SEGGER J-Scope

User Guide

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0
Date: January 18, 2018

A product of SEGGER Microcontroller GmbH

www.segger.com

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Manual versions

This manual describes the current software version. If you find an error in the manual or a problem in the software, please inform us and we will try to assist you as soon as possible. Contact us for further information on topics or functions that are not yet documented.

Print date: January 18, 2018

Software	Revision	Date	By	Description
6.12	0	170419	AB	Chapter Trigger functionality added.
5.10	0	151124	NG	First standalone version.

About this document

Assumptions

This document assumes that you already have a solid knowledge of the following:

- The software tools used for building your application (assembler, linker, C compiler).
- The target processor.

If you feel that your knowledge of C is not sufficient, we recommend *The C Programming Language* by Kernighan and Richie (ISBN 0–13–1103628), which describes the standard in C programming and, in newer editions, also covers the ANSI C standard.

How to use this manual

This manual explains all the functions and macros that the product offers. It assumes you have a working knowledge of the C language. Knowledge of assembly programming is not required.

Typographic conventions for syntax

This manual uses the following typographic conventions:

Style	Used for
Body	Body text.
`Keyword`	Text that you enter at the command prompt or that appears on the display (that is system functions, file- or pathnames).
`Parameter`	Parameters in API functions.
`Sample`	Sample code in program examples.
`Sample comment`	Comments in program examples.
Reference	Reference to chapters, sections, tables and figures or other documents.
GUIElement	Buttons, dialog boxes, menu names, menu commands.
Emphasis	Very important sections.

Table of contents

Chapter 1

What is SEGGER J-Scope?

J-Scope is a free-of-charge software to analyze and visualize data on a micro-controller in real-time, while the target is running.

Technology used

Sampling can be done using either SEGGER High-Speed-Sampling (HSS) or SEGGER Real Time Transfer (RTT) technology. Both technologies are available to all MCUs that provide background memory access. SEGGER HSS can be used without any further preparation. SEGGER RTT enables faster sampling speeds, however this requires instrumentation of the target application as described in *RTT: Instrumenting an application to use it with J-Scope* on page 33.

Chapter 2

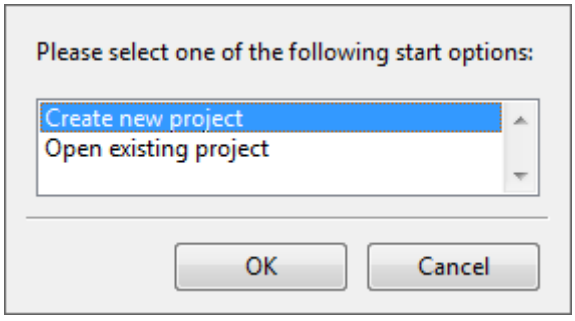
Getting Started

Preparation

Before starting J-Scope make sure the target is running the application. The application can either be downloaded using J-Flash, the J-Link Commander or it can be launched from within an IDE.

> **Note**
>
> Please note that J-Scope requires the J-Link Software and Documentation Package to be installed.

Start J-Scope by double-clicking on the executable. The welcome dialog appears.

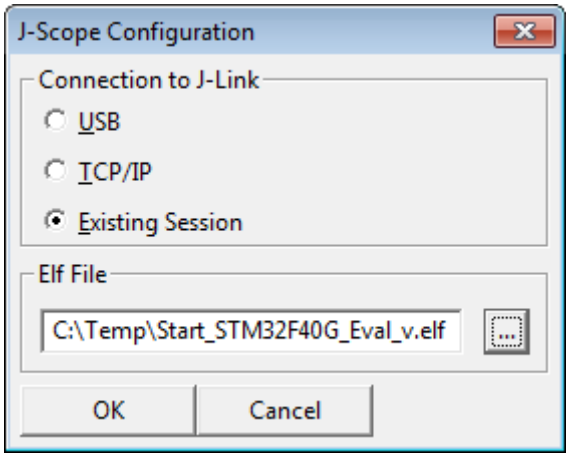


Select "Create new project" and press OK.

The J-Scope Configuration Dialog will open.

2.1 Set up Connection

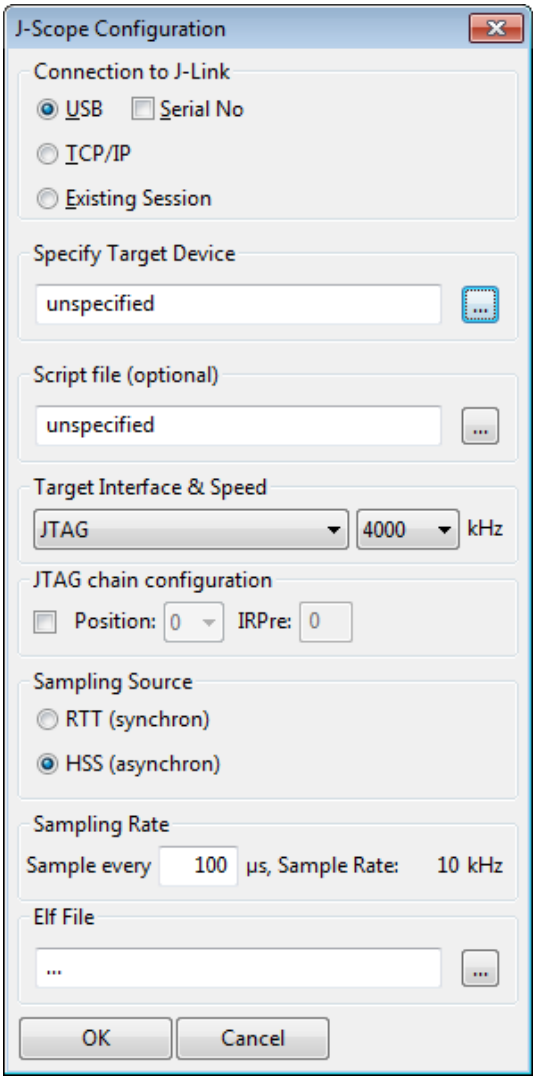
Attach to a running instance

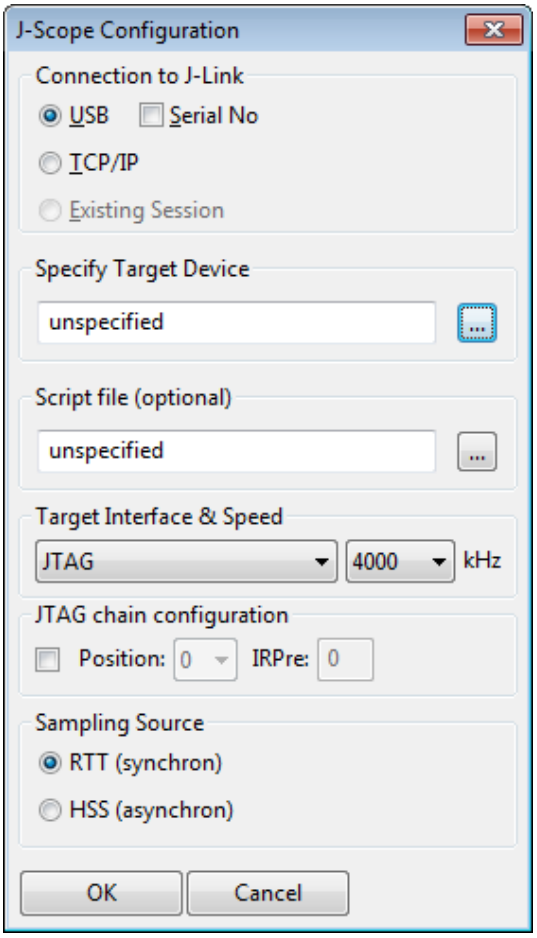


J-Scope can be used alongside other applications, e.g. a debugger, which are connected to the J-Link and share the connection to the J-Link. If J-Scope is used in this mode, select "Existing Session" as connection type. All target options will be disabled, as they are already determined by the running session.

> **Note**
>
> In attach mode J-Scope will connect to J-Link indirectly via another application connected to J-Link. J-Scope can only be used while the connection is active, e.g. a debug session is running. It is the applications responsibility to set up the target and J-Link connection and to manage target execution. RTT can not be used in attach mode.

Connecting to J-Link





If J-Scope is used in standalone mode, using a dedicated connection to J-Link, choose "USB" or "TCP/IP" as connection type and optionally enter the serial number or the IP address of the J-Link to connect to a specific J-Link.

Asynchronous Mode (HSS)

HSS mode works by sampling memory locations in regular intervals. Therefore the sample rate and an elf-file are mandatory. The ELF file is used to determine the memory addresses of the sampled symbols. It is good practice to declare the symbols "volatile" in order to have them written to the memory as soon as possible.

Synchronous Mode (RTT)

In order to use RTT mode, RTT has to be implemented in the target application. See *RTT: Instrumenting an application to use it with J-Scope* on page 33 for more information about the usage of RTT.

2.2 Select Application File and Symbols

Asynchronous Mode (HSS)

In the configuration dialog, select your elf-file and click OK. The Symbol Selection Dialog will open. Select the symbols of your application you want to watch and analyze. Click OK to finalize the setup.

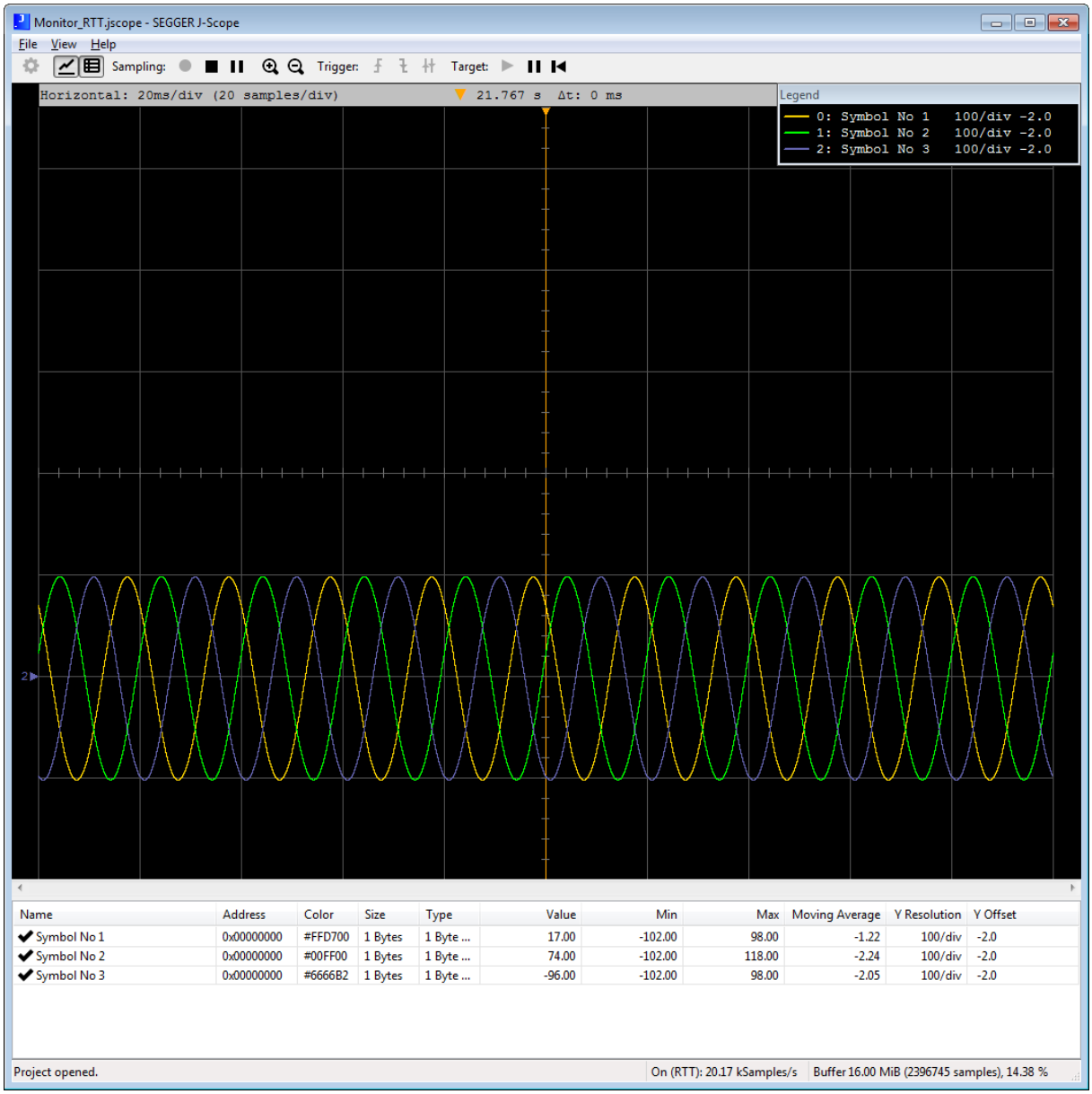
Synchronous Mode (RTT)

The data being sampled is determined by the target application and cannot be altered by J-Scope on PC-side. Neither elf-file nor symbol selection is required or available in the RTT mode.

2.3 Start Sampling

Data sampling can be started via the record-button (red dot) on the tool bar. On start of sampling, the connection to the J-Link or to the running session will be established automatically.

2.3.1 Image of Running Session (RTT)



Chapter 3

Project Management

The project configuration, which are the J-Link connection settings, the elf-application file and the configuration of the selected symbols can be saved to a J-Scope project file (.jscope). J-Scope projects can be used for further sessions and exchanged between different users.

To open a project file, the user can either select “Existing Project” in the startup dialog, open a project file in J-Scope using “Open Project…” within the “File” menu oder select one of the recently used project files listed in the “Recent Projects >” sub-menu.

If any previously sampled data has been saved to file, J-Scope will automatically open the latest data file associated with the project.

Chapter 4

Exporting Sampled Data

4.1 Export to CSV

The sampled data which is currently in the buffer can be exported into CSV format, to be opened and analyzed by other tools, for example spreadsheet programs like Microsoft Excel, Apple Numbers or LibreOffice Calc, by choosing “File” → “Export Data…”

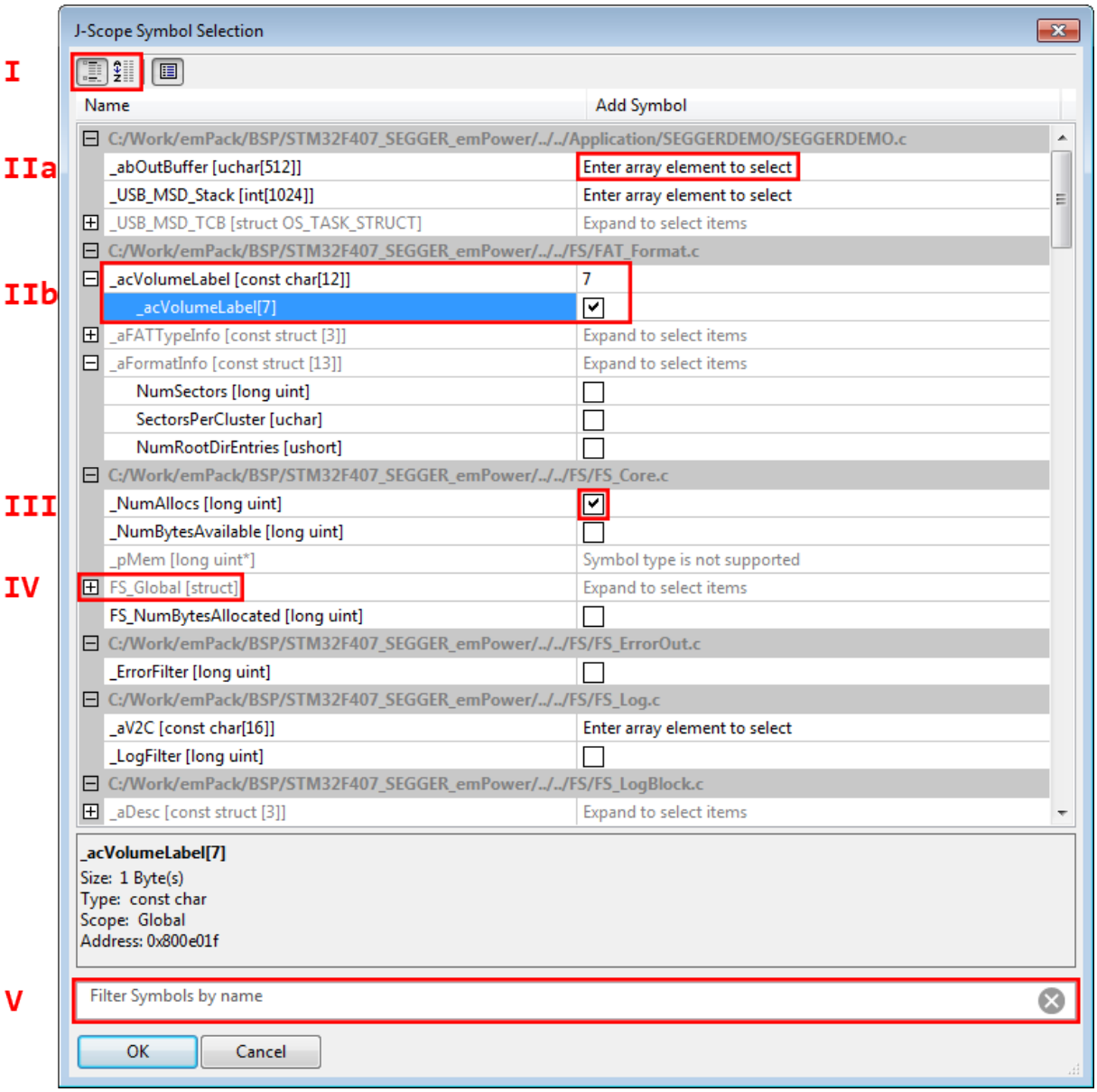
4.2 Export to RAW

The sampled data which is currently in the buffer can be saved in a RAW format, which can be reopened by J-Scope at a later point of time. RAW data files may only be used within projects with a symbol configuration matching the one used to sample the data in the first place.

The location of the latest RAW file created will be saved in the project file relative to the location of the project file. Please make sure to save the project after exporting the data file. The data file will be opened if the associated project is loaded.

Chapter 5

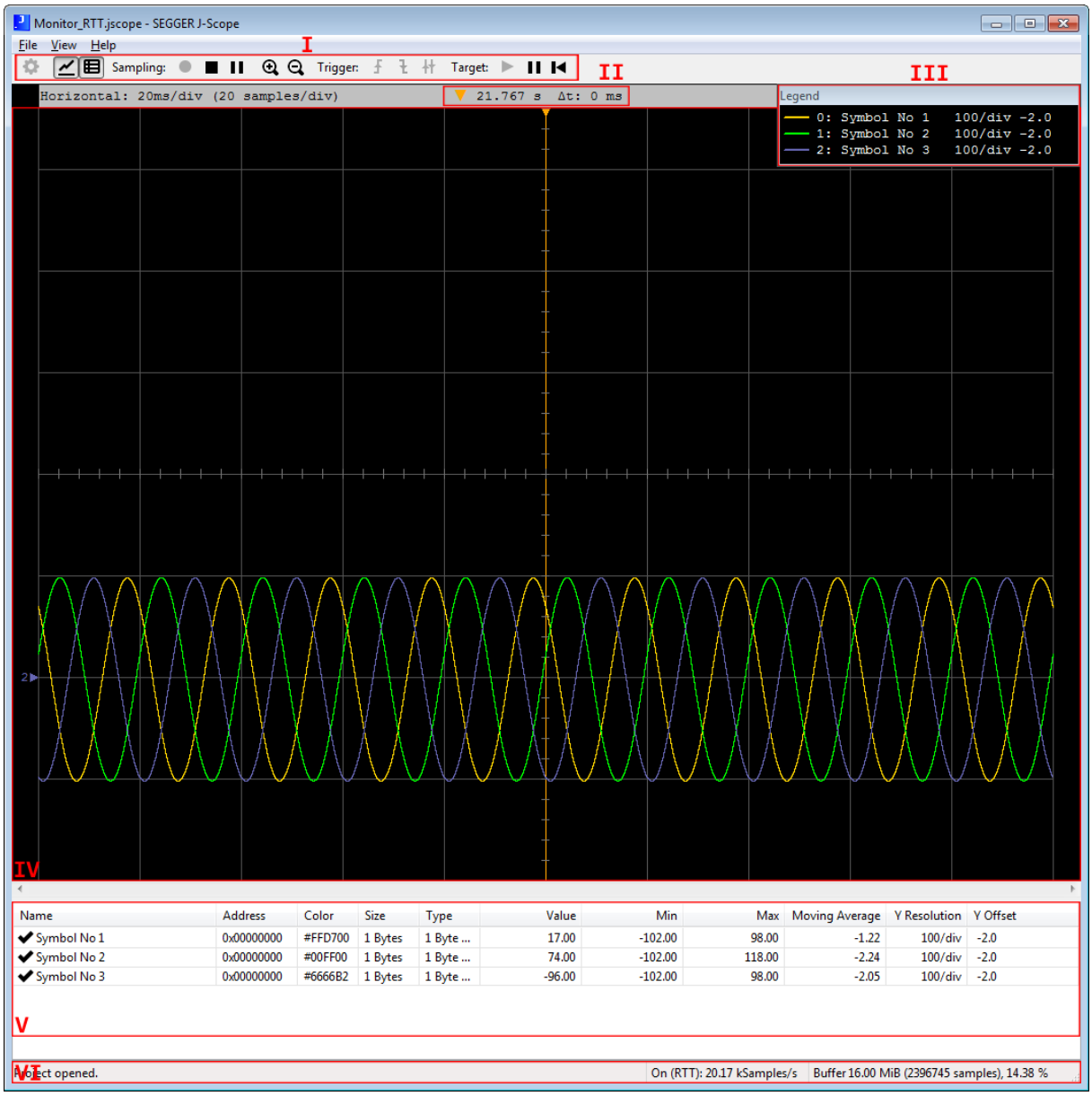
Symbol Selection Dialog



I. Categorized mode (default)	Shows the symbols in a tree view as children of their compilation unit file (e.g. _NumAllocs is defined in `FS_Core.c`)
I. Alphabetical mode	Shows all symbols in alphabetical order
II. Selection of array elements	While complete arrays are not available for sampling, array elements of supported base types can be sampled. In order to sample specific array elements, numbers can be filled in the corresponding field (IIa). After the user confirmed his input by pressing enter, a selectable row is added to the dialog (IIb)
III. Selection of base types	Supported symbols are listed with a check box in the "Add Symbol" column. Symbols can be added to the list of sampled symbols by enabling the check box.
IV. Selection of struct members	Members of a specific struct can be shown in a tree view by clicking the "+" next to a struct's name.
V. Search	Provides a case-insensitive search. Symbols which cannot be selected are not shown in the search results. Structs are shown as longs a their name or the name of at least one member contains the search string. The user can right click on a symbol in order to show all children of the symbol clicked, even if they do not match the search string.

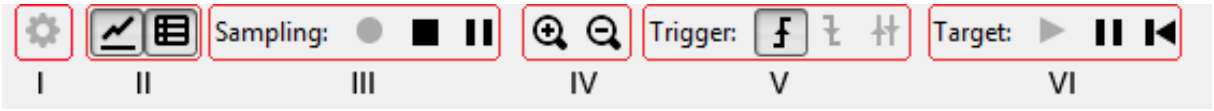
Chapter 6

Main Window



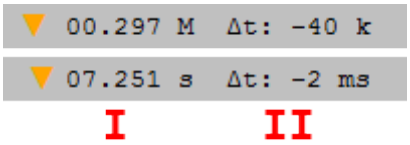
I. *Toolbar* on page 22
II. *Zoom target indicator bar* on page 23
III. *Legend* on page 24
IV. *Graph area* on page 25
V. *Symbol Watch* on page 26
VI. *Status bar* on page 27

6.1 Toolbar



I. Open project settings
II. Show/hide the graph | Show/hide watch window
III. Start sampling | Stop sampling | Pause / Resume sampling
IV. Zoom in | Zoom out
V. Set/unset trigger on rising edge | Falling edge | Any edge
VI. Start the target | Halt the target | Reset the target

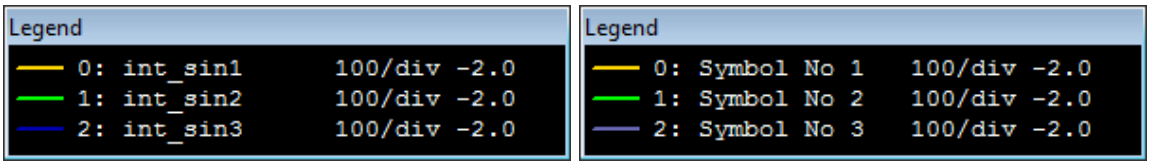
6.2 Zoom target indicator bar



I. Shows either the time (HSS mode / RTT mode with timestamps) or sample number (RTT mode w/o timestamps) at the position of the Zoom target indicator (orange line, "ZTI")

II. Show the time / sample number difference between the ZTI and the vertical central line

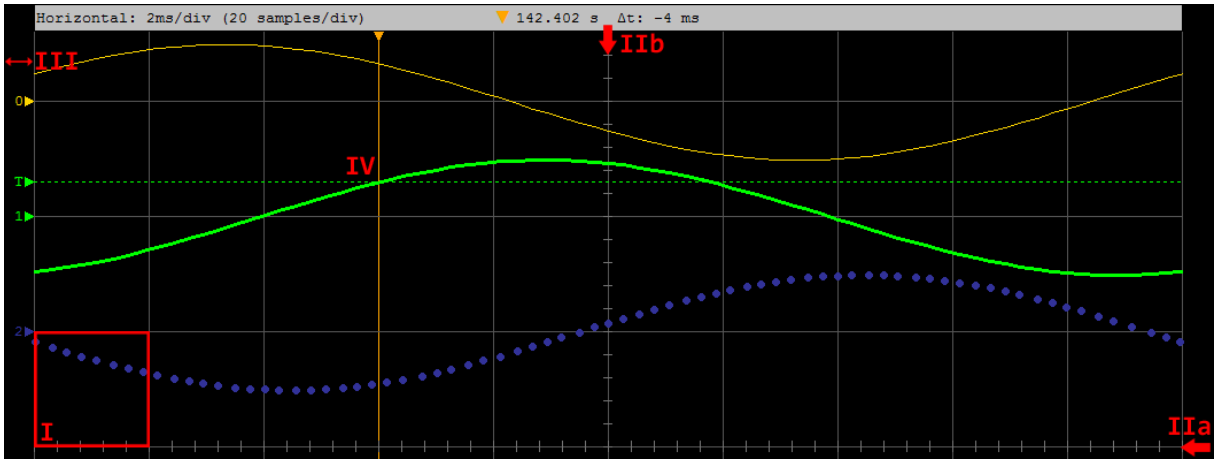
6.3 Legend



Shows Color, Number, Name, Y-Resolution and Y-Offset for each symbol.

The legend can be moved independently of the main window. If the main windows is moved, the legend will snap to the top right corner of the graph area.

6.4 Graph area



Area where the graphs are drawn. The area is divided into divisions of 100x100 pixels (thin gray lines, e.g. I).

At startup, the area is 800 pixels high and 1000 pixels wide. The 4th line from the top (IIa) and the 5th line from the right (IIb) are called central lines and have little marks every 20 pixels.

Their position is independent of the window size. On the left side of the graph area (III), each symbol's base line is indicated by a label corresponding to the symbol number. If the trigger is activated, a special symbol named "T" appears and represents the trigger level. If the trigger is active, the graph is moved in such a way, that the trigger events are located at the ZTI position (IV).

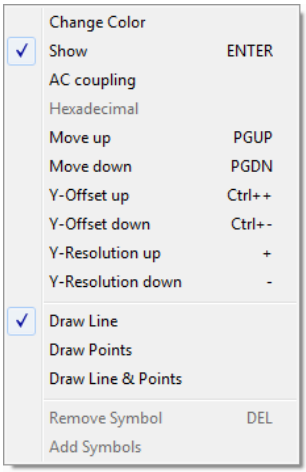
A symbol's base line as well as the trigger level and the ZTI can be changed by moving the respective label (grab and move).

6.5 Symbol Watch

I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Name	Address	Color	Size	Type	Value	Min	Max	Moving Average	Y Resolution	Y Offset
✔ fl_sin[0]	0x2000CD24	#FFD700	4 Bytes	float	0.00	0.00	0.00	0.00	1/div	-2.0
✔ fl_sin[1]	0x2000CD28	#00FF00	4 Bytes	float	0.00	0.00	0.00	0.00	1/div	-2.0
✔ fl_sin[2]	0x2000CD2C	#6666B2	4 Bytes	float	0.00	0.00	0.00	0.00	1/div	-2.0

I. Symbol name according to the .elf file provided (HSS mode) or "Symbol No n" (RTT mode). Preceded by either a check mark (symbol is shown) or a "X"(symbol is hidden)
II. Address of the symbol according to the .elf file (HSS mode only)
III. Color of the graph representing the symbol
IV. Memory size of the symbol
V. Variable type of the symbol
VI. Most current value sampled
VII. Minimum value
VIII. Maximum value
IX. Moving average of the sampled data (*General concepts / behavior of J-Scope* on page 31)
X. Vertical resolution
X. Vertical offset to central line

Context menu



In the symbol's context menu the visual appearance of the symbol can be changed:

Color	Opens a dialog for color selection
Show	Show/hide symbol
AC coupling	Remove DC bias (*General concepts / behavior of J-Scope* on page 31)
Move up	Move the symbol up one position in the symbol watch
Move down	Move the symbol down one position in the symbol watch
Y-Offset up	Increase Y-Offset (moves the symbol upwards)
Y-Offset down	Decrease Y-Offset (moves the symbol downwards)
Y-Resolution up	Increase the vertical resolution
Y-Resolution down	Decrease the vertical resolution
Draw Line	Draw the symbol's graph as line
Draw Points	Draw the symbol's graph as points
Draw Line & Points	Draw the symbol's graph as line and points
Remove Symbol	Remove the symbol (not available for RTT)
Add Symbols	Opens the Symbol Selection Dialog for selecting new symbols (not available for RTT)

6.6 Status bar

I. Shows the latest status message
II. Indicates Status (On / Off), Type (RTT/HSS) and current sampling speed. The value in brackets is the configured sampling speed and may differ from the real sampling speed.
III. Shows the current buffer size, the maximum number of sampling packets fitting in the buffer and the current occupation of the buffer in %

Chapter 7

Trigger functionality

Triggering can be activated by clicking the appropriate symbol on the tool-bar while the desired symbol to trigger on is selected in the watch window. While trigger mode is active, data is sampled continuously as without triggering. If a trigger event occurs, the visible part of the graph is moved.

When triggering is active, the trigger level can be adjusted by moving the trigger label left of the graph window.

Chapter 8

Controls

Function	GUI Input	Shortcut
Graph Area Settings		
Zoom in (X-Axis)	Tool-bar	Left, Ctrl + Wheel up
Zoom out (X-Axis)	Tool-bar	Right, Ctrl + Wheel down
Set trigger level	Drag Trigger Indicator	N/A
Set Zoom target	Drag ZTI	N/A
Change X-Axis scope	Move Scrollbar / Drag Graph Area	Wheel up / down
Symbol Settings *(Apply to the symbol currently selected)*		
Change color	Symbol Context menu	N/A
Show / Hide toggle	Symbol Context menu	Enter, Space
AC coupling toggle	Symbol Context menu	N/A
Move up	Symbol Context menu	PGUP
Move down	Symbol Context menu	PGDOWN
Zoom in (Y-Axis)	Symbol Context menu	+
Zoom out (Y-Axis)	Symbol Context menu	-
Change draw style	Symbol Context menu	N/A
Y-Offset up	Drag Base Line Indicator	Ctrl + +
Y-Offset down	Drag Base Line Indicator	Ctrl + -
Y-Resolution up	Symbol Context menu	+
Y-Resolution down	Symbol Context menu	-
Remove Symbol	Symbol Context menu	Delete
Add Symbol	Symbol Context menu	N/A
Trigger Controls		
Set trigger on rising edge	Tool-bar	N/A
Set trigger on falling edge	Tool-bar	N/A

Function	GUI Input	Shortcut
Set trigger on both edges	Tool-bar	N/A
Sampling Controls		
Start Sampling	Tool-bar	F5
Stop Sampling	Tool-bar	F9
Pause Sampling	Tool-bar	N/A
Start Target	Tool-bar	N/A
Halt Target	Tool-bar	N/A
Reset Target	Tool-bar	N/A
General		
Exit J-Scope	File Menu	Alt + X, Alt + F4
J-Scope Manual	Help Menu	F11
About Dialog	Help Menu	F12
Project Management		
Open Project	File Menu	Ctrl + O
New Project	File Menu	Ctrl + N
Save Project	File Menu	Ctrl + S
Save Project as	File Menu	Ctrl + Shift + S
Recent Projects	File Menu	N/A
Export CSV	File Menu	Ctrl + D
Export RAW	File Menu	Ctrl + R
Import RAW	File Menu	Ctrl + T

Chapter 9

General concepts / behavior of J-Scope

- The sample buffer acts like a circular buffer. If the buffer is full, each new entry overwrites the oldest data.
- If sampling is paused, neither will the target be halted nor will HSS/RTT be suspended, but all incoming samples will be discarded until sampling is resumed.
- If no timestamps are provided in RTT mode, J-Scope will number the incoming packets in order of arrival. Accordingly, all time based values will be shown as number based values instead.
- J-Scope uses exponentially smoothing for calculating the DC bias of the signal. In "AC coupling" mode the graph is moved by this value while the sampled data is not changed. Calculation is done using the following formula where alpha is set to 0.0001:

$$M_t = \alpha * S + (1 - \alpha) * M_{t-1}$$

Chapter 10

Limits of J-Scope

J-Scope does not limit the sampling speed or number of variables sampled.

Information about the capabilities of a J-Link are provided on the SEGGER website. HSS' limits on number of variables and sampling speed are described on the SEGGER J-Scope web page (Section *Model comparison*).

Information on speed limitations depending on J-Link model, debug interface speed and RTT buffer size are available on the SEGGER RTT web page (Section *Performance*).

Further limitations may be caused by the OS or USB implementation of the host PC. J-Link debug probes with Ethernet connectivity can be used with J-Scope in order to allow to achieve speeds beyond the limits introduced by USB.

Chapter 11

RTT: Instrumenting an application to use it with J-Scope

Preparation

First of all, SEGGER RTT needs to be included in the target application.

The source files and manual of RTT are part of the SEGGGER J-Link Software and Documentation Package.

In RTT mode, all data is provided directly by the target application. The target application is responsible for data integrity and providing a reliable time base, if a timestamp is required.

Main concept

The sampled data and its format are given by the target application.

This data format is announced to J-Scope by naming the RTT channel. The naming convention is stated below.

Once the target application has collected all data needed for a packet, it writes this packet using `SEGGER_RTT_Write()` to the RTT channel.

RTT channel naming convention

J-Scope searches for the first RTT channel named `JScope_FORMAT`, where FORMAT defines the format of the data written to the buffer by the target application.

- All variable identifiers consist of a type identifier and a size indication(in bytes).
- The data inside a packet has to be in same order as declared in FORMAT.
- If a timestamp is provided, it needs to be declared as first variable.

Type	Supported Sizes	Note
t	4	Indicates that every packet is preceded by a 32bit value containing a timestamp in µs
b	1	Specifies a boolean value
f	4, 8	Specifies a 32- or 64bit (IEEE 754) floating point value
i	1, 2, 4	Specifies a signed 8-, 16- or 32bit value
u	1, 2, 4	Specifies an unsigned 8-, 16- or 32bit value

Naming Examples

`JScope_t4u1i4`	Specifies that the data packets are headed by a 32bit time value, followed by an unsigned char and a signed int
`JScope_u4i1`	Specifies that the data packets contain an unsigned int, followed by a signed char

Workflow examples

- The user wants to sample a signed int, an unsigned int and a signed char
- The user wants to provide a timestamp.
- Accordingly, a RTT channel is named `JScope_t4i4u4i1`
- Depending on the use case, sampling for example is done on a timer or condition

Case I

- For this example, the user decides that sampling should be done every 100µs
- The users adds a time based interrupt which occurs every 100µs. The respective ISR collects the necessary data and the current timestamp.
- Afterwards, the ISR calls `SEGGER_RTT_Write()`

Case II

- In an other use case, the user may decides that sampling should be done once a specific function is called.
- The user adds a sub-function call to this function. The sub-function prepares the data, which either can be passed as a parameter or can be available in a global scope, and writes it to the RTT Buffer using `SEGGER_RTT_Write()`.

Policies in RTT mode

- RTT channel name and data format must not be changed during a sampling session.
- RTT channel name and data format can be changed between sampling sessions (No restart of J-Scope required).
- The RTT channel name must be set accordingly to the data format.
- Only full packets according to the data format declared by the RTT channel name may be written to the RTT channel.
- RTT packets must be sent in order.
- RTT mode should be `NO_BLOCK_SKIP` or `BLOCK_IF_FIFO_FULL`.

