

Manual and technical specs for Sys-Check II

3rd place in the ABBUC hardware contest 2014 (category “final”)

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Introduction of Sys-Check II

The project “Sys-Check” was initiated to first enable simple diagnostics of defective or problematic Atari XL/XE computers without the having to open the case. The second goal is to simplify the identification and location of bad components.

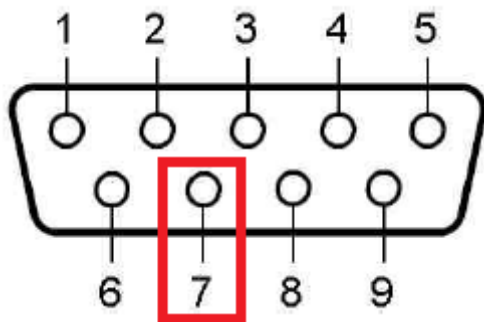
Sys-Check (from here on the “II” will be removed, because the first revision never was released to the public) is a PCB which can be connected to either an Atari 600 XL or 800 XL with a PBI connector or to an Atari 65 XE, Atari 800 XE or Atari 130 XE with ECI and cartridge connector. Some 65 XE models don’t have an ECI, unfortunately, the Sys-Check cannot be used with those.

For normal usage as a diagnostic card the DIP switches no. 1 and 2 must be in position “OFF” (pointing to the closer right border of the PCB).

Sys-Check also works fine with an Atari 600 XL, but this model should be equipped with 64 KByte main memory, otherwise you will always get errors while testing.

Usage of Sys-Check

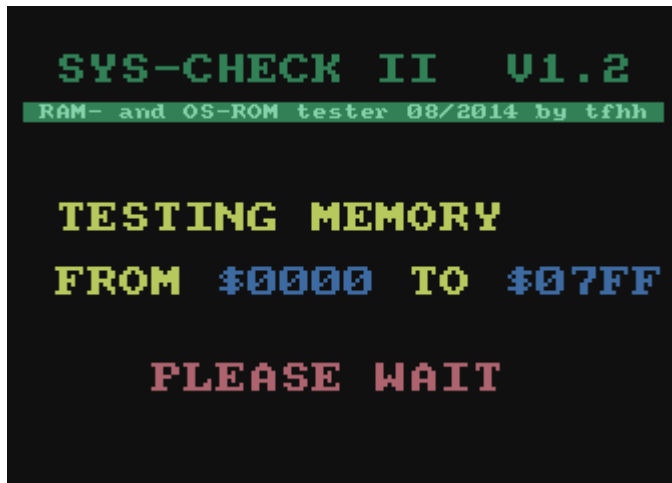
When using Sys-Check with an Atari 800 XL that does not have the “PBI 5 volts patch”, the attached red cable must be inserted to pin 7 of joystickport 2! When using an Atari 600 XL or any XE model this cable **must not** be attached.



(View in front of joystickport 2 from Atari 800 XL)

To make Sys-Check work properly please detach any inserted cartridge first. Normally this shouldn’t cause any issue, because Sys-Check deactivates internal MMU routings most times, but it’s better to have the computer without any unneeded accessories. The internal BASIC ROM is always disabled while Sys-Check is plugged in.

After the Sys-Check is inserted into the computer, and the computer is powered on, Sys-Check will immediately start with the first test:



The first 2 KByte of memory will be tested in one pass.

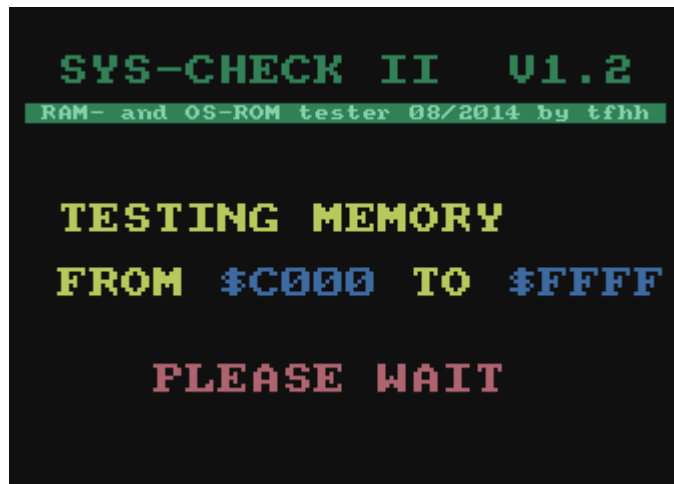
When Sys-Check reaches this point, the following statements are valid:

- CPU, ANTIC and GTIA works mostly fine
- There's no short-circuit over address- and databus-lines
- Power supply and internal power distribution seems to be stable

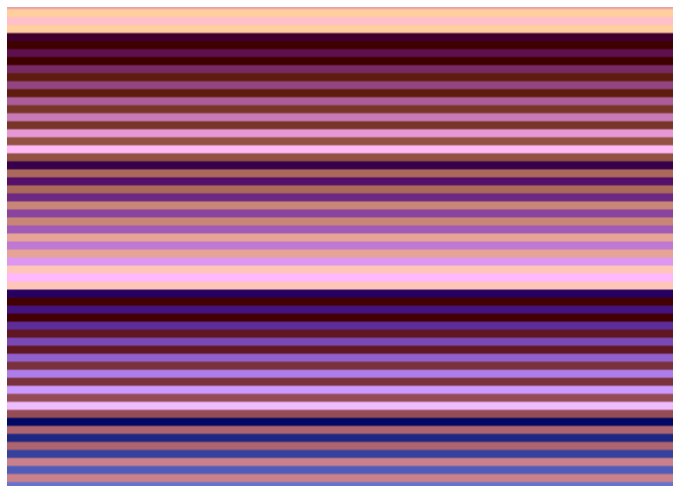
After testing the first 2 KByte of memory, the rest of 48 KByte main memory will be tested in pages of 256 Bytes each:



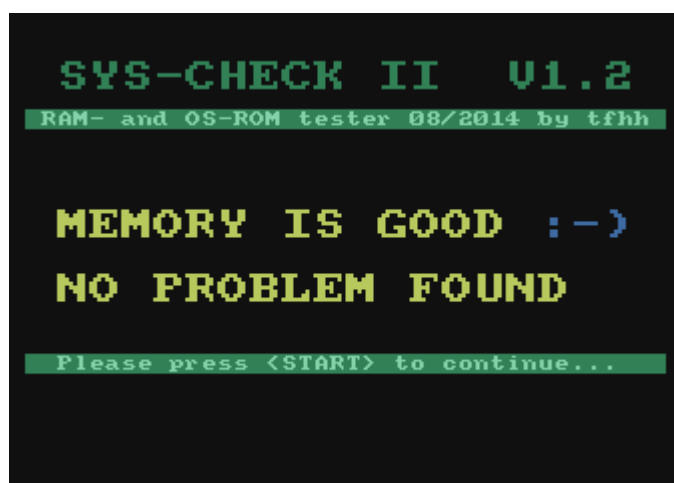
Memory from \$0800 to \$BFFF will be checked in pages. After testing the "lower" 48 KBytes, the upper 16 KByte "under the operating system" will be also investigated.



While testing this area of memory, the display will be turned off to avoid graphic flickering. To give feedback that the tests are in progress, the border color will be cycled in a manner similar to many well known Atari programs...



After successfully testing the upper 16 Kbytes, this screen should appear:

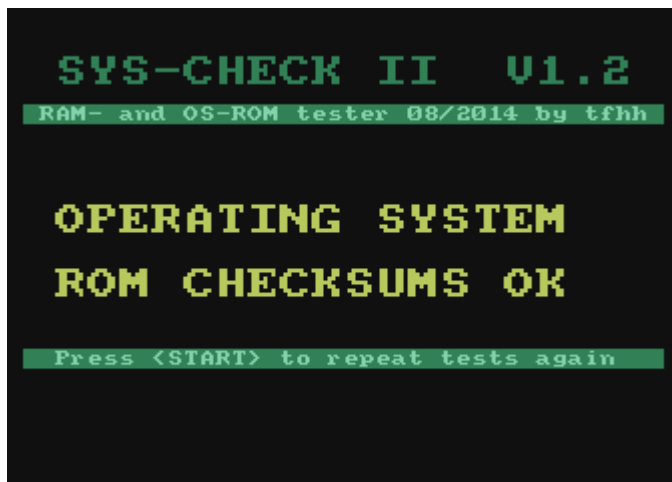


Now press START to continue. You also can press the fire button of a joystick in port 1.

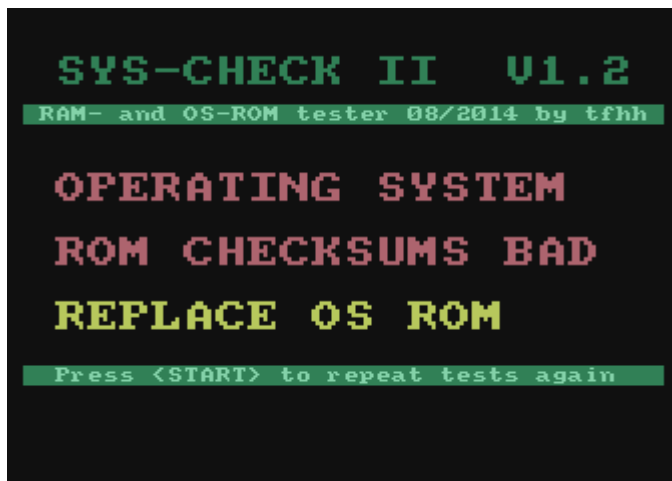
In order for Sys-Check to work properly, not all main components must be present. POKEY and PIA can be detached for the main tests, also the BASIC and Operating System ROM. Even the entire memory could be removed, but this isn't very useful for a memory test ☺

The following tests will check the Operating System ROM, so it should be present. Also the PIA must be present. Sys-Check calculates the checksums like XL/XE OS does it within the “Self Test”.

The possible results of this test are shown in two screens:



Checksums are OK – fine!



Or...

In this case the saved checksums (or what could be read by the CPU from the ROM or EPROM) doesn't match the calculated one. In some cases (some patched OS) this is normal, because some OS versions doesn't have correct checksums and/or the checksum routine is disabled or removed. Genuine XL/XE Operating Systems on ROM must (!) pass this test without failure.

Hint: When a computer is dead (no blue “Graphics 0” screen after powering on) it's always a good idea to remove all hardware mods, patched OS versions and so on. If possible, insert a genuine OS ROM from any working XL/XE, remove BASIC ROM if possible to exclude these parts from being the source of trouble.

Remark: over many years spent repairing 8-Bit Atari computers I have noticed some cases where bad OS ROMs are the reason why the computer doesn't work. Typical a red border screen (NTSC) or brown one (PAL) indicates a failure of memory – memory is so bad, that the stack (\$0100-\$01FF) couldn't be used and so the Operating System reset routines couldn't work properly. If there enough defective bits of RAM to prevent Operating System from starting, then the border color changes to black and nothing happens. When there are only “some” defective bits, the Self Test will start. But a red/brown border could also be caused by a non-functional Operating System ROM or EPROM.

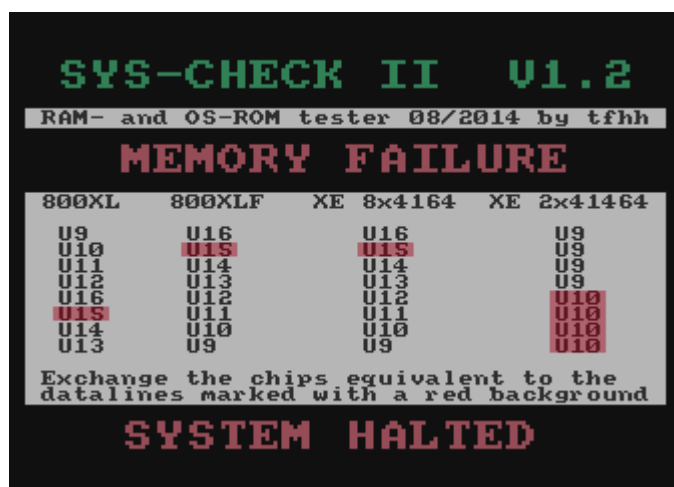
After this test, you can switch off the computer or restart the tests by pressing START (or fire button of joystick 1) again.

Detection of bad memory

An experienced Atari user will quickly recognize when the computer has some memory issues. When the computer is one of the really old series, then it's simple: Just remove the socketed DRAMs chips one by one until the bad one is found. Or change all eight DRAMs with a working set and then replace one by one from the old set to identify the bad chip(s). It's easy and quickly done.

But if the computer is a XE or a newer XL, the chips are directly soldered onto the mainboard. Even if the "Self Test" starts - the display from the Self Test's memory test, which indicates defective KByte, is quite useless, because you didn't know which one of the eight DRAMs (or more) is really bad.

This behavior provides the most powerful reason to use Sys-Check. When Sys-Check detects bad memory, it displays it like the following screen:



This example shows a defective databit 6. The screen shows exactly which DRAM chip you will need to exchange depending on the computer's model you're investigating. The position and name of the chip are the same as on your real mainboard.

This failure screen shows up four columns:

Column 1 "800 XL"

This is the mostly common version of the Atari 800 XL computer. It has five chips with 40 pins each. No difference between NTSC or PAL systems.

Column 2 "800 XLF"

This version is the newer 800 XL mainboard with the "Freddie" MMU. It has six chips with 40 pins each and the mainboard is marked with "800 XLF" in the upper right corner near the SIO plug.

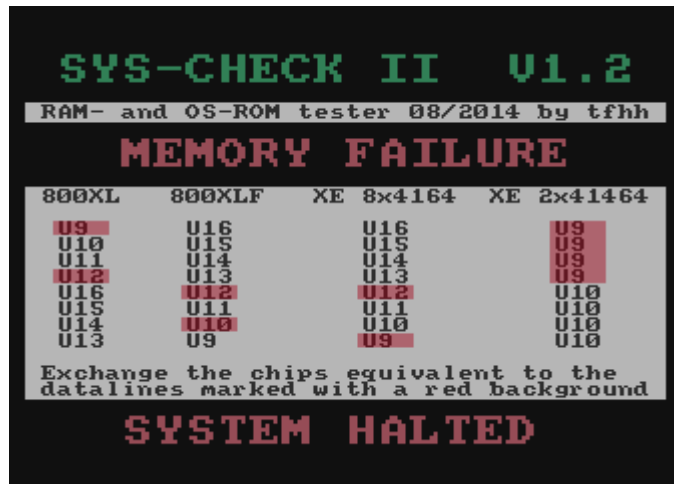
Column 3 "XE 8x4164"

Here are the positions of (bad) DRAM chips used in an Atari XE with 8 or 16 DRAM chips (marked with "4164" or similar each). The 130 XE model has 16 chips, all other only eight. The main memory (and the one tested by Sys-Check) is located always on the most left side from the mainboard. Also suitable for Atari 65 XE models.

Column 4 "XE 2x41464"

The last column explains the position of bad memory in the XE models with only 2 or 4 DRAM chips (each marked with 41464 or similar). This DRAM model holds 4 databits in one package. This is the reason, why always 4 bits are shown defective – you'll always have to change it.

In some cases more than one bit resp. the databus lines are faulty. Sys-Check also indicates this, see next screen:



This example shows two defective bits, 0 and 3. As you can see it in the column description, even the chip markings (Uxx) are the same, not all internal wirings are the same, databit 0 is U10 on 800 XLF, but U9 on XE.

This test could also be repeated by pressing START or fire button of joystick 1.

Now it's time to heat the iron, remove the bad memory and solder in a new one (better use sockets). In the most cases this should fix your Atari completely ☺

What Sys-Check can't do

Performing magic. There's not enough power in such a small thing ☺

When there are short-circuits, no system clock is generated or one of the major chips (MMU, ANTIC, GTIA or at least the CPU) are faulty, then Sys-Check can't work. Sys-Check isn't a cure-all. But as practice shows, 90% of all dead Atari computers are caused by bad DRAMs or ROMs. The search for faulty parts could be shortened with Sys-Check in a significant way.

In some rare cases I recognize that Sys-Check marks all bits as faulty. Or with every restart of the tests different bits will be marked as bad. Mostly this appears with "Micron" DRAMs. This behavior results in random defective bits and couldn't be displayed correctly by Sys-Check. When you have the right equipment (i.e. an Oscilloscope), take a look on the memory-addresslines A0...A7.

When Sys-Check doesn't work

... some possible reasons:

- CPU, ANTIC, GTIA, MMU or other major parts are really faulty
- Power supply is unstable
- Short-circuits
- PBI or ECI/Cartridge connector contacts are coated with dirt and so on

Atari XL:

Detach the mainboard from the case. Remove all shields and so on. Use an eraser to clean the PBI contacts. If another mod has added solder to the contacts of PBI, remove all extra solder as much as possible. Clean again with eraser. Remember to clean both sides ☺

Atari XE:

Use compressed air and/or a vacuum cleaner to clear the spaces between contact guides of the ECI and cartridge connector. If you see some dirt on it, use a piece of cardboard and move it up and down between the contacts – never sideways! This may damage the contacts.

Please do not use any of these “contact sprays” !!!

Don't forget to check the power. A lit up LED on the keyboard is NOT a sign for a good power. Check the voltages on the lower right corner of the mainboard – when it's below 4.75 volts, replace the power supply.

Tips for troubleshooting

Sometimes Sys-Check doesn't find a memory failure, but OS ROM will be shown as bad, even if you exchange it with a known good one. Or the memory from \$0000-\$BFFF is always fine, but the memory test from \$C000-\$FFFF indicates multiple errors.

When this behavior continues after changing the OS ROM, then you should also try changing the PIA. You can do another pre-test: Just plug an EPROM with the Atari 400/800 OS (“OLD-OS”) into your XL/XE. When the computer starts with the OLD-OS, but with the XL/XE OS not, then the PIA is definitely faulty.

Hint: Sys-Check was tested with a bunch of mainboards and very bad memory chips I collected over the years from repairs.

New since V1.3: in the earlier version of this document I report some problems with Sys-Check occasionally not reporting defective chips. This only happens when using XE computers. After performing many many tests I remembered one important difference between XL and XE: The XE family hasn't any pull-up resistors on the eight datalines. So when one DRAM chip is missing or a special kind of failure is occurring, then there's a floating situation on the bus – this might cause some wrong outputs. With firmware V1.3, I change the way of detecting bad bits, so now this behavior is gone.

Outlook

Sys-Check has the option to be “more”. When I find the time, I will add some more features for diagnosis. As an ideal, I prefer the tests from the Atari CPS (Consumer Product Service) S.A.L.T. diagnostic cartridge plus some modern tests for memory expansions. Also some simple external tests are possible, such as testing the joystick ports.

But please be patient! It may take months until I write some news (or code).

Autopsy of Sys-Check

It was my intention to make Sys-Check easy to solder and generally a simple D.I.Y. project. No SMD parts are used, only THT (through the hole) components. Each component has enough space between the next one. The PCB is fully marked with names and positions, so even a beginner should be able to easily assemble his (or her) Sys-Check.

These are the major components of Sys-Check:

SRAM 32 KByte:

Two pieces fits on the PCB. You can either use the big version (600 mil) or the smaller one (300 mil) as found on older PC mainboards, used as cache RAM. This way both chips emulate the entire 64 KByte main memory.

EPROM 27128, 27256, 27512, 27010/271001 or Flash SST39SF010A:

This ROM, EPROM or Flash holds the Sys-Check firmware or any XL/XE operating-system and will be shown in the memory are from \$C000 up to \$FFFF. If a 32 KB (27256) EPROM is used, the Sys-Check firmware must be located at the EPROM's space from \$4000...\$7FFF (all V1.xx versions)!

74LS123:

Used to generate a shortened PHI2 signal. This is needed to generate stable write signals for SRAM.

74LS74:

This chip will be used as a latch for PB0 and PB7 when writing to \$D301 (Port B of PIA). With this both signals the memory areas will be switched.

Left GAL 22V10 (Address Decoder):

This chip decodes the whole 16 bit address bus and generates chip select signals for the 74LS74 and the second GAL.

Right GAL 22V10 (Main):

The "glue" chip of Sys-Check. Used for SRAM chip select, write signals, EPROM chip select, mode selection and other things.

Functionality of Sys-Check

The nerds must not read this – just take a look into the GAL sources and schematics and everything should be clear. I hope so ☺

This chapter is only a short overview about the internal components.

In the normal mode of operation (see description of the DIP switches in the next chapter) Sys-Check claims the complete address range of the Atari computer except the I/O area (\$D000...\$D7FF). Both of the SRAMs are used as 64 KByte RAM from \$0000...\$FFFF and the EPROM takes place between \$C000...\$FFFF. Depending on the PIA PB0 and PB7 the address areas are changed the same way the MMU does it. Sys-Check drains the REF-line (Refresh) low to get control of the system. This is the same way tools such as TurboFreezer do it.

Sys-Check's firmware, especially the first part, is programmed to run without even a single byte of RAM to be in working condition. Once the first 2 KByte are tested good, some small routines are copied into this area to switch between real RAM on the mainboard, emulated RAM on Sys-Check and so on.

To make this possible, Sys-Check uses a self-defined I/O port at \$D406. This address is unused by ANTIC and was claimed for Sys-Check.

\$D406 map:

| | |
|-------------|--|
| Bit 0: | When 0, then the SRAM on Sys-Check's PCB is active. When 1, then the RAM on the XL/XE mainboard will be accessed |
| Bit 1: | When 0, then the ROM or EPROM on Sys-Check's PCB is selected, otherwise the ROM or EPROM located on the XL/XE mainboard. |
| Bit 2: | Address line A14 to Sys-Check's ROM/EPROM socket (see below) |
| Bits 3...7: | No function |

Sys-Check's firmware actually fits into 16 KBytes, a 27128 EPROM is enough. But for future expansion it's possible to use a 27256 EPROM with 32 KBytes. To make future expansions possible, I include some kind of bankswitching.

Address line A14 could be set or unset by writing to bit 2 of Sys-Check's configuration byte at \$D406. The meaning of this bit is negated. Writing bit 2 to zero means that A14 on the ROM/EPROM's socket is logical 1 and vice versa.

The reason for doing it this way is to allow the possibility of using real Atari ROMs on Sys-Check's PCB. Some genuine Atari XL/XE operating system ROMs require to be pin 27 (A14) at high level, otherwise they will not output any data. These kind of ROMs use pin 27 as a second chip enable signal, which is high active. All Atari XL/XE places for the OS ROM have pin 27 connected directly to +5 volts, so Sys-Check's logic set this pin also to high level until bit 2 of \$D406 is programmed to 1.

At least nearly all operating systems clear the I/O area at coldstart while writing zeros from \$D000...\$D3FF (except \$D301 in XL/XE OS). Without negotiation at this part any OS would hang up the computer, jumping elsewhere.

Setup the DIP switches

On Sys-Check's PCB you will find some little switches, called "DIP switches". They have numbers on each switch, beginning with 1 up to 4. You will find them close to the ROM/EPROM socket.

For normal use of operation, please set the DIP switches 1 and 2 to position "OFF". The DIP switches 3 and 4 are to selecting one of four operating systems or the Sys-Check firmware.

A fine spin-off from the first goal using Sys-Check as a diagnostic card is the possibility to use it as an external operating system switcher. For this reason you have the option to select up to four different operating systems and/or Sys-Check firmware options – if you take a big EPROM or the Flash SST39SF010A. The Flash chip could be programmed from the Atari itself, so no external programmer or tool is needed. To update the flash by yourself, special software will be provided by me.

List of usable ROM-memory types:

- EPROM 27128: One XL/XE operating system or one Sys-Check V1.xx firmware
- EPROM 27256: One XL/XE operating system or one Sys-Check V1.xx & V2.xx firmware
- EPROM 27512: Two XL/XE operating systems or two Sys-Check V1.xx & V2.xx firmware or one of each
- EPROM 27010/271001: Four XL/XE operating systems or four Sys-Check V1.xx & V2.xx firmware or three operating systems and one Sys-Check firmware and so on...
- Flash SST39SF010A: Like EPROM 27010, but the content of the Flash could be changed from Atari by yourself

With DIP switch 3 and 4 you select the desired operating system or Sys-Check firmware. The maximum size of used memory limits the amount of usable operating systems, of course.

When using a genuine Atari XL/XE operating system ROM or an EPROM 27128 / 27256, the DIP switches 3 and 4 are without function. When using an EPROM 27512, DIP switch 3 selects between both of the possible operating systems, DIP switch 4 is without function.

If Sys-Check is equipped with a SST39SF010A flash or a 27010/271001 EPROM, up to four operating systems or Sys-Check firmware could be used. Here's the list how to select them:

| | | |
|------------|------------|--|
| DIP 3: ON | DIP 4: ON | Operating System or Sys-Check Firmware no. 1 |
| DIP 3: OFF | DIP 4: ON | Operating System or Sys-Check Firmware no. 2 |
| DIP 3: ON | DIP 4: OFF | Operating System or Sys-Check Firmware no. 3 |
| DIP 3: OFF | DIP 4: OFF | Operating System or Sys-Check Firmware no. 4 |

When you get the D.I.Y. assembly kit from me, the included flash SST39SF010A is pre-programmed with the following versions:

| | |
|------------|--|
| Firmware 1 | Sys-Check Firmware V1.3 |
| Firmware 2 | Genuine Atari XL/XE operating system w/o any patches, version 2 (CO61598B) |
| Firmware 3 | QMEG 4.04 |
| Firmware 4 | Genuine Atari XL/XE operating system with Hias' Highspeed-SIO Patch V1.30 |

If you want use Sys-Check as a diagnostic system, please set the DIP switches to the following positions:

DIP switch no. 4: ON
DIP switch no. 3: ON
DIP switch no. 2: OFF
DIP switch no. 1: OFF

The other two DIP switches; 1 and 2 control the usage of memory (RAM and ROM) and where each type of memory is selected:

| | |
|----------------------------|--|
| DIP 1: OFF DIP 2: OFF | This is the general setting for use of Sys-Check as a diagnostic system. External RAM (on Sys-Check PCB) and also external ROM is selected. Any cartridges plugged in (Atari XL only) and internal ATARI-Basic are always disabled. |
| DIP 1: ON DIP 2: OFF | Choose this setting if you want to use Sys-Check as an external operating system switcher. The internal RAM (in the ATARI computer) is used, but ROM (operating system) is provided by Sys-Check PCB. With this setting all cartridges and ATARI-Basic could be used. |
| DIP 1: OFF DIP 2: ON | This setting enables only the external RAM on Sys-Check PCB, but the internal ROM (operating system) built-in the Atari computer was taken. All Cartridges and ATARI-Basic are always disabled in this mode of operation. Useful to check the computer for more defects than simply bad RAM. |
| DIP 1: ON DIP 2: ON | This setting disables Sys-Check completely. |

Ideas, Complains, Wishes, Thoughts

My intentions when creating Sys-Check were based on an uncountable number of XL/XE computers with defective memory – mostly with the “evil” Micron DRAMs. Often I got the versions with directly soldered DRAM chips, and not in all situations the piggy-pack way (putting a working DRAM over each DRAM on the mainboard one by one and test if the computer’s booting up) works well.

So maybe you’ve got a great idea? Something is wrong? You want new features?

Please share your idea or comment with me. When it’s possible, I will include it in one of the next firmware versions. Or I will correct something wrong. But please give feedback – that’s the only way to work out things or make it better.

PLEASE use only email to contact me. I’m not often in forums like AtariAge, so information could get lost. Just drop me an email to tf_hh@gmx.de – Use the word ATARI in the subject.

At last, if you found some horrible english language mistakes, also let me now. I’ve done this translation on my own, because the version produced by Google translator or similar tools are... funny, but not very helpful. Maybe this is better than the machines ☺