

# Application Note for Trace.DRAW

MANUAL

# Application Note for Trace.DRAW

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## Introduction

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Many Embedded devices feature some kind of trace port. The most prevalent are those that provide branch trace, which is sufficient to reconstruct program flow. Some, more complete, trace interfaces can also provide data trace - the means to track a value changing over time. This application note is designed to help the reader understand the ways that data values can be captured, analyzed, displayed and exported.

The examples shown in this document use the target's off-chip trace. The techniques described here are equally applicable to an onchip trace and TRACE32 'pseudo-trace' methods such as FDX, SNOOPer, LOGGER, etc. where data is logged by the user. This also includes ITM software generated trace from Cortex-M devices. This document will not detail how to configure the target trace port; that is covered in more detail elsewhere.

## Intended Audience

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Developers who want to:

- Monitor variable values non-intrusively
- Analyze, draw or chart the value of a variable as it changes over time
- Export these data values for analysis by external tools

## Prerequisites

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It is assumed that TRACE32 has been correctly configured for the target and the symbols for the application under test have been loaded. The trace port must also be configured to provide data trace and TRACE32 must be able to collect this data. The reader should also be familiar with programming embedded systems.

## Related Documents

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Trace covers a wide range of processors and technologies. The documents listed below contain more information on configuring, collecting and analyzing trace data with TRACE32. This is by no means an exhaustive list.

[“MicroTrace for Cortex-M User’s Guide”](#) (microtrace\_cortexm.pdf)

[\*\*“Training Cortex-M Tracing”\*\*](#) (training\_cortexm\_etm.pdf)

[\*\*“Training Arm CoreSight ETM Tracing”\*\*](#) (training\_arm\_etm.pdf)

[\*\*“Training Nexus Tracing”\*\*](#) (training\_nexus.pdf)

[\*\*“MCDS User’s Guide”\*\*](#) (mcds\_user.pdf)

[\*\*“Training AURIX Tracing”\*\*](#) (training\_aurix\_trace.pdf)

[\*\*“Application Note for the SNOOPer Trace”\*\*](#) (app\_snooper.pdf)

[\*\*“Application Note for Trace.Find”\*\*](#) (app\_trace\_find.pdf)

[\*\*“Trace”\*\*](#) in General Commands Reference Guide T, page 117 (general\_ref\_t.pdf)

Please also check the [\*\*Processor Architecture Manual\*\*](#) for your selected processor.

## Restrictions

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Some devices only provide small on-chip trace buffers for storing collected trace data; these are seldom sufficient for managing and analyzing trace data.

## Trace Licenses

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A trace pre-processor or a TRACE32 PowerTrace Serial module suitable for the target architecture is required for off-chip trace collection. On-chip trace collection can be performed via the debug interface and an appropriate license in the debug cable is required for this.

The ‘pseudo-trace’ methods such as FDX, SNOOPer, LOGGER, etc. do not require any trace licenses.

# Data Capture

## Full Trace

Not all targets with a trace port support data trace. Please refer to the target guides for your processor for more details.

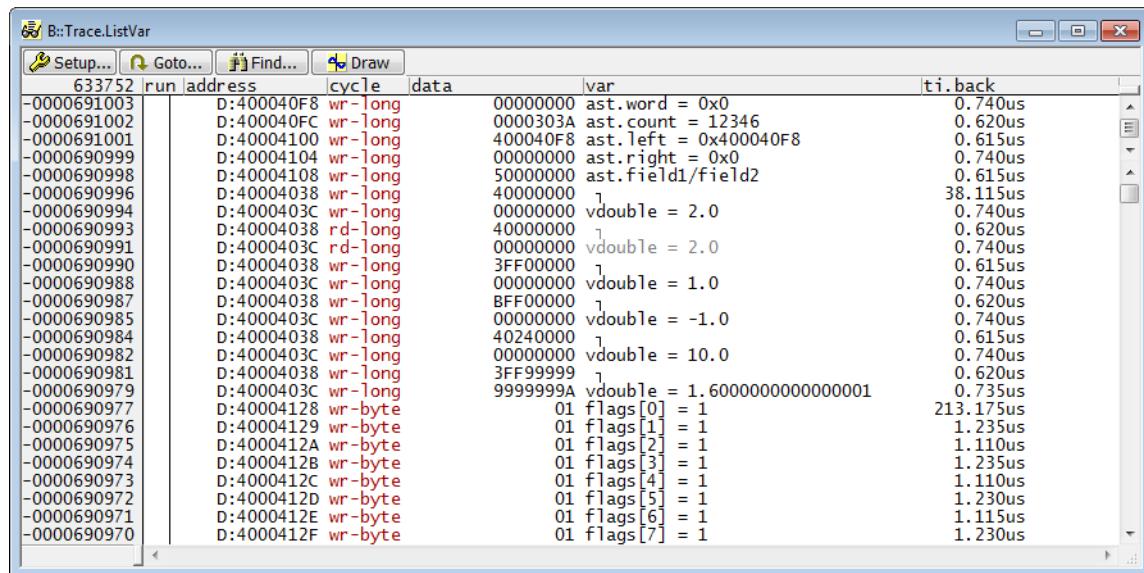
The image below shows a typical list of all reads and writes captured via the trace port.

record	run	address	cycle	data	symbol	ti.back
-0000691003		D:400040F8	wr-long	00000000	\\diabc\Global\ast	0.740us
-0000691002		D:400040FC	wr-long	0000303A	\\diabc\Global\ast+0x4	0.620us
-0000691001		D:40004100	wr-long	400040F8	\\diabc\Global\ast+0x8	0.615us
-0000690999		D:40004104	wr-long	00000000	\\diabc\Global\ast+0x0C	0.740us
-0000690998		D:40004108	wr-long	50000000	\\diabc\Global\ast+0x10	0.615us
-0000690996		D:40004038	wr-long	40000000	\\diabc\Global\double	38.115us
-0000690994		D:4000403C	wr-long	00000000	\\diabc\Global\double+0x4	0.740us
-0000690993		D:40004038	rd-long	40000000	\\diabc\Global\double	0.620us
-0000690991		D:4000403C	rd-long	00000000	\\diabc\Global\double+0x4	0.740us
-0000690990		D:40004038	wr-long	3FF00000	\\diabc\Global\double	0.615us
-0000690988		D:4000403C	wr-long	00000000	\\diabc\Global\double+0x4	0.740us
-0000690987		D:40004038	wr-long	BFF00000	\\diabc\Global\double	0.620us
-0000690985		D:4000403C	wr-long	00000000	\\diabc\Global\double+0x4	0.740us
-0000690984		D:40004038	wr-long	40240000	\\diabc\Global\double	0.615us
-0000690982		D:4000403C	wr-long	00000000	\\diabc\Global\double+0x4	0.740us
-0000690981		D:40004038	wr-long	3FF99999	\\diabc\Global\double	0.620us
-0000690979		D:4000403C	wr-long	9999999A	\\diabc\Global\double+0x4	0.735us
-0000690977		D:40004128	wr-byte	01	\\diabc\Global\flags	213.175us
-0000690976		D:40004129	wr-byte	01	\\diabc\Global\flags+0x1	1.235us

The columns show:

<b>record</b>	The trace record number
<b>address</b>	The address that was the target of a load or store operation
<b>cycle</b>	The type of cycle (read or write) and the access width
<b>data</b>	The value that was read or written
<b>symbol</b>	If this matches a symbol in the application it will be shown here
<b>ti.back</b>	The time since the previous entry in the list

The command **Trace.ListVar** may also be used which filters out just the reads and writes to variables from a complete trace and displays the cycle type, name and value.



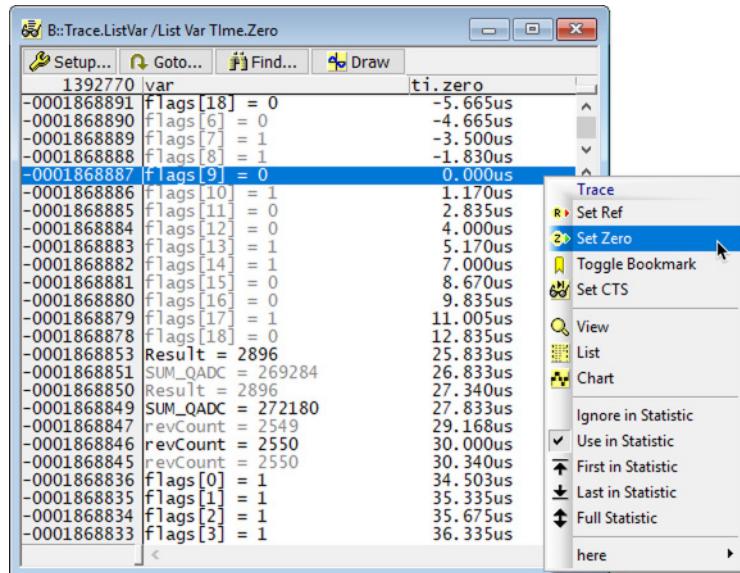
The screenshot shows a software window titled 'B::Trace.ListVar' with a list of memory operations. The columns are: run, address, cycle, data, var, and ti.back. The data table is as follows:

run	address	cycle	data	var	ti.back
633752				00000000 ast.word = 0x0	0.740us
-0000691003		D:400040F8	wr-long	0000303A ast.count = 12346	0.620us
-0000691002		D:400040FC	wr-long	400040F8 ast.left = 0x400040F8	0.615us
-0000691001		D:40004100	wr-long	00000000 ast.right = 0x0	0.740us
-0000690999		D:40004104	wr-long	50000000 ast.field1/field2	0.615us
-0000690998		D:40004108	wr-long	40000000 1	38.115us
-0000690996		D:40004038	wr-long	00000000 vdouble = 2.0	0.740us
-0000690994		D:40004038	wr-long	40000000 1	0.620us
-0000690993		D:40004038	rd-long	00000000 vdouble = 2.0	0.740us
-0000690991		D:4000403C	rd-long	3FF00000 1	0.615us
-0000690990		D:40004038	wr-long	00000000 vdouble = 1.0	0.740us
-0000690988		D:4000403C	wr-long	BFF00000 1	0.620us
-0000690987		D:40004038	wr-long	00000000 vdouble = -1.0	0.740us
-0000690985		D:4000403C	wr-long	40240000 1	0.615us
-0000690984		D:40004038	wr-long	00000000 vdouble = 10.0	0.740us
-0000690982		D:4000403C	wr-long	3FF99999 1	0.620us
-0000690981		D:40004038	wr-long	9999999A vdouble = 1.6000000000000001	0.735us
-0000690979		D:4000403C	wr-long	01 flags[0] = 1	213.175us
-0000690977		D:40004128	wr-byte	01 flags[1] = 1	1.235us
-0000690976		D:40004129	wr-byte	01 flags[2] = 1	1.110us
-0000690975		D:4000412A	wr-byte	01 flags[3] = 1	1.235us
-0000690974		D:4000412B	wr-byte	01 flags[4] = 1	1.110us
-0000690973		D:4000412C	wr-byte	01 flags[5] = 1	1.230us
-0000690972		D:4000412D	wr-byte	01 flags[6] = 1	1.115us
-0000690971		D:4000412E	wr-byte	01 flags[7] = 1	1.230us
-0000690970		D:4000412F	wr-byte	01 flags[0] = 1	

Please be aware of the following:

- In order to display the content of a variable of the type float, it might be necessary to combine two cycles (see the variable vdouble in the screenshot above).
- It is not possible to display the variable value of bitfields (see ast.field1 in the screenshot above).

The command **Trace.ListVar** has many options to adjust the way the data is displayed. Another example can be seen below which shows the variables, the values read (in gray), the values written (in black) and time since the zero point. The zero point reference marker, which by default is the start of the debug session, can be manually adjusted by the user, for example from the right-click Trace pull-down menu in any trace view window.



Tracing all data accesses can place a lot of strain on the trace port bandwidth. Many devices support stall or suppress options which causes the core to halt or to suppress the generation of certain kinds of trace data when internal FIFOs are in danger of overflowing and losing trace data. This minimizes the risk of losing data but may introduce some latency into a running system.

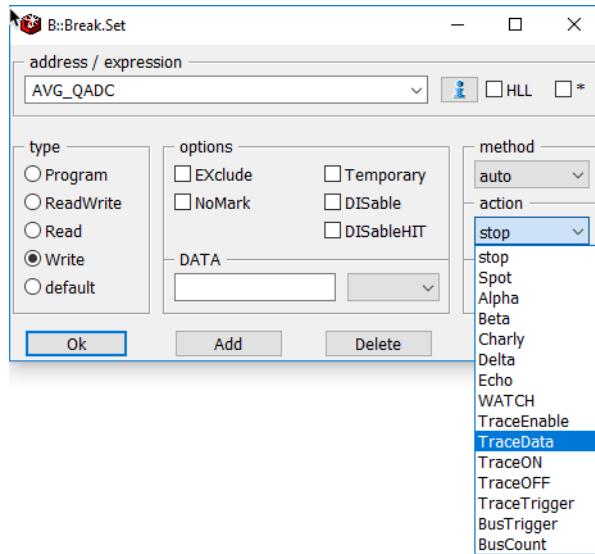
Trace data losses are called FLOWERRORs within TRACE32. See "["Trace Errors"](#)" in TRACE32 Glossary, page 48 (glossary.pdf) for more details.

The following PRACTICE script snippet can be used to programmatically check for FLOWERRORs in the trace.

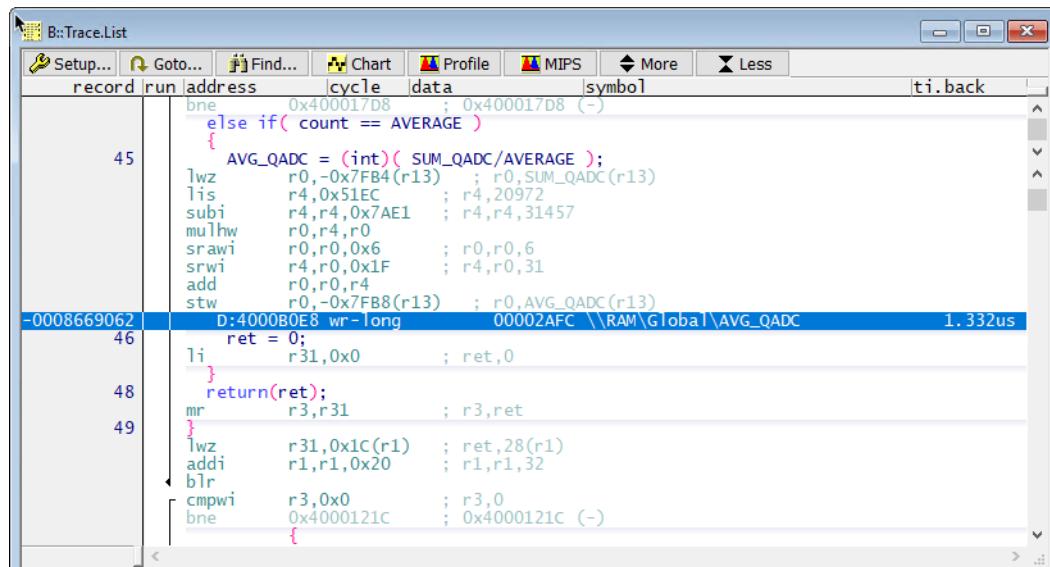
```
Trace.Find FLOWERROR /ALL

IF FOUND.COUNT() == 0
(
    PRINT "No flowerrors in the trace"
)
ELSE
(
    PRINT FOUND.COUNT() " flowerrors in the trace"
)
```

Many devices with a trace port also support some kind of on-chip event filtering to reduce the amount of trace data that is generated. Where these are available, TRACE32 will use the breakpoint features to control them. For more information, see [Break.Set](#). The control features are implemented on the target chip and, as such, are limited in number and scope. Please refer to your chipset documentation for more details about the supported capabilities. These extra ‘trace control’ breakpoints can be accessed from the regular breakpoint control interface. An example can be seen in the picture below.

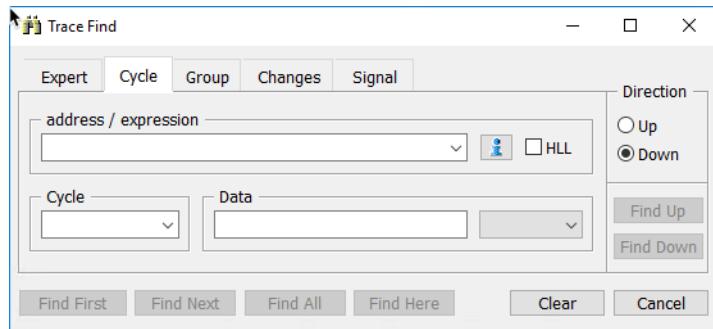


Setting a trace breakpoint like this will prevent all other data accesses to generate trace data: only those marked by the TraceData will be included in the generated trace. The image below shows program flow trace and a trace packet of a data write (highlighted) and is an example of how setting a filter affects the generated data.



# Trace Searching

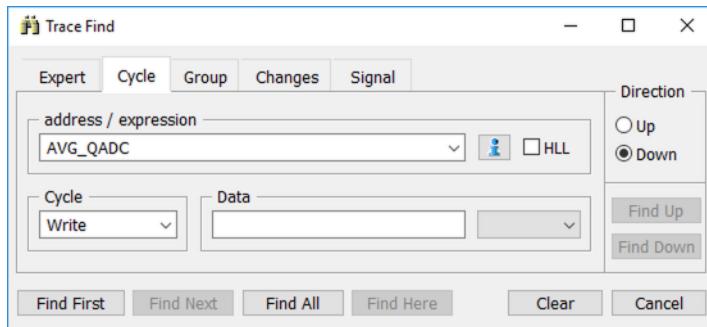
The trace data can be searched using the commands **Trace.Find** and **Trace.FindAll**. Clicking the 'Find' button in any trace view window will open a user interface to provide easy access to these functions. It looks like this.



# Locate all Writes to a Variable

## To locate all writes to a variable:

1. Set the Address/Expression field to the variable name (AVG\_QADC).
2. Set the Cycle drop-down list to **Write**.



3. Click **Find All** to view the results.

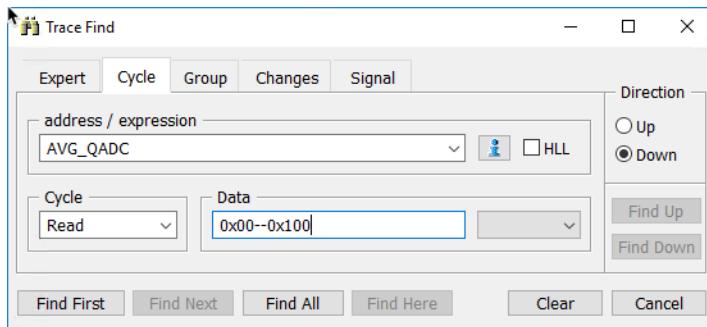
620	run	address	cycle	data	symbol	ti.back
-0022790944		D:4000B0E8	wr-long	00000000	\RAM\Global\AVG_QADC	16.176ms
-0022752993		D:4000B0E8	wr-long	00002AC7	\RAM\Global\AVG_QADC	15.293ms
-0022716343		D:4000B0E8	wr-long	00002B01	\RAM\Global\AVG_QADC	15.271ms
-0022679692		D:4000B0E8	wr-long	00002B05	\RAM\Global\AVG_QADC	15.271ms
-0022643041		D:4000B0E8	wr-long	00002B02	\RAM\Global\AVG_QADC	15.271ms
-0022606389		D:4000B0E8	wr-long	00002B01	\RAM\Global\AVG_QADC	15.272ms
-0022569738		D:4000B0E8	wr-long	00002B04	\RAM\Global\AVG_QADC	15.272ms
-0022533088		D:4000B0E8	wr-long	00002B01	\RAM\Global\AVG_QADC	15.271ms
-0022496437		D:4000B0E8	wr-long	00002B01	\RAM\Global\AVG_QADC	15.271ms
-0022459785		D:4000B0E8	wr-long	00002B02	\RAM\Global\AVG_QADC	15.272ms
-0022423134		D:4000B0E8	wr-long	00002B04	\RAM\Global\AVG_QADC	15.272ms
-0022386484		D:4000B0E8	wr-long	00002B00	\RAM\Global\AVG_QADC	15.271ms
-0022349834		D:4000B0E8	wr-long	00002B01	\RAM\Global\AVG_QADC	15.271ms
-0022313182		D:4000B0E8	wr-long	00002B01	\RAM\Global\AVG_QADC	15.272ms
-0022276531		D:4000B0E8	wr-long	00002B05	\RAM\Global\AVG_QADC	15.272ms
-0022239880		D:4000B0E8	wr-long	00002B05	\RAM\Global\AVG_QADC	15.271ms
-0022203230		D:4000B0E8	wr-long	00002B04	\RAM\Global\AVG_QADC	15.271ms
-0022166581		D:4000B0E8	wr-long	00002B05	\RAM\Global\AVG_QADC	15.270ms
-0022129930		D:4000B0E8	wr-long	00002B02	\RAM\Global\AVG_QADC	15.271ms
-0022093278		D:4000B0E8	wr-long	00002B02	\RAM\Global\AVG_QADC	15.272ms
-0022056627		D:4000B0E8	wr-long	00002B03	\RAM\Global\AVG_QADC	15.272ms
-0022019977		D:4000B0E8	wr-long	00002B01	\RAM\Global\AVG_QADC	15.271ms
-0021983326		D:4000B0E8	wr-long	00002B02	\RAM\Global\AVG_QADC	15.271ms
-0021946674		D:4000B0E8	wr-long	00002B01	\RAM\Global\AVG_QADC	15.272ms
-0021910023		D:4000B0E8	wr-long	00002B03	\RAM\Global\AVG_QADC	15.272ms

Selecting any of the items in this display will cause any open **Trace.List** window to synchronize to the same point in time.

# Locate Dedicated Reads to a Variable

To locate all reads from a variable where the value is less than 0x100:

1. Set the Address/Expression field to the variable name (AVG\_QADC).
2. Set the **Cycle** drop-down list to **Read**.
3. Set the data value to the required range (0x00--0x100). Ranges are supported but greater than and less than are not.



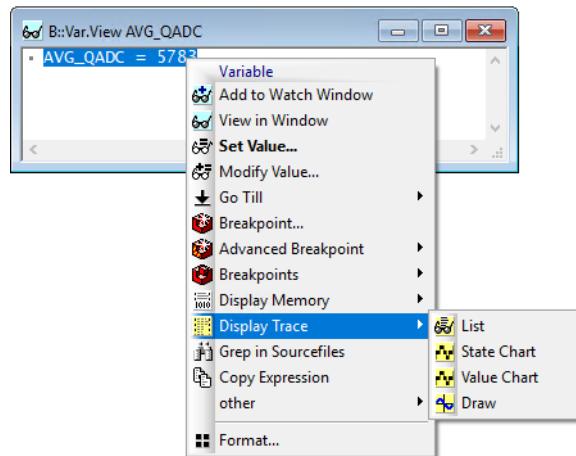
4. Click **Find All** to view the results.

run	address	cycle	data	symbol	ti.back
-0015563417	D:4000B0E8	rd-long	00000005	\\RAM\\Global\\AVG_QADC	15.264ms
-0015526457	D:4000B0E8	rd-long	00000074	\\RAM\\Global\\AVG_QADC	15.271ms
-0015489476	D:4000B0E8	rd-long	00000071	\\RAM\\Global\\AVG_QADC	15.266ms
-0015452495	D:4000B0E8	rd-long	00000072	\\RAM\\Global\\AVG_QADC	15.278ms
-0015415479	D:4000B0E8	rd-long	00000073	\\RAM\\Global\\AVG_QADC	15.287ms
-0015378436	D:4000B0E8	rd-long	00000073	\\RAM\\Global\\AVG_QADC	15.297ms
-0015341365	D:4000B0E8	rd-long	00000070	\\RAM\\Global\\AVG_QADC	15.251ms
-0015304442	D:4000B0E8	rd-long	00000070	\\RAM\\Global\\AVG_QADC	15.260ms
-0015267491	D:4000B0E8	rd-long	00000071	\\RAM\\Global\\AVG_QADC	15.270ms
-0015230512	D:4000B0E8	rd-long	00000071	\\RAM\\Global\\AVG_QADC	15.268ms
-0015193534	D:4000B0E8	rd-long	00000072	\\RAM\\Global\\AVG_QADC	15.280ms
-0015156516	D:4000B0E8	rd-long	00000073	\\RAM\\Global\\AVG_QADC	15.286ms
-0015119476	D:4000B0E8	rd-long	00000072	\\RAM\\Global\\AVG_QADC	15.295ms
-0015082409	D:4000B0E8	rd-long	00000071	\\RAM\\Global\\AVG_QADC	15.249ms
-0015045489	D:4000B0E8	rd-long	00000071	\\RAM\\Global\\AVG_QADC	15.259ms
-0015008537	D:4000B0E8	rd-long	00000070	\\RAM\\Global\\AVG_QADC	15.268ms
-0014971563	D:4000B0E8	rd-long	00000071	\\RAM\\Global\\AVG_QADC	15.274ms
-0014934572	D:4000B0E8	rd-long	00000071	\\RAM\\Global\\AVG_QADC	15.279ms
-0014897569	D:4000B0E8	rd-long	00000073	\\RAM\\Global\\AVG_QADC	15.286ms
-0014860532	D:4000B0E8	rd-long	00000072	\\RAM\\Global\\AVG_QADC	15.293ms
-0014823479	D:4000B0E8	rd-long	00000071	\\RAM\\Global\\AVG_QADC	15.248ms
-0014786557	D:4000B0E8	rd-long	00000072	\\RAM\\Global\\AVG_QADC	15.260ms
-0014749607	D:4000B0E8	rd-long	00000072	\\RAM\\Global\\AVG_QADC	15.267ms
-0014712636	D:4000B0E8	rd-long	00000072	\\RAM\\Global\\AVG_QADC	15.271ms
-0014675648	D:4000B0E8	rd-long	00000072	\\RAM\\Global\\AVG_QADC	

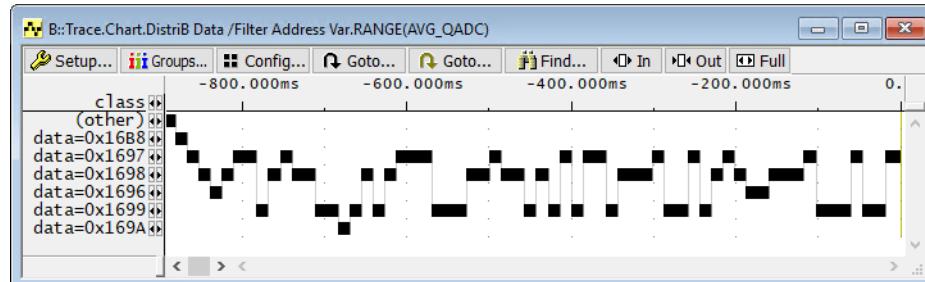
# Monitoring a Variable Over Time

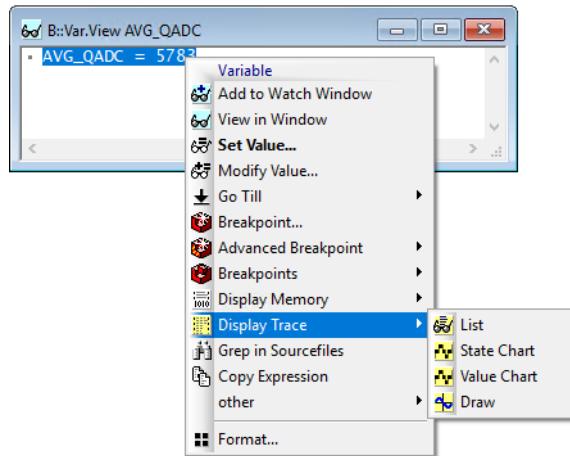
## Static Analysis

The values assigned to a variable over the duration of the trace sampling period can be displayed in a number of formats. These will work equally well with a full trace or a filtered trace. Right-clicking a variable in any view window will provide access to the trace analysis options. It will look like this.

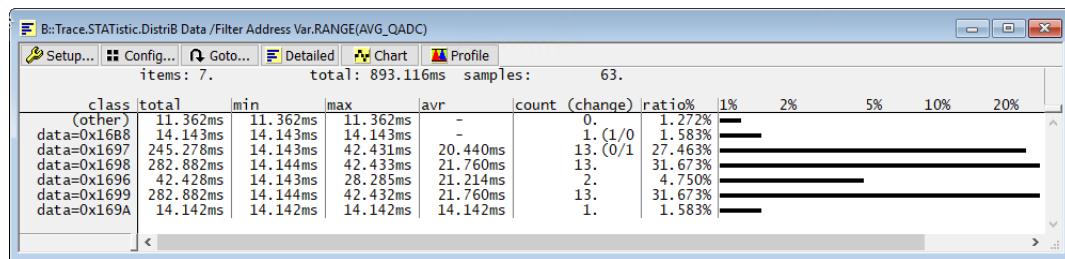


If you select **Value Chart** this opens a window which shows how the variable value changes over time (command **Trace.Chart.DistriB**). The **Data** and **/Filter** options narrow down what is to be displayed.





If you select **State Chart** a list of all values that were assigned to a variable can be displayed (command **Trace.STATistic.DistriB**).

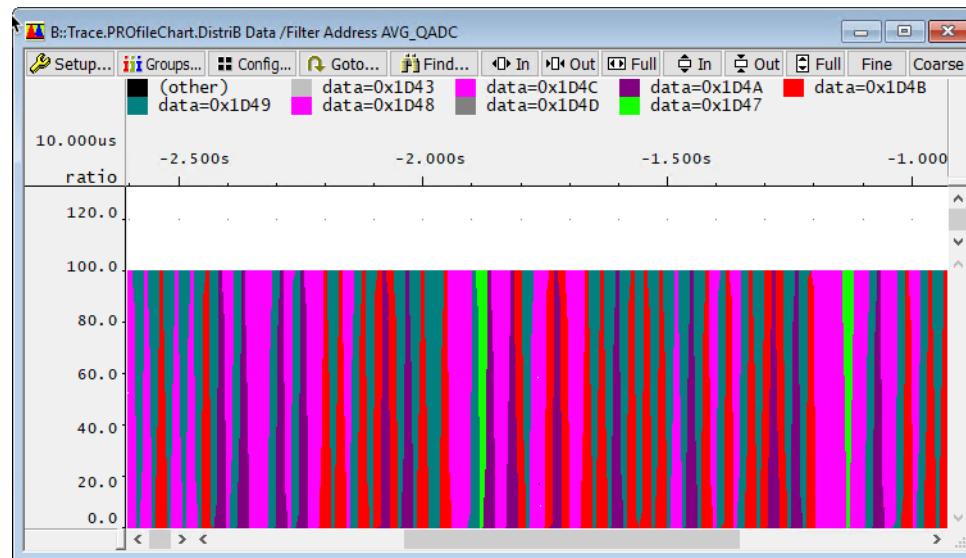


The columns shown are

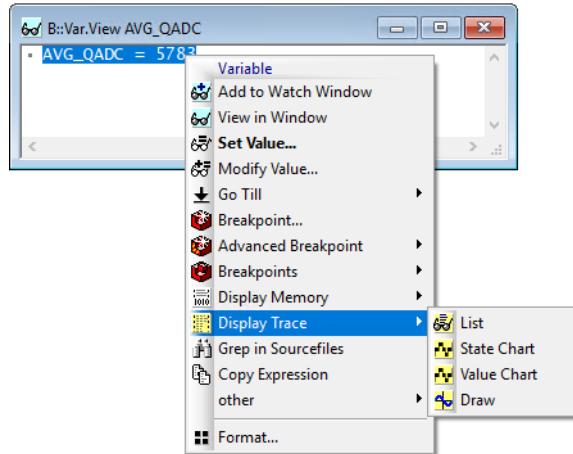
<b>class</b>	The data value assigned to the address that is being monitored.
<b>total</b>	The total time for which the address held this value.
<b>min</b>	The minimum length of time that this value was held at this address.
<b>max</b>	The maximum length of time that the variable held this value.
<b>avr</b>	The mean length of time that the variable held this value.
<b>count</b>	The number of times this value was assigned to the variable.
<b>ratio</b>	The total time that this value was held as a ratio of the total time sampled.
	A bar graph to show the ratio value graphically.

Clicking the 'Config' button allows the user to add or remove columns from the display.

Clicking the 'Profile' button in the **Trace.STATistic.DistriB** window uses the command **Trace.PROFileChart.DistriB** to show a graphical representation of the values as a percentage of a timeslice. The width of the timeslice is dependent upon the scale of the x axis.

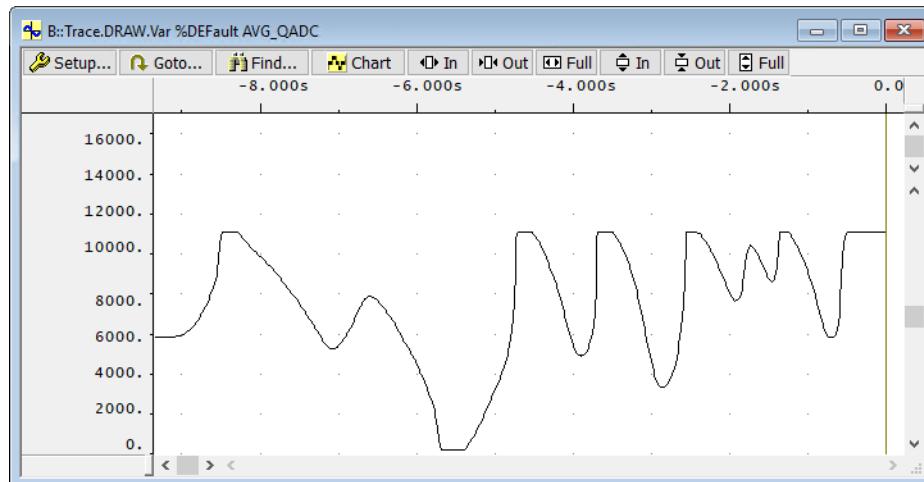


# Variable Graphs



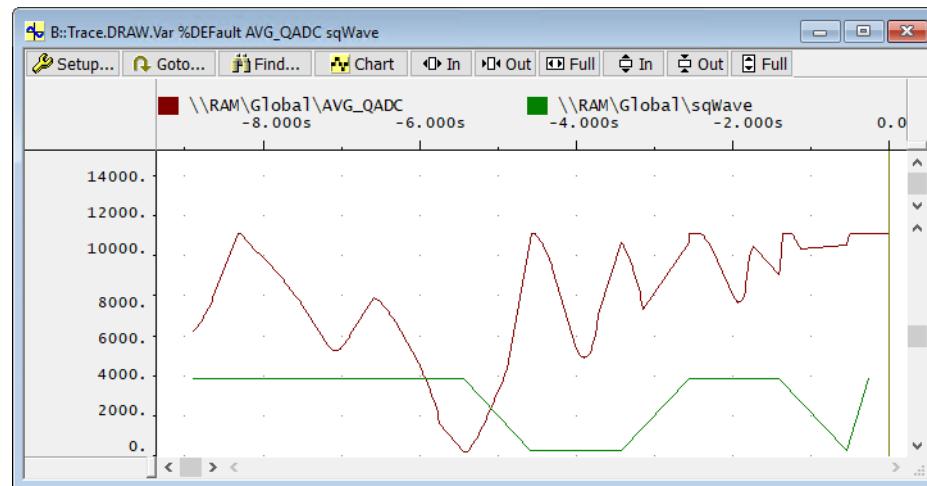
If you select **Draw** (**Trace.DRAW.Var**) the value of a variable is plotted against time. The display of **Trace.DRAW.Var** refers to the variable type by default. Adding **%DEFault** causes TRACE32 to treat all following arguments as variable names.

```
Trace.DRAW.Var %DEFault AVG_QADC
```



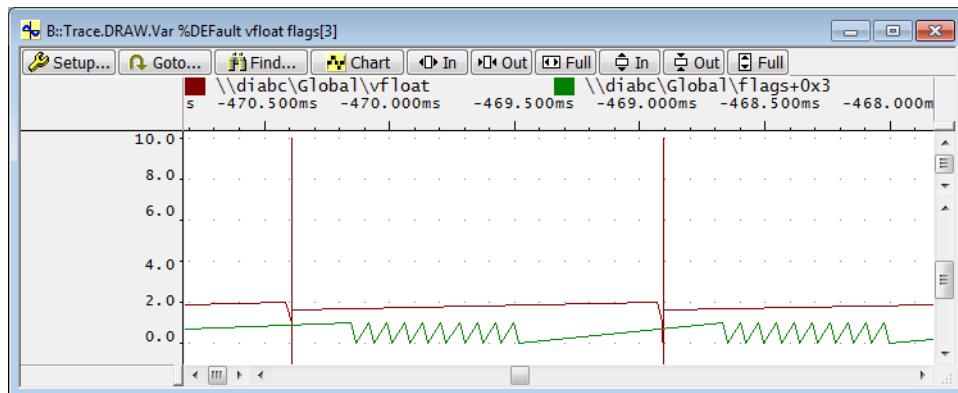
Trace.DRAW.Var can draw multiple variables in the same window. Each line will be colored differently:

```
Trace.DRAW.Var %DEFault AVG_QADC sqWave
```



Please be aware of the following:

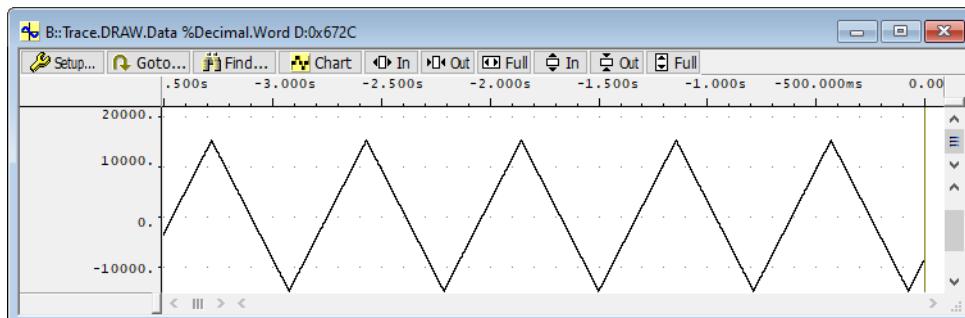
- It only makes sense to display two or more variables in a window if they have a similar value range.
- If one of the variables is of type float, float scale is used.



Using the command **Trace.DRAW.Data** for an address, the contents of a memory location can be plotted against time. **Trace.DRAW.Data** requires a definition of the access bus width.

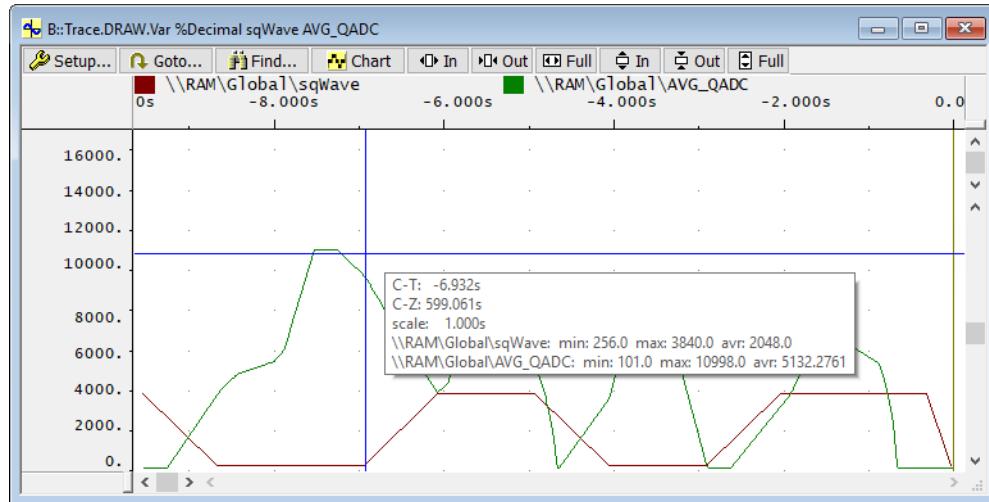
```
; plot a 16-bit value at address 0x672C
Trace.DRAW.Data %Decimal.Word 0x672C

; if no access width is specified, the access width is determined by the
; size of the <data_range>
Trace.DRAW.Data %Decimal 0x672C--0x672D
```



## Mouse Support

Left-clicking a **Trace.DRAW** window will pop-up a balloon text with more details about the chart.



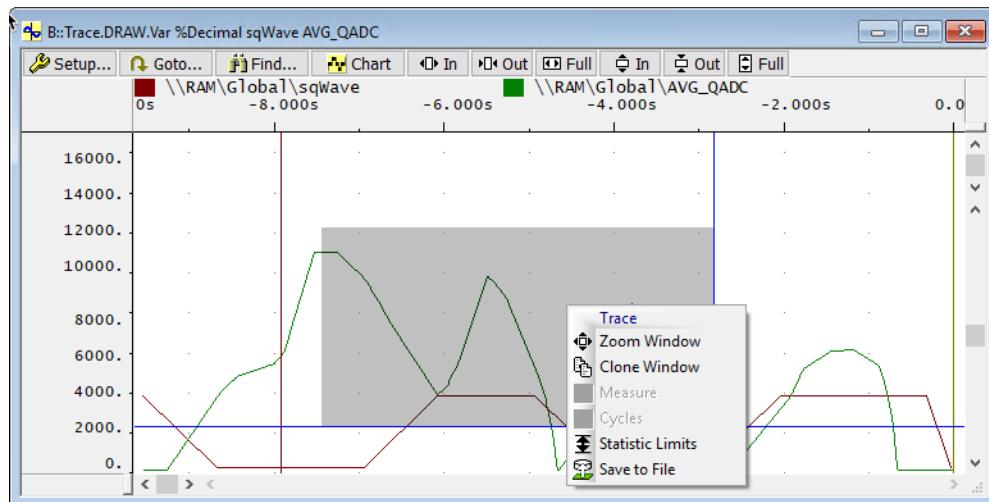
**C-T** Current time (selected by user) to Trigger time. This is often the end of the trace recording unless a trigger has been programmed.

**C-Z** Current time to zero time. This is usually when the debugger started or a user-defined zero point.

**scale** The time scale along the x axis.

**other** A list of all variables displayed, showing min, max and mean values.

An area of the chart can be selected by left-clicking and dragging. Right-clicking within this area opens a different menu.



- The window can be zoomed to the selected area (Zoom Window).
- The selected area can be opened in a new window (Clone Window).
- The limits for statistical analyses can be set to only include the selected area.
  - The set limits are used for all subsequent **Trace.STATistic** commands (Statistic Limits).
- The trace buffer that covers the selected area can be saved to a file. See **Trace.SAVE** for more information.

## Drag & Drop

---

The simplest way to synchronize two trace view windows is via the Drag & Drop interface.

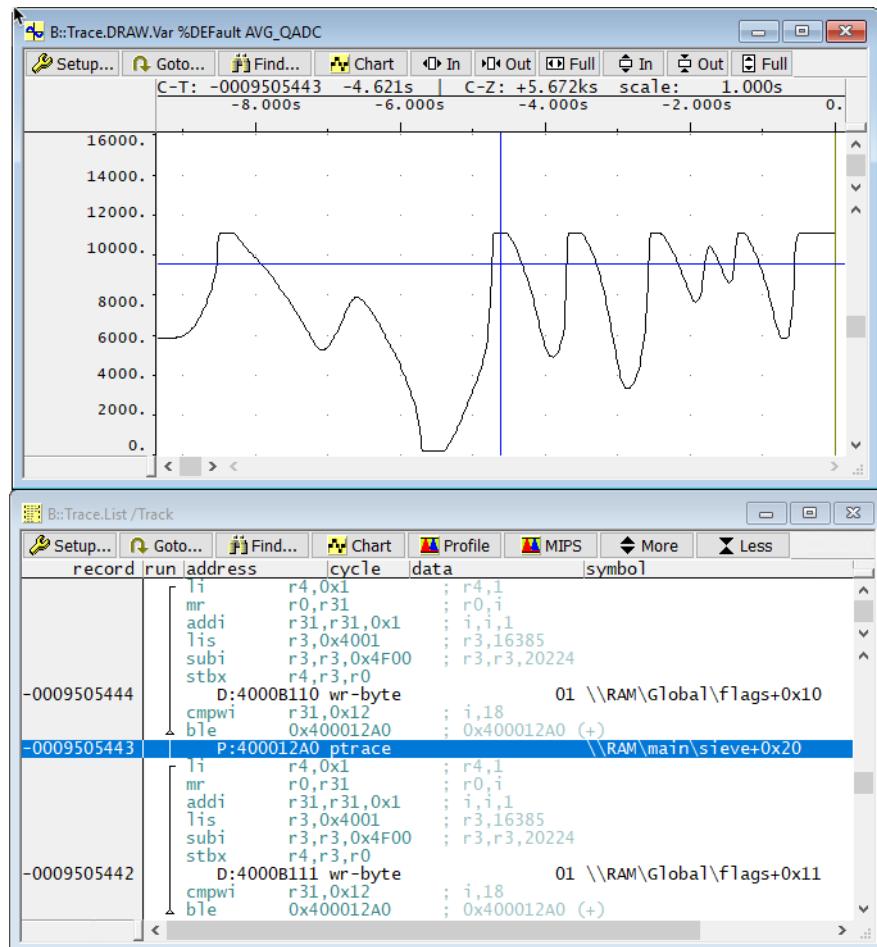
1. Open a **Trace.DRAW.Var** window and a **Trace.List** window.
2. Left-click a point in the **Trace.DRAW.Var** window.
3. Left-click the same point but don't release the mouse button press.
4. Holding the left mouse button, drag the mouse to the **Trace.List** window
5. The view in the **Trace.List** window will snap to the selected point in the other window.

It may take a little practice to get it right but the mouse hotspot is very forgiving for the second click and subsequent drag operation.

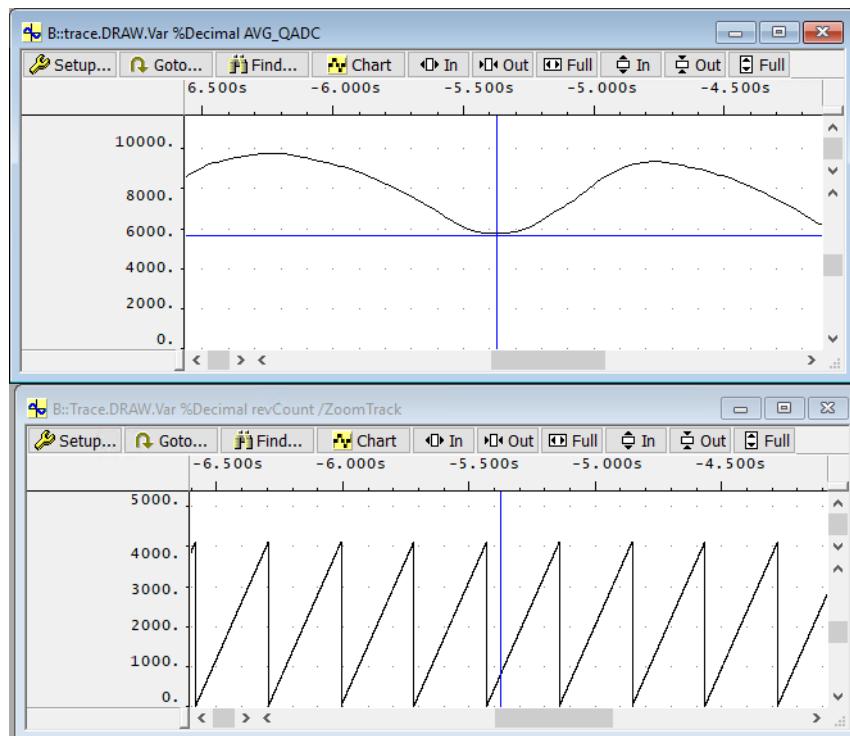
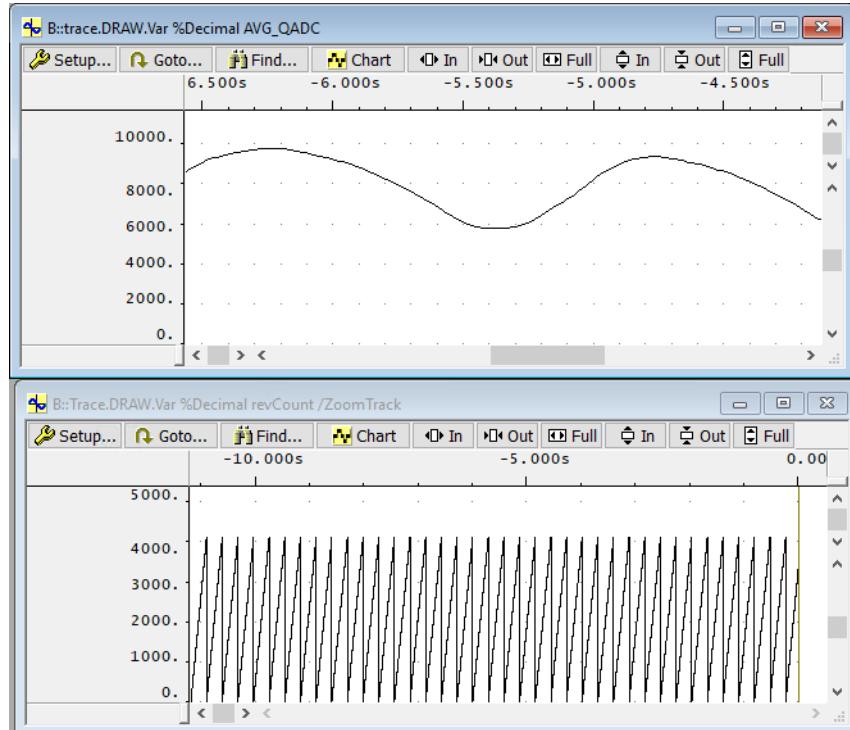
## Track Option

Any trace view window that is opened with the **/Track** option will automatically jump to synchronize with a user placed cursor in any other trace view window. The tracking is based upon the timestamp information captured as part of the trace data. If no timestamps are available (such as on-chip trace) then the record number is used.

An example can be seen here. The user has left-clicked the **Trace.DRAW.Var** window and the **Trace.List** window has synchronized to that point. The blue cross-hairs indicate where the user has clicked the mouse button in the top window.

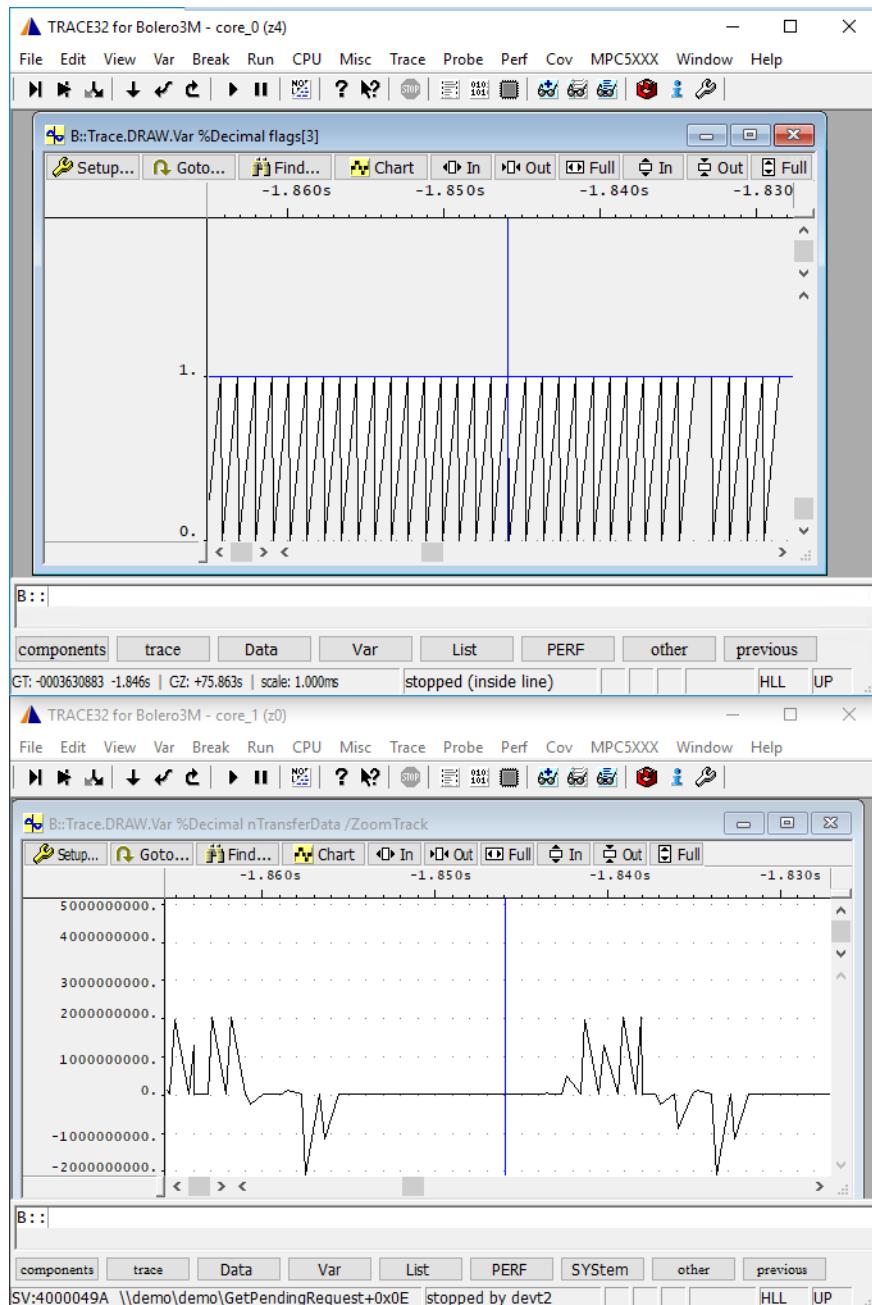


Windows linked with the **/ZoomTrack** option will not only jump to the user selected point but will adjust their scale to match that of the user selected window. Consider the before and after images on this page. In the second set, the scale of the lower window has been automatically adjusted to match that of the upper window.



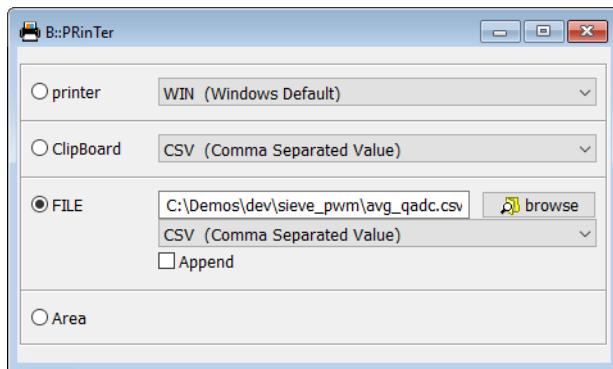
# Synchronizing Between TRACE32 Instances

If AMP debugging is configured and the TRACE32 instances are synchronised via **InterCom** then the trace displays can also be synchronised between them. This allows the **/Track** and **/ZoomTrack** options to work across multiple TRACE32 PowerView GUI. The time synchronisation between instances of TRACE32 is configured using the command **SYnch.XTrack**. The image below shows the lower instance of TRACE32 synchronised and zoomed to a user click event in the upper instance of TRACE32.



# Exporting Data

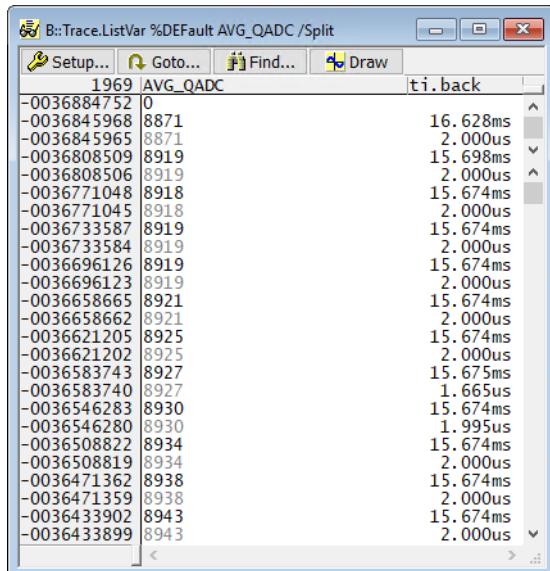
To export trace data, first configure the TRACE32 printer. This is done using the **PRinTer** command which can be accessed from the 'File' menu. The control window looks like this.



The example above has been configured to create a CSV file with the specified name. The command line equivalent would be:

```
PRinTer.FILE "C:/demos/dev/sieve_pwm/avg_qadc.csv" CSV
```

Collect and display the required data using **Trace.ListVar**, **Trace.FindAll** or **Trace.List**. The example below shows trace of both data reads (in grey) and data writes (in black).

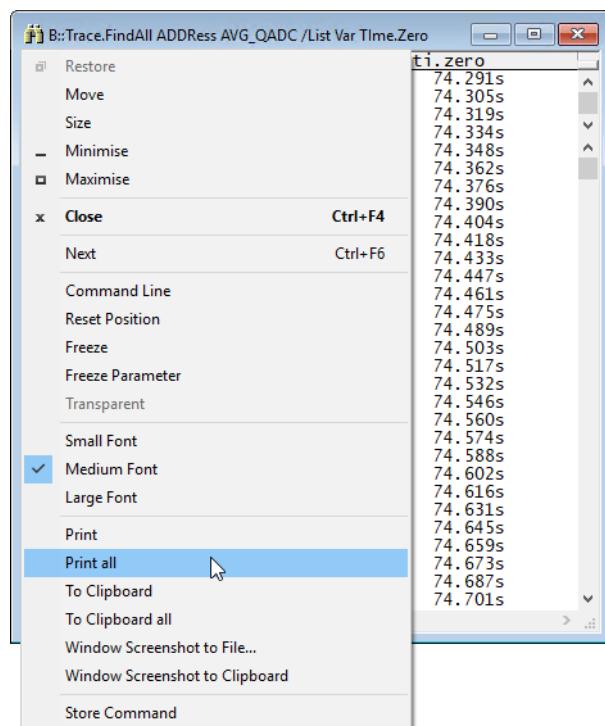


Export the selected data by prefixing the window command with the command **WinPrint** or by left-clicking the menu icon and selecting 'Print' or 'Print all' from the menu. For example:

```
WinPrint.Trace.ListVar %DEFault AVG_QADC /Split
```

or alternatively:

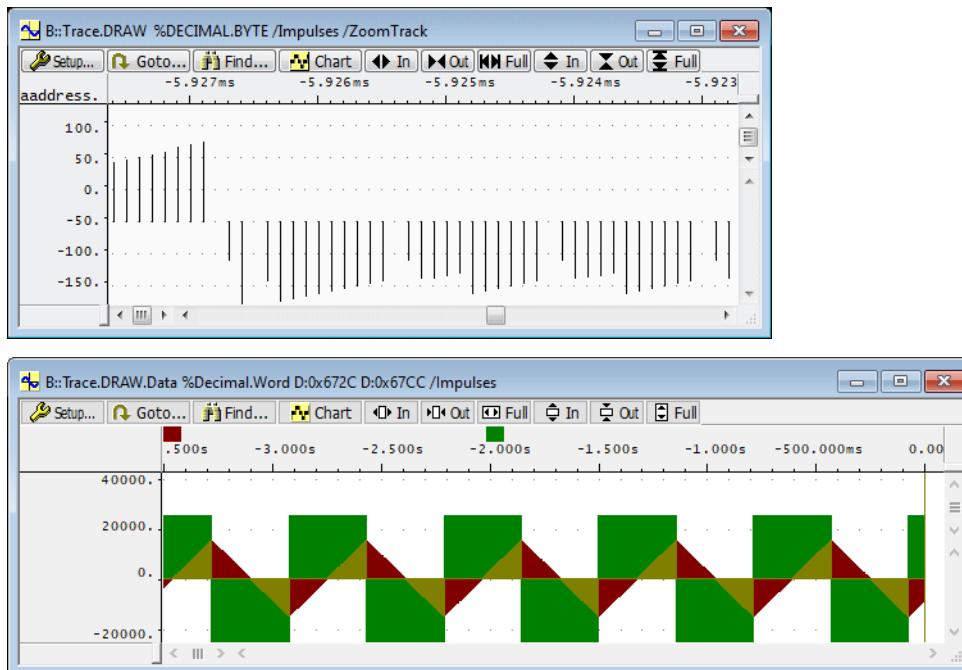
```
WinPrint.Trace.FindAll ADDRess Var.RANGE(AVG_QADC) /List Var TIme.Zero
```



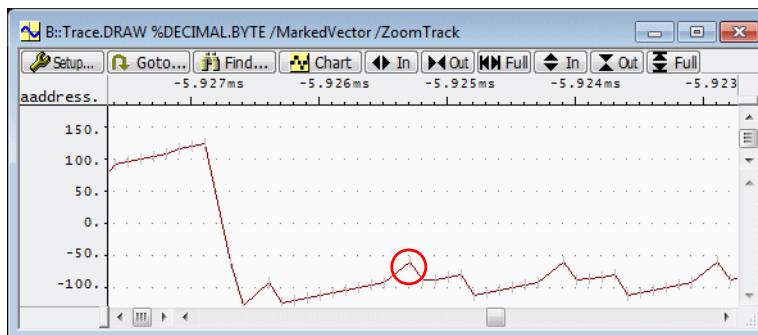
# Appendix: Trace.DRAW Draw Options

**LOG:** Displays the data values in a logarithmic format.

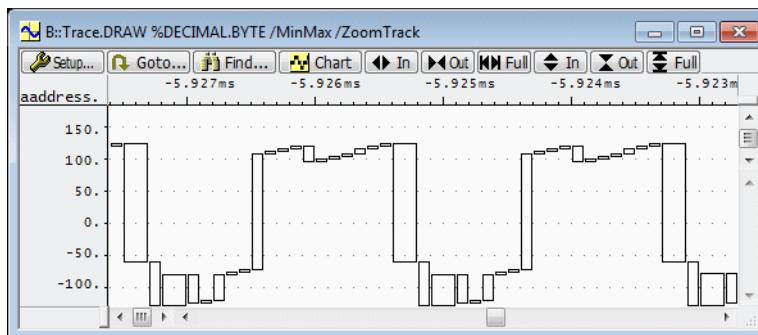
**Impulses:** Draws each data value as a single pulse.



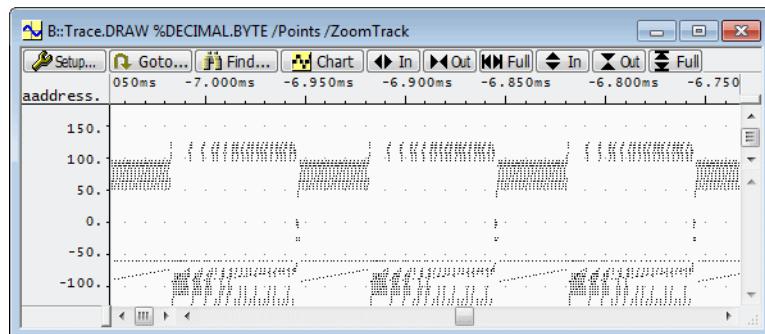
**MarkedVector:** Highlights the trace records that contain a data value by short, vertical lines.



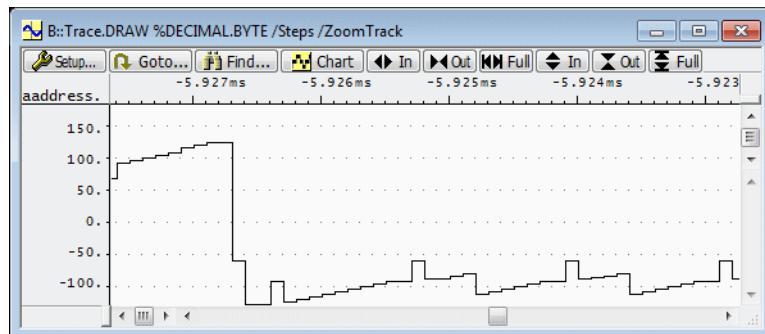
**MinMax:** Displays the minimum and maximum data value for each range.



**Point:** Displays each data value as a dot.



**Steps:** Connects the dots for the data values by steps.



**Vector:** Connects the dots for the data values by vectors (default).

