Application Note: Using PiSnoop with OpenECU

General OpenECU support: openecu@pi-innovo.com

OpenECU website: www.openecu.com

PiSnoop enquiries: pisnoop@pi-innovo.com

PiSnoop website: www.pisnoop.com

Contents

Introduction and Scope

This document is a guide on getting started using the PiSnoop CAN-based debug/calibration tool with Pi Innovo's OpenECU product.

This document is included in the general PiSnoop online HTML help, but may also be available as a standalone application note. Links in this document to other PiSnoop help pages will work only in the online help version.

PiSnoop is a tool for developing, debugging and testing ECU software, providing an ideal partner to OpenECU.

PiSnoop provides the immediate low-level access to variables and memory typical of a debugger, but communicates via CAN to an ECU operating in real time, in the same way as a calibration tool. It therefore provides a powerful means of rapidly testing and experimenting with software operating in a live environment such as a vehicle or bench set-up.

PiSnoop is optimised for software engineers to develop and test programs, but also provides a cost-effective means of adapting calibration values in most projects.

PiSnoop can read the linker description file for the software build directly, giving access to all parameters including data structures, arrays, and pointers, and both constants and RAM variables. It does not require data descriptions or an ASAP2 file (but this can be read if desired), and no rebuild of software is required to make additional parameters accessible to the tool. All parameters and variables can be modified (if allowed by the ECU) in debugger-style watch windows.

Note: in Simulink builds, this means Real-Time Workshop structures such as `rtDWork` and `rtB` can be explored, making "hidden" block-related values, seen in the autocode, available for debug purposes.

PiSnoop's features include flash reprogramming, data logging, diagnostic message exchanges via J1939 or UDS/KWP/J1979, CAN traffic generation and logging with DBC file support, and ASAP3 control.

This document concentrates on the OpenECU-specifics of working with applications, calibrations and variables. For other PiSnoop functions, see the general PiSnoop help.

Terms and Abbreviations

ASAP2	Standard for .a2l format data description (parameters, types, units, ranges)
CCP	CAN Calibration Protocol standard from www.asam.net

References

1. OpenECU user guides> (Start... Programs... OpenECU Developer Software... [version]... Documentation... User Guide... [PDF/HTML and Simulink/C-API versions]

Installation and Licence

Note: you may need administrator privileges for the installation process.

Download PiSnoop from the Pi Innovo website. Follow the demo download link from:

www.pisnoop.com (registration required to download the installation package)

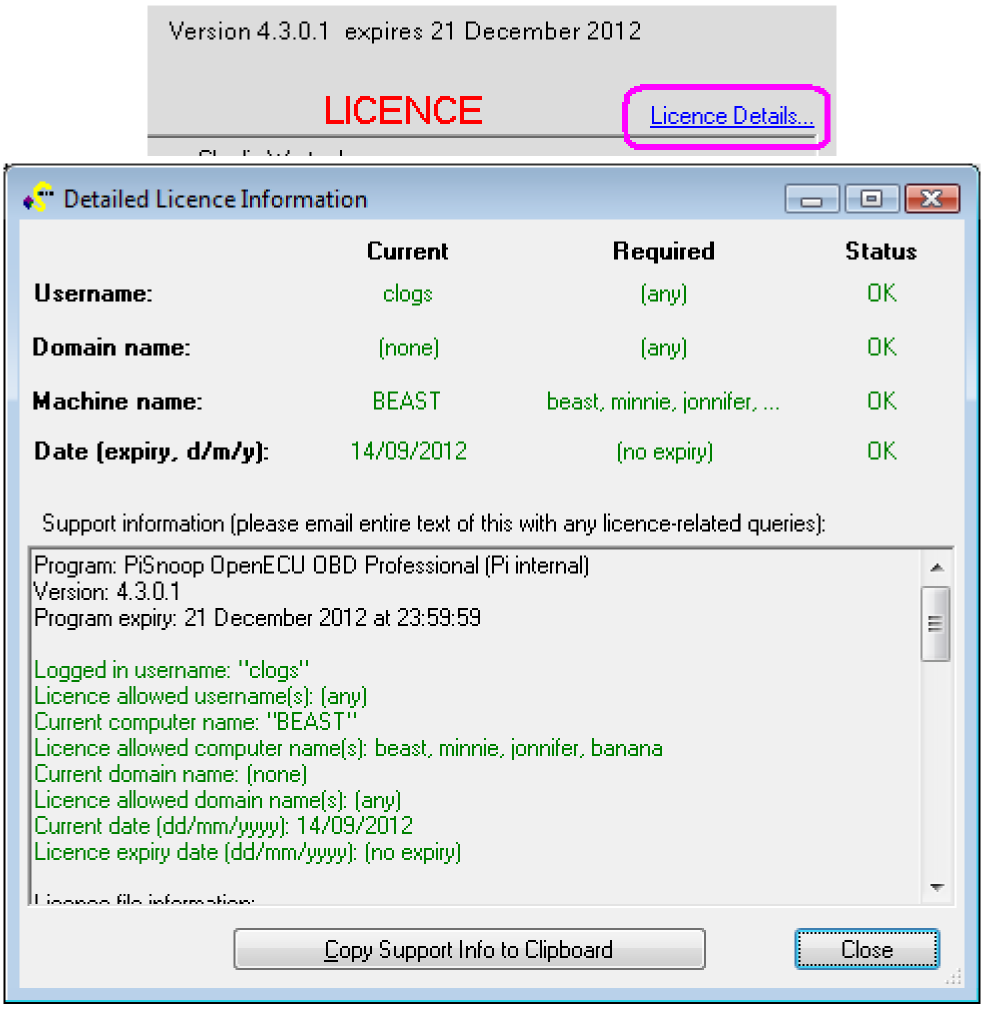
Run the PiSnoop installation program (.msi file) to install the program on your PC.

PiSnoop will install by default to a program directory of `C:\Program Files` on 32-bit versions of Windows or `C:\Program Files (x86)` on 64-bit versions (or the equivalent in other languages).

A basic licence file is included automatically (`snoop_licence_demo.txt`). This allows all features to be tried, but has various limits on all operations.

For full operation, obtain a full (purchased) or time-limited trial licence file from Pi Innovo. This will be called `snoop_licence.txt`. Copy it to the program directory, and it will be found by PiSnoop the next time it runs.

For details of the licence file currently in use, and to troubleshoot any licence issues, click on this link on the splash screen (which can be called up later by doing Help... About):


Version 4.3.0.1 expires 21 December 2012

LICENCE

Licence Details...

Detailed Licence Information

	Current	Required	Status
Username:	clogs	(any)	OK
Domain name:	(none)	(any)	OK
Machine name:	BEAST	beast, minnie, jonnifer, ...	OK
Date (expiry, d/m/y):	14/09/2012	(no expiry)	OK

Support information (please email entire text of this with any licence-related queries):

```
Program: PiSnoop OpenECU OBD Professional (Pi internal)
Version: 4.3.0.1
Program expiry: 21 December 2012 at 23:59:59

Logged in username: "clogs"
Licence allowed username(s): (any)
Current computer name: "BEAST"
Licence allowed computer name(s): beast, minnie, jonnifer, banana
Current domain name: (none)
Licence allowed domain name(s): (any)
Current date (dd/mm/yyyy): 14/09/2012
Licence expiry date (dd/mm/yyyy): (no expiry)
```

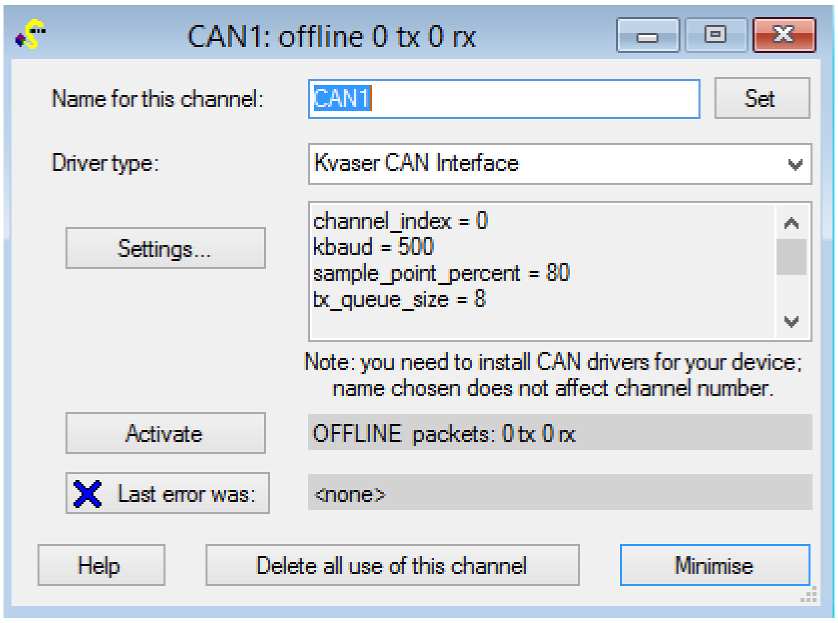
Hardware Configuration

PiSnoop currently supports Vector, Kvaser and PEAK-System CAN interfaces as primary options. (Some ETAS interfaces also work using the Vector option.)

Experimental support is also provided for USB "virtual COM port" CAN interfaces ranging from USBtin (fairly usable) to Lawicel/USBCAN (light bus load OK) and EasySync (only works with very light bus load, produces incorrect receive IDs and/or just stops working at higher load). All of those devices have some issues, e.g. may require USB unplugging and reinsertion to clear errors. Some CCP timeouts will be seen with any of those devices due to their slower operation and bandwith limitations.

You must have Windows device drivers for your hardware installed (from the manufacturer website) before using PiSnoop, but the PiSnoop installation includes the application interface DLLs for all supported hardware.

Do File... New Hardware Comms Channel to define a hardware interface:


CAN1: offline 0 tx 0 rx

Name for this channel: CAN1 Set

Driver type: Kvaser CAN Interface

Settings...

```
channel_index = 0
kbaud = 500
sample_point_percent = 80
tx_queue_size = 8
```

Note: you need to install CAN drivers for your device; name chosen does not affect channel number.

Activate — OFFLINE packets: 0 tx 0 rx

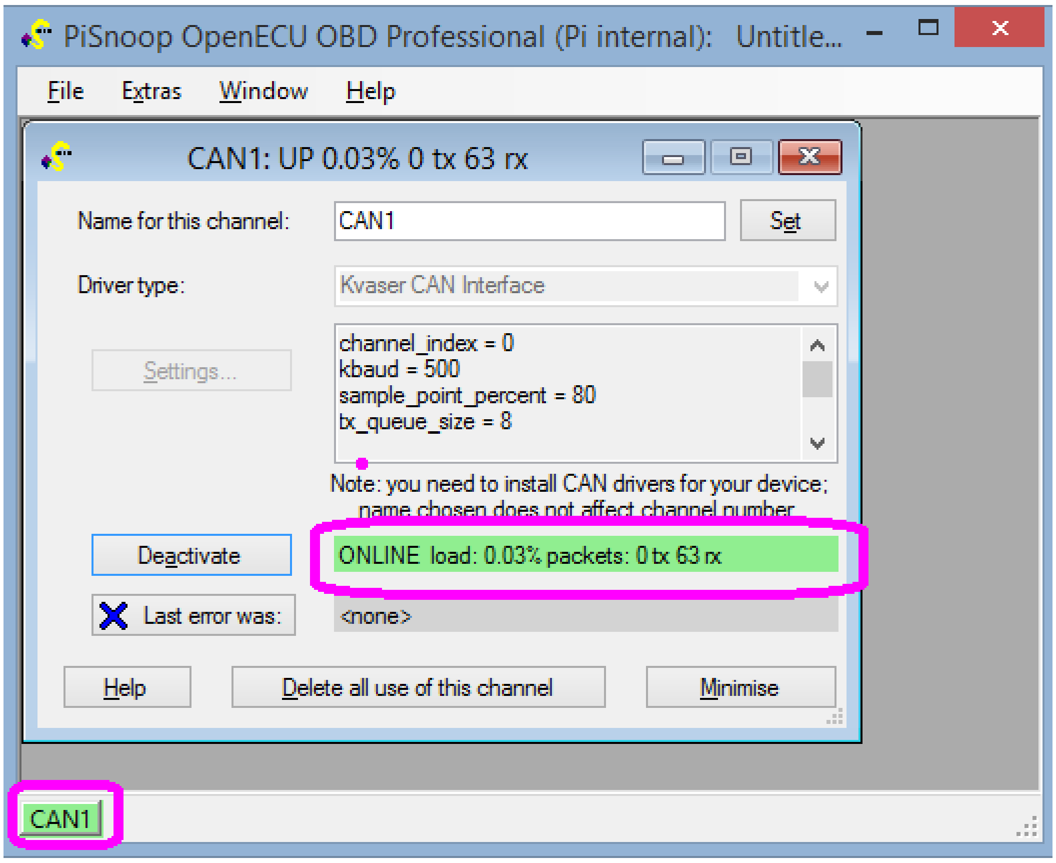
Last error was: <none>

Help | Delete all use of this channel | Minimise

By default the first channel defined is called CAN1, but this is just a name, which you can change. It does not relate to the hardware channel in use.

Click on Settings... to alter parameters such as which specific hardware channel you wish to use and the baud rate for your ECU (typically 500 or 250 kbit/s).

Click Activate to enable the channel. If successful, the indicator will turn green, and a small indicator in the status bar will also turn green:


PiSnoop OpenECU OBD Professional (Pi internal): Untitle...

File Extras Window Help

CAN1: UP 0.03% 0 tx 63 rx

Name for this channel: CAN1 Set

Driver type: Kvaser CAN Interface

Settings...

```
channel_index = 0
kbaud = 500
sample_point_percent = 80
tx_queue_size = 8
```

Note: you need to install CAN drivers for your device; name chosen does not affect channel number.

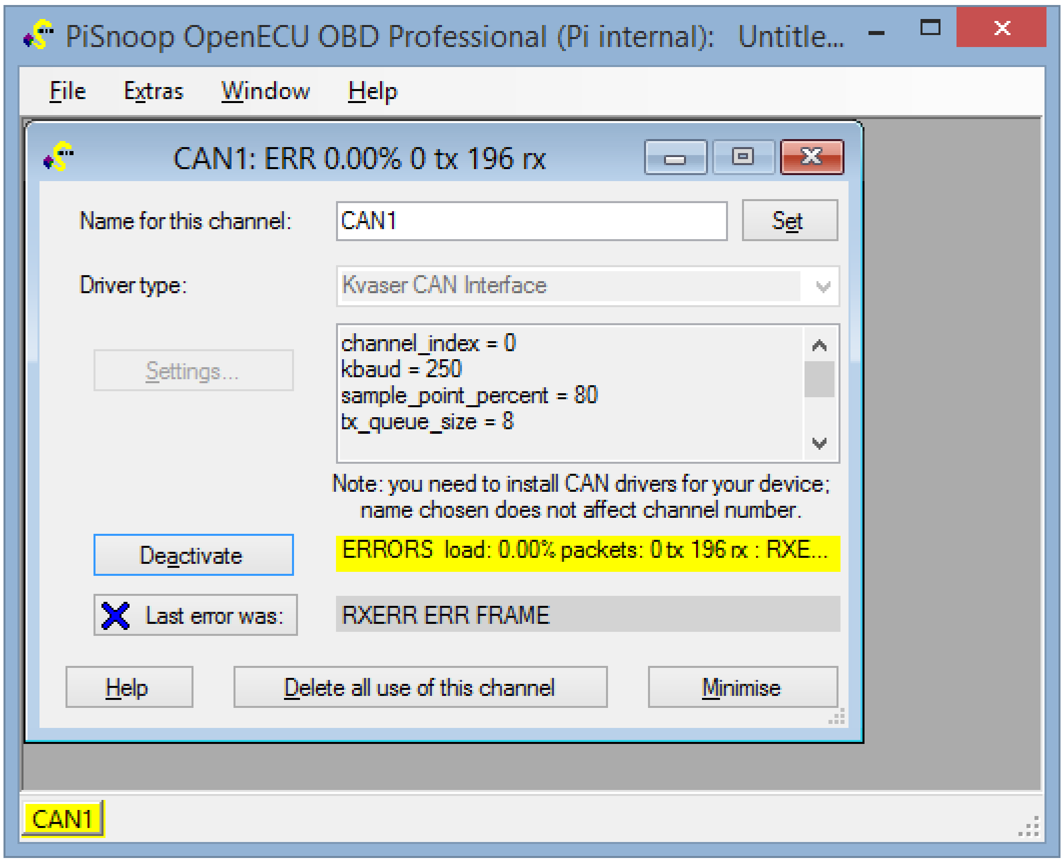
Deactivate — ONLINE load: 0.03% packets: 0 tx 63 rx

Last error was: <none>

Help | Delete all use of this channel | Minimise

CAN1

If the wrong baud rate is selected, no other device (e.g. ECU) is present on the bus, or a terminating resistor is not present, errors may be flagged, e.g.:


PiSnoop OpenECU OBD Professional (Pi internal): Untitle...
File Extras Window Help
CAN1: ERR 0.00% 0 tx 196 rx
Settings...
Deactivate
Help
Delete all use of this channel
Minimise
Set
CAN1

Name for this channel: CAN1

Driver type: Kvaser CAN Interface

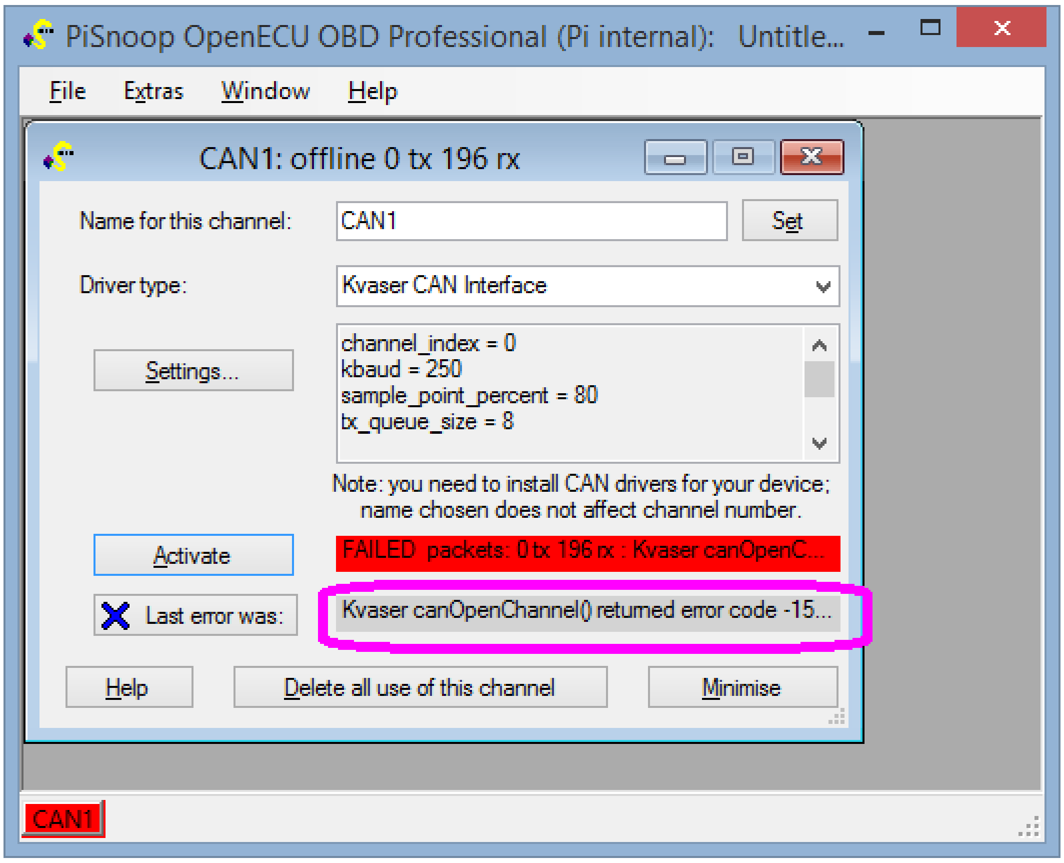
```
channel_index = 0
kbaud = 250
sample_point_percent = 80
tx_queue_size = 8
```

Note: you need to install CAN drivers for your device; name chosen does not affect channel number.

ERRORS load: 0.00% packets: 0 tx 196 rx : RXE...

Last error was: RXERR ERR FRAME

A serious error (e.g. no hardware interface connected to PC) gives a red indication:


PiSnoop OpenECU OBD Professional (Pi internal): Untitle...
File Extras Window Help
CAN1: offline 0 tx 196 rx
Settings...
Activate
Help
Delete all use of this channel
Minimise
Set
CAN1

Name for this channel: CAN1

Driver type: Kvaser CAN Interface

```
channel_index = 0
kbaud = 250
sample_point_percent = 80
tx_queue_size = 8
```

Note: you need to install CAN drivers for your device; name chosen does not affect channel number.

FAILED packets: 0 tx 196 rx : Kvaser canOpenC...

Last error was: Kvaser canOpenChannel() returned error code -15...

(Hover over the error text to see the complete message.) Correct the problem and if necessary click Deactivate and then Activate to try again. This cycle clears the use of the hardware driver and re-initialises it.

You many minimise the hardware window once it is set up to save screen space. However, if completely closed, the channel is deleted.

Working with Calibrations and Variables

OpenECU uses a separate calibration area of flash memory for storing calibration parameter values, intended for adjustment and adaptation. This is separate from the code area of flash. Most OpenECUs place calibrations in the area 0x40000 to 0x7FFFF at the time of writing, but some older targets use different address ranges. By default, PiSnoop detects the correct address range automatically when loading symbols from an .a2l or .elf file.

Most OpenECU targets have external SRAM. When the ECU is powered up, all of the calibration values are copied from the calibration area of flash to SRAM, and then the microcontroller memory is reconfigured so that further accesses to the calibration area are directed to SRAM. This means it is possible to change the values while the ECU is running ("calibration on the fly"). Therefore calibration parameters can be modified in PiSnoop just like RAM variables using Watch, Memory and Lookup windows.

There is also a specific Calibration Editor window which allows you to compare and combine calibration values from different files.

Each time you change a value, PiSnoop uses download commands to request that the ECU alters the memory values immediately. However, the values are lost if the ECU is depowered. To make the value changes permanent, the calibrations must be programmed into flash memory.

Some OpenECU targets, intended for production use, do not have external SRAM, to save cost. Calibration on the fly is not possible for these targets, because their calibrations are stored only in flash, which is read-only unless a flash reprogramming operation is performed. However, it is still possible to modify calibration values offline in PiSnoop and then reflash the calibration area with the new values. See Offline Calibration below.

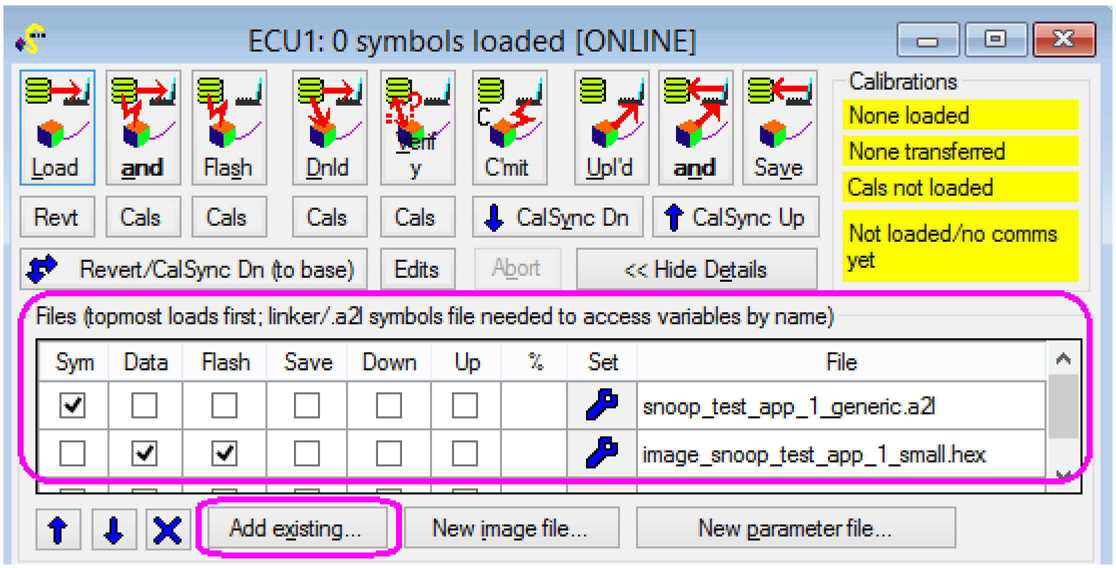
Loading Symbols and Default Values

To adapt calibration values, you will usually need:

- symbol file (.a2l or .elf), so that the names and addresses of parameters in the current build are known; you may load both an .a2l file (with parameters defined in data dictionaries) and an .elf file (containing all symbols, but without descriptions and ranges) simultaneously if desired. It does not matter which variety of .a2l file you use (_generic, _inca, _ati, _canape) from the OpenECU build.
- An image file (.s37 or .hex), which has the actual default data values which are normally loaded into flash memory. You can work with the "small" image file which contains both code and calibrations. If available however, only the "_cal" image file is actually required, and this is much smaller and quicker to flash to the ECU subsequently if the ECU already contains compatible code from precisely the same build of software.

Note: the image file is not required if you are working online with variables and do not need to see or upload changes from the original build values for calibrations.

The quickest way to add files to an ECU is to drag and drop them from Windows Explorer into PiSnoop. Alternatively, use the "Add existing..." button in the ECU window. Here the .a2l and .hex files have been loaded and the workspace saved in the same directory, so the relative file paths displayed are reduced to just the filenames:

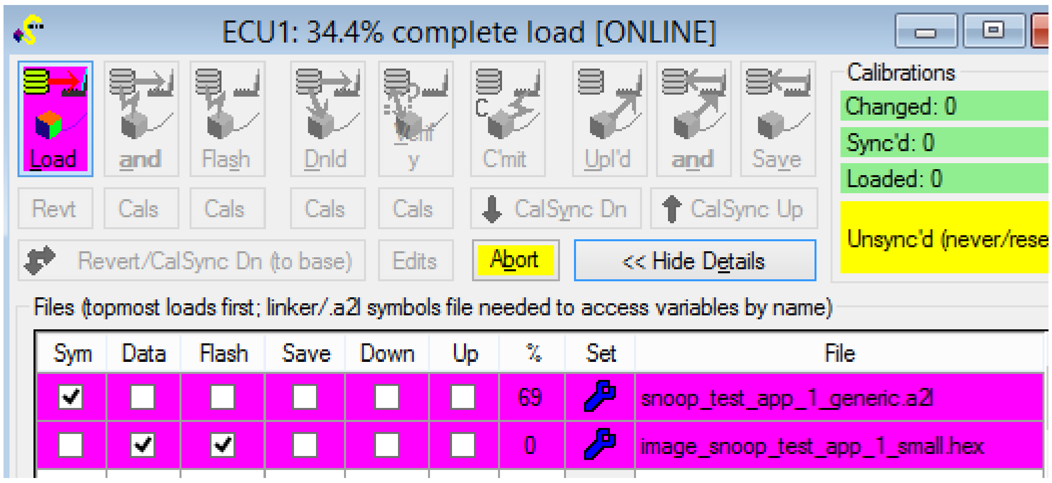


Files (topmost loads first; linker/.a2l symbols file needed to access variables by name)

Sym	Data	Flash	Save	Down	Up	%	Set	File
✓	☐	☐	☐	☐	☐			snoop_test_app_1_generic.a2l
☐	✓	✓	☐	☐	☐			image_snoop_test_app_1_small.hex

(It does not matter which variant of the OpenECU .a2l file you use, and both .hex and .s37 format image files can be used.)

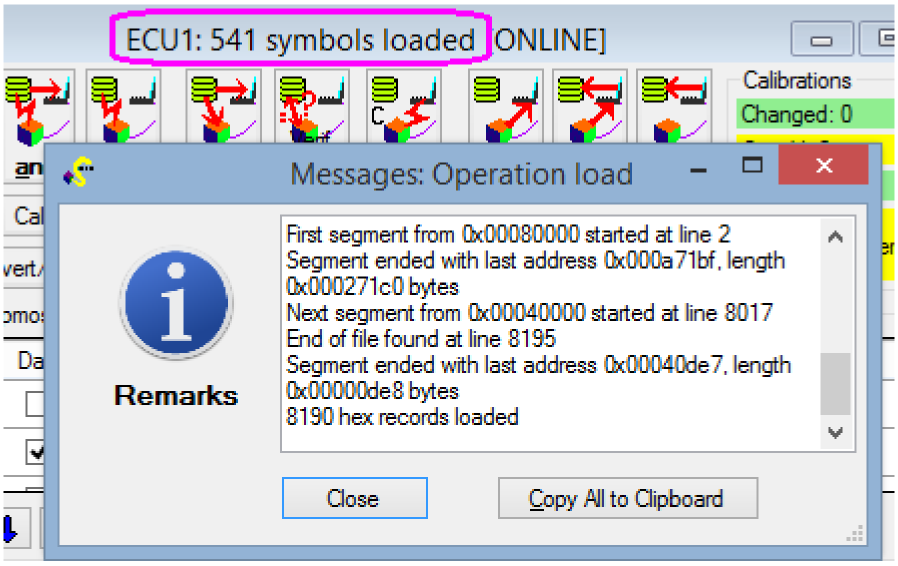
Click "Load" to load the symbols and data into PC memory in PiSnoop. While loading, the "Load" button is highlighted, and the percentage progress shown for each file and for the overall operation, which is typical during PiSnoop operations:



Files (topmost loads first; linker/.a2l symbols file needed to access variables by name)

Sym	Data	Flash	Save	Down	Up	%	Set	File
✓	☐	☐	☐	☐	☐	69		snoop_test_app_1_generic.a2l
☐	✓	✓	☐	☐	☐	0		image_snoop_test_app_1_small.hex

Once loading has completed, a message will appear, and the ECU window should indicate that symbols (parameter names and addresses) have been loaded:

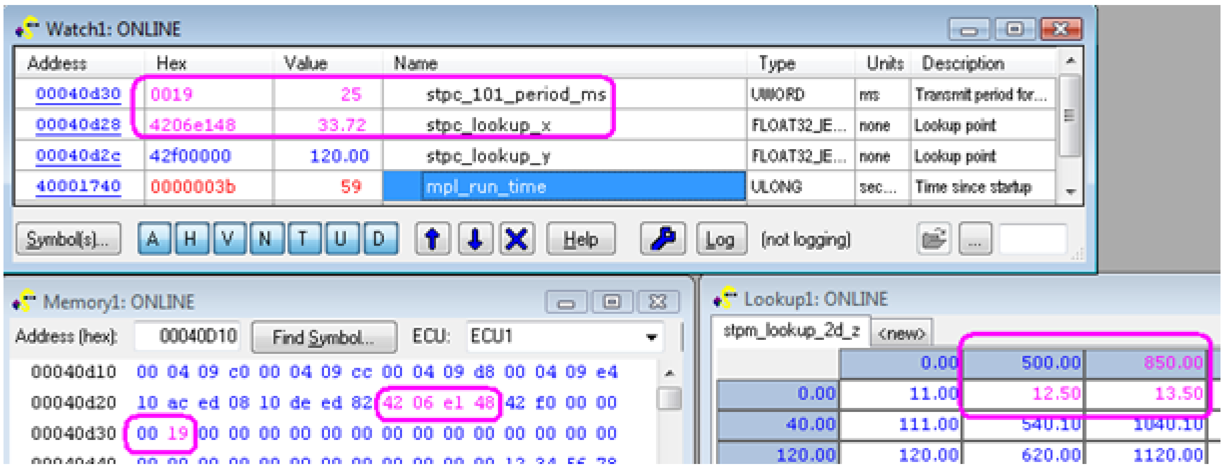


```
First segment from 0x00080000 started at line 2
Segment ended with last address 0x000a71bf, length
0x000271c0 bytes
Next segment from 0x00040000 started at line 8017
End of file found at line 8195
Segment ended with last address 0x00040de7, length
0x00000de8 bytes
8190 hex records loaded
```

You may now use Watch, Lookup and (with caution) Memory windows to edit the PC memory contents. Values which you have altered compared to the original values loaded from the .s37/.hex file are highlighted in colour:

- pale brown: offline value loaded from file (base value)
- green: offline value uploaded or edited in PC memory (same as base value, or no base value)
- purple: offline value which differs from file-loaded (base) value
- grey/question marks: unavailable (e.g. RAM measurement value not yet uploaded, when offline)
- blue: online value continually refreshed from ECU
- pink: online value from ECU which differs from loaded value in PC memory

For example, here the ECU is online, so most values are blue (live) or red (just changed). However, values that have been edited are pink (live, but value changed from the PC memory value loaded from the image file). Note that user-altered RAM variable values are never highlighted in pink, because they have no default values loaded from the image file.


Watch1: ONLINE

Address	Hex	Value	Name	Type	Units	Description
00040d30	0019	25	stpc_101_period_ms	UWORD	ms	Transmit period for...
00040d28	4206e148	33.72	stpc_lookup_x	FLOAT32_IE...	none	Lookup point
00040d2c	42f00000	120.00	stpc_lookup_y	FLOAT32_IE...	none	Lookup point
40001740	0000003b	59	mpl_run_time	ULONG	sec...	Time since startup

Memory1: ONLINE

Address (hex): 00040D10 Find Symbol... ECU: ECU1

```
00040d10  00 04 09 c0 00 04 09 cc 00 04 09 d8 00 04 09 e4
00040d20  10 ac ed 08 10 de ed 82 42 06 e1 48 42 f0 00 00
00040d30  00 19 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

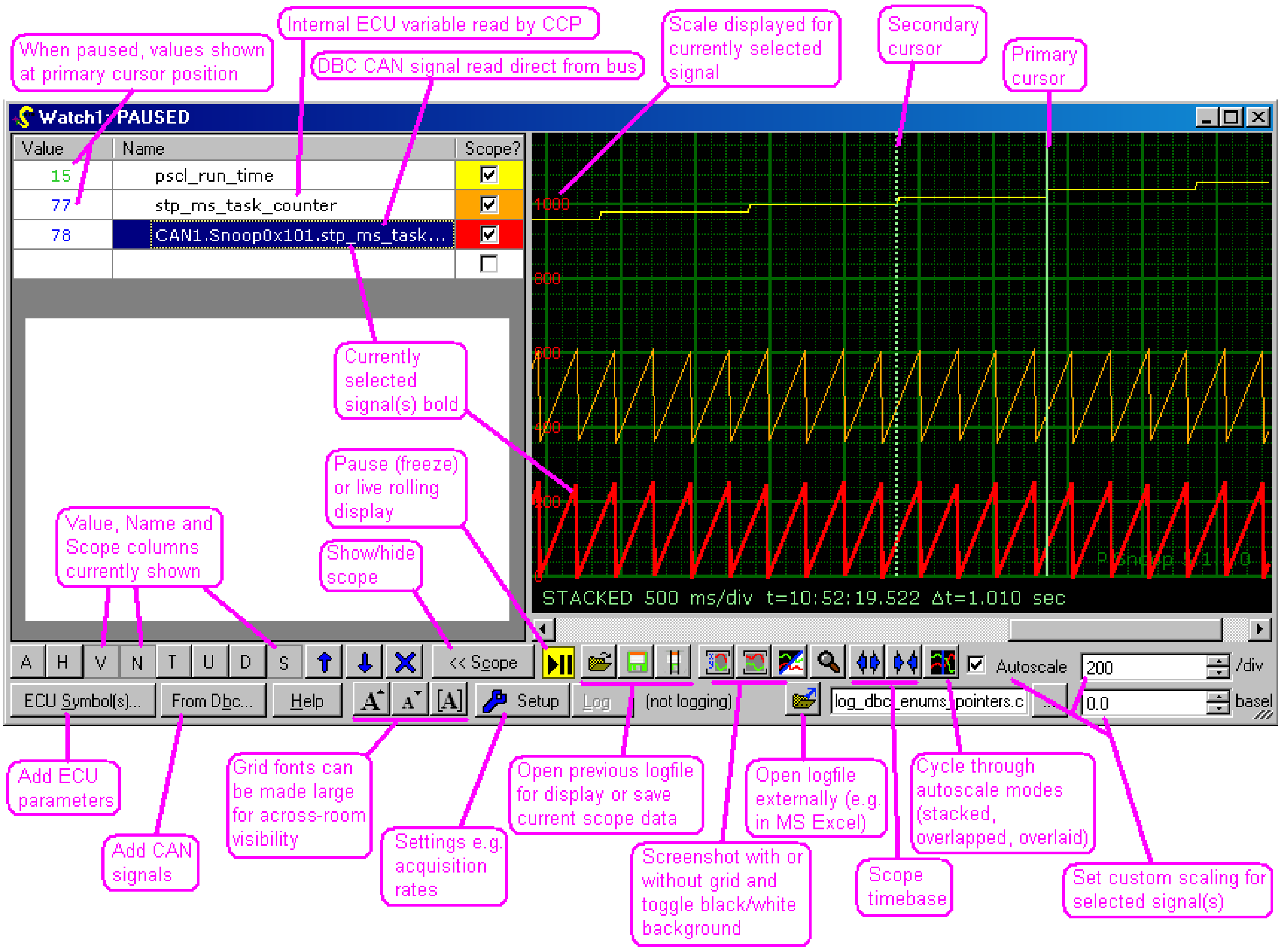
Lookup1: ONLINE

	0.00	500.00	850.00
0.00	11.00	12.50	13.50
40.00	111.00	540.10	1040.10
120.00	120.00	620.00	1120.00

Variable Value Logging

PiSnoop .CSV-format logfiles can be created either by saving data which has accumulated in the oscilloscope view (though old data is eventually discarded), or by starting a logfile. Old logfiles can be re-opened in a Watch/Scope window, or opened in an external program such as Microsoft Excel.

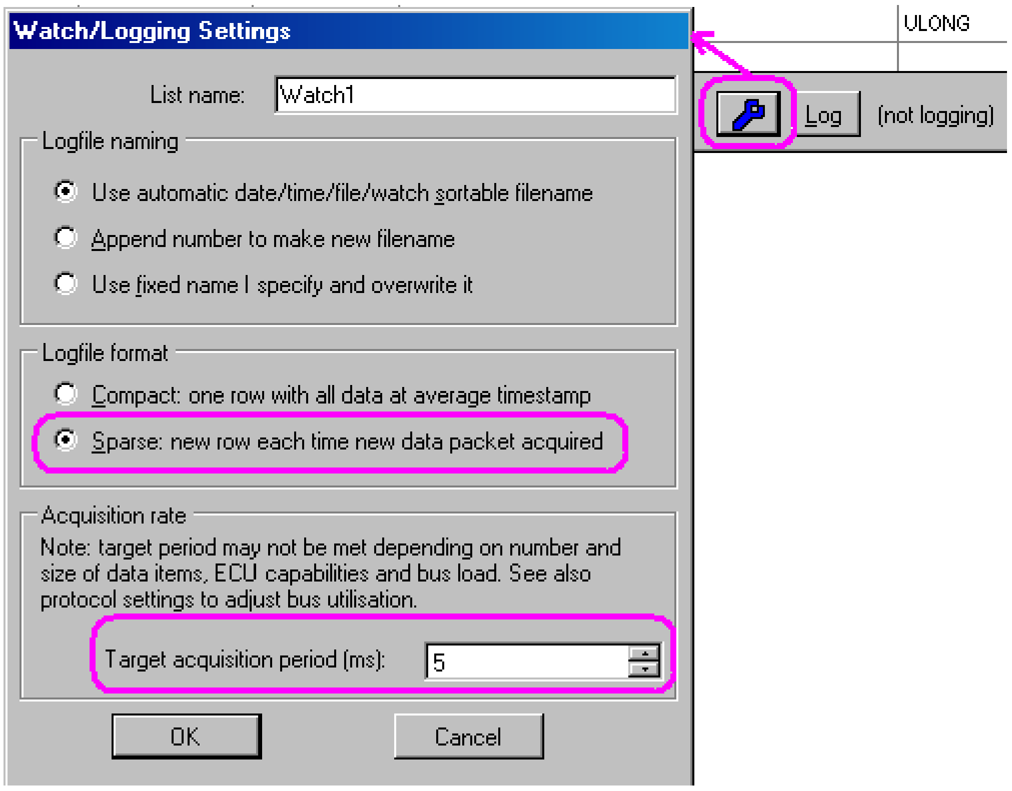
The scope view is shown below. See the main Watch window help for more details.


When paused, values shown at primary cursor position
Internal ECU variable read by CCP
DBC CAN signal read direct from bus
Scale displayed for currently selected signal
Secondary cursor
Primary cursor
Watch1 - PAUSED
Currently selected signal(s) bold
Pause (freeze) or live rolling display
Show/hide scope
Value, Name and Scope columns currently shown
STACKED 500 ms/div t=10:52:19.522 Δt=1.010 sec
<< Scope
Autoscale
200 /div
0.0 basel
ECU Symbol(s)...
From Dbc...
Help
Setup
Log
(not logging)
log_dbc_enums_pointers.c
Add ECU parameters
Add CAN signals
Grid fonts can be made large for across-room visibility
Settings e.g. acquisition rates
Open previous logfile for display or save current scope data
Screenshot with or without grid and toggle black/white background
Open logfile externally (e.g. in MS Excel)
Scope timebase
Cycle through autoscale modes (stacked, overlapped, overlaid)
Set custom scaling for selected signal(s)

Value	Name	Scope?
15	pscl_run_time	☑
77	stp_ms_task_counter	☑
78	CAN1.Snoop0x101.stp_ms_task...	☑
		☐

Click the spanner (wrench) icon to adjust logging settings. By default CCP DAQ is used to speed up data transfers when available, as it is for OpenECU, and currently 5 ms is the fastest supported rate for OpenECU targets. Click the 'Log' button to start logging.

If the ECU power is cycled during logging, data acquisition is automatically resumed when the ECU starts responding again. To log startup behaviour as fast as possible, choose a 5 ms rate and the 'Sparse' format option, and begin logging *before* you turn on the ECU.


Watch/Logging Settings

List name: Watch1

Logfile naming

- [✓ Use automatic date/time/file/watch sortable filename]
- Append number to make new filename
- Use fixed name I specify and overwrite it

Logfile format

- Compact: one row with all data at average timestamp
- [✓ Sparse: new row each time new data packet acquired]

Acquisition rate

Note: target period may not be met depending on number and size of data items, ECU capabilities and bus load. See also protocol settings to adjust bus utilisation.

Target acquisition period (ms): 5

Note: you may get a few extra datapoints by setting an even smaller target period (e.g. 1 ms), but these will be one-off uploads and not synchronised CCP-DAQ.

Nonsense Variable Values?

Both calibration parameters and RAM values will, in general, occupy different memory addresses in different software builds. If the software running is a different build to the one you have symbols loaded from (.a2l or .elf), values will appear non-sensical. To avoid this, always load symbols from precisely the build that is running in the ECU. The 'Load **and** Flash' button makes it easy to ensure that loaded symbols match the current build of software flashed into the ECU.

Warning: if you alter values when the wrong symbols are loaded, the effect on the ECU software is completely unpredicatable and it may well crash or exhibit other unexpected behaviour.

Although OpenECU does not currently support CCP-DAQ in reprogramming mode, it does support CCP uploads. Therefore PiSnoop will continue to display live values if the ECU is in reprogramming mode because FEPS has been applied or if the application is invalid, etc (see the OpenECU user guide for details of flash codes which indicate when the ECU is in this mode and for what reason).

Calibration values will appear normal in reprogramming mode, but cannot be altered as they are not 'shadowed' into external SRAM. An error will be reported if you try to change them.

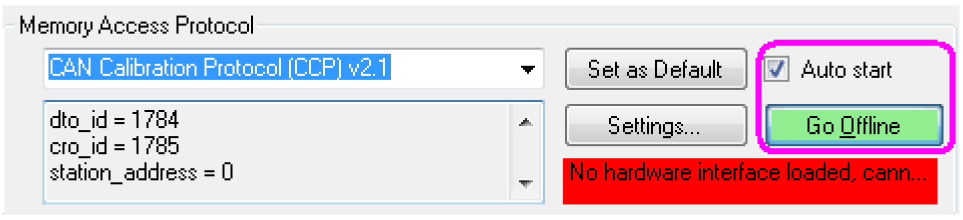
However, the boot loader has its own variables which occupy the same RAM space as the application variables uses when *it* is running. Therefore if you have application symbols loaded when the boot loader is running, the variable values will generally appear non-sensical. This is a similar situation to having the wrong application symbols loaded, and can be a clue that your ECU is in reprogramming mode unexpectedly (for example, if you have forgotten to cycle the ECU power after flash reprogramming).

Note: for OpenECU developers, it is of course possible to load the boot loader symbols to view the relevant variables correctly in reprogramming mode.

Offline Calibration

It is possible to adapt calibration values offline if no ECU is available, or if the ECU in use does not support "shadowing" of calibration parameters in RAM for on-the-fly value changes.

To work offline, create an ECU window if you do not already have one (File... New ECU) and then click **Go Offline** in the Memory Access Protocol section. Also uncheck "Auto Start" if you will regularly be working offline. (In this picture, no hardware channel is defined for ECU communications in any case, as no ECU is required at this stage.)

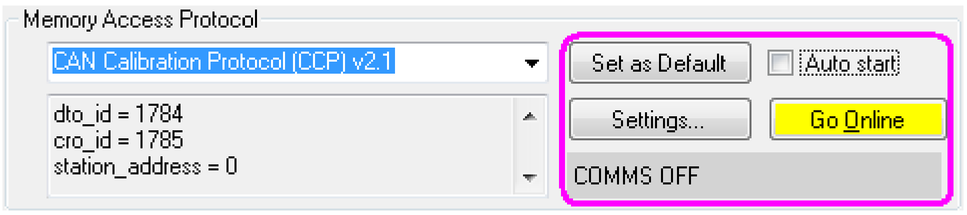

Memory Access Protocol

CAN Calibration Protocol (CCP) v2.1

dto_id = 1784
cro_id = 1785
station_address = 0

No hardware interface loaded, cann...

Once communications are turned off, the display will look like this:

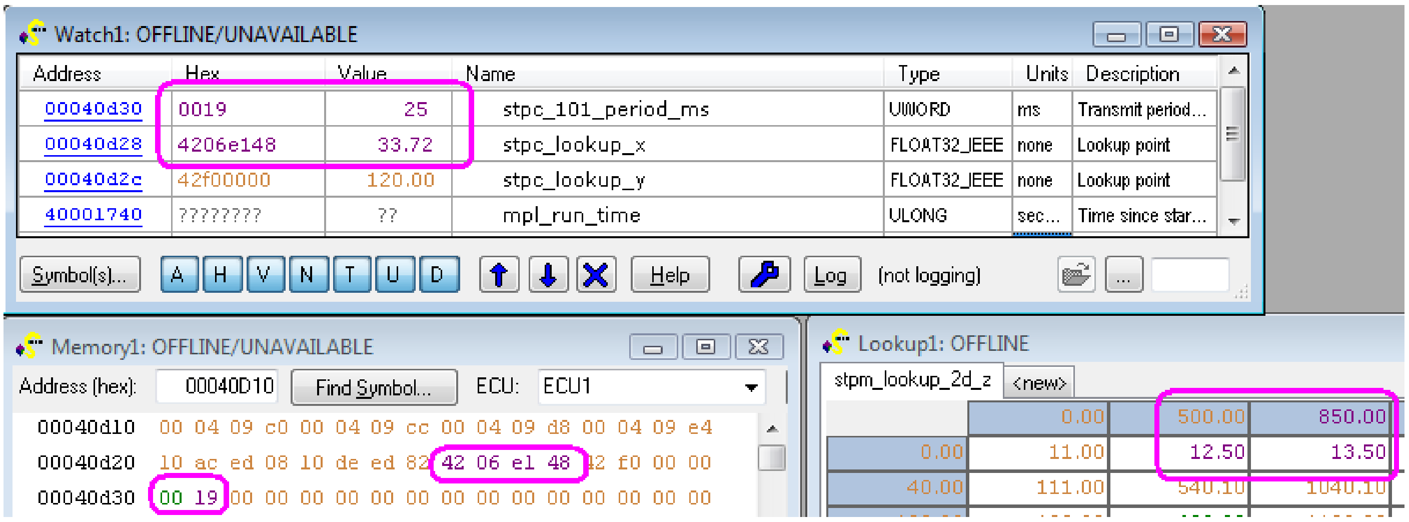

Memory Access Protocol

CAN Calibration Protocol (CCP) v2.1

dto_id = 1784
cro_id = 1785
station_address = 0

COMMS OFF

Now PiSnoop will work only with offline data in PC memory, and not attempt to upload or download data to an ECU. The calibration values loaded from the image file will be displayed in brown, and edited values differing from base values in purple:


Watch1: OFFLINE/UNAVAILABLE

Address	Hex	Value	Name	Type	Units	Description
00040d30	0019	25	stpc_101_period_ms	UWORD	ms	Transmit period...
00040d28	4206e148	33.72	stpc_lookup_x	FLOAT32_IEEE	none	Lookup point
00040d2c	42f00000	120.00	stpc_lookup_y	FLOAT32_IEEE	none	Lookup point
40001740	????????	??	mpl_run_time	ULONG	sec...	Time since star...

Memory1: OFFLINE/UNAVAILABLE

Address (hex): 00040D10 Find Symbol... ECU: ECU1

```
00040d10  00 04 09 c0 00 04 09 cc 00 04 09 d8 00 04 09 e4
00040d20  10 ac ed 08 10 de ed 82 42 06 e1 48 42 f0 00 00
00040d30  00 19 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

Lookup1: OFFLINE

stpm_lookup_2d_z <new>

	0.00	500.00	850.00
0.00	11.00	12.50	13.50
40.00	111.00	540.10	1040.10

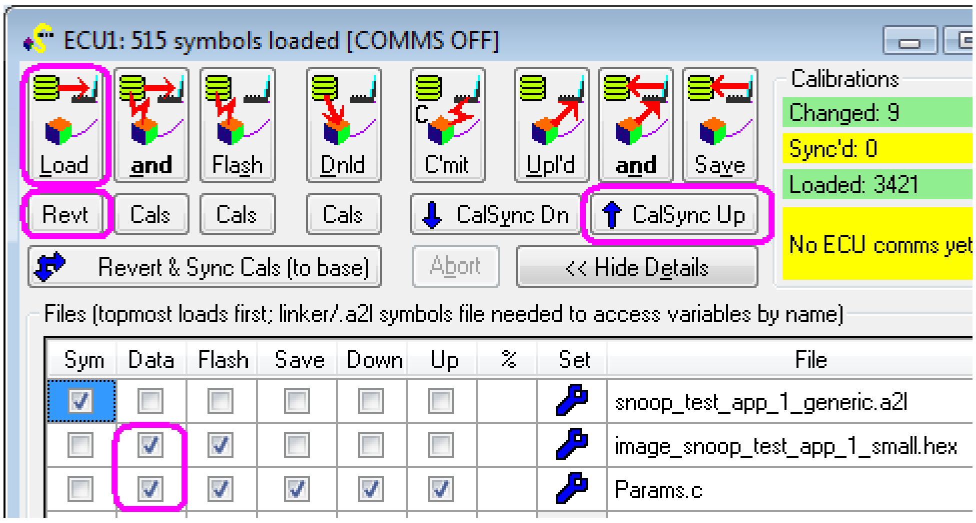
Managing Offline Calibration Values

Even with automatic memory access (live Watch updates) turned off, you can use the **CalSync Up** button to transfer all current calibration values from the ECU to the PC scratchpad memory. Use this if your ECU already contains a good calibration which you wish to make some modifications to.

Alternatively, you may have previous calibration edits saved as a parameter file, which can be loaded at the same time (or independently of) the base calibration from the .hex/.s37 image file. While the base values are loaded as "file" data, the parameters are loaded as "scratchpad" data, so that differences can be displayed and retained if the parameter file is re-saved after further edits. See also Saving calibrations as a parameter file below.

Finally, the **Rev't** (revert) button discards all calibration edit values from PC scratchpad memory and reverts to the base values loaded from the .hex/.s37 file.

For more detail on these controls, see the ECU help page. These particular options are highlighted below:



Files (topmost loads first; linker/.a2l symbols file needed to access variables by name)

Sym	Data	Flash	Save	Down	Up	%	Set	File
✓	☐	☐	☐	☐	☐		🔧	snoop_test_app_1_generic.a2l
☐	✓	✓	☐	☐	☐		🔧	image_snoop_test_app_1_small.hex
☐	✓	✓	✓	✓	✓		🔧	Params.c

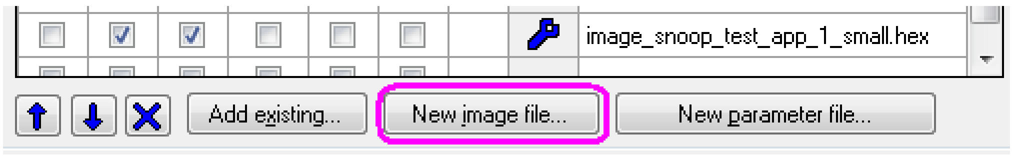
Saving calibrations as an image file

Note: this method is documented for completeness, but has the disadvantage that it only works for the current build (see below for saving as a parameter file which is portable between different builds of software).

Your altered calibration values can be simply saved back to the .s37/.hex file, so that if the file is later used for flash reprogramming, the ECU will get the edited values.

Warning: if program code bytes in the image file are edited, the program checksum will fail and/or the program will crash if run, with unpredictable results.

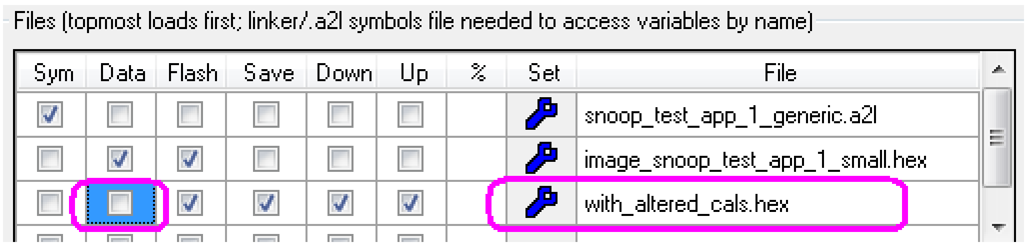
Alternatively a new .s37/.hex file can be created with your modified calibrations as follows:



☐	✓	✓	☐	☐	☐		🔧	image_snoop_test_app_1_small.hex

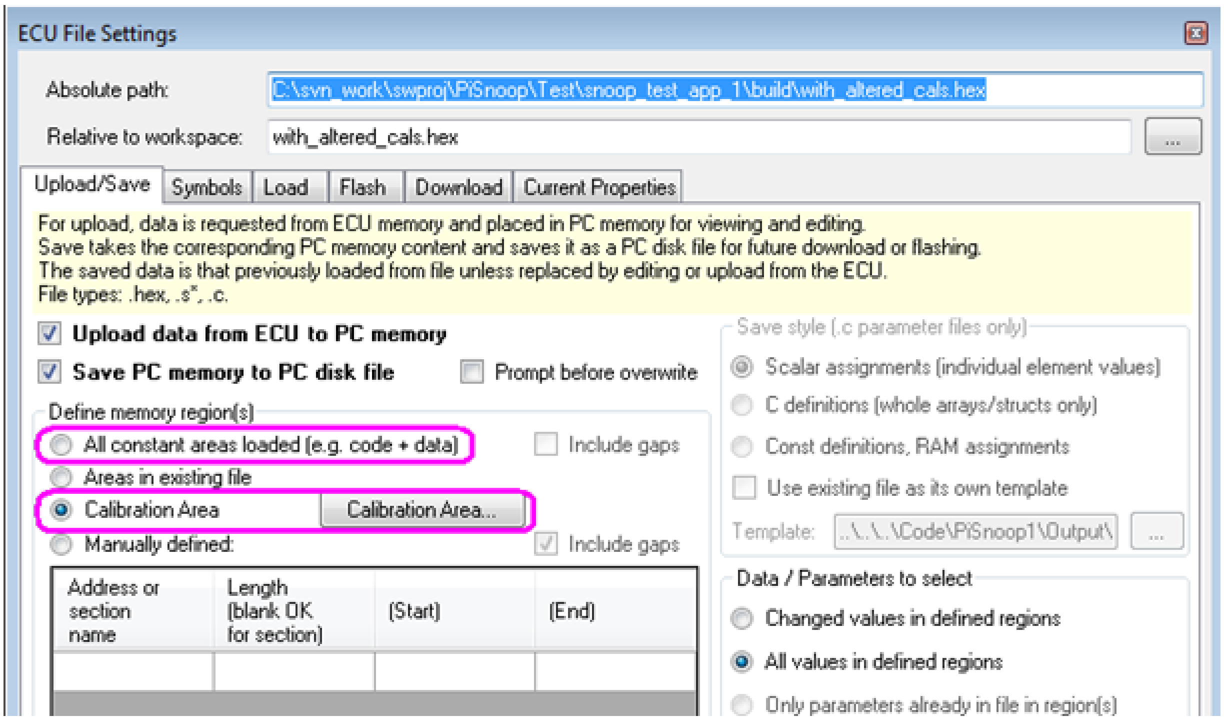
This can cover just the calibration parameter area of memory (for faster reprogramming, where the ECU already has code from exactly the same build), or the whole calibration + code area. The file properties are displayed automatically when you create a file; otherwise click on the spanner (wrench) icon.

Here 'Data' has been unchecked so that if the ECU is connected, the altered values will show up as modified compared to values loaded into PC memory. But if you wish to make offline edits in future, 'Data' should be checked so that the modified values are loaded into PC memory.



Files (topmost loads first; linker/.a2l symbols file needed to access variables by name)

Sym	Data	Flash	Save	Down	Up	%	Set	File
✓	☐	☐	☐	☐	☐		🔧	snoop_test_app_1_generic.a2l
☐	✓	✓	☐	☐	☐		🔧	image_snoop_test_app_1_small.hex
☐	☐	✓	✓	✓	✓		🔧	with_altered_cals.hex


ECU File Settings

Absolute path: C:\svn_work\swproj\PiSnoop\Test\snoop_test_app_1\build\with_altered_cals.hex

Relative to workspace: with_altered_cals.hex

Upload/Save | Symbols | Load | Flash | Download | Current Properties

For upload, data is requested from ECU memory and placed in PC memory for viewing and editing.
Save takes the corresponding PC memory content and saves it as a PC disk file for future download or flashing.
The saved data is that previously loaded from file unless replaced by editing or upload from the ECU.
File types: .hex, .s*, .c.

- [✓] Upload data from ECU to PC memory
- [✓] Save PC memory to PC disk file
- [ ] Prompt before overwrite

Define memory region(s)
- ( ) All constant areas loaded (e.g. code + data) — [ ] Include gaps
- ( ) Areas in existing file
- (●) Calibration Area — Calibration Area...
- ( ) Manually defined: — [✓] Include gaps

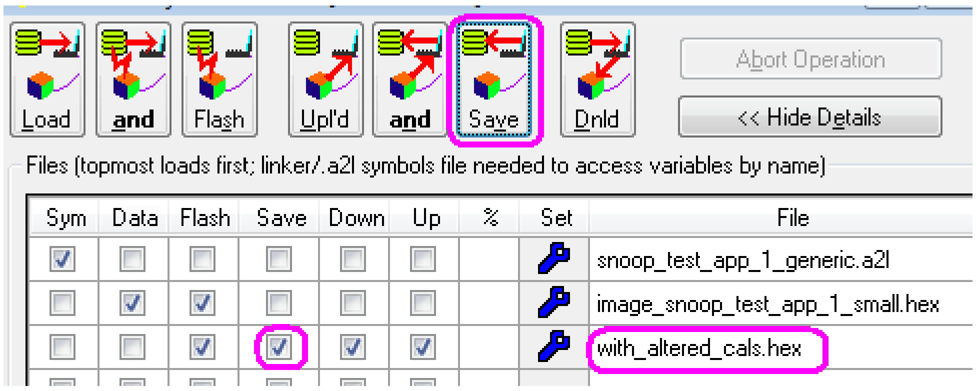
Address or section name	Length (blank OK for section)	(Start)	(End)

Save style (.c parameter files only)
- (●) Scalar assignments (individual element values)
- ( ) C definitions (whole arrays/structs only)
- ( ) Const definitions, RAM assignments
- [ ] Use existing file as its own template

Template: ..\..\..\Code\PiSnoop1\Output\

Data / Parameters to select
- ( ) Changed values in defined regions
- (●) All values in defined regions
- ( ) Only parameters already in file in region(s)

To actually save the modified image file, click '**Save**' if you are working offline (just saves PC memory to disk):



Files (topmost loads first; linker/.a2l symbols file needed to access variables by name)

Sym	Data	Flash	Save	Down	Up	%	Set	File
✓								snoop_test_app_1_generic.a2l
	✓	✓						image_snoop_test_app_1_small.hex
		✓	✓	✓	✓			with_altered_cals.hex

But if you are working online with an ECU, use the 'Upload **and** Save' button to ensure the latest values in ECU memory are first transferred to PC memory, and then saved to disk.

Saving calibrations as a parameter file

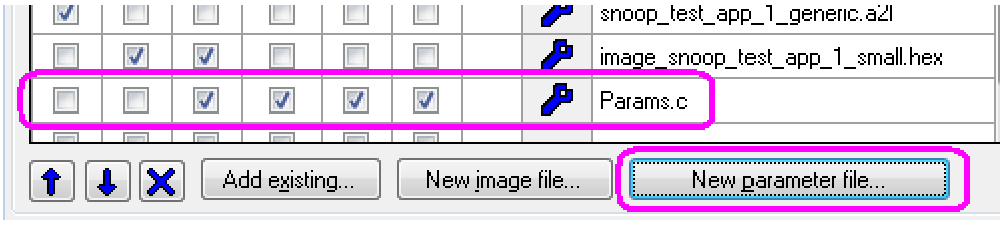
Each time you rebuild software, you should assume in general that parameter addresses will change. So if you wish to reuse the altered calibration values with a different build in future, those values must be stored by parameter name and not as a memory image.

Currently PiSnoop stores parameters in these formats:

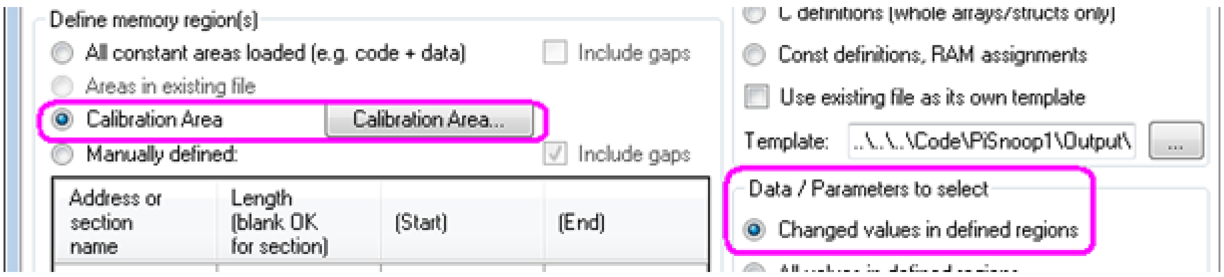
- A custom C file format. This allows the possibility that C code programs can actually have their source code value definitions updated.
- MATLAB M-file format*. This allows altered calibrations to be read into the MATLAB workspace to use in Simulink simulation.
- DCM format*. This is portable to some other calibration tools.

Note: currently OpenECU generates .a2l file entry names such as APD_STPM_LOOKUP_2D_X for an axis array called stpm_lookup_2d_x in the model. When saving in M-file format, the model-compatible name is used automatically.
**Ultimate variant required for these calibration file formats.*

Do 'New parameter file...' to create such a file:



By default the file will be configured to save only value changes compared to what was loaded from file in PC memory. This means that only those parameters you have actually edited will be used in future. Any other values defined in later builds will be left with their default values:


Define memory region(s)
All constant areas loaded (e.g. code + data)
Include gaps
Areas in existing file
Calibration Area
Calibration Area...
Manually defined:
Include gaps
Address or section name
Length (blank OK for section)
(Start)
(End)
C definitions (whole arrays/structs only)
Const definitions, RAM assignments
Use existing file as its own template
Template: ..\..\..\Code\PiSnoop1\Output\
...
Data / Parameters to select
Changed values in defined regions

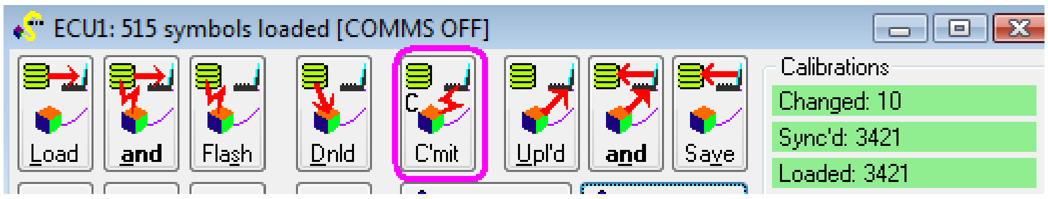
Again click '**Save**' to create the file if working offline, or 'Upload **and** Save' if working online with an ECU. You should find that the parameter file contains C-style statements which set up the values you have altered (you may drag and drop the file directly from PiSnoop to an editor):

```
void init_params(void)
{
    /* SNOOP_CONST_PARAM_ASSIGNMENTS_BELOW */
    APD_STPM_LOOKUP_2D_X[2] = 850.00;
    stpm_lookup_2d_z[1][0] = 12.50;
    stpm_lookup_2d_z[2][0] = 13.50;
    stpc_lookup_x = 33.72;
    stpc_101_period_ms = 25;
    /* SNOOP_CONST_PARAM_ASSIGNMENTS_ABOVE */
```

Programming the altered calibrations into the ECU

Instant Commit to Flash

If you are happy that the PC has all of the calibration values you require (e.g. loaded from file or uploaded from ECU, and then possibly edited), the fastest way to flash the ECU with the altered values is to use the Commit button:

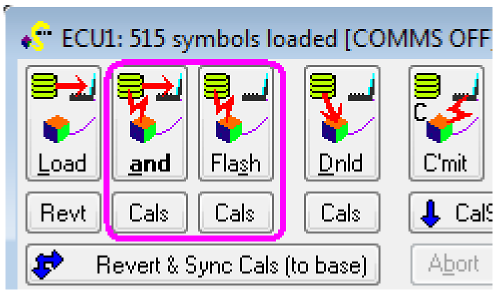


Flashing Calibrations using File(s)

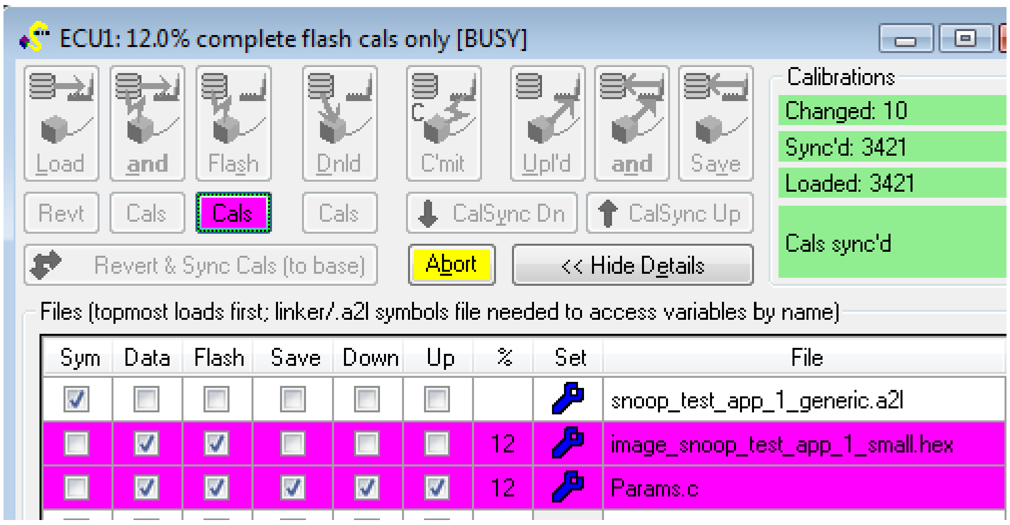
If flashing with a parameter (.c) file, you must also flash with an image file (.hex or .s37) covering the whole calibration area, so that values are defined for all memory locations used by your application. The parameter file values are then "superimposed" on top of the image file, if loaded in that order, so the values flashed to the ECU will be the parameter file values where defined, or the image file values otherwise. You may not flash with *only* a parameter file, because that would leave "gaps" of undefined values for all of the other memory locations, because the whole flash block is cleared to 0xFF values during the flash erase process.

If you have rebuilt software since you last flashed the ECU, you must reflash with the complete code + calibration image file (e.g. model_small.s37) so that the code and calibration locations are consistent, using the '**Flash**' or 'Load **and** Flash' button.

But if your ECU already has the current code flashed, you can use the '**Cals**' button underneath to flash only the calibration area, which is much faster, leaving the ECU code area untouched.


ECU1: 515 symbols loaded [COMMS OFF

In the picture below, symbols were already loaded and up to date, and the ECU code already matched the current build, so using just the 'Flash **Cals**' button is fine (and fast). If symbols were not previously loaded, or if a new build had been made since they were last loaded, the 'Load **and** Flash' or 'Load and Flash **Cals**' button should be used instead so that symbols are reloaded, in case any parameters have changed address or type since the last build.


ECU1: 12.0% complete flash cals only [BUSY]

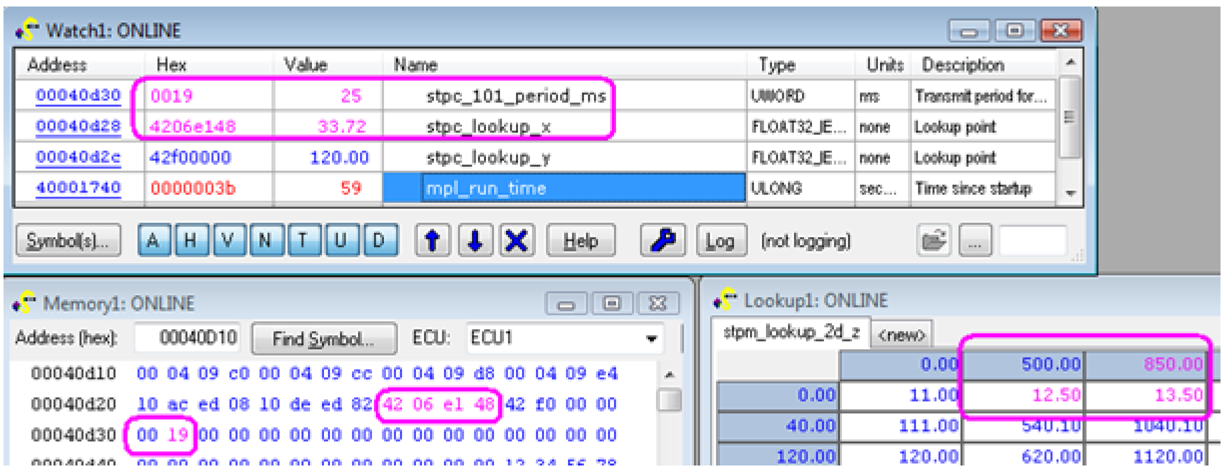
Calibrations
Changed: 10
Sync'd: 3421
Loaded: 3421
Cals sync'd

Files (topmost loads first; linker/.a2l symbols file needed to access variables by name)

Sym	Data	Flash	Save	Down	Up	%	Set	File
✓	☐	☐	☐	☐	☐			snoop_test_app_1_generic.a2l
☐	✓	✓	☐	☐	☐	12		image_snoop_test_app_1_small.hex
☐	✓	✓	✓	✓	✓	12		Params.c

After Calibration Flash Reprogramming

After flash reprogramming has completed and the ECU power is cycled, the online values show the calibration values previously edited are now permanently resident in ECU flash (highlighted in pink here because they differ from the loaded .hex file, which still contains the default build values):


Watch1: ONLINE

Address	Hex	Value	Name	Type	Units	Description
00040d30	0019	25	stpc_101_period_ms	UWORD	ms	Transmit period for...
00040d28	4206e148	33.72	stpc_lookup_x	FLOAT32_IE...	none	Lookup point
00040d2c	42f00000	120.00	stpc_lookup_y	FLOAT32_IE...	none	Lookup point
40001740	0000003b	59	mpl_run_time	ULONG	sec...	Time since startup

Memory1: ONLINE

Address (hex): 00040D10 ECU: ECU1

```
00040d10  00 04 09 c0 00 04 09 cc 00 04 09 d8 00 04 09 e4
00040d20  10 ac ed 08 10 de ed 82 42 06 e1 48 42 f0 00 00
00040d30  00 19 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

Lookup1: ONLINE

stpm_lookup_2d_z <new>

	0.00	500.00	850.00
0.00	11.00	12.50	13.50
40.00	111.00	540.10	1040.10
120.00	120.00	620.00	1120.00

Keeping Calibrations Synchronised with the ECU

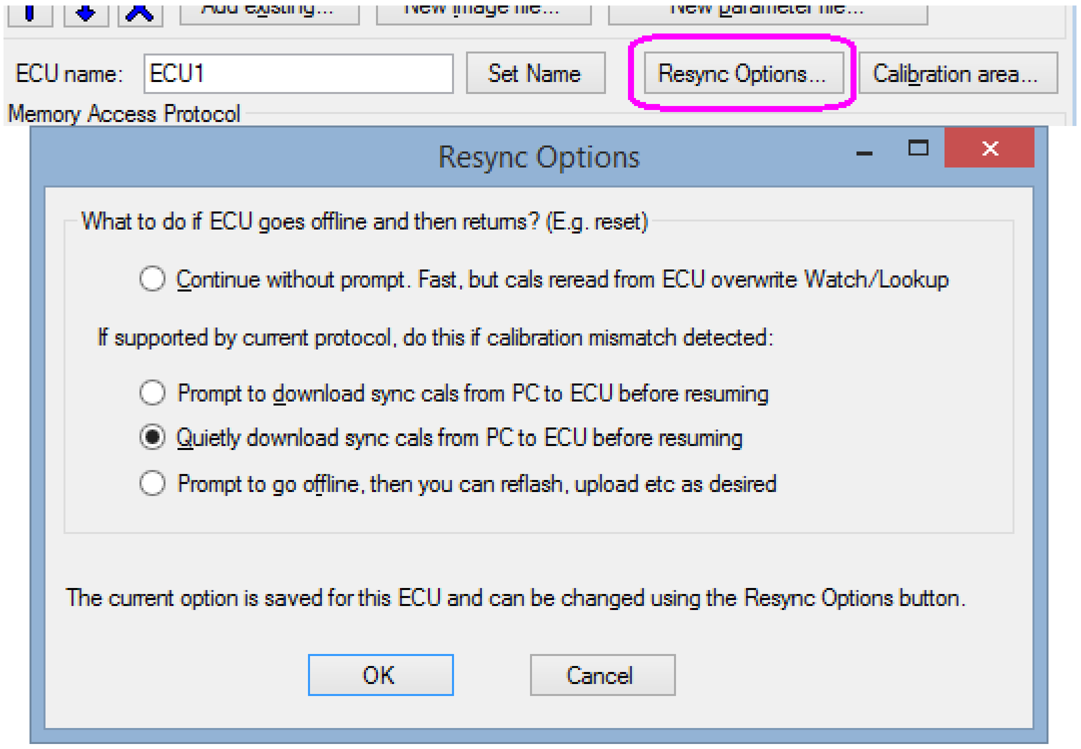
By default, PiSnoop continually uploads values in Watch and Lookup windows when online. It also allows Watch window logging and oscilloscope display to continue as soon as possible if the ECU resets or goes through a power cycle. This is best for uninterrupted debugging and for observing startup behaviour, when variable value changes within tens or hundreds of milliseconds after startup may be important.

However, during calibration work, this means that edited calibration values are "lost" if the ECU resets, because the post-reset ECU value will be automatically uploaded, overwriting any value you have displayed on screen. If your edits are saved in a parameter file, you can use the "Download calibrations" button manually to restore them.

But instead, you can choose to have the ECU calibration resynchronised with the PC automatically on reset.

Note: this only works with protocols that support the concept of a session such as CCP. It is not available with UDS or S3P for example.

To do this, bring up the Resync Options by clicking this button in the ECU window:



ECU name: ECU1

Resync Options

What to do if ECU goes offline and then returns? (E.g. reset)

- ( ) Continue without prompt. Fast, but cals reread from ECU overwrite Watch/Lookup

If supported by current protocol, do this if calibration mismatch detected:

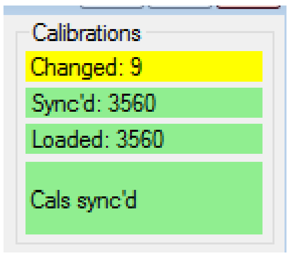
- ( ) Prompt to download sync cals from PC to ECU before resuming
- [✓ Quietly download sync cals from PC to ECU before resuming]
- ( ) Prompt to go offline, then you can reflash, upload etc as desired

The current option is saved for this ECU and can be changed using the Resync Options button.

Choosing the "Quietly download sync cals" option pictured causes PiSnoop to do the following when a reset or power cycle is detected:

1. First, go offline, so that no post-reset calibration values from the ECU overwrite the current values in Watch or Lookup windows.
2. Verify whether the ECU calibration area memory contents match the PC scratchpad memory (loaded values plus edits).
3. If necessary, perform a "calsync down" download operation, to restore the ECU calibration values to the current PC values.
4. Finally, go back online.

The result of this process is that within a short time of any reset, the ECU calibration is restored to the values you have been working with in PiSnoop. This is indicated in the ECU window:


Calibrations
Changed: 9
Sync'd: 3560
Loaded: 3560
Cals sync'd

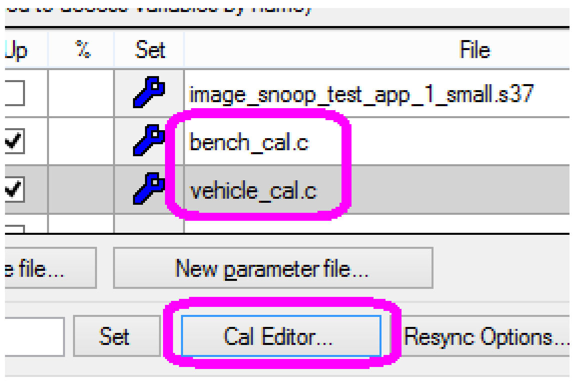
But remember this resync process takes some time, so it should be turned off if you wish to observe fast ECU startup behaviour. Note also that the download of calibrations to the ECU is not instantaneous, and before it completes, the ECU will be using its post-reset values (e.g. base values).

For more detail on the other options see Calibration Help.

Comparing and Merging Calibration Parameter Files

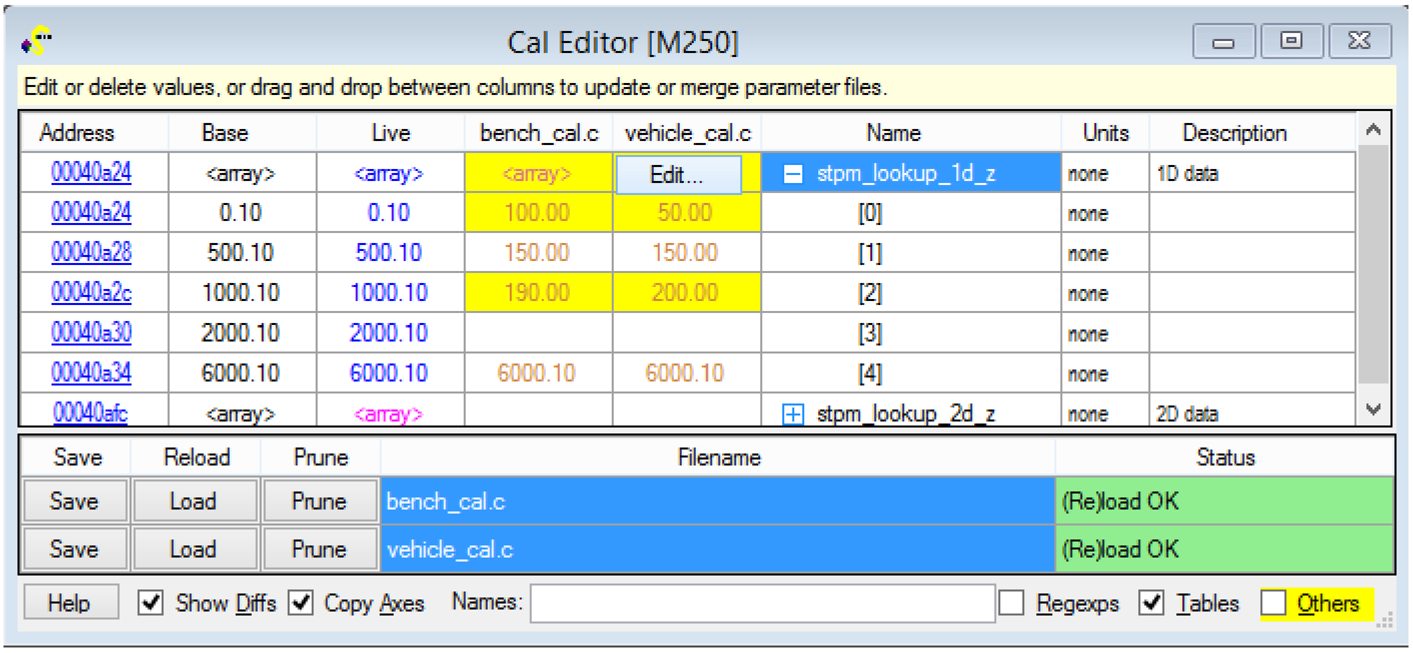
The Calibration Editor allows you to display the base, ECU and paramter file values of calibrations side by side, edit them, highlight differences, and drag values from one to another.

It is launched from the ECU Window by clicking the "Cal Editor..." button:



Up	%	Set	File
☐			image_snoop_test_app_1_small.s37
✓			bench_cal.c
✓			vehicle_cal.c

The Calibration Editor then appears listing the values for all parameters in the calibration area of memory:



Edit or delete values, or drag and drop between columns to update or merge parameter files.

Address	Base	Live	bench_cal.c	vehicle_cal.c	Name	Units	Description
00040a24	<array>	<array>	<array>	Edit...	⊟ stpm_lookup_1d_z	none	1D data
00040a24	0.10	0.10	100.00	50.00	[0]	none	
00040a28	500.10	500.10	150.00	150.00	[1]	none	
00040a2c	1000.10	1000.10	190.00	200.00	[2]	none	
00040a30	2000.10	2000.10			[3]	none	
00040a34	6000.10	6000.10	6000.10	6000.10	[4]	none	
00040afc	<array>	<array>			⊞ stpm_lookup_2d_z	none	2D data

Save	Reload	Prune	Filename	Status
Save	Load	Prune	bench_cal.c	(Re)load OK
Save	Load	Prune	vehicle_cal.c	(Re)load OK

Help ☑ Show Diffs ☑ Copy Axes Names: ☐ Regexps ☑ Tables ☐ Others

See Calibration Editor Help for more.

Return to Getting Started (in PiSnoop online help only)