimal or Octal form. The default is hex.

To redefine the active data radix:

1. Activate the Radix dialog box through EDIT | RADIX or the 

button on the toolbar.



2. Click the hexadecimal, decimal or octal radio button.
3. Click OK to close the dialog box.

Highlights:

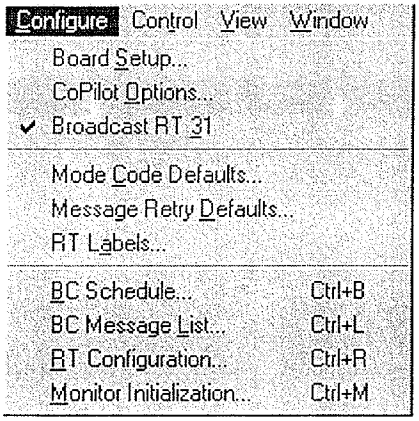
- Radices regulates Edit Checks within the **BC** or **RT Data Editor** and controls the **Message View** data display. A separate radix button in the **Monitor** window controls the display of monitor data.
- Radices do not affect the display of RT, Subaddress and Word Count in the BC command. They are always displayed in decimal.
- The active radix selection is displayed on the status bar.
- The radix definition can be changed any time.

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Defining Bus Characteristics

Configure Menu

Bus Controller, RT and Monitor initialization specifications are defined through the Configure Menu. This information is loaded into the 1553 card when a simulation is started through the **Start** command. Clicking Configure on the CoPilot menu bar brings up the menu panel pictured below. The most frequently used configure capabilities are also available through the CoPilot Toolbar.



Note: Configuration windows may not be accessed while the bus is running.

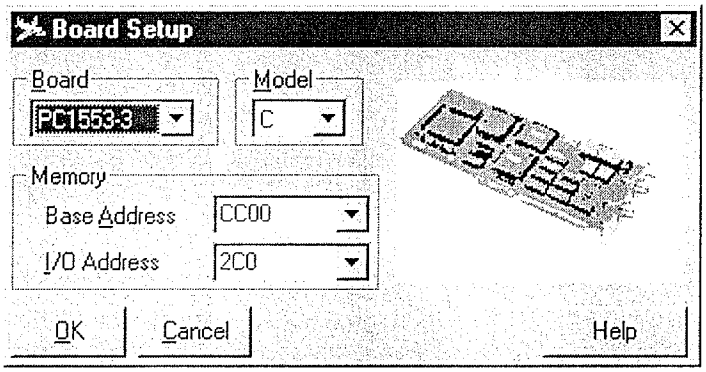
Configure Board Setup

Your MIL-STD-1553 simulation capability varies depending on which Ballard 1553 board is installed.

Although it is not mandatory that you identify the board before you define terminal configuration data, it is a good idea. Data cannot be transferred to the 1553 board if the board type is not correctly defined.

To define the board type:

1. Click the CONFIGURE | BOARD SETUP on the menu bar to access the Board Setup dialog box.



2. Click the Board down arrow to select the board type.
3. Click the Model down arrow to select a model type.

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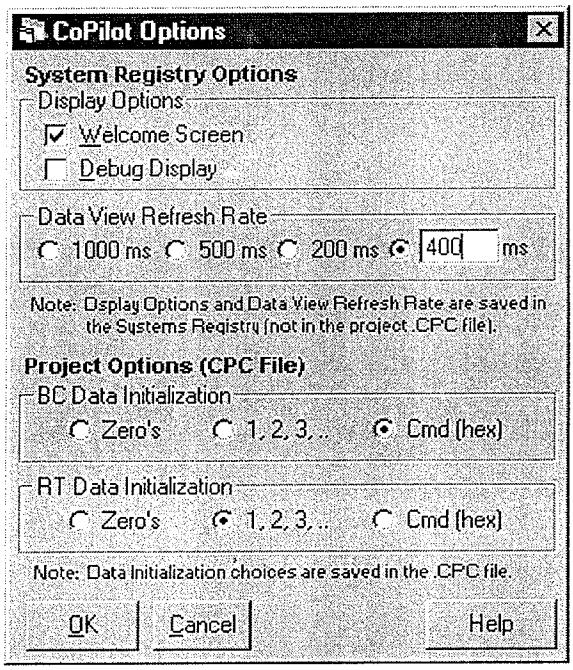
4. If necessary, redefine the Base Address, I/O Address or Card Number to resolve memory conflicts.
5. Click OK to close the window.

The memory addresses are not required with PCI, cPCI or PCMCIA products but you must specify a card number if multiple 1553 boards are installed.

This information is preserved in your CPC file and in the Host System Registry.

CoPilot Options

Items on the upper portion of this window define standard CoPilot behavior and are therefore saved in the Host System Registry. Data Initialization options are unique to each project and are therefore saved with other project definitions in the CPC file.



- Welcome Screen: This option allows you to specify whether or not the welcome screen will appear when CoPilot is first opened.
- Debug Display: Selecting this option allows you access a board memory window through the View Menu.
- Data View Refresh Rate: This option allows you to control the rate the Data View Windows are refreshed with current information.
- BC Data Initialization: All data words associated with messages sent from BC to RT (e.g. RT receive) are defined by one of these three choices unless they are defined through the BC Data Editor.
    * Zero's: All data words sent from BC to RT are set to zero.
    * 1, 2, 3: The first data word of all BC to RT messages is 1, followed by 2, 3…etc.
    * CMD (Hex): Data words are defined by an incrementing sequence of values based on command word values. For example, the first data word associated with 1-R-2-3 is 0843.

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- RT Data Initialization:
  - Zero's: All data words transmitted by an RT are set to zero.
  - 1, 2, 3...: The first data word of all RT Transmit messages is 1, followed by 2, 3...etc.
  - CMD (Hex): Data words are defined by an incrementing sequence of values based on command word values. For example the composite command word for 1-T-2-3 is 0C43.

All data assigned to the board at run time are defined by these data initialization rules unless you specify unique data words through the BC or RT Data Editor.

Broadcast RT 31

Simultaneous Commands

Broadcast messages are BC commands that are sent simultaneously to multiple RTs. Under Notice 2 to MIL-STD-1553B, data words may not be broadcast, but a selected set of mode codes are allowed (see **Mode Code Initialization**. When used, broadcast messages are addressed to RT 31.

Notice 2 Compatible

CoPilot is initialized to allow broadcast messages. To illegalize broadcast messages:

1. Click CONFIGURE on the Menu Bar.
2. Click on BROADCAST RT31 to change broadcast from legal to illegal (checked to unchecked).

RT 31 can be used for directed RT messages if broadcast messages are not legalized.

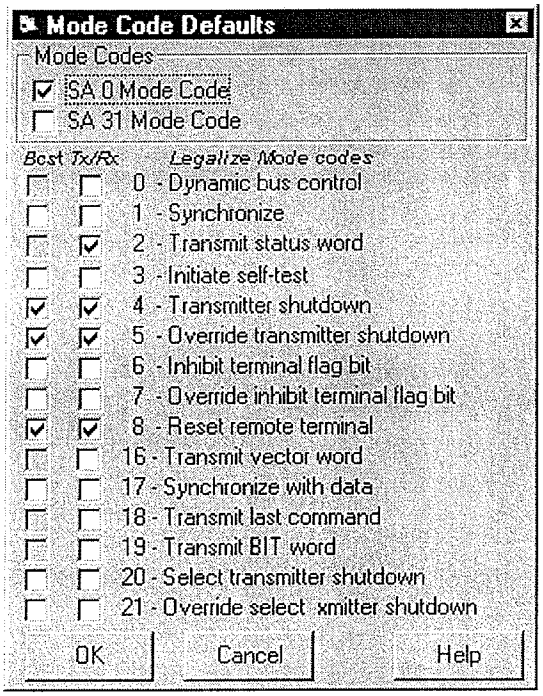
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Mode Code Initialization

The Mode Code settings in CoPilot are based on definitions established within MIL-STD-1553, Notice 2.

To change these defaults:

1. Click CONFIGURE | MODE CODE INITIALIZATION on the Menu bar to activate the window.



2. Click on any of the check boxes you wish to change.
3. Click OK to close the window.

Mode codes legalized within this menu apply to all RTs simulated by the 1553 board unless uniquely changed as part of the **RT Configuration** process. Broadcast mode codes may only be defined through this window.

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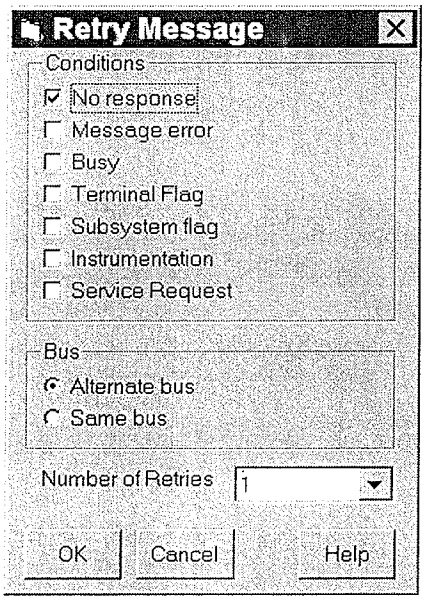
Message Retry Initialization

In most circumstances, the Bus Controller makes one attempt to transmit a message, then advances whether successful or not, to the next message in the schedule. However, that behavior can be changed so that a BC message is retransmitted if an error or no response condition occurs.

To retransmit messages, retry criteria must be defined and the critical messages must be identified through the **BC Message Editor**. The standard retry criterion is shown in the window below.

To change the Retry Criteria

1. Click CONFIGURE | MESSAGE RETRY to access this window.



2. Click one or more option in the Conditions frame.
3. Click one of the option buttons under Bus.
4. Click the down arrow to select number of retries.
5. Click OK to close the window.

Retry criteria may also be defined individually for each message by clicking the Retry Edit check box within the Message Editor window.

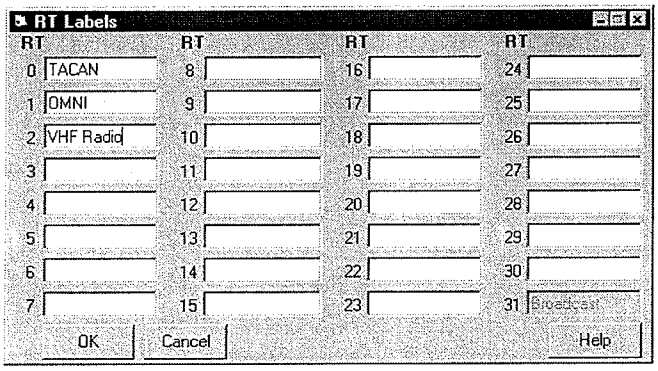
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RT Labels

RT Labels are used throughout CoPilot. BC and Monitor messages display an 11 character label. The RT Configuration windows display up to 20 characters.

To define RT Labels:

1. Click CONFIGURE | RT LABELS on the Menu Bar.



2. Click the RT cell(s) you wish to define and type a label name.

Note: Pressing the enter key advances the cursor to the next cell.

3. Click OK to close the window.

If RT labels are not defined through this window, CoPilot creates an alternate RT label "RT nn," where nn is the RT number.

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BC Schedule

The content and pace of information transmitted on the 1553 bus is determined by the Bus Controller. BC operations are controlled by the Bus Controller Schedule.

Frames, Messages and Frame Time

The BC schedule is defined by a sequence of commands that direct Remote Terminals to transmit or receive information. These commands are grouped into one or more **Frames** and each frame is processed in a time interval known as **Frame Time**. You may assign names to frames and messages.

You can define and modify every element of a Bus Controller schedule through the BC Schedule window. All BC messages are defined through the **BC Message Editor**. Data that originates in the BC are defined based on conventions selected in the **CoPilot Options** window or they may be uniquely defined through the **BC Data Editor**.

Accessing the Schedule Window

To access the Schedule window, click the  button on the CoPilot toolbar, select Configure | BC Schedule from the menu or press the (CTRL+B) shortcut keys.

Frames

The Key to Scheduling

Understanding the use of frames is the key to understanding and developing a BC Schedule. In simplest terms, a frame is a named folder containing an ordered list of BC commands. In some 1553 presentations, the Schedule may be referred to as a major frame and groups of messages within the schedule are associated with minor frames.

- Frames may be named through the **Frame Editor**.
- Messages can be made visible or invisible by clicking the "+" or "-" sign in front of the frame name.
- Frames many be edited or moved using the standard Edit commands.
- When a frame is copied to another place in the schedule, the messages are copied as a part of that frame.

Frame Time

Each frame in the schedule is allocated a processing interval referenced as **Frame Time**.

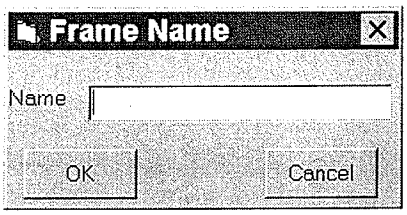
Frame Editor

The Frame Edit dialog box is activated by the FRAME button within the BC Schedule. Alternately, you may access this dialog box to rename an existing frame name in the schedule by highlighting that frame name and clicking the EDIT button.

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Naming is Optional

Assigning a frame name is optional. If you close this dialog box without defining a frame name, CoPilot creates one.



To assign a meaningful name:

1. Type a Frame name or description into the text box.
2. Click the OK button to close the window.

The Frame Name may be up to 50 characters in length and may contain imbedded blanks.

Frame Time

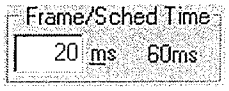
Establish common or unique frame times

"Frame time" (sometimes referenced as Minor Frame Time) defines the time available to process all messages in a single frame. Control passes from one frame to the next when the frame time allocation is exhausted.

- Frame time of each frame may be defined individually.
- Frame time is defined through a textbox in the Frame/Schedule frame.
- The standard frame time allocation is 20 milliseconds or 50 frames per second. The largest frame time allowed is 1300 ms.

To change the default value:

- Type a new frame value in the "ms" text box.



- Schedule time, shown on the right portion of the Frame/Schedule frame, reports the time allocated to process all frames in the schedule.

Naming Frames and Messages

Building readable schedules

When simulating a bus with large numbers of terminals or processing long and complex schedules, you may wish to assign names to RTs, messages and frames.

- Frame and Message names can be named through the Frame and Message Editor.
- Assigning a frame name is optional. If you do not choose to assign a unique name, CoPilot creates one for you.

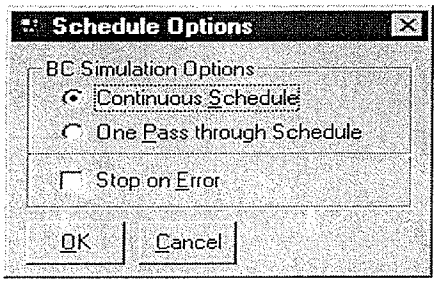
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Schedule Options

The BC Schedule is processed according to the criteria specified through the Schedule Options dialog box.

To redefine schedule operations:

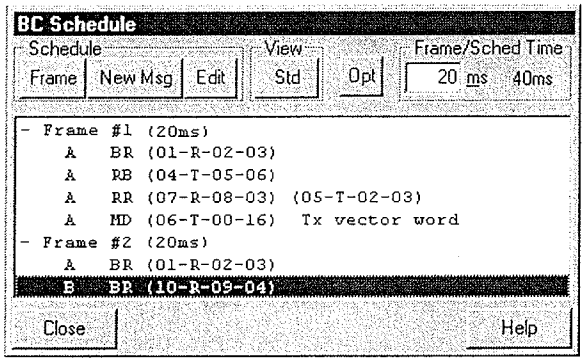
1. Click the Opt button in the BC Schedule window to activate the Schedule Options window.



2. Click the "Continuous" or "One Pass" radio button.
3. Click the Stop on Error check box if you want BC Schedule transmission to be stopped on detection of an error.
4. Click the OK button to return to the BC Schedule window.

Defining a Schedule

All the controls required to build a Bus Controller Schedule are accessible through the BC Schedule window. To create the schedule illustrated in the figure below:



1. Click the New Message button New Msg to access the **BC Message Editor**. *A frame is automatically inserted when a message is inserted into a blank schedule.*
2. Define one or more command words in the Message and click OK to return to the Schedule Window. *The 4 commands shown in this example were defined through 20 clicks of the left mouse button.*
3. Click the Frame button to access the **Frame Editor**, then OK to return.
4. Click on the first message, **Copy**, click on the "Frame 2" label, then **Paste.**
5. Click the New Message button to access the BC Message Editor and compose the final message.

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Note: A frame name is automatically inserted when a message is inserted into a blank schedule.

Message Display

CoPilot allows you to define how messages are displayed.

To toggle, select the view button 

among the four alternate display types:

- Standard A RB (02-T-03-02)
- Label A Miles-to-Stn Inertial Nav-> BC
- Detail A RB der (1462) 02-T-03-02
- Brief A RB (1462)

Decoding the message display

The bus is represented by an "A" or "B." The command types are BR (i.e., BC to RT), RB, RR and MD. The four segment (02-T-03-02) command form defines the same command as the 4 character (1462) hex value. "Miles-to-Stn" and "Inertial Nav" are examples of Message Names and RT Labels assigned by the user.

The special "der" characters in the "Detail display" reveal whether or not

d BC transmit data have been defined.

e The message is tagged for **Error Injection**.

r **Message Retries** have been enabled.

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BC Message List

The BC Message List retains a single copy of **messages** defined through the **BC Message Editor** or imported from an LRU or Configuration file. Messages created through the **BC Schedule** window are appended at the bottom of the message list.

Organized by Message Name

All messages are identified internally by a message name. Consequently, if you want a specific BC command to transmit a different combination of data words at various points in the schedule, then simply assign that command and data combination to a different message name. You can vary the bus assignments, error injection or Retry properties in the same way.

Accessing the Message List

To access the Message List window, click the  button on the CoPilot Toolbar, select Configure | BC Message List from the menu, or press the (CTRL+L) shortcut keys.

Messages

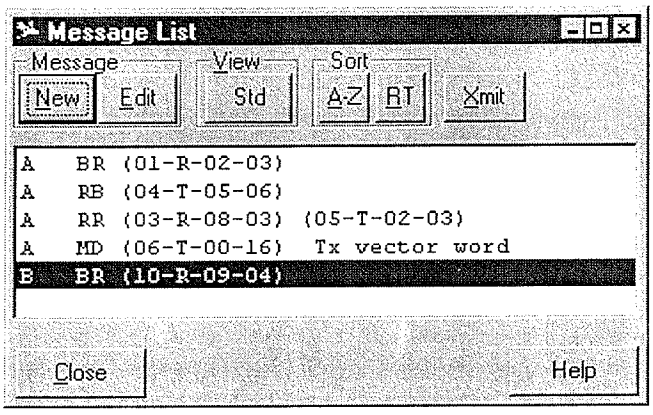
A BC Message is a combination of the command word, data words, error injection and retry properties. All BC messages are created or edited through the Message Editor.

- A single 64 word buffer is reserved on the Ballard Technology 1553 card for each message used in the schedule.
- The **BC Message List** contains a single copy of all messages used in the schedule.
- If messages are deleted from the BC Message List they are automatically purged from the Schedule also.
- Messages may be transferred into the Schedule from the BC Message List through Copy/Paste or **Drag and Drop** editing.
- Messages may be added or deleted within the schedule through Edit **Cut**, **Copy** and **Paste** commands.
- The display format of messages can be changed by toggling the View button at the top of the Schedule or Message List window.

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Using the Message List

The buttons at the top of the Message List window can simplify the creation and use of BC messages.



Defining a Message:

Clicking the New or Edit buttons in the Message Frame activates the **BC Message Editor**.

- To create a new message: position the cursor on the line above where you want to insert the new message(s), then click the **New** button to access the Message Editor.
- To edit an existing message: position the cursor on the Message you wish to edit, then click the **Edit** button to access the Message Editor.

Changing the Message Display

- If all the facts associated with each message were shown, the message list would become cluttered and unreadable. This information is organized in four alternate formats. To select among them click the View button to change the **message display**.

Sorting Messages

When the Bus Controller is part of a large multi-terminal network, the message list may become large and disorganized. To reorganize the display order:

- Click A-Z to sort messages in alphabetical order by message name.
- Click RT to sort messages in RT/Subaddress order.

Building a Schedule

The first step in building a schedule is selecting the messages and defining how frequently each message should be transmitted. When constructing the schedule, you may establish more than one Frame, then assign messages to them based on the desired frequency.

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Transmitting a Single BC Message

When testing, it may be useful to transmit a specific message. If an authorized 1553 card is installed and properly defined through the **Board Setup** dialog box, you may transmit any message in the BC Message List by:

- Clicking the selected message.
- Then clicking the XMIT button 

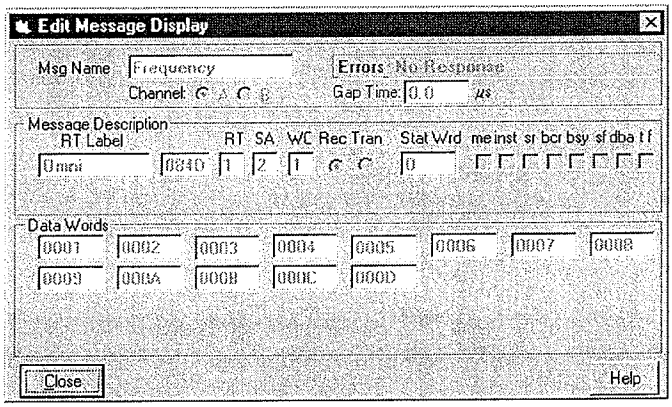
to activate the 1553 card.

CoPilot activates the card, transmits the selected message, activates the **Message Display window** and stops the card. Thereafter, as long as the Message Display window is visible, you can select and transmit any message in the Message List by double clicking a message.

Single Message Display

Single BC messages can be loaded on the 1553 board and transmitted on the bus by clicking the "XMIT" button in the Message Editor or Message List. As with all other board interactions, the installed 1553 board must be authorized for use with CoPilot.

The results of that single message transmission are displayed in the Message Display window.



- All data, message and RT labels, RT response and error conditions are presented.
- Errors, when present are defined in the **Error Detection** listing.

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BC Message Editor

BC commands are defined and modified through the BC Message Editor. You can access the Message Editor from the **BC Message List** window or the **BC Schedule** window.

Creating a BC Message

To create a new message through the Message Editor:

1. (Optional) Type a Message Name.
2. Click one of the option buttons in the Message Type frame.



Note the changes in the window.

3. Click buttons on the decimal keypad to define the command. *Alternatively you may type directly into the RT, SA and WC cells.*
4. (Optional) Click the Data Edit button to bring up the **BC Data Editor**.
5. (Optional) Click the "A" or "B" option buttons and/or click on the Retry check box or Edit button to change the settings.
6. Click OK to close the BC Message Editor or the NEXT button to define a second message. *Clicking the NEXT button allows you to construct additional commands without returning to the Schedule or Message List.*

Added to Message List

All messages are added to the Message List when you click the "Next" or "OK" button. If the editor was called from the BC Schedule window, the message is also inserted immediately following the highlighted message.

Transmitting a Single Message from the Editor

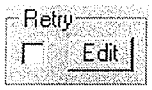
Any completed BC message may also me transmitted on the bus by clicking the XMIT button as long as a keyed 1553 board is properly defined and installed. A full display of that message and the RT response appears in the **Message Display** window.

BC Message Retries

When defining a message through the **BC Message Editor**, you can tag the message for retries by clicking the "Retry Check Box." When that message is processed through the schedule, it is transmitted based on global criteria defined through the **Message Retry Initialization** window or if you wish according to retry criterion uniquely defined for each message.

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To define retry criteria for a specific message:

Click the Retry Edit button 

in the Message Editor to activate the BC Message Retries window:

1. Under Conditions, click one or more of the circumstances that should trigger re-transmission of a message.
2. (Optional) Click on one of the radio buttons under Bus.

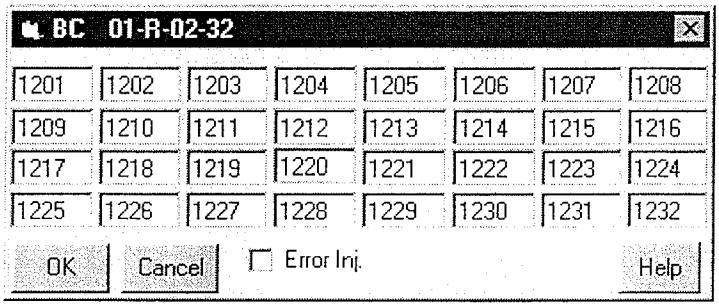
(Note: The Summit Processor used in the CM1553-1 does not permit messages to be assigned to the alternate bus.)

3. (Optional) Click the down arrow to select number of retries.
4. Click OK to close the window.

When you return to the Message Editor, the Retry check box is checked.

BC Data Editor

The BC Data Editor may be accessed by clicking the Data Editor button within the BC Message Editor. If data words for receive commands are not defined through the Data Editor prior to running the simulation, CoPilot sets the data values in accordance with choices registered within the **CoPilot Options** dialog box.



To enter data:

1. Position the cursor in any cell and click to establish focus and type values directly into a data word text box.

Edit checks on the data are based on the current Radix selection.

2. Press the enter key to move the cursor to the next data-word or click a different text box to continue with step 1 above.
3. If your board supports error injection, you may click the Error Injection check box to assign global **Error Injection** attributes to this message.
4. Click the OK button when the data entry is complete.

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RT Configuration

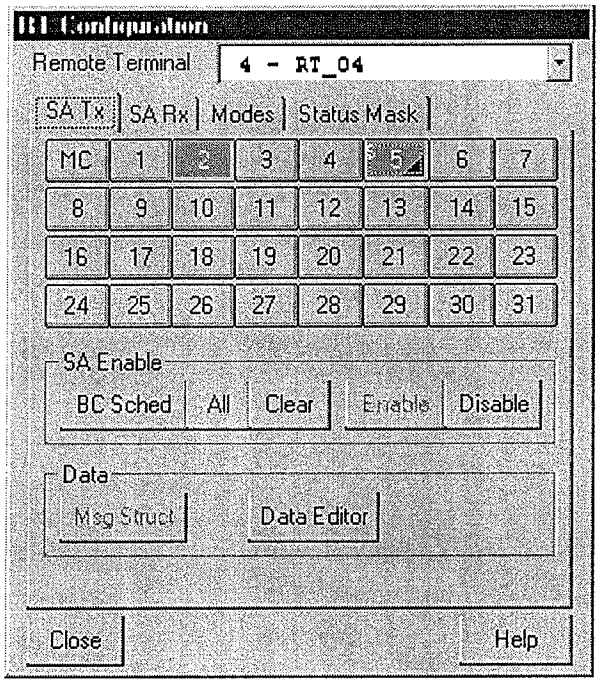
In many cases, simulating an RT is a simple process. Click the RT button(s) in the TSA window, then click the Start button. CoPilot then initializes the board based on **RT Initialization Defaults**.

The RT Configuration window allows you to define each RT in detail. You can enable or disable transmit and receive subaddresses, define data, invoke error injection, legalize mode codes and create a unique status mask for each RT.

Click the  button, select Configure | RT Configuration from the menu or press the (CTRL+R) shortcut keys to activate the RT Configuration window.

To Specify RT attributes:

1. Click the down arrow on the Remote Terminal list box.



2. Click on one RT label to select an RT.
3. (Optional) Click one of the Tabs to bring up and define Transmit Subaddress, Receive Subaddress, Mode Code Legalization or Status Mask attributes.
4. Define choices in each the tabbed windows as required.
5. Repeat steps 1 through 5 for additional RTs as required or click the OK button to close the window.

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RT Initialization Defaults

Defaults - the Key to Simplicity

Unless changed through the RT Configuration window, each simulated RT is defined as follows:

- All transmit and receive subaddresses are legalized or enabled.
- RT Transmit data words are set to zero or as defined by CoPilot data options.
- Error Injection (if applicable) is not set.
- Mode codes settings are based on Notice 2 to 1553B.

Or global specifications you defined through the ***Mode Code Initialization*** *window.*

- If the **Broadcast RT 31** menu item is selected, each simulated RT is set to receive Broadcast mode codes defined through the Mode Code Initialization window.
- RT Labels are set to "RT nn."

These defaults are reestablished each time the FILE NEW command is specified.

Transmit or Receive Subaddresses

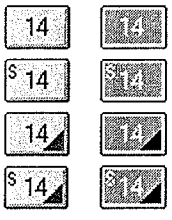
Subaddresses Legalized by Default

When a new file is loaded, all subaddresses are enabled or legalized. You can change the status of each subaddress through the subaddress keypad or the special macro buttons. The RT Data Editor, linked to these windows, provides a way to define data and (if you are using the 1553-3C board) to invoke error injection in status or data words.

Subaddress Keys

The marking on keys provides important clues regarding the state of each transmit / receive subaddress and what actions may be appropriate. Legalized or enabled subaddresses are green.

Illegalized Legalized



Double clicking a key reverses the legalization status. When the simulation is initiated, a 64 word message buffer is established on the 1553 board for each legalized subaddress.

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Changing Subaddress Legalization through SA Enable Macros



- The "BC Sched" button legalizes all subaddresses referenced in the BC schedule and illegalizes all other subaddresses.
- The All button legalizes all subaddresses.
- The Clear button illegalizes all subaddresses.
- A single click on the Enable or Disable button sets the status of a highlighted subaddress key.

Accessing the Data Editor

Clicking the Data Editor button 

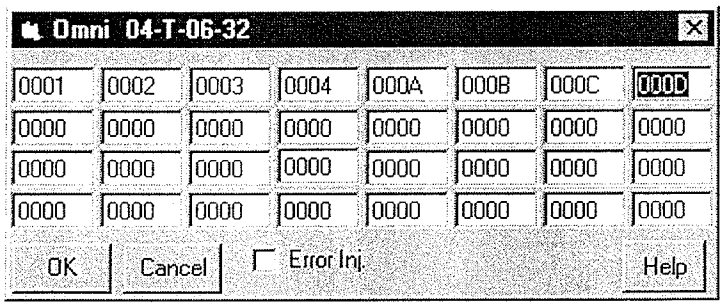
gives you access to the **RT Data Editor**.

When you have completed the legalization and data input for all subaddresses:

- Click the Remote Terminal list box to select another RT.
- Click on one of the tabbed windows to define another RT attribute.
- Click the OK button to close the window.

RT Data Editor

RT transmit data can be defined through the RT Data Editor. To access the RT editor, click the Data Editor button within RT Configuration window. If RT transmit commands are not defined through the Data Editor prior to running the simulation, CoPilot sets the data values in accordance with choices registered within the **CoPilot Options** dialog box.



To enter data:

1. Position the cursor in any cell and click to establish focus, then type values directly into a data word text box.

Edit checks on the data are based on the current Radix selection.

2. Press the enter key to move the cursor to the next data word or click a different text box. Repeat step 1 above as needed.
3. (Optional) If your board supports error injection, you may click the Error Injection check box to assign global **Error Injection** attributes to this message.
4. Once the data entry is complete, click the OK button.

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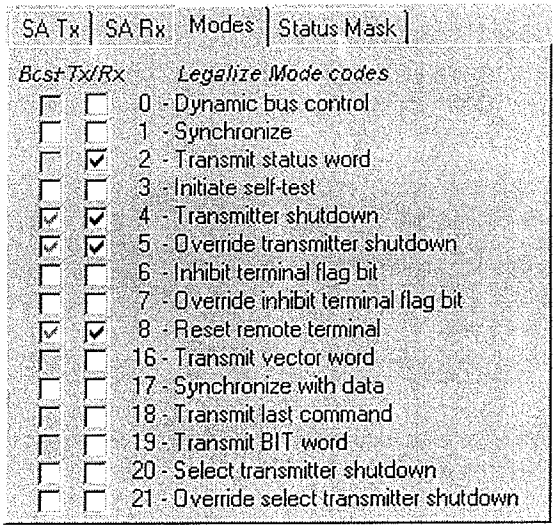
RT Mode Codes

Changing Mode Code Selections

If the mode codes legalized through the **Mode Code Initialization** window adequately define all RTs, you do not have to define RTs individually. You can, however, override these global definitions and define mode code legalization for each RT. Values associated with mode code data words are defined through the RT Data Editor.

To enable a unique set of mode codes for a specific RT:

1. Click on the label of the RT you wish to update.
2. Click the Modes tab to access current Mode Code definitions.



3. Click check boxes in column 1 to change the legalization criteria for the specified RT.
   Broadcast mode codes are defined through the Mode Code Initialization window and appear here for informational purposes only.

To advance to another window, click on another tab, select another RT or click OK to close the RT Configuration window.

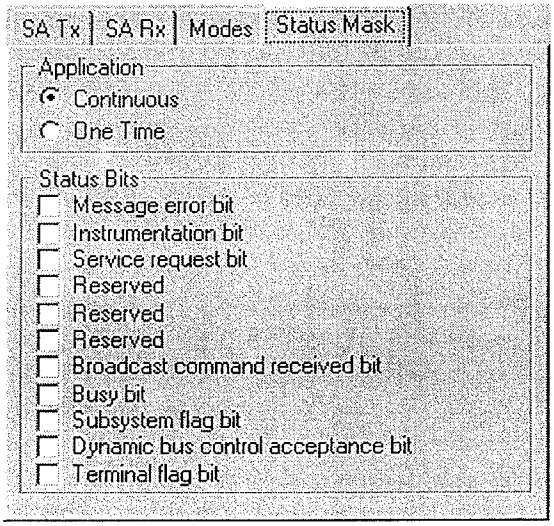
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RT Status Mask

When simulating an RT, the Ballard 1553 board constructs a status word based on the circumstances of each message. When testing a Bus Controller however, you may want to specify which **Status Bits** are set.

To define a unique status word for an RT:

1. Click on the label of the RT you wish to update.
2. Click the Status Mask tab to access current definitions.



3. Click one of the radio buttons under application:
   "One Time" - The status mask is cleared after single use
   "Continuous" - The status mask is defined until further notice.
4. Click the status bits you want set in the status word.

To advance to another window, click on another tab, select another RT or click OK to close the RT Configuration window.

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Status Bits

The first 5 bits of the 16 bit status word are reserved for the RT Terminal Address. In normal operation, status bits are set to zero.

The following conditions are represented by status bits:

- **Message Error**: This bit is set to 1 by several error conditions defined under MIL-STD-1553B. In most cases the transmission of the status word is suppressed.
- **Instrumentation**: This is used to distinguish command and status words from data words. If used, this reduces the number of subaddresses from 31 to 15, since the instrumentation bit uses the first bit of the subaddress. This bit is always set to zero under 1553B.
- **Service Request**: This bit is set to 1 when the RT wants the BC to service it in some manner.
- **Broadcast Command Received**: This bit is set to 1 any time a valid broadcast command has been received. RTs do not transmit status words in response to broadcast commands.
- **Busy**: This bit is set to 1 when a functional RT cannot transfer data to or from its subsystem in response to the BC command. When the RT is busy, only the status word is transmitted.
- **Subsystem Flag**: This bit is set to 1 when there is some fault condition in the RT.
- **Dynamic Control Accepted**: This is used only by RTs that can accept Dynamic Bus Control. Dynamic Bus Control is prohibited by both Notice 1 and Notice 2.
- **Terminal Flag**: This bit indicates some fault condition in the RT. *Typically, this bit is set upon a failure in built-in test, which might have been requested by an initiate self test mode command.*

Since the status word is a property of the RT, it applies to all transmit and receive subaddresses for an RT.

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Monitor Initialization

The Bus Monitor functions as an independent terminal on the 1553 bus and collects messages based on Terminal / Subaddress **Capture Filters**. Selected messages are retained on the card and may be saved to a binary or ASCII file when the data capture is complete. PC1553-3 and LP1553-3 records are marked by a 32 bit time tag. The CM1553-1 has a 16 bit time tag.

Starting the Monitor

You can engage the monitor capture process in two ways:

- Through the Start  command or
- Separately through the Monitor Start  and Pause  buttons.

Captured data appears on screen automatically unless the user disables the display through the Minimize Option on the Monitor Initialization window.

Changing monitor settings

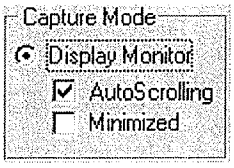
Click CONFIGURE | MONITOR or click the  button on the CoPilot Toolbar,

1. Select options in the Capture Mode, Option and Recording State panels.
2. Click the RT or Message filter tab to define Capture Filters.
3. Click the OK button to close Monitor Initialization window.

Monitor Operations

Monitor Display Considerations

The 1553-3 board has a minimum capacity of 3000 to 4000 records even at the fastest transmit speed. If average message word count is less than 32 data words or the incoming data rate is slower, the 1553-3 Display Monitor will retain many more messages. The CM1553-1 monitor can hold a minimum of 765 records and many times that if the incoming data rate is slow.



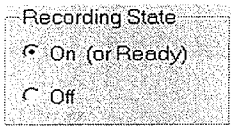
When the bus monitor is specified, CoPilot begins recording bus traffic on the card as soon as it is activated through the start command and continues until memory is full.. Through the monitor initialization window you can choose whether messages are displayed immediately as they are received and whether those messages will appear in a fixed or scrolling window.

Although the active display of incoming data is useful when the bus traffic is light or when you are monitoring a limited number of messages it is often preferable to delay the display until after the monitor capture is complete. When the Minimize check box is selected, messages will be captured quickly and Monitor display will appear automatically when the card is stopped.

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Linking the Monitor

When the ON (or Ready) option button is selected, the monitor begins collecting data automatically when the 1553 board is loaded through the Start command.



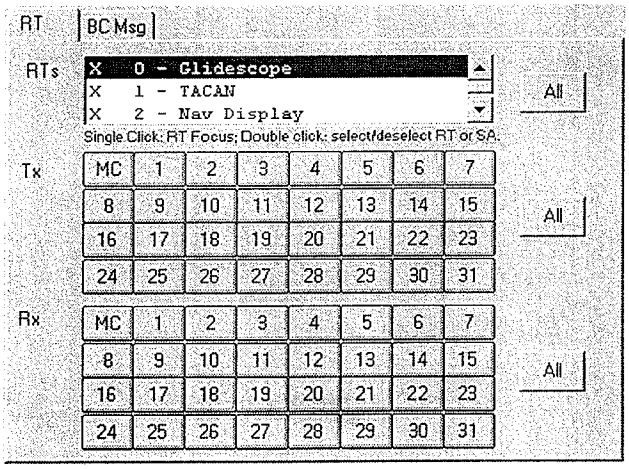
If you are using the 1553-3C board, you may wish to engage the monitor sometime after the start of the BC and/or RT simulation. To accomplish that, select the "Off" option. Then, when the board is running, start and stop the monitor through the  and  buttons on the CoPilot Toolbar.

Capture Filters

When a new CoPilot file is opened, the monitor is initialized to record all monitor traffic. To change these capture rules, click the RT or BC Msg tab of the Monitor Initialization window.

RT / Subaddress selection:

All RT's marked by an X in the first column are included in the data capture. Subaddresses represented by green are included in the monitor capture. Subaddress represented by gray keys are excluded.



- RT Selection: Double click an RT in the RT list box to select or deselect. The subaddress keys shown always correspond with the highlighted RT.
- Subaddress selection: Double click any of the individual subaddress keys to exclude or include subaddress capture. A GRAY subaddress key indicates the subaddress IS NOT included in the monitor capture.

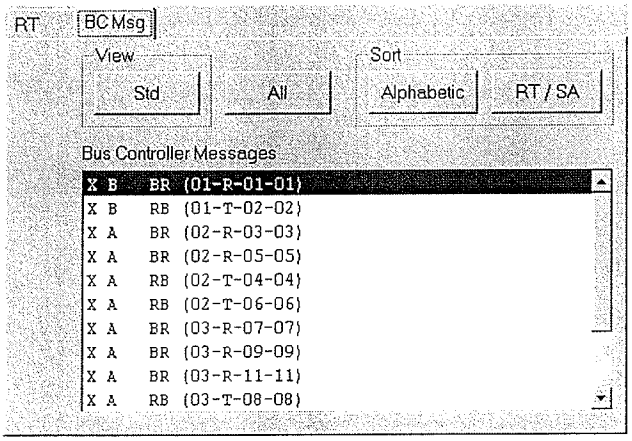
Note: Subaddress filtering is not available on the 1553-3A or CM1553-1 boards, therefore the subaddress keys will not be visible.

- The All Keys: Clicking the RT or Subaddress All Key changes the selection to an ALL-ON or ALL-OFF state.

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BC Message selection

The BC Msg tab is accessible if the Bus Controller is being simulated and your 1553 board supports Concurrent Monitoring (i.e. 1553-3C). Selecting messages through this window is the most efficient way to capture a subset of bus traffic.



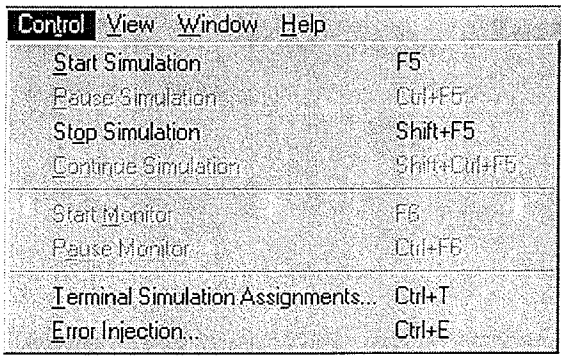
- Messages that are marked by an X in the first column will be captured as past of the sequential monitor record.
- Double clicking a message changes the capture Filter status.
- Clicking the All button changes the filter selection to an ALL-ON or ALL-OFF state.
- Clicking the View or Sort button changes the display or order of messages in the message list box.

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Simulation and Test

Control Menu

Mil-Std 1553 simulation is controlled though selections listed under the Control Menu or by clicking the control buttons on the CoPilot Toolbar.



Error Injection characteristics may be changed while the bus is running and you may observe and change data associated with simulated BC or RT messages while the bus is active through the **Data Selection** window.

Board status (Running, Paused and Stopped) is displayed on the Status Bar.

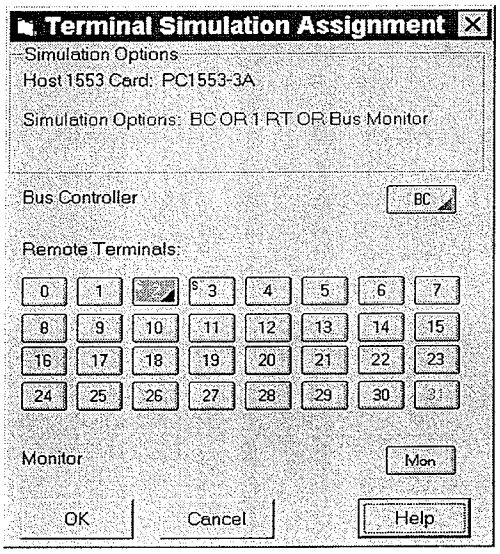
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Terminal Simulation Assignment

The Terminal Simulation Assignment (TSA) window allows you to specify which terminals will be simulated.

To define simulation objectives:

1. Click  on the CoPilot toolbar, select CONTROL | TSA from the menu or press the (CTRL+T) shortcut keys.



2. Click the BC, RT, or Monitor button to identify the terminals you wish to simulate. The host board defined through the **Board Setup** window and its **capabilities** are shown under simulation options.
3. Click OK to close the TSA window.

Color Coded Buttons

When selected BC, RT  and Mon buttons change from gray to green. If a BC Schedule is defined, buttons for RTs referenced within the schedule are marked with an "S." A dark green triangle appears in the lower right-hand corner of the BC or RT buttons if data or error injection conditions were defined through the Schedule or Data Edit windows.

Observing External RTs

If you use the 1553-3A and select Monitor, you may choose between **Shadow Monitor** and the Sequential monitor. Clicking the Shadow Monitor check box allows you to observe one external RT at a time through the **Message View** window

Transferring specifications to the board

CoPilot attempts to load the configuration data based on selections defined in the TSA window when the Start command is activated. If the installed board was not authorized (or keyed) to operate with CoPilot or if the board was not correctly identified through the Board Setup window, the Simulation cannot be executed.

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Start Simulation

A 1553 simulation can be initiated by clicking the Start Button  on the CoPilot Toolbar, by selecting the CONTROL | START menu or pressing the (F5) shortcut key. If the Terminal Simulation Assignments have not been defined, the **TSA window** will appear automatically.

Running or Ready?

If the card is being used to simulate a Bus Controller, the Start command activates the BC schedule. If a bus controller is not simulated, the Start command puts the simulated RTs and/or Monitor in a ready position.

Simulation can be halted through the **Stop**  or **Pause**  command.

Run Options

Setting up the Schedule

The bus controller simulation will continue indefinitely unless you direct otherwise through the **BC.Schedule Options** dialog box.

Changing Data while the bus is running

When the simulation is running on the 1553 board, you may:

- Select, display, and change data from simulated terminals through the **View** command.
- Observe external RTs through the **shadow monitor**.
- View sequential data captured by the **Bus Monitor**
- If you are using the 1553-3C board you may define and attach **error injection** properties to simulated BC and/or RT messages.

Pause / Continue Simulation

A Simulation run is stopped by:

- Clicking the PAUSE/CONTINUE  button or
- Clicking the STOP  buttons on the CoPilot toolbar.

Differences between Pause and Stop

If a simulation is terminated through the Stop  command, the simulation can only be restarted through the Start command. Since the start command always reloads configuration data before a simulation is initiated, all data changes made during the previous simulation will be lost.

If you wish to preserve working data between runs, use the  PAUSE-CONTINUE combination. When a simulation is reactivated through the Continue command, it is restarted without reloading configuration data to the board.

Note: The pause feature is available on 1553-3 boards but not on the CM1553-1.

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Stop Simulation

An active simulation run may be terminated by:

- Clicking the Stop button .
- Selecting CONTROL | STOP from the Menu bar.
- Pressing the (Shift+F5) shortcut keys.

The simulation can be restarted by clicking **Start** command.

Start / Pause Monitor

The Monitor can be controlled separately

Monitor capture can be started after the card is:

- Loaded by clicking the button on the Toolbar and
- Paused independently by clicking the button.

If the monitor is paused and restarted while the bus is active, the data are appended to existing monitor records.

Error Injection

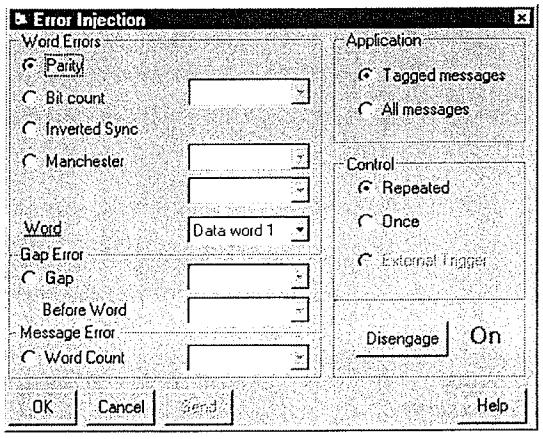
Available on the 1553-3C

The Error Injection window may be accessed:

- Through the button.
- By selecting Control | Error Injection from the menu.
- Pressing the (CTRL+E) shortcut keys.

Note: Error Injection is only available on 1553-3C boards.

You may define these global error injection properties prior to or during a simulation run. Changes made while the bus is active are sent to the 1553 board but are not preserved in the Configuration (.CPC) file. To apply error injection to BC and RT messages they must be tagged through the BC or RT Data Editor.



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To establish global error injection properties:

- Define the type of error and its association with words or bits.
- Define linkage and control attributes.
- Activate through the Engage or Arm button.

Types of Errors

Errors are classified in three groups:

- MESSAGE ERRORS.
- WORD ERRORS - including Bit Count Error, Parity Error, Inverted Synch Error and Manchester Error.
- GAP ERRORS.

To define an error, click one of the option buttons and select a value from its associated drop down list box. When defining a bit error, you must associate that bit error with a specific word. When error definitions are changed during a run, you must click the SEND button to transfer this definition to the 1553 board.

Error Injection Controls

Application

Error Injection may be limited to messages tagged in the BC Data Editor or RT Data Editor or applied to every BC or RT message processed by the 1553 card.

Control

If you select "Repeated" errors, the tagged messages will be identified and loaded when the Start command is applied. The "once" option gives you more precise control over the injection of errors. In the latter case, you can apply errors to specific BC or RT messages through an Error button in the Message View window. This control option cannot be changed after a simulation begins.

Activating Error Injection

To activate or apply error injection, click the 

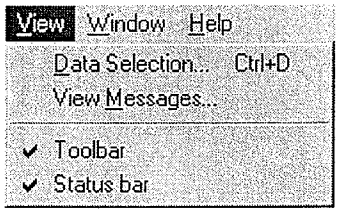
button.

- When Control is set to Repeated, error injection is engaged when the status indicator is **On** and disengaged when the status is **Off**. To change that state, click the Engage / Disengage button.
- When Control is set to Once, the Engage button will be disabled. Error injection can be applied to specific messages by clicking the Error Injection button within the **Message View** window.

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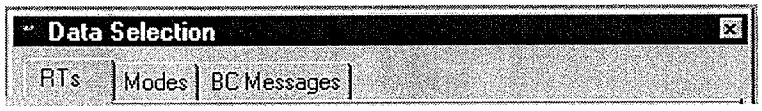
View Menu

The View Menu provides access to data being transmitted across an active bus and control over the CoPilot display.



Data Selection

The View menu allows you to select, view, and change data messages or individual data words being transmitted across an active bus. Selection is made through the Data Selection window and displayed in a Message View window.



Selecting Messages

You may select up to 16 BC or RT / Subaddress or Mode Code messages for display through tabbed RT Message, RT Mode and BC Message windows.

The selected subaddress messages can be activated anytime through the  (View Message) button.

Reorganizing the Message View Display

Occasionally you may find that messages overlap or become disorganized after you have moved or deselected individual message windows. If Message View windows are on-screen, you can put them back into readable order by clicking Cascade under the **Window** menu item.

Note: The message selection list is maintained as part of the configuration file. Selections may be purged from this list however, when you select or deselect terminals through the TSA window. If so, you may add them while the simulation is being run.

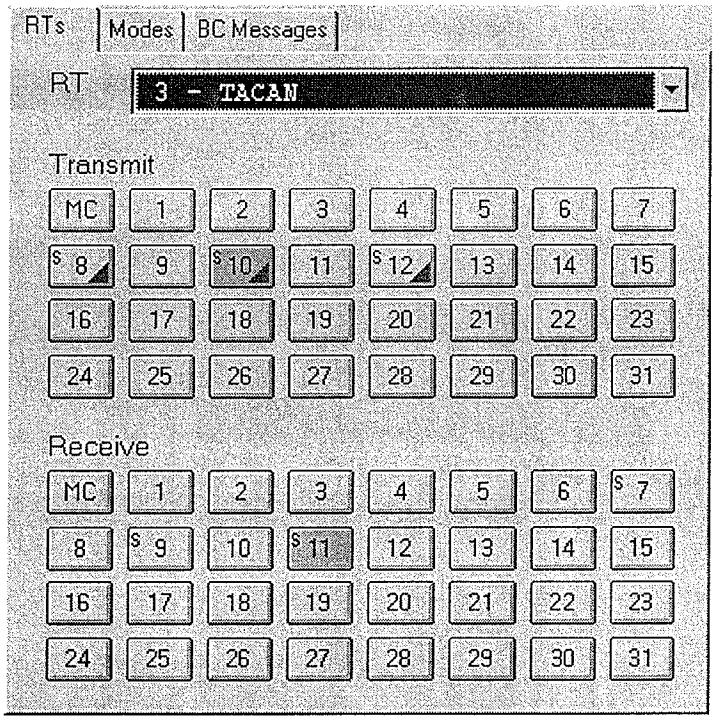
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Selecting RT Data Messages

The RT Msg tab provides access to transmit and receive messages on the bus from an RT point of view. Data for transmitted subaddresses may be observed and changed. Received data can only be observed. *Exception: When a 1553-3C is being used, you can actively change the error injection assignment for both transmit and receive data.*

To select an RT message:

1. Click the down arrow on the RT window and click on one of the RT terminal labels.



2. Double click one or more Transmit / Receive buttons for the subaddress you want to view. When selected, the RT/SA buttons will change from gray to green.

   Double clicking the green subaddress buttons or clicking the close button (X in the upper right corner) on the message display window will remove a subaddress from the select list.

3. Select another RT (step 1 above), click the **BC Message** tab or click OK to close the window.

If you have a multi-terminal CM1553-3, PC1553-3, LP1553-3 or LC1553-3 board, you may also select and observe data associated with external RTs.

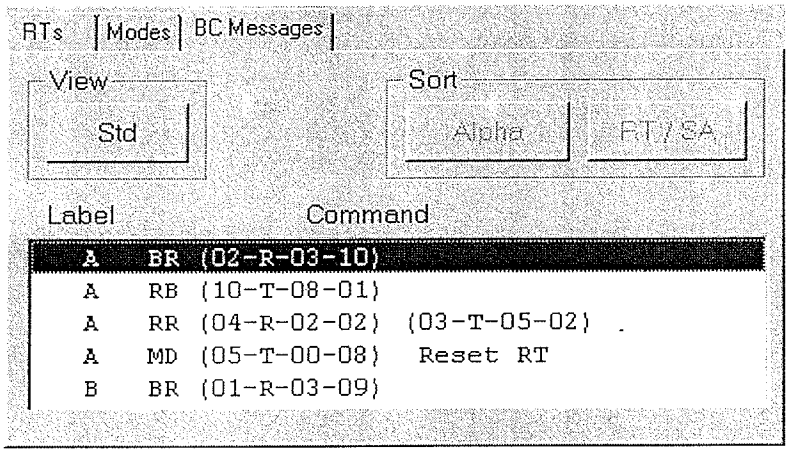
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Selecting BC Data Messages

When a Bus Controller is simulated, you may wish to access transmit or receive messages from the BC's point of view. Data which originate from the Bus Controller *(BC→RT)* may also be changed and reloaded to the board while the bus is running. Data which are received from an RT *(RT→BC)* may be viewed but not changed.

To select a BC Message

1. Double click a BC message.
   An "X" marks all selected message..



2. To select another BC message (step 1 above) click the **RT Msg** tab or click OK to close the window.

Click the View button to select among four **Message Display** types or one of the Sort keys to change the order of the messages.

Shadow Monitor

You may access both simulated and external RTs through the **Data Selection** window. Data for simulated terminals can be observed and changed while the bus is active. Because data transmitted to or from an external source can only be observed, we refer to it as Shadow Monitoring.

Capacity depends on which board is installed

Your capacity to shadow external RTs depends on the board you are using and the number of terminals being simulated.

Shadow RT Summary

Board	Max No. of External RTs	Define in TSA
CM1553-1	n.a.	n.a.
1553-3A	1	yes
1553-3B$_4$	4 (less no. of sim. term)	only if no simulates term.
1553-3B$_{32}$	32	only if no simulates term.
1553-3C	32	only if no simulates term.

For example, if you are using a 1553-3B$_4$ board to simulate two RTs, you may also shadow any two external RTs at the same time.

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Accessing external RT Data

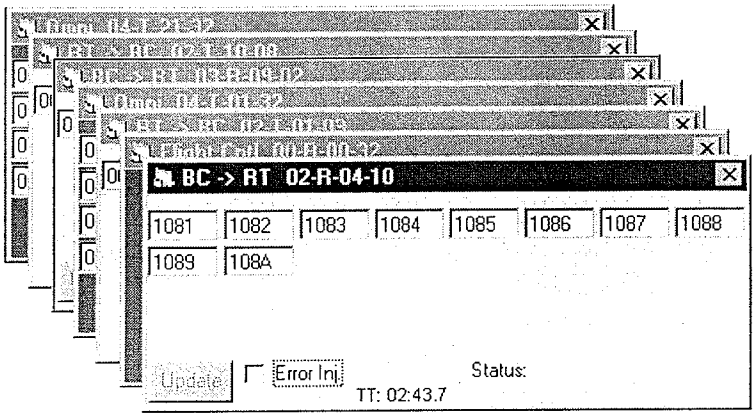
To observe messages to or from an external RT through Message View windows:

- Click the Shadow button in the TSA window.
- Select the RT/SA through the Data Selection window. Selection is the same for external and simulated RTs.

Note: If the BC is simulated, there is no reason to shadow external RTs since all messages are accessible through the BC message list.

View Message

The message windows can be activated or deactivated by clicking  button or clicking the View Message entry under the View menu. The view message option activates the display of messages selected through the Data Selection window.



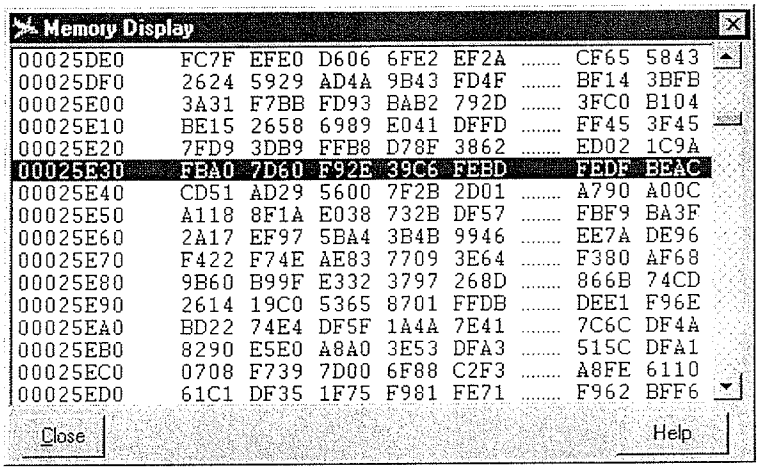
Characteristics of Message displays:

- RT and BC messages are recognizable by their green or yellow background color.
- Messages are refreshed twice each second.
- BC and RT transmit data can be updated while the bus is running and transferred back to the board by clicking the Update button.
- Data display is controlled by the active **Radix** selection.
- If an error was detected, the word ERROR will appear at the bottom of the effected message display. (Click the error button to reset.)
- If you are using a 1553-3C board, messages can be tagged for errors by clicking the Error check box. *(If the "Once" option is selected in the Error Injection window, a one time error can be assigned to a specific message by clicking the Error button.)*

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View Memory

To view host memory data, select VIEW | MEMORY from the CoPilot menu bar. In normal operation the memory option is not available but is made accessible through the Debug Display check box in the CoPilot Option window.



Abreviated view

The contents of memory is displayed through a scrollable window.

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Bus Monitor

Monitor Highlights

Setup through Monitor Initialization Window

The CoPilot Bus Monitor may be used to capture and review bus traffic on a MIL-STD-1553 bus. Data capture is based on criteria specified through the Monitor Initialization window. This includes a specification of which BC Messages, RTs or subaddresses will be recorded, when the recording will begin and whether the monitor will appear immediately as data is captured. This information is loaded onto the board when the **Start** command is executed.

Monitor data is extracted directly from the active databus unless you are simulating both the bus controller and the monitor on the 1553-3C. In that case, the sequential monitor record is constructed from the BC message record on the 1553-3C board. (See Concurrent Monitoring.)

Controlling Data Capture

In normal operation, the monitor collects data when the Start command is executed and the BC Schedule begins transmitting commands. You can also control the monitor directly through the  (Start) and  (Pause/Continue) buttons on the CoPilot Toolbar.

Special Functions Simplify Analysis

The CoPilot Monitor window can be used to display messages from an active bus (at the same time these messages are being recorded into on-board memory) or from a previously recorded monitor file In both cases, the option frames at the top of the window provide control over **Monitor Display Formats**, **Filtering** captured records, **Playback** and **Data Search** tasks.

Concurrent Monitoring

When the Monitor and Bus Controller are simulated concurrently on a 1553-3C board, the sequential monitor record is constructed from internal message buffers associated with BC commands. This approach is used to give priority to processing the BC Schedule.

Although all the message records are recorded in the sequential monitor file, it is important to understand how the process works.

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Special Considerations

- **Bus Connection**: The presence of valid messages from external terminals demonstrates that the board is connected to the 1553 bus and the transceiver is working properly. Since data associated with the simulated BC or RTs are written directly to the monitor from internal buffers, these messages will appear in the sequential monitor record even if the 1553 board is not connected to the bus.
- **Error Detection**: Errors are detected by the decoder on the 1553 board. Therefore all errors originating with external terminals are accurately recorded. Error injection and detection between simulated terminals is not shown since these messages are not processed through the decoder.

Monitor Operations

When the monitor is engaged, messages are recorded in board memory, based on specifications defined through the **Monitor Initialization** window. A monitor window will appear immediately when data capture begins on the bus unless the Minimize option is selected..

Board Capacity

Standard PC1553-3, LP1553-3, LC1553-3 and CM1553-3 boards have 128k words of memory. Each message requires eight words of memory plus one word for each data word. Therefore. if every message includes the maximum 32 data words, you can retain over 3000 messages in on-board memory. If the data word count average is 4 words, there may be room for 10,000 messages in board memory. The CM1553-1 has 32k words memory and the monitor capacity is proportionally less.

When using the 1553-3C for concurrent monitoring along with simulating the Bus Controller or RTs, the 64 word message buffers for BC and RTs are allocated first and the monitoring capacity is reduced accordingly.

Saving Monitor Records

Sequential monitor data can be saved to a user defined filename through the FILE | SAVE or FILE | SAVE AS menu. Both commands save monitor data in a binary file that can be reloaded into the CoPilot Monitor. You can also save monitor records in **ASCII** format so they can be read by other application programs (For example, Microsoft Word, Excel, or Access).

If you attempt to close the Monitor window through the Close "X" or OK button, a message will appear warning if the data was not previously saved.

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Monitor Display Formats

You can control the display of Monitor information through option buttons in the Display Frame.

Record Detail

Click the leftmost button to change the presentation of monitor records.

Brief: Each monitor message is presented in a single line. Data words are not shown.

Full: All message information is presented in a multi-line display, including all data words. Data words may be presented in Hex, Decimal or Octal, depending on the Radices specified under Display.

Form: Messages are displayed in fixed format so that changes in command word, error conditions or data are easily detected. The radices of data can be changed.

Radix

Click the middle button of the Display Frame to alter the display radix of data words between Hex, Decimal, and Octal.

The Radix button on the CoPilot toolbar applies to data in the Data Editor and Message View windows, but does not effect data in the Monitor window.

Time

Click the Time button to access the Monitor Time dialog box. Select Incremental or Cumulative to define the time tag display in the Brief format.

Monitor Display Filters

Display filters may be used to limit the display of monitored data.

Defining Edit Criteria

To restrict the display of monitor records, click the Edit 

button. The Display filter window appears and you can define an RT/SA subset message to be displayed. If you are simulating both the BC schedule and the monitor using the 1553-3C board, you may also select specific BC messages. **Capture Filters** and Display Filters are defined in exactly the same way; the difference is in application. Display filters restrict the display of messages actually monitored from the bus. They do not affect the content of the monitor file.

Invoking the Display Filter

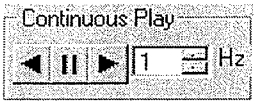
Once defined, the display filter can be engaged or disengaged through the On/Off button.

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Monitor Playback

One of the useful ways to examine a sequential monitor file is to display monitored data at a readable speed through the Continuous Play buttons. That may be especially useful in conjunction with display filters. To engage this display feature:

1. Set the frequency rate (messages per second)



2. Click the forward or back arrow or pause button to operate.

Time Tag

All bus traffic captured by the Bus Monitor is defined by a time-stamp, indicating the moment that the message was received. The internal time tag clock is initialized to zero when bus activity begins. When displayed, the Sequential Time Tag is separated by periods.

(minutes.seconds.milli-seconds.micro-seconds).

The Delta Time Tag displays the time between successive captured messages in microseconds.

(micro-seconds)

The PC1553-3, LP1553-3, LC1553-3 and CM1553-3 family of boards use a 32 bit time tag, and the CM1553-1 a 16 bit tag.

Searching through Monitor Records

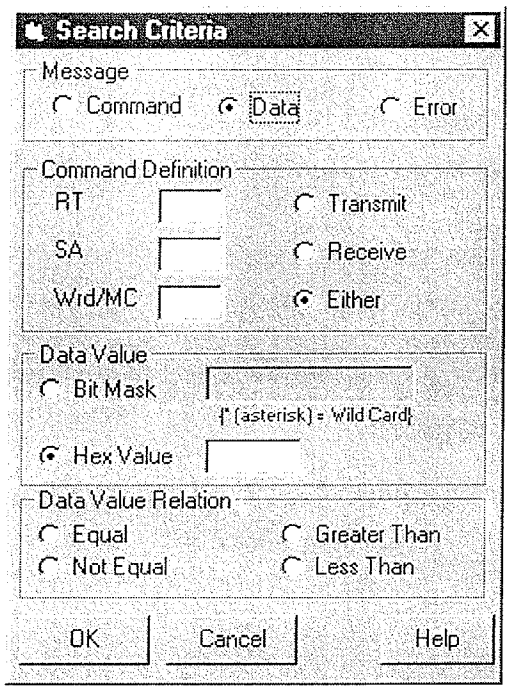
The fastest way to traverse a monitor file is to move the slide in the vertical scroll-bar up or down. Click the Up or Down arrows on the scrollbar or the forward / reverse arrows in the Step Frame to move the display one message in either direction.

Each message is marked by a message number. To display a specific message, enter the message number in the "Go To Message" text box, then click the "Go" button.

Searching for a Specific Message

To locate a specific message in monitor record click the Define button in the Search frame. The Search Dialog box will appear.

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Message:

- A command search is defined by an RT and/or SA combination.
- A data search compares the contents of a specific data field defined by TA, SA, and WC with the data or the Bit Mask Value.
- An error search locates the next message in which an error was detected.

Command Definition:

- If you selected Data or Command, you must define one or more text boxes within the command or data frames.
- A blank in either one of these is treated as a wild card.

Data Value:

- A hex or Bit Mask value must be defined if a search is requested.
- An asterisk in the Bit Mask sequence defines a wild card.

Data Value Relation:

- Data will be evaluated based on an equal condition unless you specify otherwise.
- The data relation for a bit mask is limited to an equal or not equal condition.

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Examples

The Use of Defaults

Each time you start a CoPilot 1553 terminal session, the system is initialized by a series of defaults. These default settings are restored each time you issue the FILE | NEW command. These allow you to set up and run a typical MIL-STD-1553 simulation with a few clicks of the mouse. In the two examples that follow, you discover how a **Bus Monitor** can be activated or an **RT** can be simulated with almost no effort -- based on defaults.

Simulating an RT

Default Settings

If you simulate an RT without uniquely defining RT attributes or data:

- All transmit and receive subaddresses are legalized. (They are defined to exist and 40 word message buffers will be reserved on the 1553 board for each subaddress.)
- Data words for each transmit subaddress are set to zero. Alternatively, the data value defaults can be defined through the **CoPilot Options** dialog box.
- Each RT is legalized to transmit (or receive) mode code modes 2, 4, 5, and 8 (or as defined by **Mode Code Initialization**.
- Each RT is enabled to receive broadcast mode codes 4, 5, and 8.

RT Simulation Objectives:

Simulate RTs #3, #7 and #12. *(Your RT simulation capacity is determined by the installed 1553 board.)*

Solution:

1. Activate CoPilot.
2. (Optional) Click Configure | Board Setup if you intend to use a different 1553 board than the one listed in the Status bar.
3. Open the TSA window, click RT buttons 3, 7 and 12, then click "OK" to close the TSA window.
4. If the multi-terminal 1553 board is installed, click the Start button  to start the simulation.

(You can examine and change data transmitted and received to these 3 RTs while the bus is running through the Data View windows.)

5. Click the Stop button  when you wish to end the simulation.

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Capturing Bus Traffic

Monitor Default Settings

Unless otherwise specified, when the Bus Monitor is engaged:

- All bus traffic is captured and saved in on-board memory.
- The data capture continues until board memory is full.

The CM1553-1 board can retain approximately 750 messages and the 1553-3 board can hold 3000+ messages.

Bus Monitor Objectives:

Create a sequential record of all traffic on the bus. No filtering.

Solution:

1. Activate CoPilot.
2. (Optional) Click Configure | Board Setup if you intend to use a different 1553 board than the one listed in the Status bar.
3. Click the TSA  button, click the Monitor button, then click "OK" to close the TSA window.
4. If the 1553 board is installed, click the Start button  to initiate the data transfer to the board.
5. Click the Stop button  when you wish to stop the monitor.

(This example assumes you are monitoring a bus in which the Bus Controller and RTs are represented by external terminals or by another 1553 board.)

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Defining a Multi-Terminal Simulation

To illustrate how you might use CoPilot to setup a simulation, let's consider a simple example in which we use a multi-terminal 1553 board to simulate a

- NAV Computer (BC),
- Nav Display (RT #1),
- CtrlHead (RT #2),

to test a real terminal (RT #3 TACAN).

The details of setting up the BC and RT are defined in **Setting up a BC Schedule** and **Setting up an RT Configuration**. The complete configuration is also documented as a demonstration file named "NavComExample.CPC." The monitor file is documented in "NavComMonitor.CPM".

To run the simulation, you must have a multi-terminal 1553-3 board installed.

To define the board:

1. Click **Configure | Board Setup** on the menu bar.
2. (Optional) Click Configure | Board Setup if you intend to use a different multi-terminal board than the one listed in the Status bar.
3. Click OK to close the Board Setup window.

To assign names to RTs:

1. Click **Configure | RT Labels** on the menu bar.
2. Click the text box for RT 1.
3. Then type "Nav Display" (enter) "Control Head" (enter) and "TACAN". *The cursor advances to the next text box when the enter key is pressed.*
4. Click OK to close the RT Label window.

Setting up a BC Schedule

In the schedule of seven commands (referenced below), the three commands associated with RT #2 are sent 20 times each second and the remaining four commands are processed 10 times per second.

Using Frames

The simplest solution is to use two frames. All seven BC commands are included in the first frame. The three BC commands associated with RT #2 are assigned to a second The schedule must be processed 10 times per second but since there are two frames in the schedule, the **frame time** must be set to 20hz.

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General Specifications:

1. Click the  button to open the BC Schedule window.
2. Click the View button until it reads "Label."
3. Click the right-most text box within the frame labeled "Frame-time" and type 20 (Hz).

To define the first frame

1. Click the Edit button to open the **BC Message Editor**.
   - Click in the Name text box, type "TacData".
   - Click the BC→RT option button.
   - Click keys 1, 1, 3 to define RT, SA, and WC.
   - Then click the "Next" button to create a new message.

   Following that pattern add the following BC commands:

"NavBearing"	RT→BC	1, 2, 1,	next
"NavStat"	BC→RT	1, 3, 4,	next
"Bearing"	RT→BC	2, 1, 1,	next
"Frequency"	RT→BC	2, 2, 2,	next
"NavConfig"	BC→RT	2, 3, 4,	next
"TacSet"	BC→RT	3, 1, 2,	OK (to close)

   Seven commands are listed in the schedule under "Frame #1".

The second frame:

Since the three high priority messages already defined above, you can build this frame using standard **Edit** commands.

1. Click the Frame button, type "Control Head (only)", then click OK to close.
2. Click on the "NavStat," message name then click the  copy button.
3. Click "Control Head (only)", then click the  button to paste the "NavStat" message into the "Control Head" frame.
4. Following the pattern of #2 and #3 above, place a copy of "Frequency" and "NavConfig" into this frame.

Default Data Values

Although you could define unique data values through the BC Data Editor for each of the above messages, you can also populate data words through the CoPilot Options window.

1. Selecting CONFIGURE | COPILOT OPTIONS,
2. Then, click the "1,2,3" radio button in the BC Data Initialization frame and "Cmd(hex)" under RT Data Initialization.
3. Then, click "OK" to close the Options window

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Setting up an RT Configuration

To define the "NavDisplay" and "ControlHead" terminals:

1. Click  on the toolbar to open the RT Configure window.
2. Click on the down arrow in the text box adjacent to "RT Address" and click on "RT 1 NavDisplay".
3. Click the "SA Tx" tab then click the "BC Sched" button. *Transmit subaddress #2 is enabled since it is referenced in the BC Schedule. All other subaddresses are illegalized.*
4. Click subaddress SA 2 then click the "Data Edit" button. The **RT Data Editor** window will appear.
5. Type "123" in the first cell, then click "OK" to close the Data Editor.
6. You could at this point repeat steps 2 through 5 for the "Control Head" terminal. Instead click the "OK" button to close the RT Configuration window. *All transmit and receive subaddresses are legalized and the transmit data is defined the data rules selected through the CoPilot Options window.*

Running a Multi-Mode Simulation

To run the NavCom Example:

1. Click the  button to open the **TSA window**.
2. Click the BC, RT#1, and RT#2 buttons, then click OK to close.
3. To start the simulation, click the  button.

You may view and change data while the bus is running through the **Message View** windows.

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Glossary of Terms

Base Address
The beginning address of a 4096 byte space in host segment memory reserved for the Ballard 1553 board.

Bit Count Error
A word error in which the named MIL-STD-1553 word is not defined by 20 bits. When invoking a Bit Count Error, you can increase or decrease the word length by one, two or three bits.

Broadcast RT31
The Broadcast RT31 menu item allows you to declare whether or not RT 31 is reserved for broadcast messages. Broadcast mode codes 0, 2, 16, 18 and 19 are not allowable under 1553B, Notice 2.

Capture Filters
Capture Filters define which RT / Subaddress Messages are eligible for inclusion in the Monitor record. The may be defined from an RT / Subaddress menu or (if the Bus Controller is also being simulated on the same 1553 board) from a list of Bus Controller messages.

Concurrent Monitoring
Concurrent Monitoring is the ability to actively monitor a 1553 databus at the same time the board is simulating a Bus Controller and one or more Remote Terminals.

CPC file
The CoPilot file in which user defined configuration data is saved. This file carries an extension of .CPC.

Gap Error
An illegal gap between data words. You may insert a gap or 3 or 4 microseconds in front of the named data word.

Host System Registry
The host system file in which multi-session initialization data are preserved. This same Host System Registry often includes the names of recently used CoPilot configuration or monitor files.

I/O Memory Address
The beginning address of an 8 byte space reserved in the host I/O address space for the Ballard 1553 board.

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