LAUTERBACH
DEVELOPMENT TOOLS

Training Simulator and Demo Software

MANUAL

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Version 06-Jun-2024

About the Demo

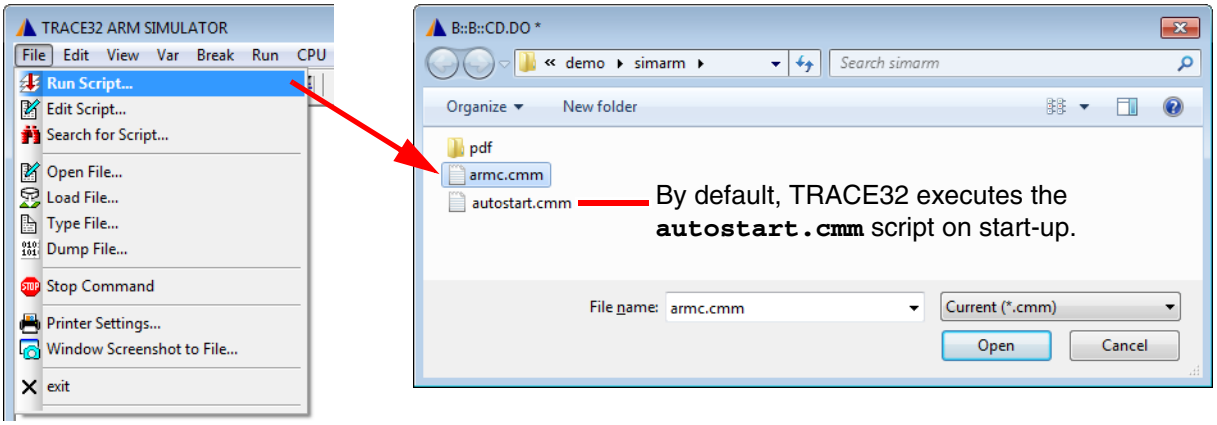
What is this? This is a guided tour through TRACE32 - a tutorial. We use a simple program example in C to illustrate the most important debug features, and give lots of helpful tips & tricks for everyday use.
How long does this tutorial take? 0.5 to 1 hrs.

How can I learn most from this tutorial? Work completely through all chapters in sequence and then do the quiz at the end.
Where can I download the TRACE32 Simulator for the hands-on debug session? From: **https://www.lauterbach.com/download.html**. You do not need any hardware for this tutorial.

Starting the TRACE32 Simulator

1. Unzip the downloaded file. You do not need to install the TRACE32 Simulator.
2. Double-click the `t32m<architecture>.exe` file (e.g. `t32marm.exe`) to start the demo debug session. When the TRACE32 Instruction Set Simulator starts, a start-up PRACTICE script that sets up a debug session is automatically executed.

You can manually execute the same start-up PRACTICE script by choosing **File** menu > **Run Script**.



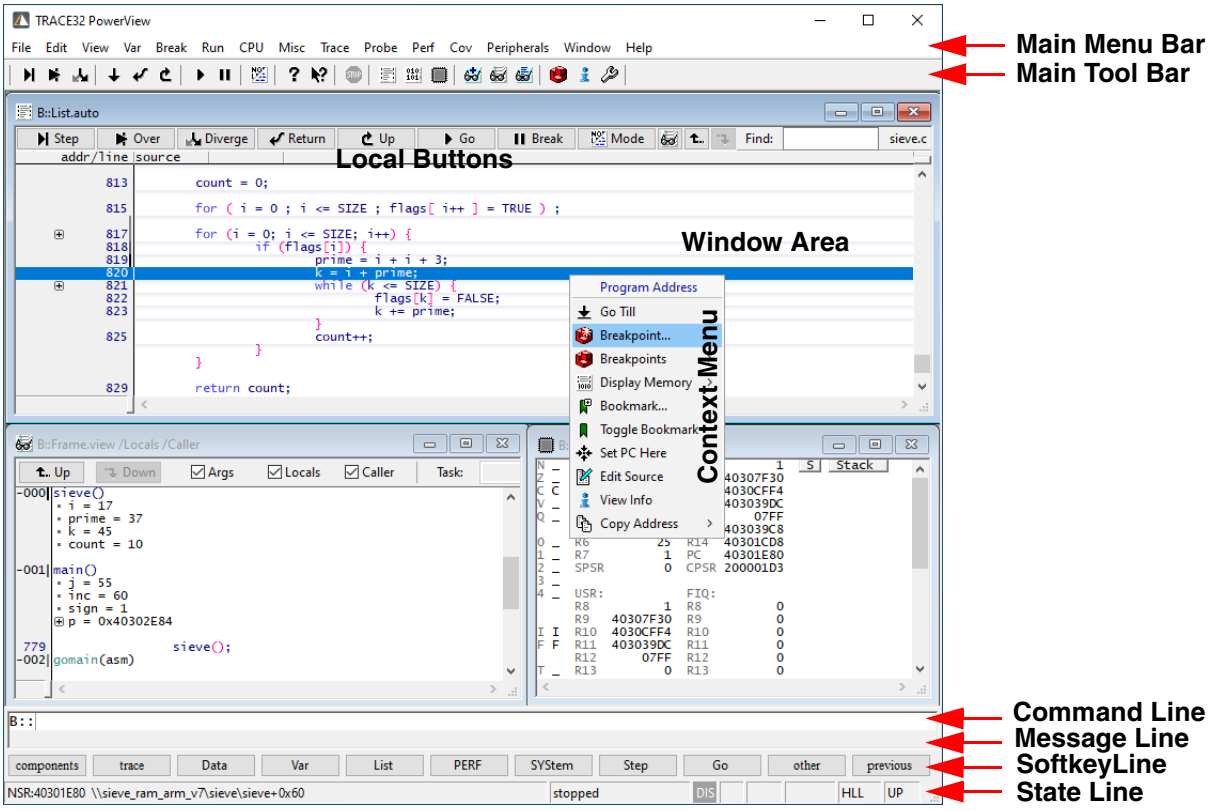
PRACTICE, the Lauterbach script language, is used for automating tests, configuring the TRACE32 PowerView GUI and your debug environment.

For our demo debug session, the PRACTICE start-up script **armc.cmm** loads the application program **armle.axf** and generates a TRACE32 internal symbol database out of the loaded information.

User Interface - TRACE32 PowerView

The graphical user interface (GUI) of TRACE32 is called TRACE32 PowerView.

The following screenshot presents the main components of this interface.

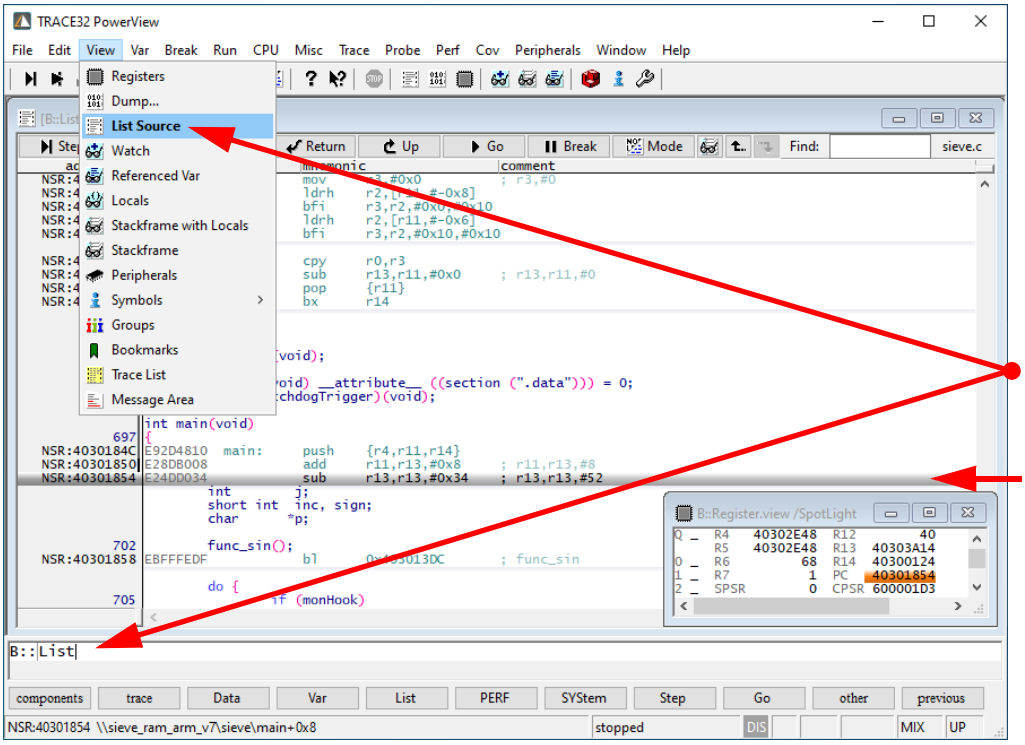


We'll briefly explain the GUI using the **List** command and **List** window as an example. For a more comprehensive introduction, a video tutorial about the TRACE32 PowerView GUI is available here: **support.lauterbach.com/kb/articles/introduction-to-trace32-gui**

To open the **List** window, do one of the following:

- Choose **View** > **List Source from the menu**
- At the TRACE32 command line, type: **`List`** (or **`L`**)

The **List** window displays the code in both assembler mnemonic and HLL (High-Level Language). HLL refers to the programming language of your source code, e.g. C or C++.



In the **List** window, the gray bar indicates the position of the program counter (PC). In the screenshot above, it is located at the symbolic address of the label **`main`**.

A video tutorial about the source code display in TRACE32 is available here:
support.lauterbach.com/kb/articles/displaying-the-source-code

To summarize, you can execute commands in TRACE32 PowerView using the following methods:

1. Menus on the menu bar
2. Buttons on the main toolbar and the buttons on the toolbars of TRACE32 windows
3. Context menus in TRACE32 windows
4. Using commands via the TRACE32 command line.

TRACE32 commands are **not** case sensitive: **`register.view`** is the same as **`Register.view`**

- UPPER CASE letters indicate the short forms of commands and must not be omitted.
- All lower case letters can be omitted.

This makes short forms an efficient time saver when entering frequently-used commands in the command line.

Examples:

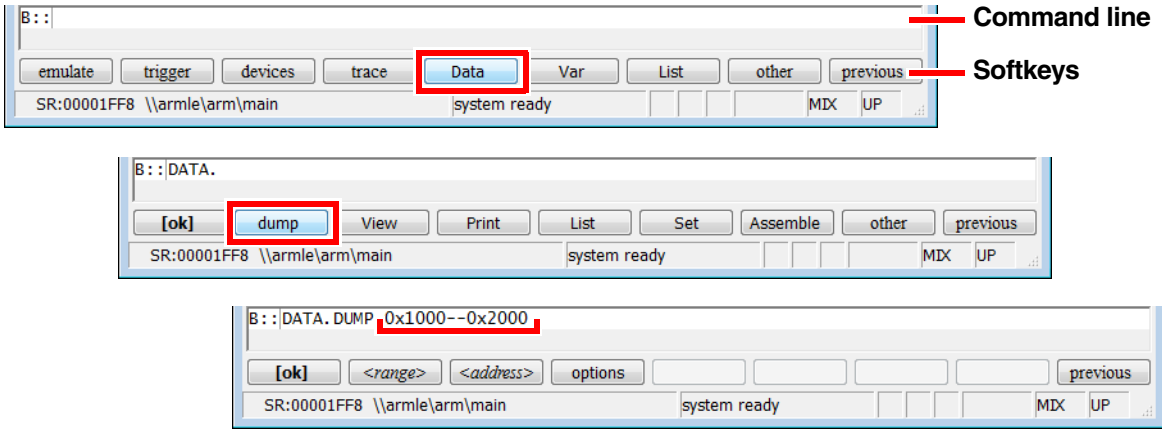
- Instead of the long form **`Register.view`** type just the short form **`r`** or **`R`**
- Instead of the long form **`List`** type just the short form **`l`** or **`L`**

The softkeys are located below the command line. The camel casing (i.e. upper and lower case letters) on any softkey indicates the long form of a command. The softkeys guide you through the command input, displaying all possible commands and parameters.

Example - To assemble the Data.dump command using the softkeys:

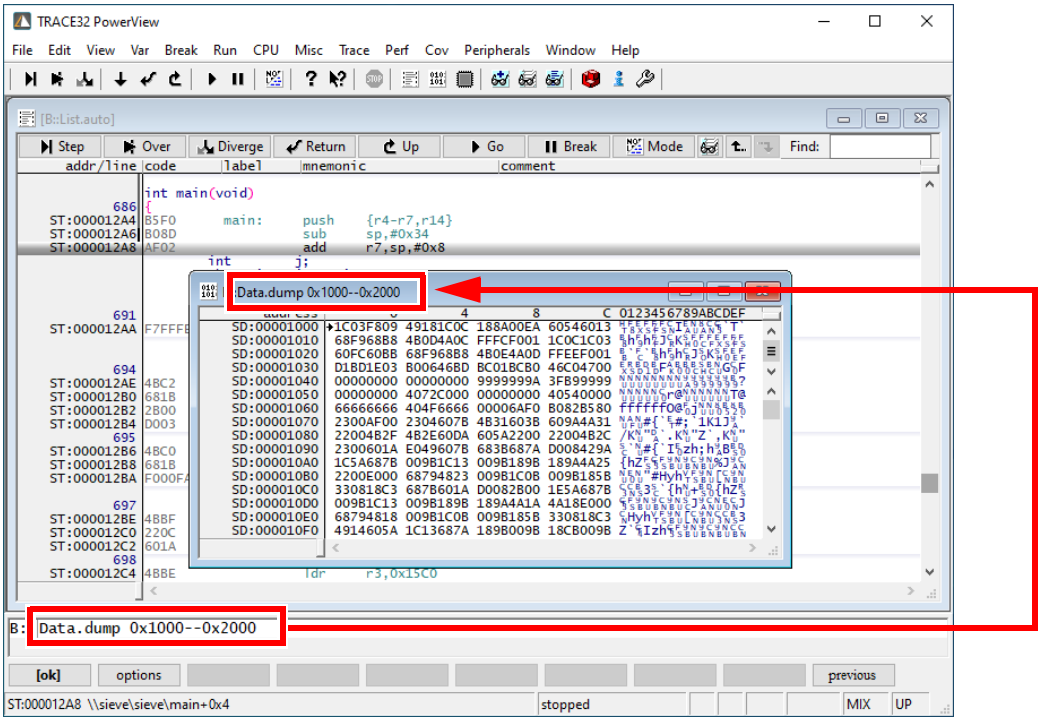
1. Click **Data**.
2. Click **dump**.
3. Type the *<range>* or *<address>* you want to dump. For example, **`0x1000--0x2000`**
4. Click **[ok]** to execute the command.

The **Data.dump** window will open.



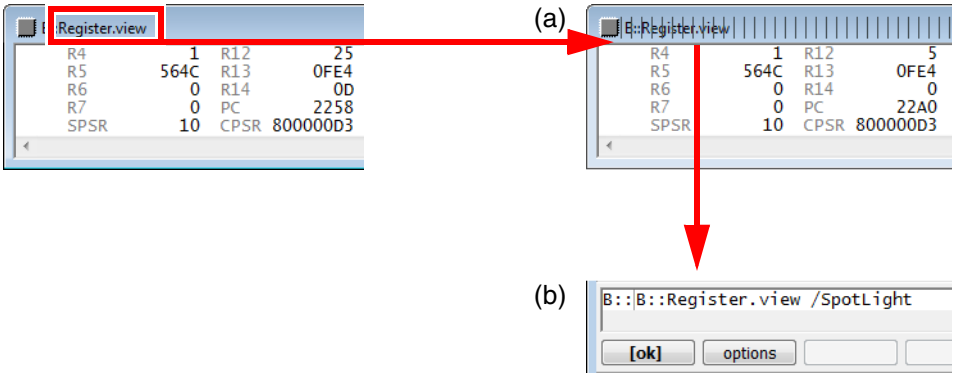
Window Captions - What Makes Them Special in TRACE32?

The command used to open a window is displayed in the window caption, along with any parameters and options used.



You can **re-**insert a command from a window caption (a) into the command line (b) in order to modify the command. Let's do this with the **Register** window.

1. Choose **View** > **Register** from the menu.
2. Right-click the window caption (a).
3. Modify the command, e.g. by adding the **`/SpotLight`** option: This will highlight changed registers.



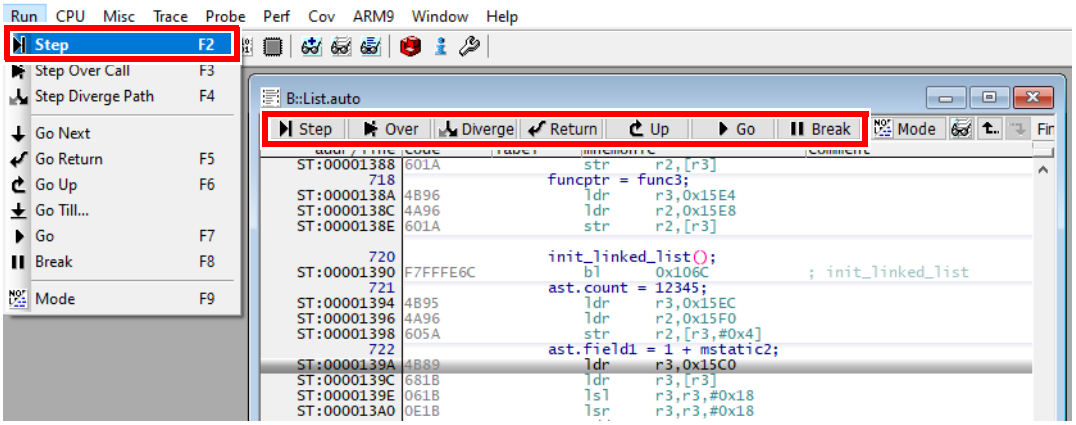
4. Click **[ok]** to execute the modified command.
5. Click **Single Step** on the TRACE32 toolbar. Changed registers are highlighted immediately.

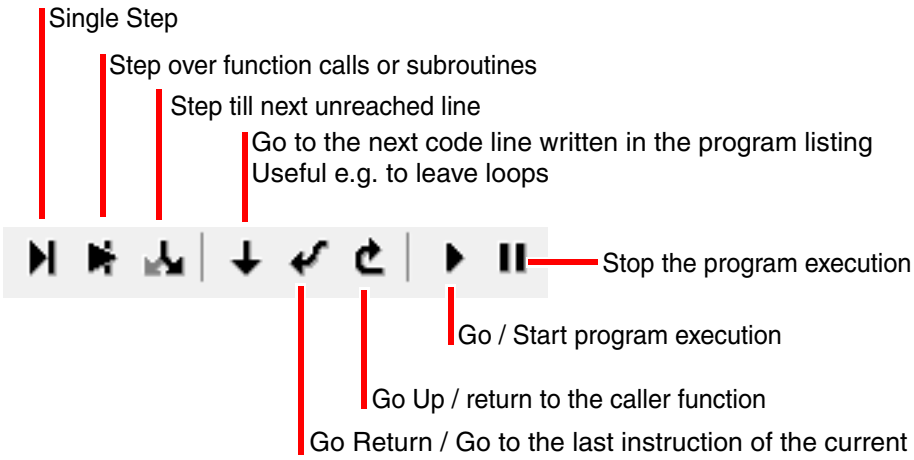
Basic Debug Commands

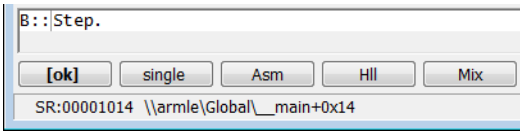
The basic debug commands are accessible from:

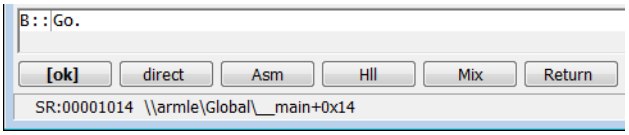
- the **Run** menu
- the toolbar of the **List** window
- the main toolbar
- the TRACE32 command line.

Single stepping is one of these fundamental debug commands.









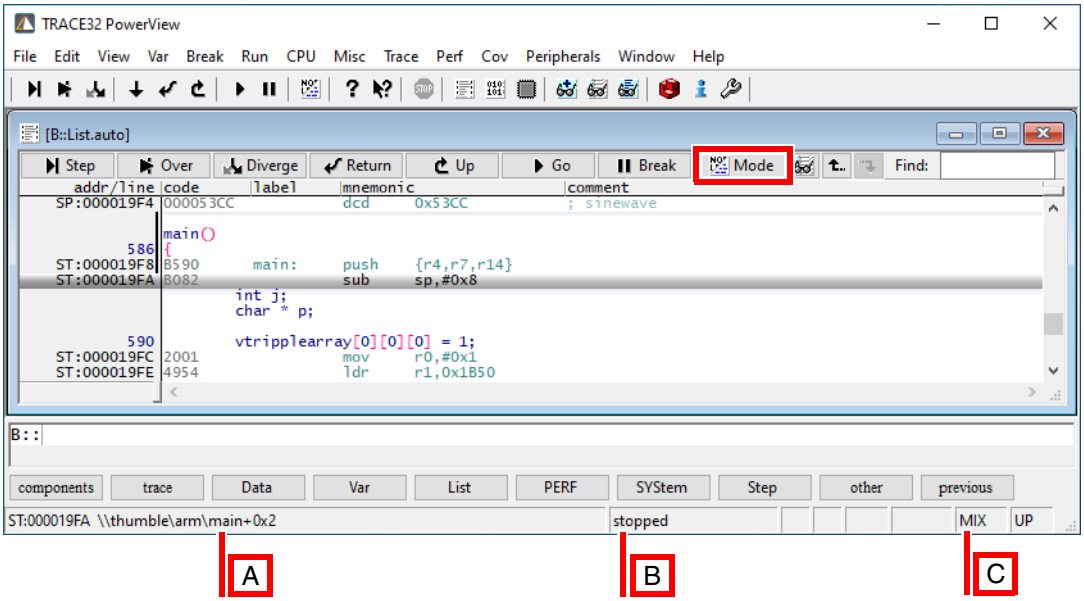
TRACE32 PowerView also offers more complex debug control commands. For example, you can step until an expression changes or becomes true.

Example:

```
Var.Step.Till i>11.          ; single-steps the program until the
                             ; variable i becomes greater than 11.
                             ; Please note that TRACE32 uses a dot to
                             ; denote decimal numbers.
```

Debug Modes

Take a look at the state line at the bottom of the TRACE32 PowerView main window:



The state line provides the following information

A The (symbolic) address of the current cursor position.
The program counter (PC) is highlighted in gray.

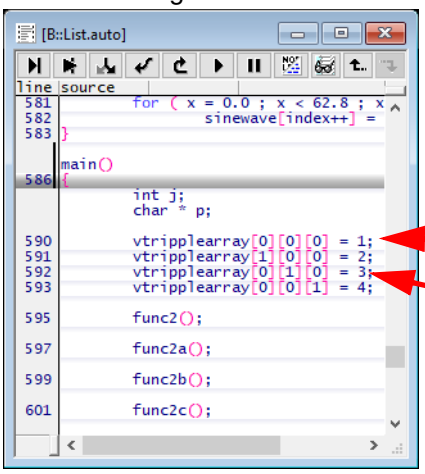
B The state of the debugger: **stopped** indicates that the program execution is stopped. At this point, you can inspect or modify memory, for example.

C The state line displays the currently selected debug mode, which can be:

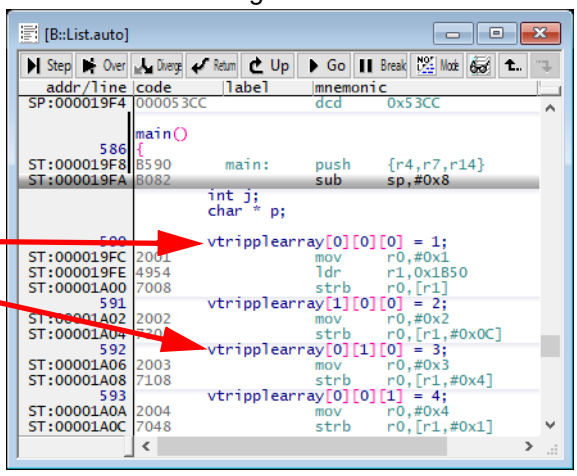
- **HLL** (High Level Language)
- **ASM** (assembler)
- **MIX**ed mode showing both HLL and its corresponding assembler mnemonic.

1. On the toolbar of the **List** window, click Mode **Mode** to toggle the debug mode to **HLL**.

Debug mode HLL



Debug mode MIX

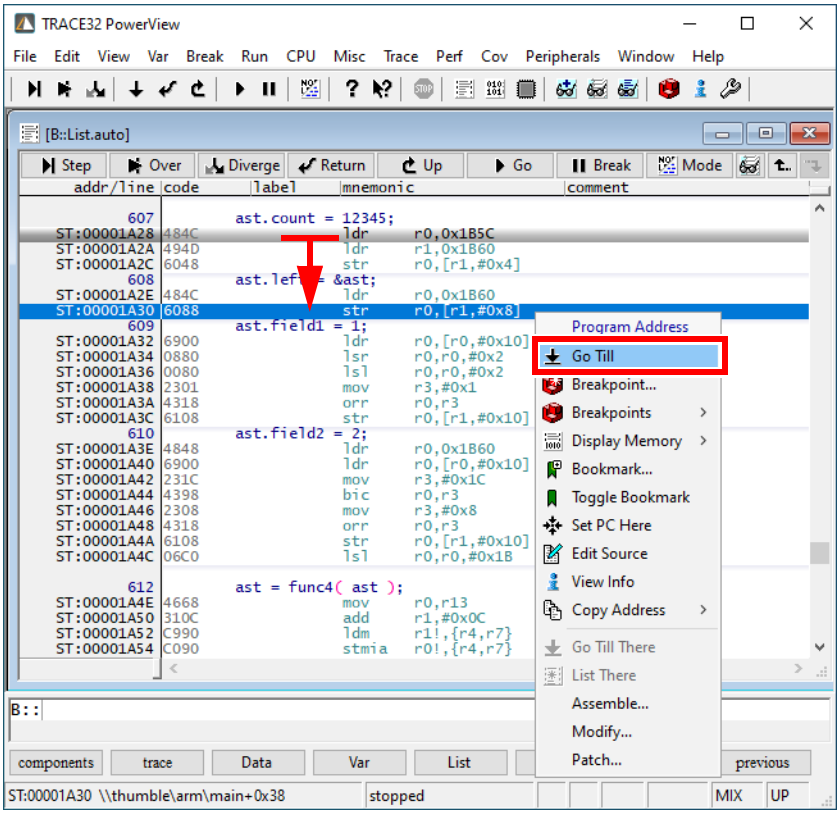


2. Click Step **Step**.
In HLL mode, this action moves the program execution to the next source code line.

3. Click Mode **Mode** again to toggle the debug mode to **MIX**.

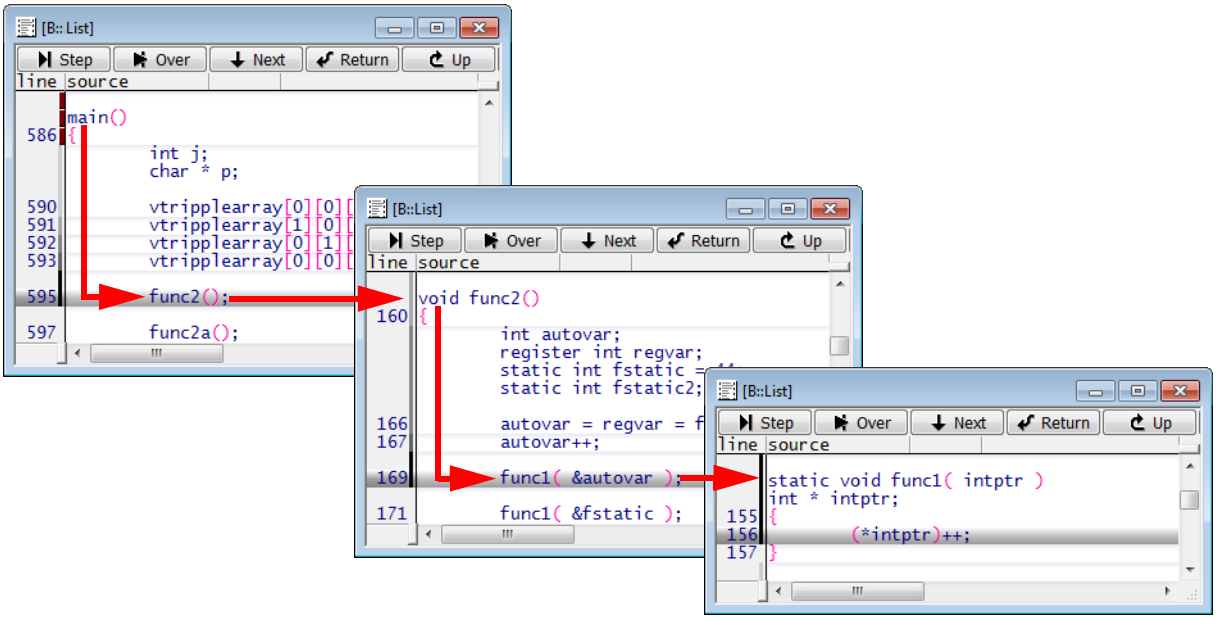
4. Click Step **Step**.
This time, the step executes one assembler instruction.

5. Right-click a code line, then select **Go Till**.
Program execution starts, and stops when the program reaches the selected code line.



Displaying the Stack Frame

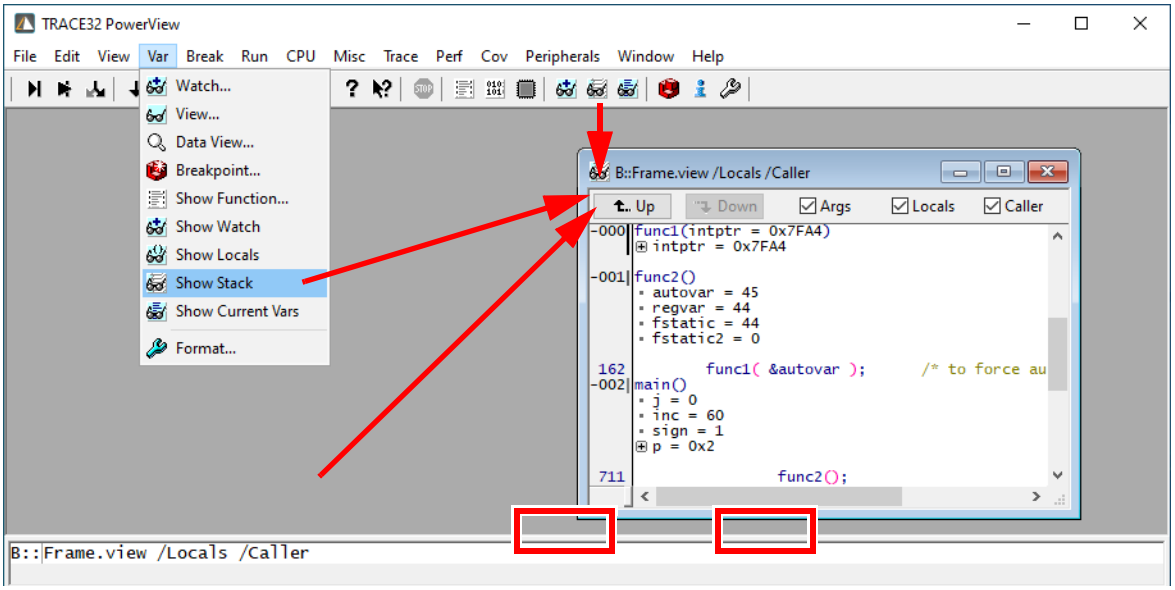
For the next example, we will assume that we have the following call hierarchy: **`main()`** calls **`func2()`** and **`func2()`** calls **`func1()`**:



Select **Show Stack** in the **Var** menu. This will open the **Frame.view** window, displaying the call hierarchy.

The **/Locals** option displays the local variables of each function, while the **/Caller** option shows a few source code lines to indicate where the function was called.

This screenshot corresponds to the calling hierarchy described above.



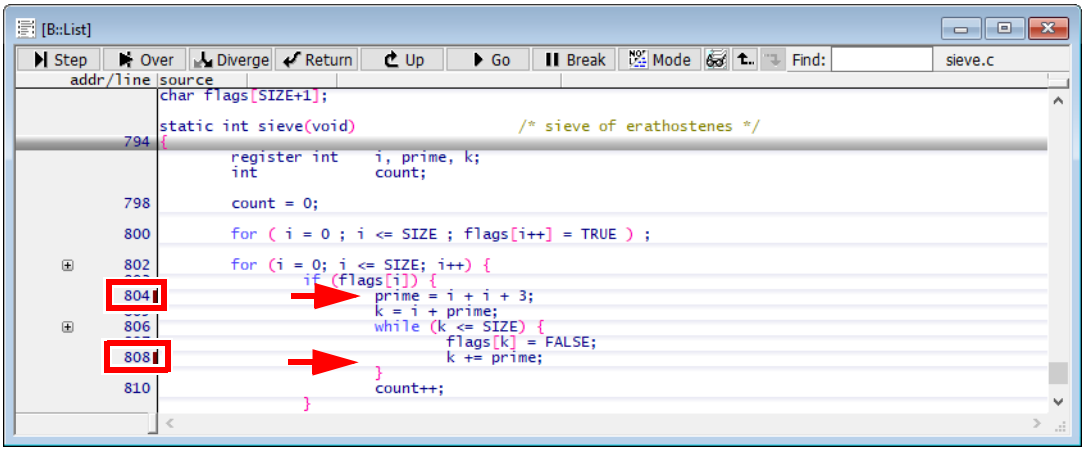
Breakpoints

Video tutorials about breakpoints in TRACE32 PowerView are available here:
support.lauterbach.com/kb/articles/using-breakpoints-in-trace32

Setting Breakpoints

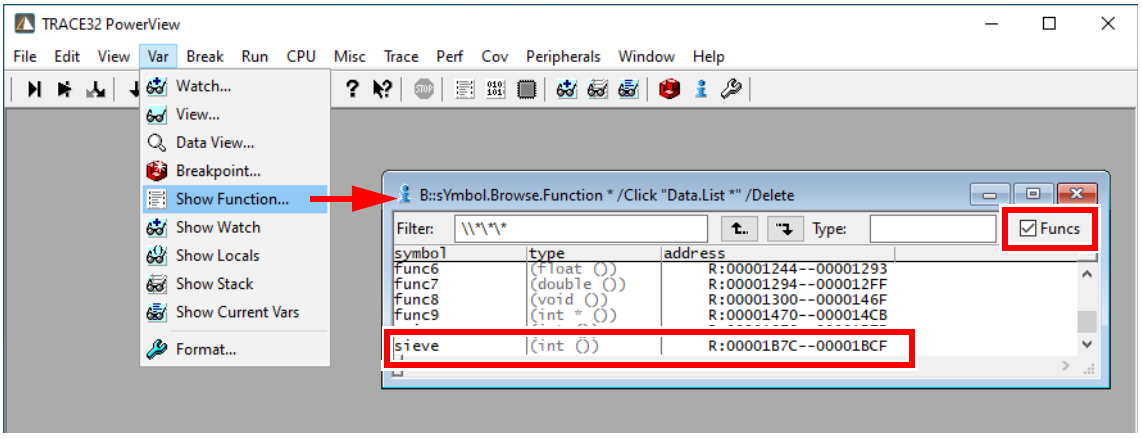
Let's set a breakpoint at the instruction **`prime = i + i + 3`** and the instruction **`k += prime`**

To set a program breakpoint, double-click a code line where you want to set the breakpoint. Ensure to click the white space in the code line, and not the code literal. All code lines with a program breakpoint are marked with a red vertical bar.



To set a breakpoint to an instruction that is not in the focus of the current source listing:

1. Choose **Var** > **Show Function** from the menu.
   The **sYmbol.Browse.Function** window opens.

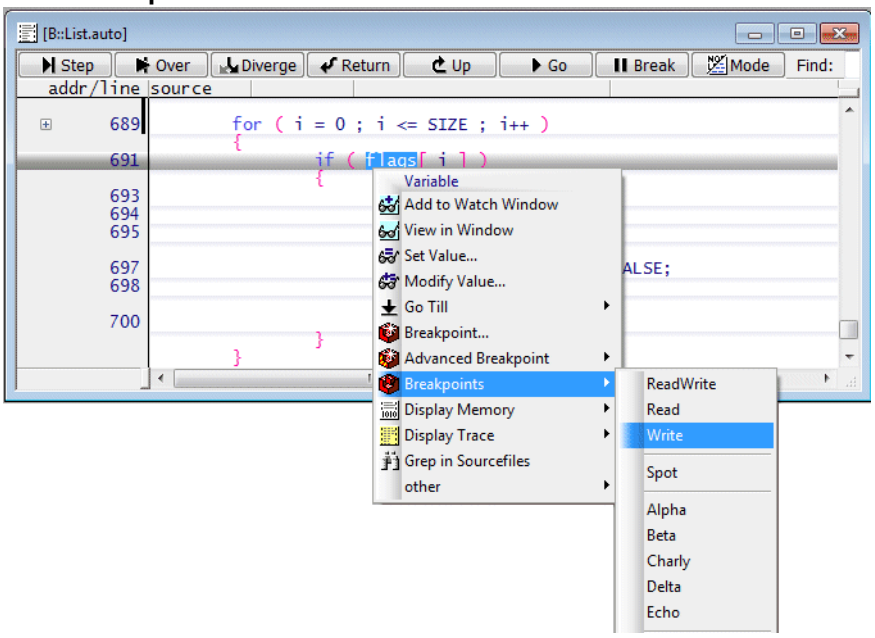


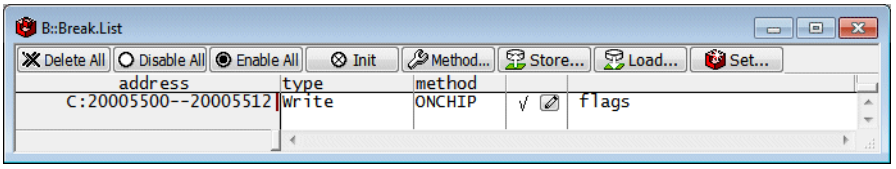
2. Select the function you are interested in, for example **`sieve`**.
   The **List** window will open, displaying this function. This window is now fixed to the start address of the function sieve and does not move with the program counter cursor.

Setting Read/Write Breakpoints

You can set a breakpoint that halts the program execution at a read or write access to a memory location, such as global variable.

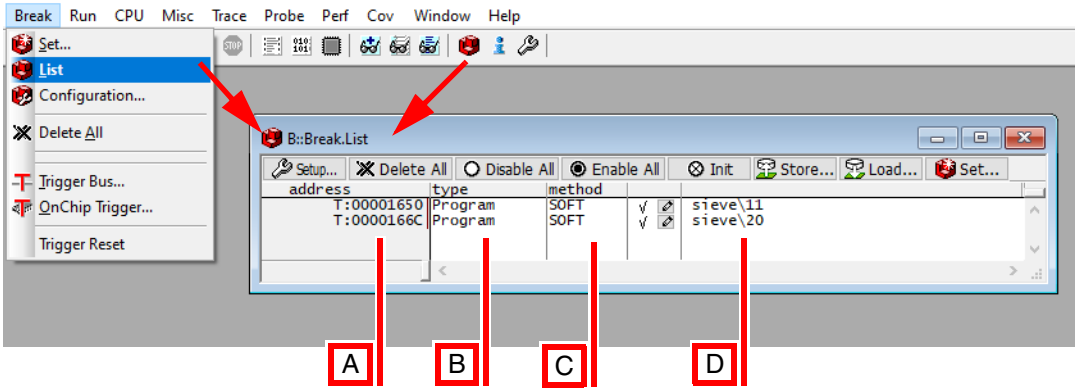
To set a breakpoint on the array **`flags`**, for instance, right-click on the array name in the **List** window then select **Breakpoints > Write**.





Listing all Breakpoints

1. Choose **Break** > **List** from the menu to list all breakpoints.
   The **Break.List** window opens, providing an overview of the set breakpoints.



A Address of the breakpoint.

B Breakpoint type, for example Program, Read, Write

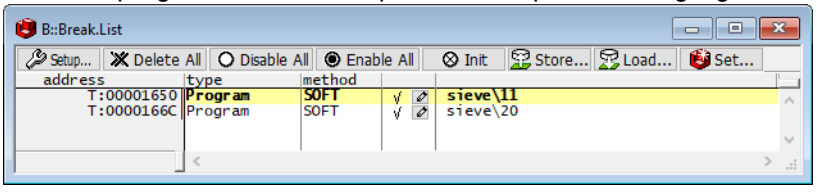
C Breakpoint method: SOFTware, ONCHIP or DISABLED.

D Symbolic address of the breakpoint. Example:

- **`sieve\11`** means source code line 11 in function **`sieve`**.

2. On the toolbar, click **Go** to start the program execution.

3. When the program execution stops at a breakpoint, it is highlighted in the **Break.List** window.



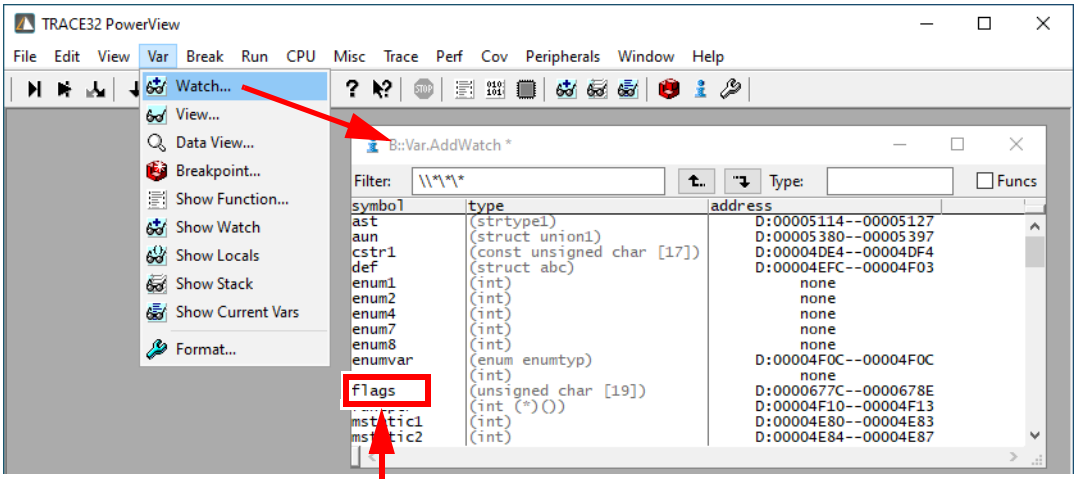
Variables

Video tutorials about variable display in TRACE32 are available here:
support.lauterbach.com/kb/articles/variable-logging-and-monitoring-in-trace32

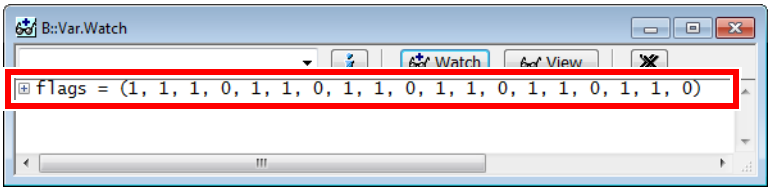
Displaying Variables

Let's display the variables **flags**, **def**, and **ast**.

1. Choose **Var** > **Watch... from the menu.**
   The **Var.AddWatch** window will open, displaying the variables known to the symbol database.

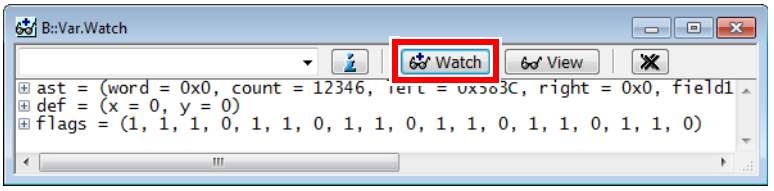


2. Double-click the variable **flags**.
   The **Var.Watch** window will open, displaying the selected variable.



3. **Alternative steps:**

   - In the **Var.Watch** window, click Watch **Watch**, and then double-click the variables **def** and **ast** to add them to the **Var.Watch** window.



   - From a **List** window, drag and drop any variable you want into the **Var.Watch** window.
   - In a **List** window, right-click any variable, and then select **Add to Watch window** from the context menu.

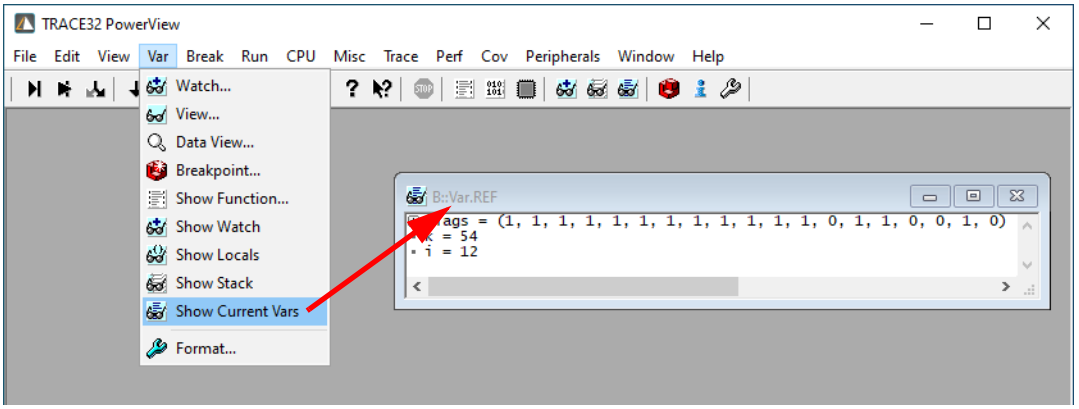
- If you want to display a more complex structure or an array in a separate window, select the menu **Var** > **View**.

Displaying Variables of the Current Program Context

1. Set the program counter (PC) to the function **`sieve()`** by typing the following at the TRACE32 command line:

```
Register.Set PC sieve
```

2. Select the menu **Var** > **Show Current Vars**.
The **Var.REF** window opens, displaying all variables accessed by the current program context.



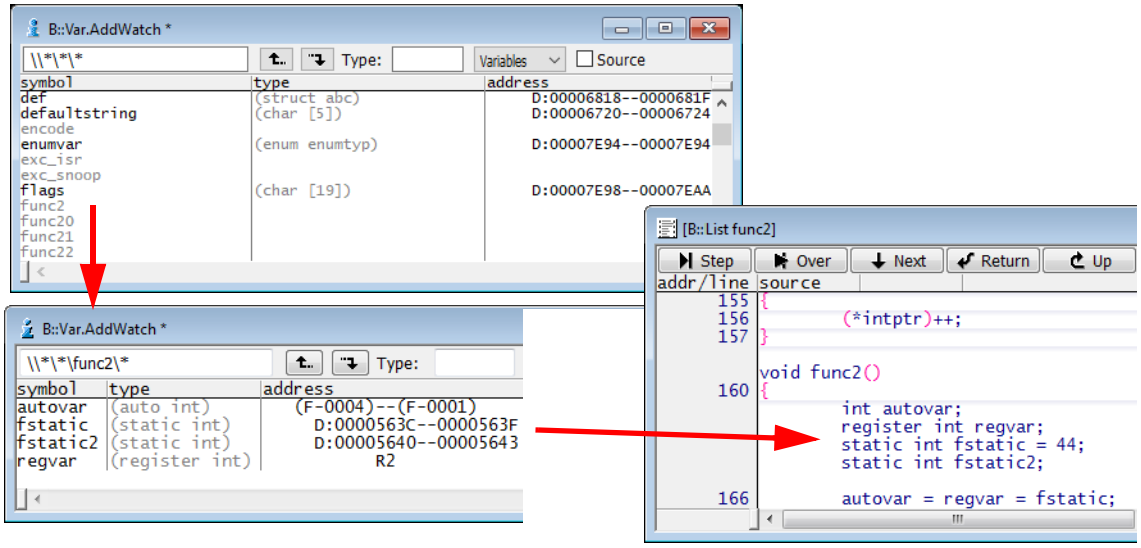
3. Click **Step** on the TRACE32 PowerView toolbar to execute a few single steps.
The **Var.REF** window is updated automatically.

Using the Symbol Browser

The symbol browser offers an overview of the variables, functions, and modules currently stored in the symbol database.

1. Select **Var** from the menu, then choose **Watch...**
The **Var.AddWatch** window will open, allowing you to browse through the contents of the symbol database. Global variables are displayed in black and functions in gray. Double-clicking a function will display its local variables are displayed.

2. In the **Var.AddWatch** window, double-click **`func2`**.



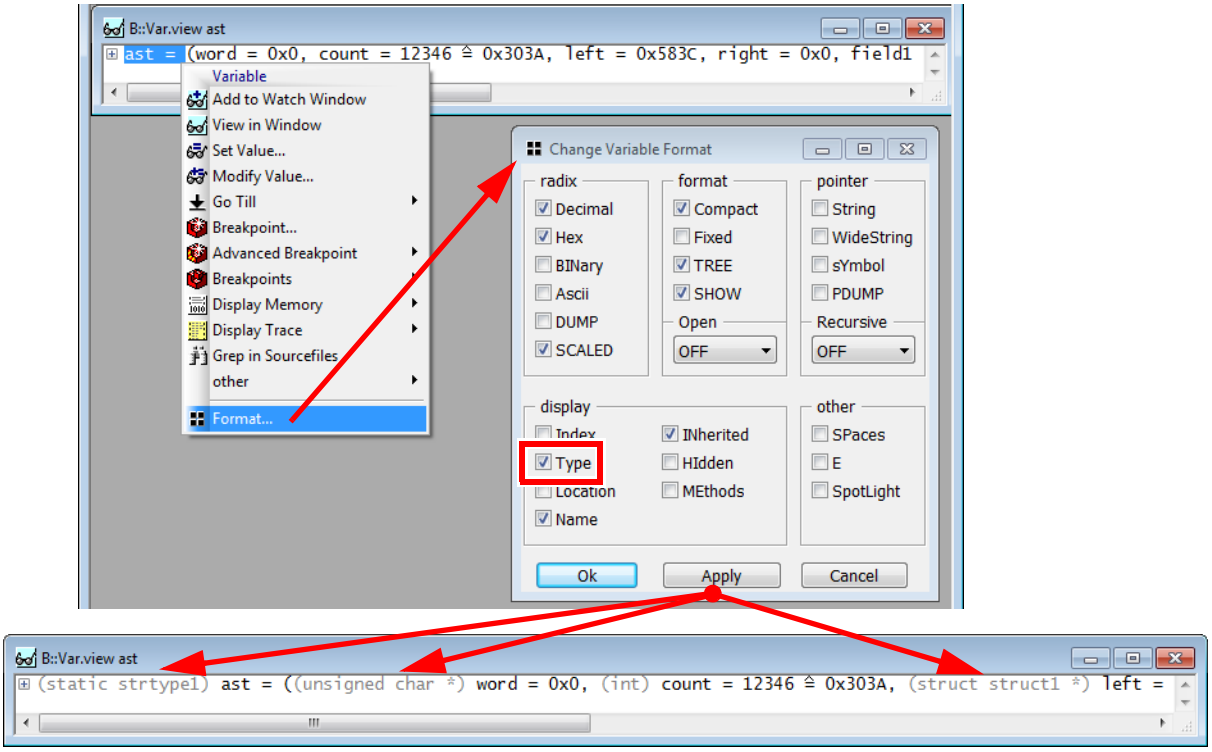
Formatting Variables

To format the display of variables with global settings:

1. Choose **Var** from the menu, then select **Format**.
2. In the **SETUP.Var** window, configure your settings. TRACE32 applies your settings to all **Var.view** windows that you open *afterwards*.

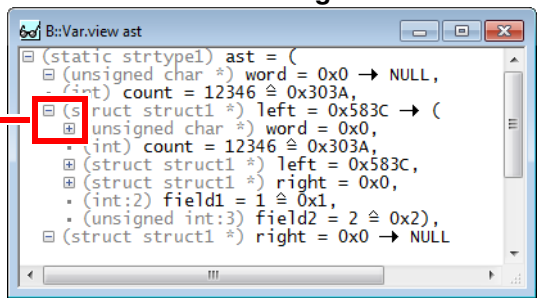
To format the display of an individual variable:

1. At the command line, type: **`Var.view ast`** (The variable **`ast`** is included in this demo.)
2. In the **Var.view** window, right-click **`ast`**, and then click **Format**.
   The **Change Variable Format** dialog opens.
3. Select the **Type** check box to display the variable **`ast`** with the complete type information.
4. Click **Apply**. The format of **`ast`** in the **Var.view** window is updated immediately.



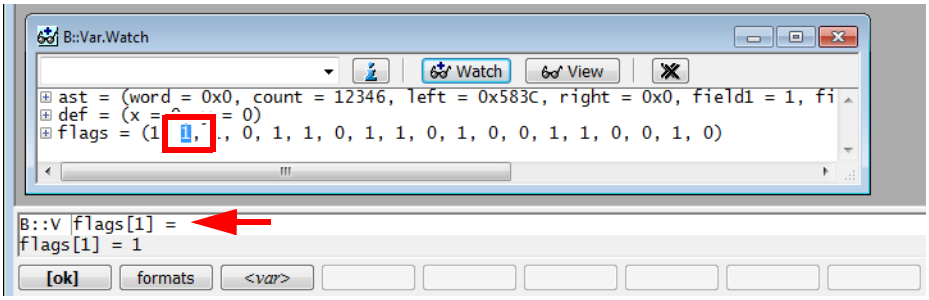
5. For more complex variable select **TREE** in the **Change Variable Format** dialog box.

Click **+** and **-** to expand and collapse the tree.



Modifying Variables

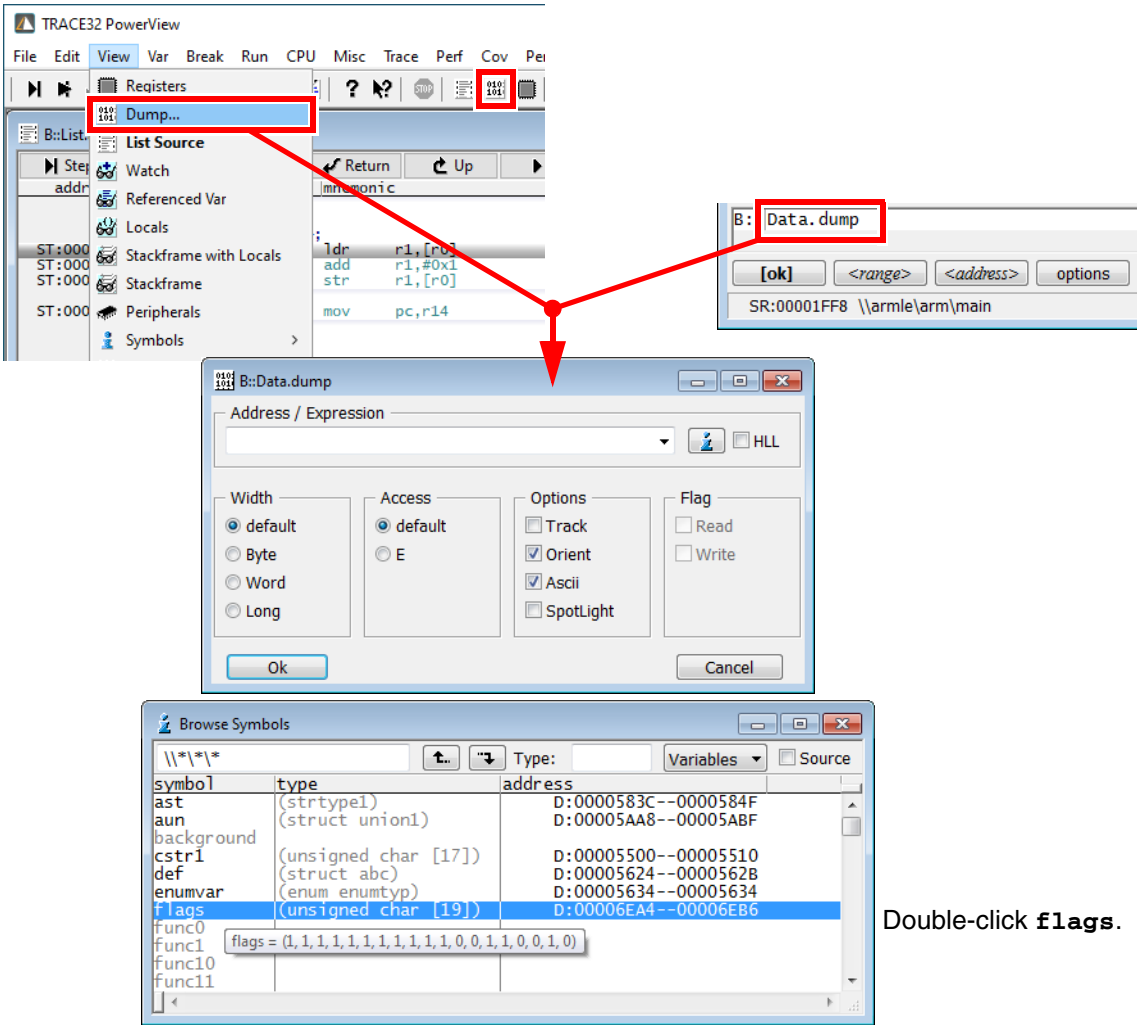
1. Double-click the variable value to modify the value. The **Var.set** command will be displayed in the command line. The short form of the command is **`V`** or **`v`**



2. Enter the new value directly after the equal sign and confirm with **[ok]**.

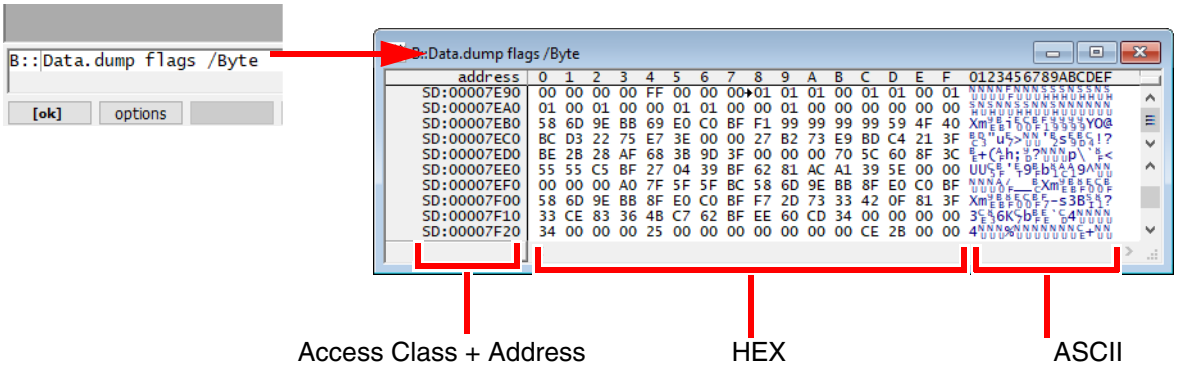
Displaying Memory

1. To display a memory dump in a **Data.dump** window, do one of the following:
   - Choose **View** from the menu then select **Dump**,
   - Click **Memory Dump** on the toolbar,
   - Type: **`Data.dump`** in the TRACE32 command line. You can also specify an address or symbol directly, e.g.: **`Data.dump flags`**
2. In the **Data.dump** dialog, enter the data item, e.g. **`flags`**
   - Alternatively click to browse through the symbol database.
3. In the **Browse Symbols** window, double-click the symbol **`flags`** to select it, and then click **OK**.



Double-click **`flags`**.

In the following screenshot, the **Data.dump** window is called via the TRACE32 command line.



There are different ways to define an address range:

- *<start_address>--<end_address>* (SD is an access class)

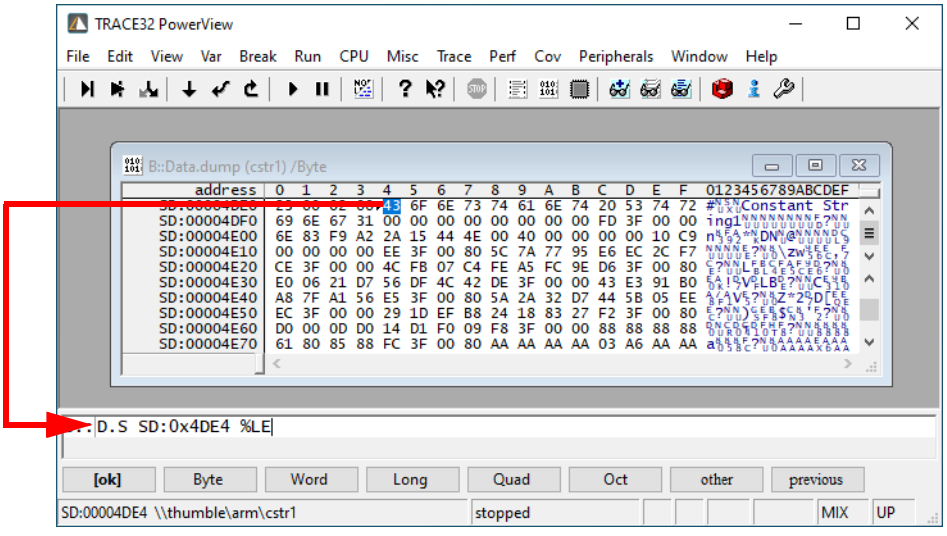
```
Data.dump SD:0x5530--SD:0x554F
```

- *<start_address>++<offset>*

```
Data.dump cstr1++0x1f /Byte ;start at cstr1 plus the next 0x1f bytes
```

Modifying Memory

1. In a **Data.dump** window, double-click the value you want to modify.
   A **Data.Set** command for the selected address is displayed in the command line. The short form of the command is **`D.S`** or **`d.s`**



2. Enter the new value directly after **%LE**, and then confirm with **[ok]**.
   (**%LE** stands for Little Endian).

Peripheral View

TRACE32 supports a freely configurable window for displaying and manipulating configuration registers and on-chip peripheral registers at a logical level. Predefined peripheral files are available for most standard processors/chips.

You can open the peripheral register view in the TRACE32 by selection the **CPU** menu, then **Peripherals**, or by using the command **PER.view** in the TRACE32 command line.

PER.view	Display peripheral registers