twiSTEr

Thunderstorm-Team

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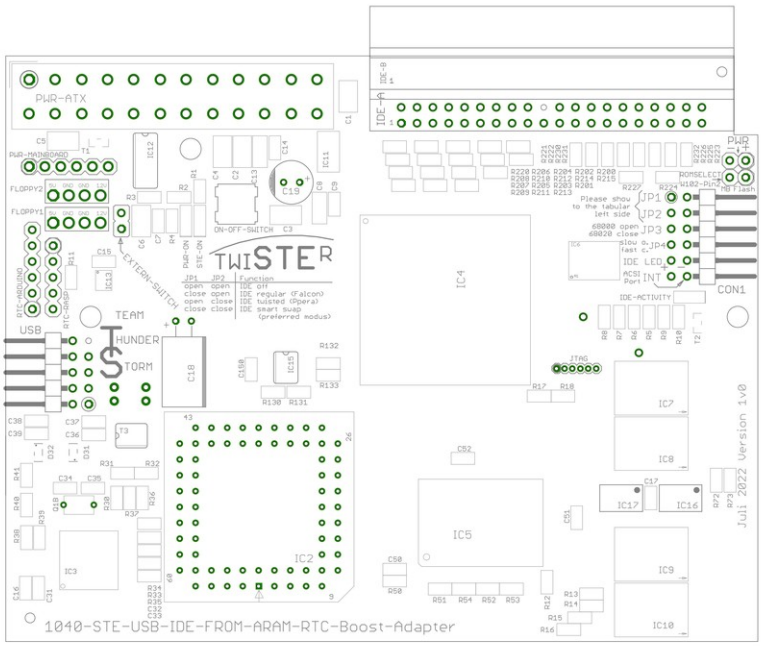

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acknowledgement

A special mention and a very big thank you goes to Götz Hoffart for proofreading this text.

Inhaltsverzeichnis

1 About this guide

1.1 Foreword

First of all, we would like to congratulate you on your purchase of the combination card, the TWISTER , for the 1040 STE! We hope that you will enjoy this product in the long run and that you will have a lot of fun with the card. The TWISTER was created by a team of five people in their spare time. It has been tested for all possible combinations of use. The aim of the development was always to create a stable and well functioning map for the 1040 STE. It should be possible to switch back to the original 1040 STE at any time in order to have the best possible compatibility with one's usual computer.

We, that is a group of five persons[1] who have decided to develop various extensions for the Atari ST and Atari TT. The resulting products do not aim to make money from development. We do this development because we enjoy it. The payment for our products is primarily used to recoup the material and assembly costs. Sure, there is a little money left over, but we use it to collect new ideas and pre-finance prototypes. Once such a product is on the market, we don't leave our customers out in the cold. Support for our products also covers a significant part of our free time.

We would like to thank our loyal customers and also for the many constructive feedbacks on our products. We have been able to collect a number of suggestions, which in turn have been incorporated into the improvement of our products, including in this case our latest product: the TWISTER .

You can usually reach us Five well via the forum
`https://forum.atari-home.de`.
If you have any questions, suggestions or help, please do not hesitate to contact us.

The previous manuals for our products were usually written in pure ASCII format so that they could be delivered on a diskette with the product. The manual should always be readable on the Atari as well. At the same time an extensive installation manual was deposited on the
`https://www.newtosworld.de/viewforum.php?f=33`
homepage. However, the maintenance of the above homepage does not offer as many creative possibilities as such a text created in LaTeX. We hereby dare a new idea!

The layout of the TWISTER has been created with the programme EAGLE. These written instructions have been produced using the typesetting and layout program LaTeX[2].

[1] For those who have not yet heard the names, here in detail in alphabetical order of the surnames: Matthias Gaczensky (GaGa), Robert Rohlfing (R^2), Ingo Uhlemann (tuxie), Christian Zietz (czietz), Holger Zimmermann (Pakman)

[2] Please note, that this is a german Latex version. So some text passages, e.g., under the pictures reads "Abbildung" and not as it would be more correct "picture". We apologize for this in the English edition.

1.2 Legal matters

A few legal notes may be permitted. You have purchased an expansion card with the name TWISTER for your Atari 1040 STE via a private sale. Thus you have bought such a card, but not the installation in your computer – you have to do this yourself. The private sale is made under exclusion of warranty for material defects.

By purchasing the TWISTER combination card, we guarantee the proper operation of this card. The card has been tested in general during its development time and also each individual product has been tested for proper function before delivery. The card can be used in an Atari 1040 STE with the installation instructions described in this manual. The TWISTER is *not* intended for use in the Mega STE.

We are expressly not liable for defects and damage to your own computer. If damage occurs to your computer, you are responsible for this damage.

We are also not liable for any personal injury that may occur as a result of opening and/or handling your computer. We draw your attention to the fact that high voltages exist in your computer which can lead to life-threatening injuries. Please ensure that you protect yourself adequately against damage.

1.3 The name of the product

The name TWISTER refers to a tornado with incredible strength. It usually rages in North and Central America. It draws its strength and power from its elongated vortex, which stretches from the ground to the highest layers of air. The twister is narrow and rotates quickly. Its power and speed were the reasons why the combination card for the 1040 STE was so named. With its two processors and extensive enhancements, it is an exceptional combination for the 1040 STE with high speed and many comfort features.

To make it clear that it is a product for the 1040 STE, the three letters within the product name are slightly highlighted. The result is: The TWISTER .

1.4 Scope of delivery

In the scope of delivery of the TWISTER you will not only find the actual board, the TWISTER , but also a few more things. You will find the following things in your package:

- bracket with two USB sockets
- floppy disk with additional programs and more readme files
- additional cables, some of them already pre-assembled and possibly soldered to the TWISTER

- Additional components for the conversion of the mainboard (e.g. the 33 pF capacitor for the /BG line on the mainboard).

If there are any other items in your package, these are friendly *additives*. They are included because they may have had to wait a little longer - due to component availability or similar. - had to wait a little longer for your parcel. Or because we simply wanted to give you a treat. In most cases, a free clock module is included in the package.

The scope of delivery thus includes not only hardware, but also software[3] and form a good complete package for the start. A hard disk driver is not included in the scope of delivery and may have to be purchased elsewhere. A pre-assembled bracket for the rear of the computer is also not included. There are several reasons for this. On the one hand, no user has yet agreed to offer a solution for this. Should this happen, we will certainly try to negotiate an addition with this user. On the other hand, this is due to the fact that the customers' design wishes are as individual as our customers themselves (use of a Pico ATX power supply, use of the original power supply, design of the jumpers as toggle or slide switches, ... and many more ideas).

1.5 Structure of this guide

With a product as extensive as the present combination card TWISTER for the Atari 1040 STE, it is always difficult to find the beginning and also to choose a structure so that every reader or user can find his way around with it. In the present text we have chosen a classical way of a manual.

The size of this manual does not correspond to today's practice! It is rather, like in the good old Atari times, *larger and more detailed*. You might be put off by the fact that it's not a short Facebook or Twitter message note[4]. You have to bite through the text a little more. For the experienced Atari mechanic, it is certainly worth skipping the chapter on disassembling the computer. You can do the same – generally – with the other chapters. If you want, you can go straight to the appendix. There are short checklists that describe the entire conversion and installation in a compact form. The installation is then done and the essential things should be known. However, if you still have questions, please also read the previous chapters! There are a lot of things (worth knowing) explained there. Perhaps many questions will then become superfluous.☺

First of all, the disassembly of the computer, modifications to the computer and the installation of the board follow. The following chapter provides an overview of all the functions of the board. In the respective subchapters, the respective function of the product is explained in more detail. In each of these subchapters there is usually a general section, then a description of the hardware with instructions on how to connect something (external), and finally a note on any necessary software and its setting options.

[3] The creation and testing of hardware takes time. But also the creation and testing of the enclosed software requires time and effort. As a reminder, software and hardware are created in one's spare time.

[4] Which, unfortunately, are all too often devoid of any content.

We have tried to limit the pictures to the essentials. The appearance of the software and the dialogue boxes – if available – may also differ from software version to software version. We apologise in advance if we have perhaps not integrated the latest status in the instructions here and will describe the function more textually.

1.6 Tools and installation aids

The TWISTER is – except for one cable – a so-called plug-and-play solution. For the actual installation of the card, very few tools are needed. There are (unfortunately) also changes to be made to the mainboard itself, but these are not particularly complex. All necessary cables or various small components for commissioning the TWISTER are included in the scope of delivery. The following things are needed for the conversion of the mainboard and the installation of the TWISTER itself:

- screwdriver, very small, to lever the PLCC processor out of its socket. Alternatively, a PLCC extractor is also very useful here, if available.
- a soldering iron and a bit of solder to connect the /INT signal for the IDE hard drive to the TWISTER using a cable, as well as to make a few other small changes on the motherboard.
- a multimeter can be very helpful.

To open the case of your Atari 1040 STE, a bit more tools are certainly necessary, but they should be found in every well-stocked household:

- Phillips screwdriver, small size (PH1)
- Phillips screwdriver, medium size (PH2)
- Flat nose pliers, medium size, to straighten the sheet metal lugs of the sheet metal trim.
- Patience[5].

Do not forget! Before opening your Atari, please remove the power cable. Proceed slowly and with the greatest care when disassembling the Atari. If necessary, write down which part belongs where later.

[5] OK! Admittedly, here it will be difficult to find such a thing in a household.

1.7 The disassembly of the 1040 STE

The assembly of the Atari 1040 STE is actually logical and simple. You can't do much wrong. If something doesn't come apart immediately, please don't use a lot of force. Surely you have forgotten a screw or two. If you always keep in mind that the Atari has been assembled by humans, you know that you can disassemble it yourself without destroying anything!

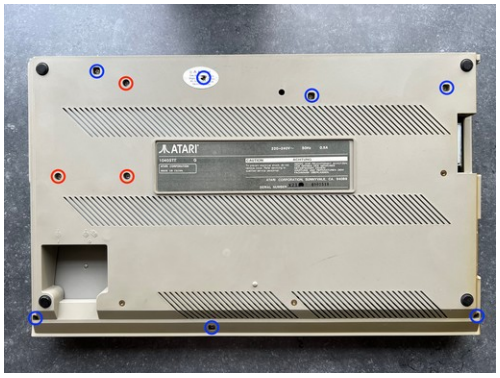


Abbildung 1: underside of computer

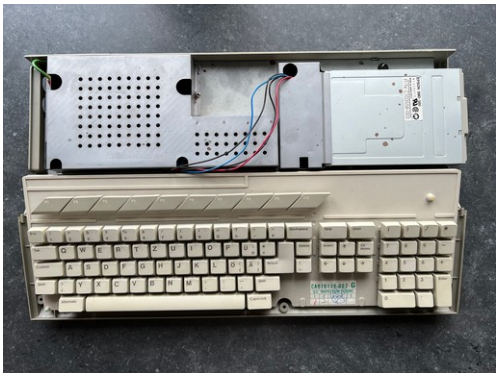


Abbildung 2: computer open

It is best to start by disconnecting the computer from the power supply and then from all its external devices. Then turn the computer over and unscrew the seven housing screws (marked with blue borders in the picture). The three screws holding the floppy (marked red) should also be removed. This will make it easier to pull the upper part of the case over the floppy eject button later. Now carefully turn the computer over and lift off the lid. The easiest way to do this is to lift the upper part of the case slightly to the right of the lower part of the computer. Since the floppy drive is already unscrewed, you can also push the floppy drive inwards if necessary. The upper part of the housing will then slide over the eject lever more easily. If the floppy drive twists slightly, it doesn't matter. It will be removed immediately anyway.

Another tip about the cables with the plugs: You should never pull on the cables directly, because otherwise the cables may come loose directly in the plug and you will be forced to re-solder them. It is better to take the plugs in your

Abbildung 3: keyboardplug

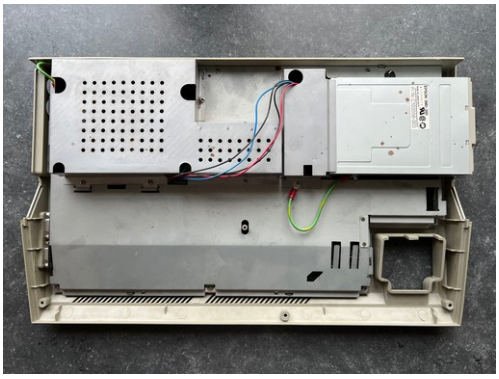


Abbildung 4: computer without keyboard

fingers and pull on them. If this is not possible, flat-nose pliers will help. A small screwdriver helps with the locks on some plugs.

The next what to do is to disconnect the keyboard from the mainboard with its plugs. After that, we unscrew all the screws that we see. This should be a few more screws than on the bottom of the computer. The two housing parts above the floppy and also above the power supply can now also be loosened. The earth cable at the floppy can also be removed. It will not necessarily be needed again later. The floppy drive can also be removed. The ribbon cable can also be removed quite easily by carefully levering it with a small screwdriver. Caution: The power supply for the floppy drive has a detent.

Removing the top part of the Atari 1040 STE's sheet metal screen is a bit tricky. The reason is that the two screws of the power supply at the bottom of the mainboard have to be unscrewed as well. The screws will most likely fall into the sheet metal cage. That's not bad, because we will find the screws later, after removing the shield. You can also take the opportunity to remove the brass dome of the floppy drive from the mainboard. It has probably been lost in the metal screen by now. In order to completely remove the upper part of the metal screen, the entire metal box with the power supply unit and the mainboard must be lifted out of the plastic housing. To do this, we lift the entire sheet metal screen slightly at the front and lift it up a little and pull it towards us. We have to help the two joystick sockets on the side a little to get out of the lower part of the housing. We put the lower part of the case aside for the time being and concentrate on the metal screen around the mainboard. The mainboard is still only partially visible.

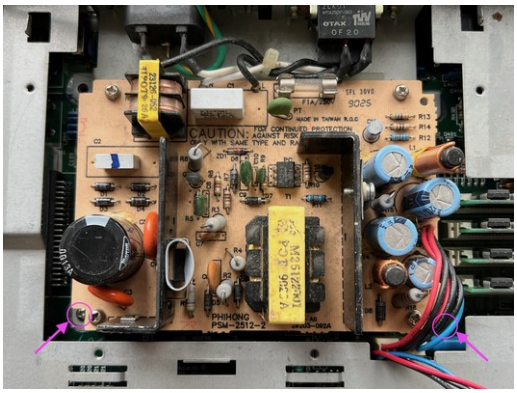


Abbildung 5: power-supply-screws

The sheet-metal entanglement still can't be un-earthened. There are, three reasons for this: Firstly, there is still a screw on the back of the on/off switch that needs to be removed. See the picture above with the coloured marking. Secondly, the plug from the power supply that leads to the mainboard must be disconnected. Please make sure that this plug has snap-in

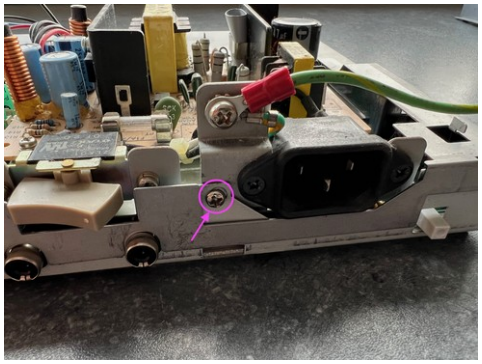


Abbildung 6: screw at the back of the power supply

Abbildung 7: lead-nose

on the back! And thirdly, you have to straighten the metal lugs around the metal cage. With a little patience, the upper part of the metal cage can now be removed from the lower part. The mainboard can now be seen. Now think of screws, small parts, etc. that should be removed.

Now that the upper sheet metal cage is removed, everything else becomes easy. Dismantling is also easy because we will simply not install the upper sheet metal cage later. This has many advantages. It's easier to get to the electronics if you want to change something. And there are no unwanted short circuits.

1.8 Preparation of the mainboard

We must not conceal the fact that additional changes to the main board of the 1040 STE are still necessary for the safe operation of the combi card and the main board. Two of these measures are mandatory. The remaining measures are only necessary if there should be problems during operation. Before the modification measures are explained in detail, once again a little history and explanations in advance.

The 1040 STE has – as is well known – a blitter on the mainboard. There are two different types of blitter used in the 1040 STE. Atari first equipped the mainboards with a separate blitter in the style of their previous products. This blitter sits in socket U101 on the mainboard, if it is a *old* mainboard variant. This old motherboard variant can be recognised by the following components:

- IC U101 is present. It is the solitary blitter. The IC there most likely has the following designation: C101643-011 ©Atari 1988 etc.
- IC U400 is also present. It is the MMU/GLUE of the 1040 STE. It has the designation C300589-001 ©Atari 1988 etc.
- R111 and R112, to the right of socket U101 are *not* populated.

Alternatively, they have an Atari 1040 STE with a *newer* assembly. In this case, the blitter has been designed into the combination chip of MMU and GLUE. So you have a combination chip of MMU, GLUE and blitter. Your mainboard should be identifiable as follows:

- IC U101 is *not* present. The socket or the placement slot is empty!
- IC U400 is present. It is the MMU/GLUE with blitter of the 1040 STE. This component has the designation C302183-001 ©Atari 1991 etc.
- R111 and R112, to the right of socket U101 are both zero ohms.

Basically all 1040 STE mainboard variants are almost identical. They are also all constructed in such a way that the two blitter variants can be optionally installed in each

mainboard. If you have a mixture of the two variants listed above, then it is very likely that it has been modified. The following variants are conceivable, which would certainly have or will have their pitfalls during operation. Either you have no blitter at all. Then at least your 1040 STE would have a chance to work! Or someone has built an external blitter into a 1040 STE with a combination chip (MMU plus GLUE plus blitter). This variant should certainly already doesn't work in normal operation when the blitter is switched on in the desktop entry: There should be a bomb atmosphere!

One more note on the individual mainboards: A 74LS164 can be piggybacked on U211. The lines to this additional chip are somewhat carelessly fixed to the mainboard with hot glue. This is an official Atari patch and realises a delay of the interrupt signal from the printer port. The patch remains as it is and has no influence on the proper operation of the TWISTER .

Back to our mainboard modification. This first modification is a mandatory measure. The blitter can – even in normal operation without TWISTER – tend to crash. This in turn may be due to a lack of power supply over the decades. Capacitors may be said to have lost their original capacity over the decades – whether with operation or by simply standing around on the shelf. This can be due to capacitors on the power supply or those on the mainboard. The cause of such a bomb mood can thus be due to *many* capacitors at the same time. We will discuss this later. Back to our *blitter patch*. The capacitors losing their capacity are only promoting the actual cause. However, the cause is a fault on the /BG line between the processor and the blitter. The /BG signal is used to transfer the bus in the Atari. If there is a fault on the signal, the bus may be transferred incorrectly between the processor and the blitter. The user notices this again by many bombs on the screen.

To avoid this, we will now solder a ceramic capacitor into the mainboard in the immediate vicinity of the respective blitter. The problem is therefore latent in every 1040 STE and is forced by the age of the capacitors. If the TWISTER is now installed, this problem can occur more strongly again. If the blitter is designed as a combi-chip, the probability of the interference appearing on the /BG line is greater than with the separate blitter variant. So if we are already in the process of preparing the mainboard for installation, this is certainly a very good measure to take at the same time.

Because there are two different types of blitter, there are also two different locations for the capacitor. In both cases it is a wired ceramic capacitor with a nominal capacitance of 33 pF. It is included in the scope of delivery of the TWISTER . Please handle the capacitor with care and do not bend the legs too much. The capacitor is – due to its construction – very prone to breakage. Even if the legs still hold mechanically, the contacts may already be broken internally.

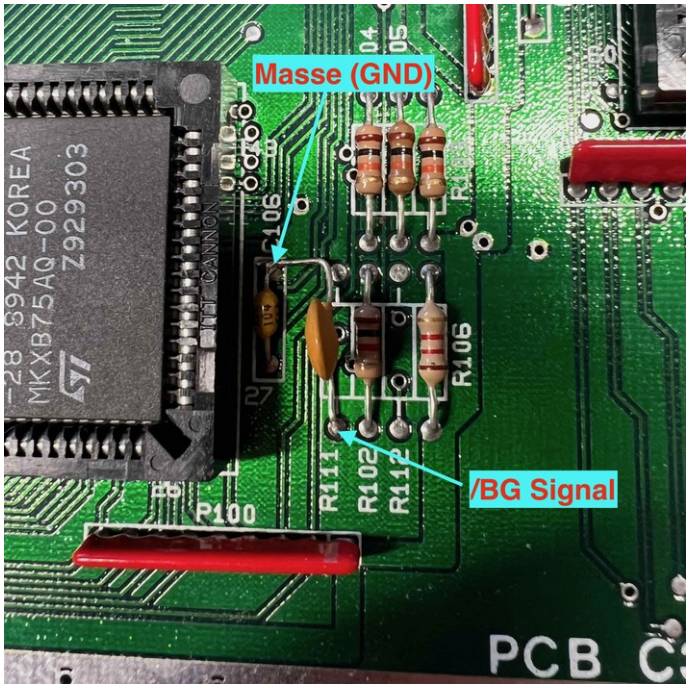


Abbildung 8: blitter separately as U101

In the case of the *old* blitter version with two ICs (U400 and U101 are populated), the installation is quite simple. You can use one pin of the free space for R111 to solder one leg of the capacitor. The other pin is soldered to ground of the neighbouring capacitor C106. The whole thing should look like the picture on the right. With the multimeter you should check – to be on the safe side – whether the ground pin of capacitor C106 is really the ground pin. The correct side of the capacitor should have a zero-ohm connection to the surrounding ground of the mainboard. If the multimeter only beeps briefly and the value in the display rises, then it is not the ground pin but the 5 volt pin of the capacitor. However, since the 1040 STE mainboards are quite similar, the capacitors should not have a completely different direction as shown in the pictures.

In the case of the *newer* blitter with the combi-combination chip (U101 not present and U400 present), a little more dexterity is needed to install the capacitor. As you can see in the picture, we use a through-hole for one side of the capacitor. Since there are several vias in the area, you have to use the multimeter to find the one that has direct contact with pin 11 of socket U100 (processor socket). When soldering the capacitor, please make sure that the pin in the vias really has electrical contact! Please carefully remove the solder resist from the top of the vias beforehand. The rest is the same. The other pin of the capacitor is connected to ground, as in the previous case. The ground pin should again be near the blitter. Here C404 is a good choice. Again, please check briefly with the multimeter which pin is really connected to ground. The hardest part is done! A short test of the computer to see if it still works as before is certainly helpful and calms the nerves.

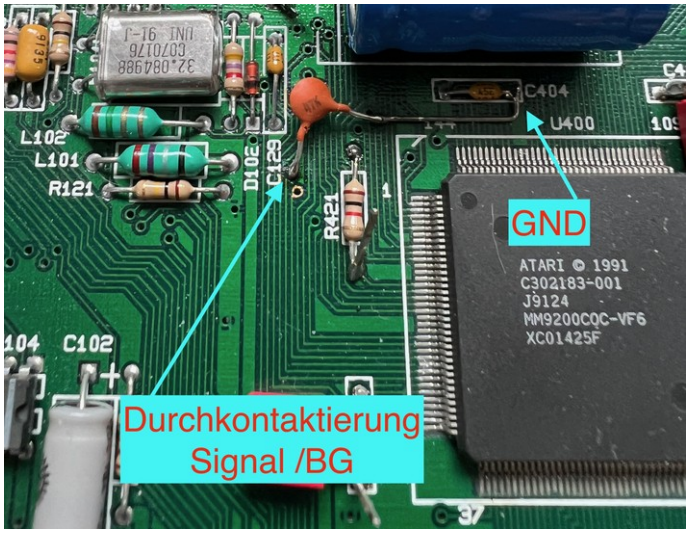


Abbildung 9: blitter integrated in U400

If one now wants to use both the mainboard ROM[6] and the flash ROM on the TWISTER , it is necessary to design the mainboard ROM *switchable*. On the main board, both 28-pole 1-megabit ROMs or 32-pole EPROMs can be used as the operating system. For this purpose, there are a total of three jumpers (W102, W103 and W104) on the mainboard right next to the ROM sockets. Unfortunately, Atari has not equipped these jumpers with pin headers but with zero-ohm resistors. We remove the resistors and solder three 3 pin headers here instead. Please note how the resistors were soldered in. Jumpers will be used for this later instead.

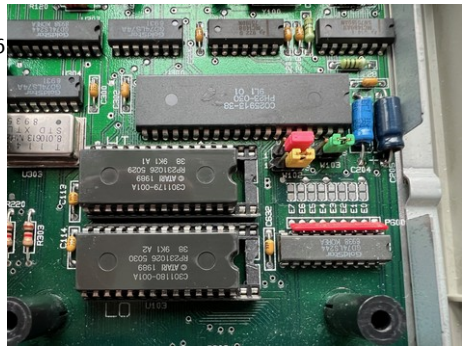


Abbildung 10: 1-MBit-ROMs

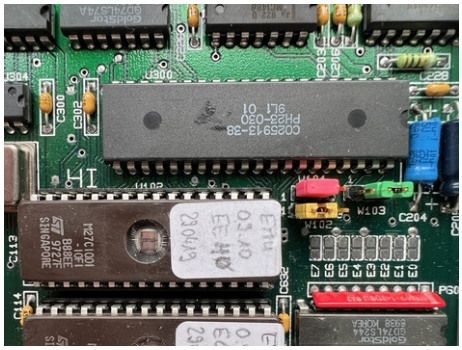


Abbildung 11: EPROMs

[6] Also the mainboard EPROM is meant here.

1.8.1 Optional changes

Now follow some other recommendations which do not have to be carried out. They should only be carried out if faults occur in the operation of the computer. Preventively swapping various things on the mainboard does not always make things better! The conversion can also cause damage. Therefore, please only do it if it is necessary. If in doubt, simply contact a member of the Thunderstorm team and ask. But now the changes in the order of their importance.

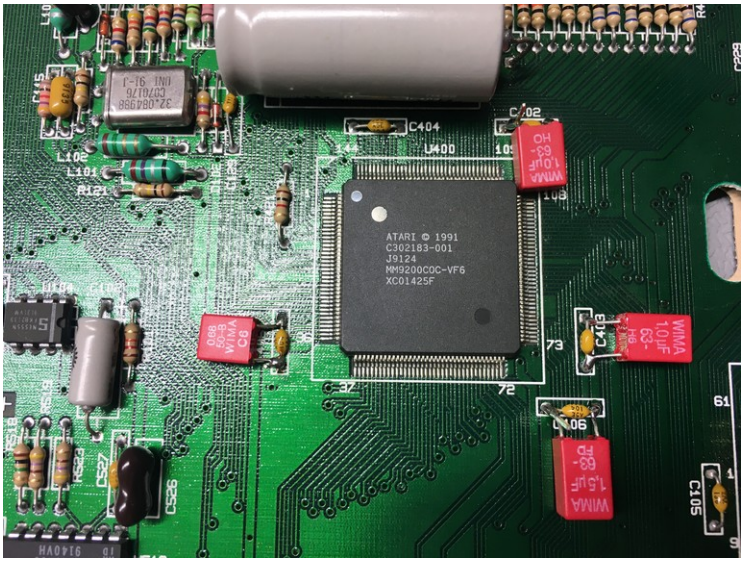


Abbildung 12: additional capacitors around U400

The blitter moves many address and data lines simultaneously. The levels of these lines change depending on the address or date[7] very differently for the bit sequence of the individual data lines. In the worst case scenario – purely theoretically – all address and data lines could change at the same time. This would then be 24 plus 16 equals 40 lines. The output drivers in the blitter must completely supply the current to change the levels on the address and data lines, since the blitter is the bus master in this case. This current must be made available to the blitter from the power supply for a short time. Short-term means that you need a good and fast buffer directly at the blitter. Large electrolytic capacitors[8] are usually too slow for such a task. Around the blitter, *fast* ceramic capacitors can be found. However, they only have a limited capacity (100 nF each) and cannot provide enough energy when needed. A remedy is foil capacitors of about 1 μF capacity. The conversion can then look like the picture on the right. The exact capacitance value is not that important. Only – as already written – the capacitors should be *phatically fast*! Fast capacitors are – for us mere mortals – either ceramic capacitors or film capacitors[9]. In the picture, the capacitance values are also not the same. They vary between 0.68 μF up to 1.5 μF. This is also OK.

[7] The "date" is a fixed term. It is current combination of high and low levels on the entire data bus. So it is no mistake to talk (or write) about the singular *The Date*

[8] The short form of electrolytic capacitor is: ElKo. Sometimes also written Elko or El-Ko

[9] The ultimate master of capacitors are the "organic capacitors". These are particularly well suited for such applications. In return, however, they put an immense strain on the wallet and are absolutely exaggerated for the present case.

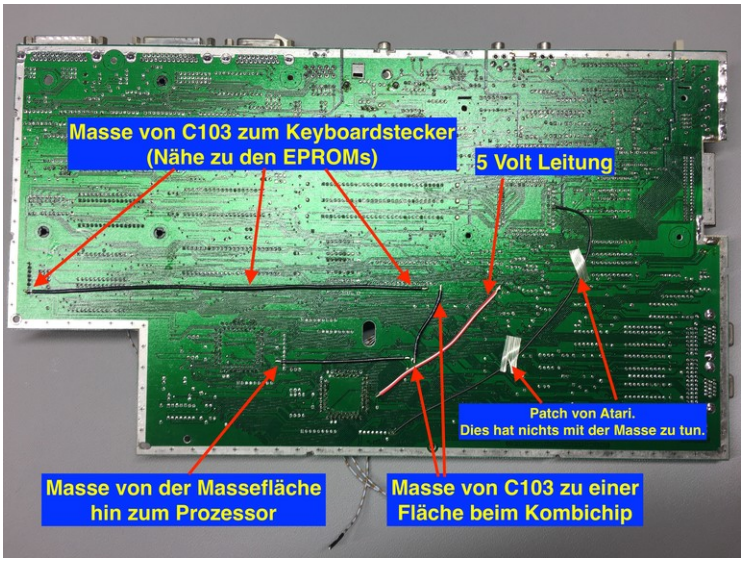


Abbildung 13: additional ground and 5 volts below the mainboard

The last recommendation has its reason in the layout of the mainboard itself. At that time, Atari had rightly promised to bring a computer onto the market that would be cost-effective. Thus, most Atari computers have only a two-sided mainboard. This means that there is not necessarily a good ground and voltage supply throughout. This is in the nature of things. Only the Atari computers with four-layer layouts have a good ground connection[10]. This Atari 1040 STE has its weaknesses. If you want to do something good for the ICs on the mainboard, you can dramatically improve the ground and 5 volt supply with a few wires and a bit of patience. The underside of the mainboard could then look as shown in the picture.

You can see that from the large capacitor C100 downwards there is now a direct ground connection from the capacitor to the left towards the EPROMs, as well as two short connections each from capacitor C100 once to U400 and to the processor. That is enough. With this, the ground is already much better. The situation is similar for the 5 Volt. The supply from the main capacitor C100 is good in the left-right direction on the mainboard. But in the top-bottom direction the supply on the mainboard is not quite as good. The next *placement strip* below capacitor C400, at the level of the processor, is already not so good. So here, too, a connection from capacitor C100 to the vicinity of the processor.

1.9 The installation of the TWISTER

We assume that you have successfully freed your Atari 1040 STE from the upper part of the metal cage and that the mainboard is now back in the lower plastic shell. They have also carried out the so-called *blitter patch* and – depending on your choice – made one or the other recommendation to improve the mainboard. A functional test in between showed that your Atari is still among the living.

When assembling the computer later on, it is best not to install the upper part of the metal screen at all. This is much easier and you will have much less space problems with all the parts in the computer afterwards. The somewhat tricky installation of the sheet metal screen can thus simply be avoided. ☺

[10] As far as I know, these are the Mega STE, the Falcon and the Atari TT.

In order for the IDE hard disk to function properly afterwards, an additional signal must be fed from the TWISTER to the mainboard. This signal is not present at the PLCC socket of the processor. It is the interrupt line from ACSI. The interrupt line comes from ACSI and is routed to the MFP[11]. If the IDE interface is now used on the TWISTER , we have to tell the computer in the prescribed way that there is data from the IDE hard disk. To do this, we use the /INT signal and pass our information from the TWISTER to the system on this open collector signal.

The /INT signal can be tapped at several points in the computer. It is also possible to do this directly at the back of the ACSI socket, but this looks a bit strange when a cable is on the outside of the socket and then fed into the computer. Therefore, we look for a more suitable place in the computer. A good point is resistor R421, which is located to the left of IC U400.

We solder a wire (supplied) to the lower end of R421 and continue it to CON1 on the TWISTER . If you like, you can also solder a soldering pin[12] to the lower connection of R421 and thus make the connection pluggable on this side as well. The cable with the signal /INT is connected to the jumper strip (CON1) of the TWISTER at the very bottom pin. Please note the labelling on the TWISTER .

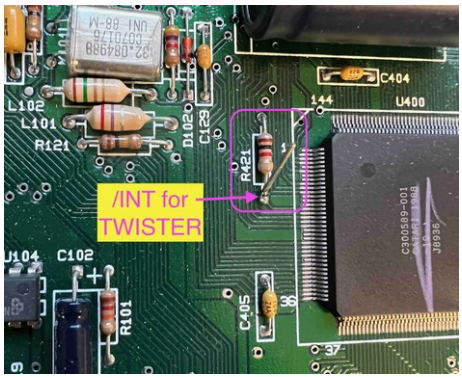


Abbildung 14: tap of signal /INT

Next we remove the processor (68000) from its socket. Fortunately, the processor is in a PLCC socket with the designation U100. With the help of a small screwdriver or a special PLCC extraction tool, the processor can be easily levered or pulled out of the socket. When using a screwdriver, please make sure that you do not lever too hard in the socket, otherwise the socket could break. The processor is also at risk from the leverage. So please proceed with caution!

[11] Multifunction Peripheral
[12] Or a soldering socket, depending on your personal taste.

The removed processor is then placed in the free PLCC socket on the combination board labelled IC2. The combination card can already be inserted into the mainboard socket U100. When inserting it, pay attention to the designation for the respective pin 1 of the respective socket.

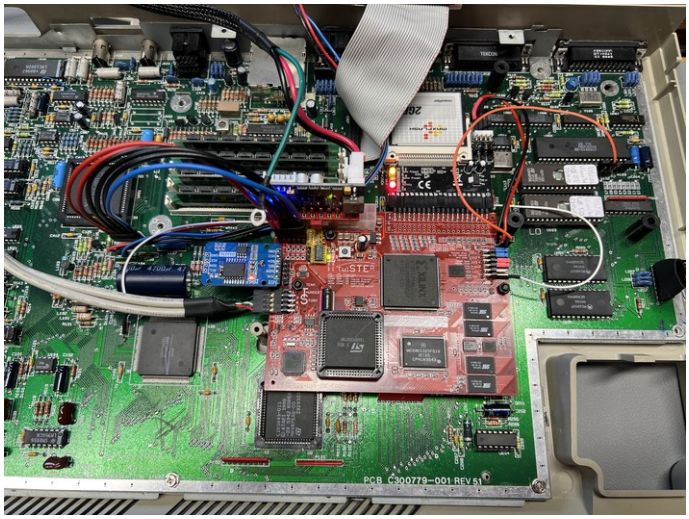


Abbildung 15: mainboard-with-twister

In general, we recommend that you do not solder cables directly onto the TWISTER , but always plug them in via the plugs provided. To do this, you will certainly need the appropriate sockets on the opposite side. However, these are easy to find at the usual electronics suppliers. It certainly also looks neater if plug contacts are used for plugging and not for soldering.

The TWISTER has the connector CON1 on the right-hand side, on which up to four jumpers can be located, an optional LED connector for an optional hard disk light-emitting diode and the /INT signal connector already explained above.

Not every user is the same in his behaviour. One user does not want to drill a hole in his case for switching hard disk operation and/or processor operation. The next user wants to operate the computer openly and does not need all this. The next user wants to have everything switchable at the front of the computer. The next user wants everything at the back of the computer. There are no limits to the variations. For us developers, this is always a difficult situation. That is why all connections on CON1 are designed in such a way that they can be extended with appropriate sockets and cables to the place where the user wants them. So that no disaster happens during operation, the jumpers are always queried after a reset or after switching on the computer. Once the position of these jumpers has been queried, this setting is retained until the next switch-on (or reset)! The reason for this measure is logical: If a user now puts the jumpers on the outside of his computer and stupidly gets to these switches, this would have devastating effects on the operating behaviour of the computer (hard disk and processor selection). So you can insert the jumpers as you like, they will only be queried again the next time the computer is reset (or switched on): a pure safety measure.

A USB bracket is supplied for the USB connection. Here, too, we do not want to tell anyone where to put the USB ports in their computer and, if necessary, create openings for them in the case. A nice possibility would be if someone were willing to design a 3D part for this, which uses the power supply connection and the power switch at the rear of the case. This would be a good place to put all the switches, USB connections and supply lines.

There are two slots when connecting the RTC clock. The reason for this is again simple. There are two equally suitable clock modules on the market with a DS3231 chip. This is firstly a slightly larger blue clock module for the Arduino board and a smaller module for the Raspberry Pi. The large Arduino module has a larger battery that lasts a long time and is easy to buy new if it should run out. The advantage of the Raspberry Pi module lies in its size. The advantages of one module are the disadvantages of the other. The user is free to choose.

Another tip about the Arduino module:
It has a very simple charging circuit on the module. If you operate the module with a battery, it will be defective after a short time and decompose. Battery acid would spread in the computer. Therefore, we strongly recommend removing the 200 Ohm resistor on the side with the non-equipped pin strip. It is located near a diode directly to the right of the Dallas IC.

Finally, you can now decide whether you want to continue using the original power supply or whether you want to use a pico-ATX power supply instead. When using the established original power supply unit, you only have to reinstall the power supply unit in reverse order to the disassembly. In this case, the use of the computer can begin.

If you want to use a Pico-ATX power supply unit, it is plugged into the free ATX connector on the TWISTER . The power supply of the Pico-ATX power supply is to be carried out at a suitable place of the Atari 1040 STE case. In addition, the connection cable from the TWISTER to the power connector of the mainboard must be installed. The connection cable is included in the delivery of the combination board.

To switch the power supply on and off, a small button is already present on the TWISTER . If you have the computer open and want to switch it on as a test, you will be able to use the button well. If the computer is installed, you cannot reach this button. Instead, it is possible to solder or plug a two-wire cable with a push-button to the two-pin connector provided for this purpose. The button can then be easily led to the back of the computer and attached here with the help of a small hole.

There! Now we have prepared the computer for the installation of the TWISTER . We also installed the TWISTER in the computer and last but not least we connected all the necessary things to the TWISTER . Thereby we already had a lot of choices for the user to find his individual solution. The computer should now be ready for use.

Please start slowly in the simplest operating mode (68000s with 8 MHz). Then slowly increase to higher speeds.

Good luck!

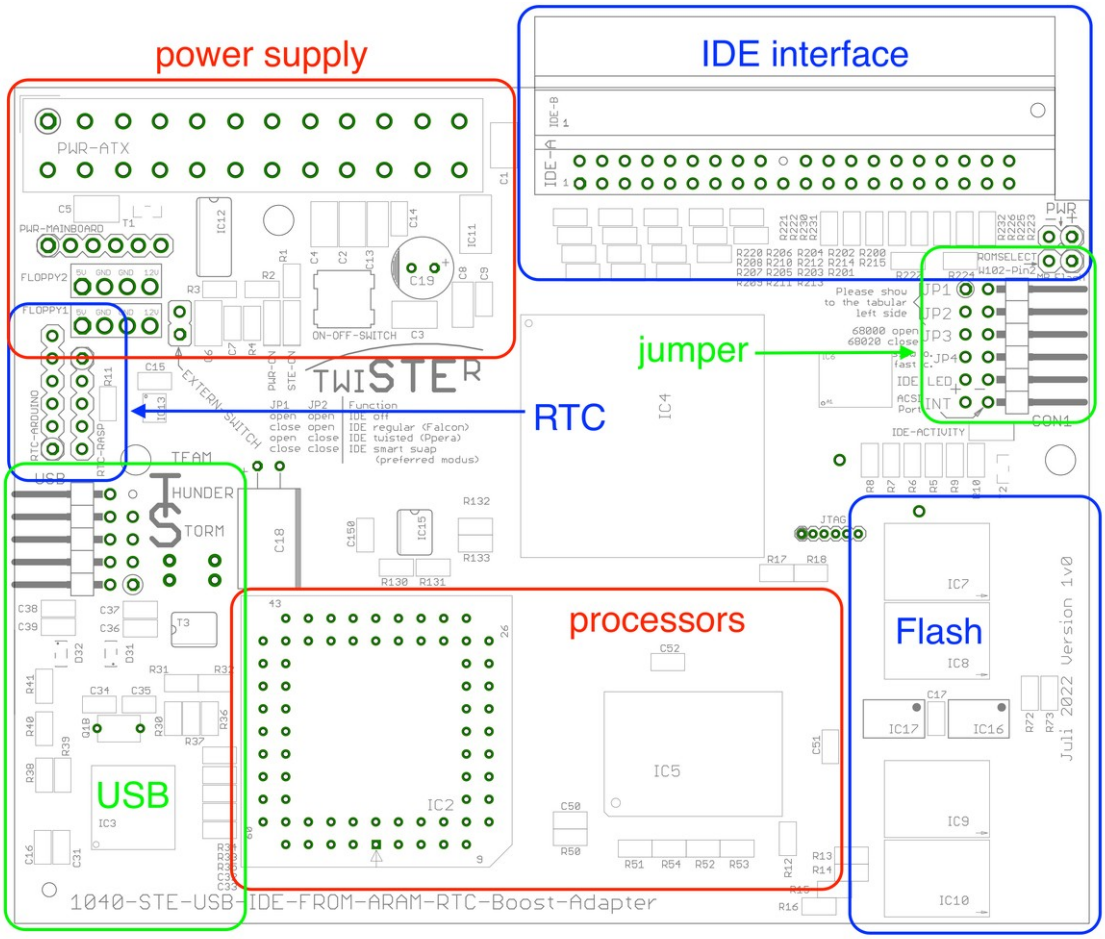
2 Function description

The present combination card, the TWISTER , contains the following functions:

- Two processors at two different operating frequencies. This results in the following four operating states:
  - mode 1: 68000 with 8 MHz clock frequency
  - mode 2: 68000 with 16 MHz clock frequency
  - mode 3: 68020 with 8 MHz clock frequency
  - mode 4: 68020 with 24 MHz clock frequency
- IDE interface with different operation modes, which will be discussed below.
  - mode 1: IDE off
  - mode 2: IDE normal → Falcon mode
  - mode 3: IDE twisted → Ppera mode
  - mode 4: IDE smart swap → DOS compatible mode
- Use of an Arduino or Raspi clock module based on a DS3231 RTC chip.
- 2 USB 1.0 ports
- 8 MByte Alternate-RAM
- 4 Flash-ROM banks, switchable by software
- clock conditioning for operation for 8 MHz, 16 MHz and 24 MHz
- Alternate operation of the entire computer via a Pico-ATX power supply (not included with the TWISTER)

2.1 Overview of the TWISTER

The TWISTER is structured according to its building and functional groups in the following picture.



- At the top left is the connector to accept a Pico-ATX power supply.
- At the bottom left of the board is the USB connector with the associated USB controller ISP1160.
- Between the USB connector and the ATX power supply connector there is a pin header and a socket connector for connecting an RTC module based on the Dallas clock chip DS3132.
- At the top right is the IDE connector for an IDE hard disk or a CF card adapter.
- Close behind the IDE connector is an 8-MByte chip for the alternate RAM and a 12-pin pin strip for jumpers and additional signals - called CON1.
- At the bottom right of the board is the 4 Flash-ROM banks in the form of four 2 MBit flash devices.
- The CPLD from Xilinx is located in the centre of the board, as well as the clock conditioning for all operating states. These components are mentioned in the following chapters; however, they do not have their own chapter. It is clear that they have an essential role for the overall function of the TWISTER .

2.2 Jumper and CON1

Probably the most important part in the daily hodgepodge on the TWISTER are definitely the jumpers and their adjustment options. The jumpers are connected to the connector CON1. CON1 can be seen at the top right. For safety's sake, there is also a description of the PCB themselves for the plug-in options.

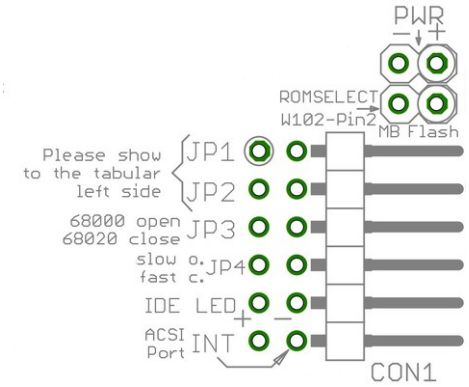


Abbildung 16: CON1

The upper two jumpers JP1 and JP2 are used to set the IDE interface and its function. This is followed by jumpers JP3 and JP4, which select the processor and its clock frequency.

Furthermore, CON1 offers the possibility to connect an additional LED for visualising the hard disk access. This LED can be individually routed and connected to the front of the computer, without a series resistor using, a two-wire cable. The brightness of this LED does not influence the brightness of the LED on the TWISTER itself and vice versa. The series resistor for the external LED is already present on the TWISTER .

At the very bottom of CON1 is the pin for the signal /INT, which is led from the TWISTER to the MFP. The connection of this pin has already been explained in the previous chapter.

A very important point at the end of this chapter about the jumpers:
The jumpers are designed in such a way that a longer line on them does not lead to a malfunction. They do not directly switch a clock or a function. This is done via the CPLD. Each user can thus — at will — guide the jumpers to a place in the housing that suits him or her. As a rule, the switching points for these signals will be on the back of the computer. In real life, this can sometimes lead to unintentional switching of the hard disk operation as well as the processor selection, because the switches (jumpers) have been reached unintentionally. To ensure that this has no effect on the current operation, the levels at the jumper inputs are queried immediately after a reset (or after switching on the computer). Conversely, this also means that pulling a jumper does not *directly* lead to a change in the operating states of the IDE interface and the processor. So don't be surprised, just press the reset button or switch the computer off and on again briefly.

This is certainly a little confusing at first. However, it serves the purpose of operational safety when working with your computer!

2.3 CON1 and the IDE interface

The following assignments result as listed in the following table.

IDE interface settings

Jumper 1	Jumper 2	Function
open	open	IDE interface OFF
plugged	open	regular operation (Falcon mode)
open	plugged	rotated operation (PPera mode)
plugged	plugged	smart-swap operation (recommended mode)

If you want to switch off the IDE interface, both jumpers must be removed. This is certainly rare. However, if you have difficulties with a game or an extension, you can switch off the IDE interface completely. In this case, the necessary addresses in the memory area are no longer available. The entire IDE interface behaves as if it were not present.

The other three operating modes depend very much on how and with which device you mainly exchange your data. To decide how to set up your hard disk, again a short explanation. The colloquial IDE interface[13], which was designed for MS-DOS compatible computers. A very big difference to computers with Motorola processors is the order of the two bytes that are transferred in a 16 bit wide access. Between these two types of computers, the order of transmission of data bits 0 to 7 and data bits 8 to 15 is exactly the other way round. When Atari introduced the IDE interface for its computers, this resulted in a rotation of the two data bytes as just explained. In the Falcon, the same data sequence on the medium is achieved by physically (back)changing the upper and lower data bytes. Only the commands on the bus are not arranged equally on the data lines.

The *PPera interface* offers a completely different approach. Here the data lines are physically rotated. This makes it possible to connect a hard disk from the MS-DOS computer directly to an Atari. Since the Atari operating system does not directly cope with these *rotated* data and commands, a patch or additional hard disk drivers are additionally necessary for this operating mode. This makes the data readable on both systems. Due to the special hard disk drivers and the adaptation of the operating system, this operating variant will certainly remain the exception.

In order not to have to constantly choose between these two systems, a so-called *smart-swap mode* is also implemented on our IDE interface. It is initially connected in the same way as a Falcon and also reads the data around in the same way as a Falcon. If you now connect a hard disk formatted on an MS-DOS computer, the interface itself

[13] The IDE interface is actually called ATA interface and is a subtype of the ATAPI interface., which also includes the 34-pin connection of a floppy drive. The latter is also called Shugart bus. You can read about all this in Wikipedia by entering the term *ATAPI*

notices that the data are present with their byte sequence exactly reversed. The interface automatically switches in smart-swap mode and reads the double byte the right way round.

If this switching were to be done by software, one has the disadvantage that with a medium that is quasi *connected the wrong way round*, one always has to read correctly first and then – by software – reverse the byte order. That software switching costs (processor) time. This is noticeable in the lower transfer performance of this hard disk.

With the smart-swap mode on the TWISTER , this is regulated by hardware itself and takes place without delay. Each hard disk, whether rotated or not, is properly recognised and mounted without any loss of time.

If you have a choice, you're spoilt for choice! The decision is certainly made by the daily hodgepodge of each user. The general recommendation is therefore: The system that you use intensively should be given priority in the setting.

If you have a Falcon or another Atari device with an IDE interface, then the *Falcon mode* is certainly the favourite. In this case it is worthwhile to set this mode on the TWISTER .

If one wants to use data in the Atari world as well as to the MS-DOS world[14]. we recommend the Smart-Swap mode. The normal main hard disk is then formatted as on the Falcon. The second hard disk may then have been set up by a Windows computer and can then also be read.

The 40-pin IDE interface connector should be familiar to most users. The connector on the TWISTER can either be installed facing upwards or away from the back or, as a third solution, away from the back as a so-called *SMD solution*. When you buy the TWISTER , you will be asked for your desired assembly. If you do not decide yet, you will usually choose the SMD version, because then an alternative connector - later - is still possible. Furthermore, the SMD version is the only version that makes it possible to operate a CF module (including adapter) below the floppy drive.

If the tub connector is installed upwards, you can ideally connect a so-called *IDE DOM module*[15]. This corresponds to very compact CF cards that have the 40-pin socket on the module. Such a DOM module still fits into the housing. It goes up behind the keyboard and does not touch the lid later!

If you use the angled connector instead, you can connect *old* mechanical hard disks to the TWISTER via a ribbon cable.

Even better is the connection of a straight tub connector as SMD variant to the TWISTER . This makes it quite easy to connect a CF-to-IDE adapter to the TWISTER . The advantage of this solution is that the CF module and adapter fit under the floppy drive and its connection cable.

If only **one** hard disk, CF card or DOM module is connected via a ribbon cable, this

[14] Meaning MS-Windows computers included.

[15] Google for such a module. Maybe it will inspire new innovative ideas.

storage medium should use the last connector on the ribbon cable. If, on the other hand, the ribbon cable is connected in such a way that there is a free end, this can lead to reflections of the signals on the data lines and thus to interference during operation. If two hard disks are used, it does not matter where the master and slave are located on the cable.

Finally, a word about the hard disk driver to use. We recommend the hard disk driver *HDDriver* by Uwe Seimet. It offers the most extensive setting options and is still published in the latest versions.[16]. Among many other settings, this hard disk driver can also be started in TT-RAM or Alternate-RAM – as on the TWISTER . This speeds up the operation of the hard disk considerably.

HDDriver also offers a so-called *soft-swap* mode. In principle, this does the same as our IDE interface does with the smart swap mode. The only difference is that now the swapping is done by software. This is slower in principle. But it works just as well. Everyone should experiment to find the right combination of settings. Once again, not to make it too difficult for the ordinary mortal user: Take the smart-swap mode of the TWISTER . As a rule, you can't go far wrong there.

2.4 CON1 and the processor choice

CON1 offers four different operating modes with jumper 3 and jumper 4. On the TWISTER you will find two processors that can optionally do their work. One is the 68000, which we already removed from the mainboard in the previous chapter and inserted into the combination board. The other is a 68EC020, which is already soldered onto the TWISTER .

The 68000 offers us the possibility to put the computer back into the original 8 MHz mode. During development, we have taken care to make this mode as original as possible. Even the signals to and from the processor are the same as in the original mode. If you switch off all additional components or do not activate them through the driver programmes, you have an Atari 1040 STE as you always had it. The best possible compatibility is therefore given.

The 68000 in the Atari 1040 STE is an N-MOS processor that can get quite warm in normal operation. Nevertheless, these processors are so good-natured that they can certainly be operated at higher than the printed clock frequency. During development, the 68000 processors available to us were always usable at 16 MHz. That is why we have this operating mode. Since we do not assume that every user will want to get a C-MOS version of the 68000, we have limited the clock frequency to 16 MHz. A higher clock frequency would also have been conceivable for the C-MOS variants. However, in order not to burden the wallet too much, we have stuck with the 16 MHz for the 68000.

[16] The hard disk driver can be found on the web at the following address: `https://www.hddriver.net`

processor settings

Jumper 3	Jumper 4	Function
open	unplugged	68000 with 8 MHz
open	plugged	68000 with 16 MHz
plugged	open	68020 with 8 MHz
plugged	plugged	68020 with 24 MHz

The implemented 68020er is strictly speaking a 68EC020 with an SQFP-100 package[17]. It does not have the full address range it can address in the "EC variant"[18] and can therefore – just like the 68000 – address only an address space of up to 16 MBytes in the present variant. This is perfect for our expansion card! The EC version accelerates the Atari 1040 STE quite nicely. The 68020 is slightly faster at 8 MHz than the 68000 at the same clock frequency. One reason for this is that the 68020 has an internal instruction cache, which is quite noticeable during operation. Although this cache is very small with 256 bytes, the processor can always prepare the next calculation step internally better – and thus faster. In addition, the bus timing of the 68020 is somewhat different (shorter). With many commands, a bus cycle can run faster than with its older predecessor, the 68000.

The two advantages of the 68020 become really noticeable in 24 MHz operating mode. Together with the Flash-ROM and the Alternate-RAM, very fast access to both components is possible. This then makes the appeal of this mode. My guess is that this will be the default operating mode of the TWISTER for most users. ☺

Just try out all the operating modes. You will also find out which programmes only work with a 68000 or are also executable with a 68020.

2.4.1 Additional feature

Shortly before the delivery of the first TWISTER to our customers, an idea came up in one of the Atari forums that we did not want to leave untried. The idea is to switch the processor and also the clock rate during operation via software.

Switching the processor on the fly will work not safely and not cleanly! The operating system sets – based on the available processor – certain things at start-up. This is not just the *machine cookie* in the cookie jar, which users can easily read. There are many other things set in the background by the choice of processor at startup. So this part idea is not implementable!

However, there remains a possible switching of the clock frequency of the processor during runtime. Here, too, one must observe a few things. The clock must always be

[17] The SQFP100 package provides fewer legs available than the full-fledged 68020 in its familiar PGA package. Thus, it also has fewer address lines routed to the outside

[18] And like all 68020s, it also does not have an MMU, which was not included in the chip until the 68030.

switched cleanly to the new clock after an edge of the current clock. No so-called *glitches* may occur. If the clock were to be switched with small short clock parts that are faster than the highest clock, malfunctions of the processor could not be ruled out. But this is possible in principle.

Now the essential info for you as a customer: We did it! ☺

Those who receive an TWISTER as a customer will receive this feature with firmware *greater than S002*[19]. The current firmware version is noted on the PCB board. The function of the jumpers is maintained at the same time. It remains as stated in the chapter on processor selection. If jumper 4 is set, the high clock rate is selected at start-up. If jumper 4 is not set, a clock of 8 MHz is applied to the processor.

With the help of the programme `SPEED.PRG` you can now switch the clock speed of the processor up with the two keyboard combinations `CTRL-ALT-PLUS` or down with `CTRL-ALT-MINUS`. The two PLUS and MINUS keys on the numeric keypad apply.

The programme `SPEED.PRG` is public domain and is included in the scope of delivery of the TWISTER . If the programme `SPEED.PRG` is started, then the high clock rate of the processor is automatically set first.

2.5 Flash-ROM

The operating system in the Atari is in chips that are usually designed for bustiming in the Atari and have a – well – let's say *moderate* access time of 120 ns to 150 ns. This fits well into a system running at 8 MHz. However, such an operating system becomes a brake when we get to higher clock speeds of the processor. The (flash) ROM components that are readily available today are, first of all, significantly faster than the components of that time. At the same time, today's flash devices can be reprogrammed in the device. Although the algorithm for programming must be observed, this is generally possible – even during operation, as we will see later. This offers two unbeatable advantages for the Atari: We can freely choose which operating system we want to run at any given time. And the access can also be much faster, provided the processor is fast enough. This is noticeable with both processors when they are set to run at more than 8 MHz!

[19] Example: "S" and a number means "series". The following number indicates the currently programmed firmware version.

The TWISTER offers no less than four Flash ROM banks. Together with the mainboard ROM, this makes a total of five different operating systems available in one computer. The jumper W102 on the mainboard plays an important role. We already got to know it in the previous chapter and modified it if necessary. If an operating system is present on the mainboard, the TWISTER detects this itself and deactivates the flash ROM. If this operating system on the mainboard is a so-called 1-MBit-ROM[20], the Flash-ROM can only be activated by removing both ICs from the two sockets![21]. If, on the other hand, the operating system is established on the mainboard in two EPROMs[22], then the situation is much simpler. In this case, you do not have to remove the operating system from the mainboard, if you want to activate the flash ROM. It is sufficient to remove jumper W102 on the mainboard and connect the middle pin of the three pins to 5 Volt.

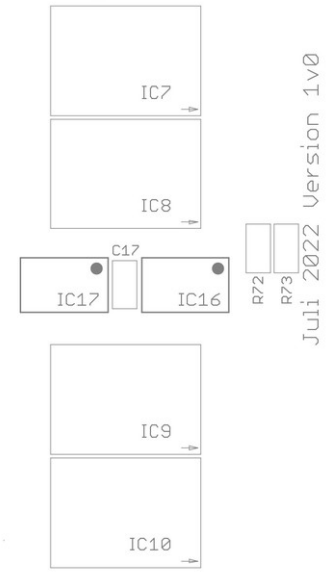


Abbildung 17: Flash-ROM

mainboard ROM settings

Type of MB-ROM	Jumper W102	Function
1M-bit devices	2-3	mainboard ROM is active
1M-bit devices	1-2	computer does not start
EPROMs	1-2	mainboard ROM is active
EPROMs	pin 2 to ground	mainboard ROM is active
EPROMs	pin 2 against 5 volts	flash ROM is active

If you are in the fortunate position that the mainboard has EPROMs instead of the 1 MBit components, you can easily deactivate the operating system on the mainboard with the middle pin 2 of the jumper W102 without having to remove it. For this purpose, there is an extra double pin header on the top right of the TWISTER with a ground and a 5 volt connection. The connection is labelled accordingly on the board. This is a convenient way to enable or disable the mainboard ROM[23]. See also the table above.

The flash ROM is displayed from memory location xE00000, just like the original operating system of the Atari 1040 STE. During the development phase we considered for a

[20] A 1-MBit-ROM is easily recognisable by its *only* 28 legs and a black housing with an Atari number, e.g., Cnnnn-001A on it.

[21] The 1-MBit-ROMs have to be removed from the mainboard because they cannot be deactivated by a wire like an EPROM. They simply lack the necessary legs on the IC

[22] An EPROM can be easily recognised by the window on top of the ceramic housing and the total of 32 legs per component.

[23] EPROMs have a so-called "output enable" pin. Depending on whether you connect 5 volts or ground here, the contents of the EPROMs are output to the data bus or not

long time whether it made sense to also support the memory area from xFC0000, as with the ST models. We decided against it for several reasons. Firstly, there are de facto only two operating systems that could be used sensibly from the address xFC0000: Firstly, TOS 1.04 and secondly KAOS 1.4.x, a derivative of TOS 1.04. Both operating systems initially have the major disadvantage that pretty much no extension of the TWISTER is supported. A patch of the IDE interface on TOS 1.04 would be conceivable, but that's about it. A 68020 does not run on TOS 1.04. KAOS is a laudable exception here. Common to both operating systems is the non-functioning of the alternate RAM, the USB interface and many other extensions. EmuTOS offers a good alternative, also for many games. Here, all extensions are supported and many old games still work. If you absolutely want to run a TOS 1.0x, you can use your original mainboard ROM without further ado. However, it does not work with the hard disk etc. either. It also does not work with the 68020. I hope that the decision we made in the team is understandable and comprehensible.

The attentive user has certainly already noticed that there are no jumpers on the TWISTER to select the flash ROM bank. This is possible with the help of software! The small programme `ToSwit_4.TOS` offers all four banks for selection. The programme does not belong in the Auto folder. It should be available in an easily accessible place on the storage medium if you want to change the operating system. The programme also shows whether one of the banks is empty or occupied. If the operating system of `ToSwit_4.TOS` is recognisable, it also shows its name and its version number. Once a selection has been made, the computer is reset by the programme and restarts with the operating system of choice.

One of the flash banks contains the latest version of EmuTOS at the time of delivery. All other three banks may be pre-assigned with other operating systems at the time of delivery. The flash banks are freely assignable with the help of the programme `FLASHSTE.TTP`. The programme can be used both when the computer with active mainboard ROM is currently in use and when the current flash bank is in active use. The currently used flash bank can also be reprogrammed.

Usually, the current flash ROM bank is reflashed directly. Only if the flash ROM bank cannot be activated will you work from the mainboard ROM. The flashing process itself is self-explanatory.

The flash process is a delicate moment. If you use an operating system in flash and want to reprogram it, it is like sawing off the branch you are sitting on! The two flash programmes mentioned above also point out this special case – possibly several times – before the flash process. Once you have made your choice after careful consideration, all access to the operating system is stopped and the flash process is initiated. This is visualised by a flickering screen. After successful flashing, the programme performs a reset. During the flash process, the computer's supply voltage must not be interrupted. It is logical that not all the necessary data is transferred to the flash ROM and that a restart of the computer is then in question.

If, for some unknown reason, something should go wrong, you can always revive the computer. The easiest way is to start the computer with the operating system on the

mainboard. The jumper W102 must be set according to the table above. The flash programme FLASHSTE.TTP is now used. With the help of this programme, as already mentioned, one can reactivate the currently activated flash ROM bank.

If you want to change the flash ROM bank when the mainboard ROM is active, you can also do this in this operating mode with the programme ToSwit_4.TOS. The flash ROM bank can also be changed during operation with the mainboard ROM. Note, however, that in this case the flash ROM bank is not activated after the reset, but the mainboard ROM remains active. If you then switch back to flash ROM operation, the new flash ROM bank is already selected. This can also be very helpful with a flash ROM bank that has been flashed.

It is also worth mentioning that if the mainboard ROM is active, the content of the flash banks - depending on the software version of ToSwit_4.TOS - may not be displayed correctly. The reason for this is again quite simple: If the mainboard ROM is active, the memory area of the flash ROMs cannot be read out unambiguously because, as is well known, it is the same address area. So you have to remember which operating system is currently in which flash ROM bank. Alternatively, you can simply switch the bank to another bank. The "defective" bank is then no longer active the next time the flash ROM is booted.

2.5.1 Special note

On the TWISTER , there are a lot of variation possibilities of the operating state in connection with the flash ROM. During operation, the flash ROM can be written with a new operating system. The operating system can be changed at any time with the help of the additional programme ToSwit_4.TOS. With the additional programme SPEED.PRG, the clock speed of the processor can be switched during operation (see the corresponding chapter earlier). These are all three major interventions in the operation of a computer! Who would be surprised if a part of the memory is not properly cleared by the previous setting? Especially the alternate RAM is not deleted by the operating system after a warm as well as after a cold start! This means that artefacts in this memory can remain after a cold start and may even still function.

Therefore, at this point the following note:
If something unusual happens after the flash process or after switching the flash ROM bank, the safest way is to switch off the computer once briefly, wait five to ten seconds and then switch it on again. Only then will the Alternate RAM also be deleted.

2.6 Alternate-RAM

The TWISTER has two types of memory. We have just got to know the flash ROM. Secondly, there is a so-called alternate RAM on the TWISTER . Before we go into the advantages of this memory in more detail, here is some more detailed information.

The Atari ST has an ST memory area of up to 4 MByte. In some Atari models, this

memory can be up to 14 MByte. A complete expansion with 16 MByte RAM is basically not possible, since the operating system (ROM) and hardware and register addresses must also be made available. Hence the limitation to a maximum of 10 up to 14 MByte, depending on your Atari computer model.

Any memory that is *not* ST memory is called Alternate RAM. If this Alternate RAM is in the possible address range of a 68000 processor, it remains with the name Alternate RAM. If this Alternate-RAM is above the address range accessible to the 68000 processor, it is also called TT-RAM[24]. The term Alternate-RAM is thus a generic term that is also used for a subgrouping under certain conditions.

The general difference between an alternate RAM and the ST RAM is that the DMA component and the shifter in the ST have access to the ST RAM. These two Atari components do not have direct access to an alternate RAM. If one now wanted to expand the ST-RAM to more than 4 MByte in the normal ST, then the above-mentioned peculiarity is that one would also have to give the shifter and the DMA component full access to the entire ST-RAM. The consequence would be that one would have to redesign the MMU[25] of the Atari ST. The effort is quite high.

The limitations of the Alternate RAM are acceptable in normal everyday life. The disadvantage can also be used as an advantage! The advantage of Alternate RAM is that exactly the two components mentioned above *not* can access the RAM. Consequently, this offers the possibility to make the access to this RAM – exclusively – for the processor with clock rates higher than 8 MHz also faster. This is also how it is solved on the TWISTER with both accelerated processor modes[26].

The TWISTER has 8 MByte Alternate RAM, which fits seamlessly with the existing 4 MByte in the ST. The ST RAM is in the address range up to the memory address `hex3FFFFF` in case of 4 MByte memory expansion. From the address `hex400000` up to `hexBFFFFF` the 8 MByte Alternate RAM then follow. If you use EmuTOS as operating system, you again have an invaluable advantage. The necessary software for integrating the Alternate RAM is already implemented in EmuTOS. No further activation programmes are needed. A tiny disadvantage of EmuTOS is that the available memory on the TWISTER is only completely integrated. A division to 4 MByte is not possible.

If you use another operating system, such as TOS 1.06 or TOS 2.06, the programme `ALTRAMON.PRG`[27]. This programme is delivered together with the TWISTER . When this programme is started, the 8 MByte Alternate RAM is integrated into the system.

If a graphics card is used, part of the addressable memory area of a 68000 processor is occupied by the graphics card. In this case, one cannot and must not include 8 MByte alternate RAM, as this would lead to address range overlaps. For this you have to use another programme with the name `ALTRAM_4.PRG`. This way, only 4 MByte of alternate RAM are integrated into the system. Otherwise everything remains the same.

[24] In some old documentations this TT-RAM is also called Fast-RAM.
[25] Memory Management Unit
[26] These are the two modes: 68000 with 16 MHz and 68020 with 24 MHz.
[27] The name is made up of three individual words: Alternate, RAM and ON=powered on

In order for a programme to really run in Alternate RAM, at least two of the three possible flags should be changed at the beginning of each programme. These are the flags *FLOAD*[28], *LALT*[29] and *MALT*[30]. These three flags can be changed with the help of some ACC or CPX modules from the public domain. One possible CPX module from this domain is named: `CHNGFLAG.CPX` Just give it a try. You can also undo any change later.

2.7 Clock module

Everyone has surely noticed how important a clock is in a computer. Files are stored on the storage medium according to the date and time of their creation. The Atari 1040 STE does not have a clock by default!

Several ways have been established in the Atari to include a clock in the system. The Atari TT and also the Atari Falcon have an internal clock that is also capable of storing various operating settings. In the ST system, the clock of the Mega ST has established itself as a quasi standard.

We certainly could have implemented the clock of the Mega ST on the TWISTER . The disadvantage of this clock is the availability of the chip[31]. Fortunately, a second clock has become established in the ST models over time. It is a clock module based on the Dallas chip DS3231. There are two modules on the market. One module is for the Arduino development board and the other is for the Raspberry Pi. Both modules can be used on the TWISTER . Both modules have their own slot on the left side of the board and are very inexpensive. Which module the user wants to use is up to him or her. The advantages and disadvantages have already been described.

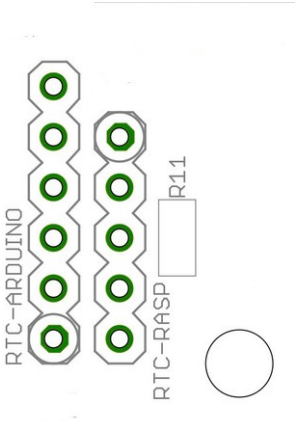


Abbildung 18: connection of a clock module

The following should be noted about the Arduino clock module: It has a very simple charging circuit on the module. If the module is operated with a battery, it will be defective after a short time and will decompose. Battery acid would spread in the computer. Therefore, we strongly recommend removing the 200 Ohm resistor on the side with the non-equipped pin strip. It is located near a diode directly to the right of the Dallas IC. If the clock module is already included in the delivery, this resistor has already been removed.

[28] With this flag the programme is loaded from the hard disk in an accelerated way

[29] With this flag it is determined whether a programme should be loaded into Alt-RAM at start-up

[30] If a programme tries to request additional memory during operation, with this flag it is determined whether this may be Alt-RAM or not

[31] Another disadvantage is formally also the non-Y2K capability, which however is or can be eliminated by patches in the operating system itself or by additional programs

Two programmes are supplied for operation under TOS 2.06. `RTC_TIME.PRG` integrates the clock completely into the system. It is read and also reset when the date and time change. The function is self-explanatory. It makes sense to place this programme in the AUTO folder of the hard disk. A direct start by double-clicking is also possible.

Another nice advantage of the implemented RTC clock can be seen when using EmuTOS. All the necessary drivers for this clock are already included in EmuTOS, the clock is immediately recognised and included and `RTC_TIME.PRG` is not needed. If it is nevertheless in the AUTO folder, this is also recognised by EmuTOS. This means that you do not even have to rearrange or change the AUTO folder when operating systems change.

`RTC_SET.PRG` on the other hand can *only* set the clock. It is intended for use in a Mega ST when the operating system embeds the Mega-ST clock as the system clock, but you still want to set an RTC clock module with a DS3231 to the correct time. Here, in the Atari 1040 STE, we do not need this programme. So, for the sake of completeness, it has been mentioned briefly.

2.8 USB connection

If one wants to realise a USB connection in the Atari, one might think of realising USB 2.0 or even USB 3.x. However, since the Atari 1040 STE – even with the TWISTER – would not be able to deliver the speeds for a USB 2.0 connection, this makes no sense at all. USB 1.0 is quite sufficient. Fortunately, many USB 2.0 devices can also be used on the USB 1.0 port chosen on the TWISTER based on the NXP chip[32] ISP-1160 can also be used very well. In order to be able to connect the various USB devices to the Atari, a USB bracket is included in the delivery. With the help of the extension cable, the USB connection on the TWISTER can be pulled up to the edge of the housing. Here, too, the user can install the connections as desired. The connection of this bracket is self-explanatory.

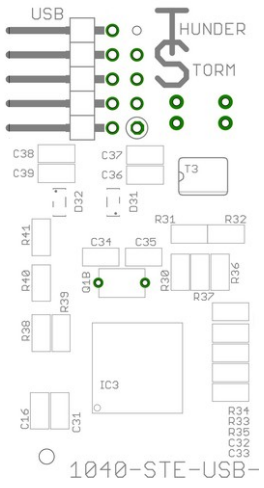


Abbildung 19: USB circuit

Many devices for the USB connection are conceivable. The number of drivers is increasing for the devices over time for the Atari. There are currently drivers for USB keyboards, USB mice (with scroll wheel support), USB sticks, USB floppy drives, USB Ethernet adapters, USB WLAN adapters, USB touch pads and USB printers. The drivers for these are supplied together with detailed installation instructions. Therefore, we refer to these instructions at this point.

In short, here are the most important things:

[32] NXP was formerly Philipps.

The same drivers are used as for the Atari ST. The drivers for the TT and the Mega STE are not used. USB.ACC should be loaded as an accessory. With the help of this accessory, you can see at any time whether a USB device has been recognised at the connection.

The following programmes should be in the AUTO folder in the order listed here:

- USB.PRG
- The individual drivers in any order.
- BLITZ_ST.PRG

The programmes mentioned above take care of the rest. The USB connection is ready for use.

2.9 ATX power supply connection

The TWISTER offers the possibility to install a pico-ATX power supply as an alternative to the original power supply to operate the entire computer. This has several advantages. On the one hand, this operation offers a higher protection against life-threatening mains voltages. With a pico-ATX power supply there is a mains transformer which is located outside the computer and provides a DC voltage of about 18 V from the 230 V mains supply. This voltage is fed into the computer via a corresponding socket and converted there into the necessary voltages (5 Volt, 12 Volt, ...) by a subordinate, smaller power supply unit[33]. On the other hand, this measure significantly reduces the heat generated in the computer because part of the power supply unit is located outside the computer. Furthermore, the use of a pico-ATX power supply offers a lot of free space in the computer, which can be used for other purposes.

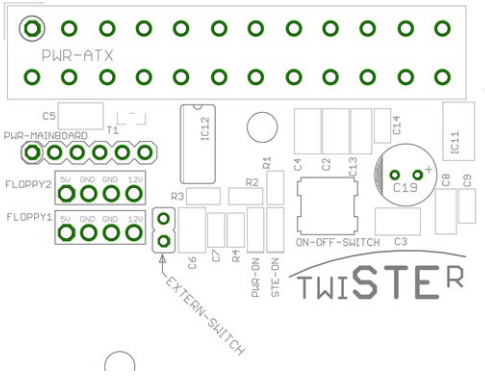


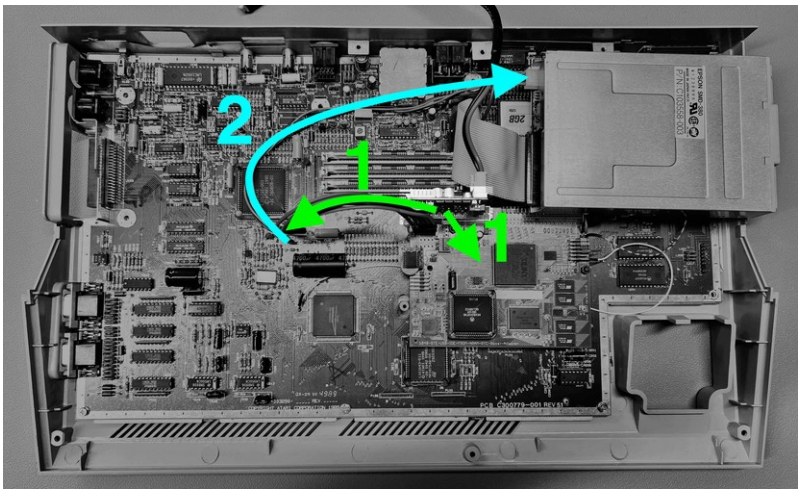
Abbildung 20: power supply function

The smallest Pico ATX power supply has a power consumption of 80 Watt. The Atari 1040 STE needs a power consumption of about 50 W (without additional extensions). This is therefore more power than one usually needs. It doesn't matter if it's a Pico-ATX power supply with a 20 pin or a 24 pin connector. Both power supplies work on the TWISTER . Reverse polarity is not possible due to the coding of the connector when plugging it in. When buying, the height of the power supply should be taken into account. If the Pico-ATX power supply is too long due to its higher power, it may hit the top shell of the case later during assembly. A short visit to

[33] As a rule, this small power supply unit, which is located inside the computer, is called a pico-ATX power supply unit. Formally, the external transformer must also be added to the power supply unit.

`https://www.newtosworld.de` resp.
`https://www.newtosworld.de/viewforum.php?f=33`
shows a few useful tips and links to power supplies that are suitable and what you should look out for when buying.

If you have a normal ATX power supply unit available, you can also use this. The power supply unit is then located outside the computer. The supply line then goes to the TWISTER and can be switched on and off with the help of the button on the TWISTER . This operation is advisable when the computer is operated openly and perhaps measurements are to be carried out *on a living object*.



The picture above shows the wiring when using a (pico) ATX power supply. Since this power supply unit is located directly on the TWISTER or is plugged in, this means that

- supplies the mainboard and the TWISTER at the same time - see picture above, marked with (1) in green.
- starting from the TWISTER , the floppy drive is then supplied - see above picture, marked with (2) in light blue.

The power supply unit is plugged onto the TWISTER and wired according to the instructions of the respective power supply unit. There is a button on the TWISTER that can be used well when you have opened the computer anyway and are carrying out the first tests. For the later, assembled state, you can also connect a power supply push-button to the two-pole pin strip *EXTERN-SWITCH*, which you can then attach to the housing as you wish.

In addition, it is possible to solder two power jacks on the TWISTER for – for example – CF cards or floppy drives or other extensions. They are marked *Floppy1* and *Floppy2*. When soldering, be careful not to create any short circuits and check your work before switching on the power. On the most recently delivered TWISTER boards, these connections (Floppy 1 and Floppy2) may already be assembled. This makes the installation and commissioning of the TWISTER much easier for the user.

The TWISTER is connected to the mainboard with 5 volts and ground via the PLCC socket. This is usually sufficient. With many and/or large USB devices, however, things get a bit tight. The two supply connections on the PLCC socket are not enough. In this respect, operation with a pico ATX power supply is ideal. In this case, the TWISTER is supplied with power directly from the power supply unit (see picture above).

The connector *PWR-Mainboard* is intended to supply the Atari mainboard when a Pico-ATX power supply is used. A corresponding cable has been included in the scope of delivery for this purpose. The cable is plugged in so that the order of the pins on the TWISTER are in the same order from left to right as on the mainboard. Do not forget this cable! Otherwise, the mainboard will not be supplied with power. If you forget it, the mainboard will work if necessary. But crashes may occur. The reason: without the cable, you supply the entire mainboard in the opposite direction via the two small PLCC socket pins! This is not good in the long run!

power supply connector for mainboard				
left				right
Red 5 Volt	Red 5 Volt	Black Ground	Black Ground	Blue 12 Volt

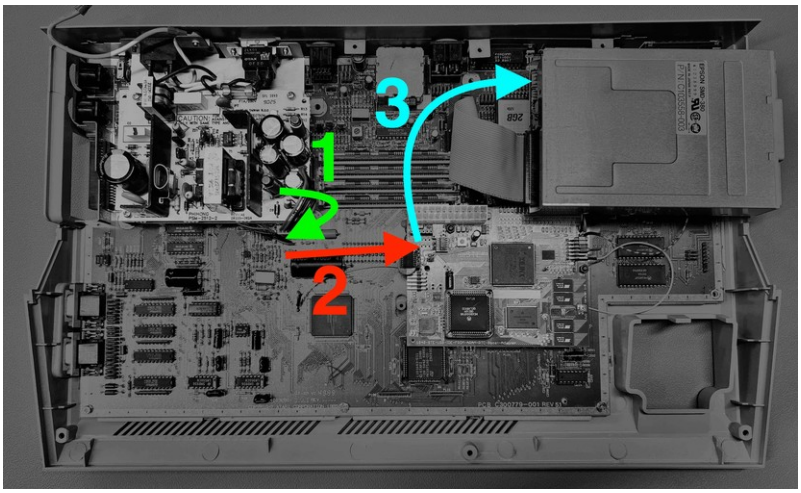
Atari uses blue wires for 12 volts. The usual wires are yellow for 12 volts.

The table above shows the colour codes for the cables as used by Atari. Black and red coincide with the otherwise standardised convention for ground and 5 volts. For 12 volts, Atari has gone its own way. If you use a (pico)-ATX power supply, you will notice that the 12 volt cables are usually marked yellow. If you have an additive in the scope of delivery, the connection cable from the TWISTER to the mainboard also has a yellow cable for the 12 volt line.

When selecting the cable from the TWISTER to the supply of the mainboard, please ensure that the cable cross-section is sufficient. This is the mainboard's power supply cable. The cross-section should not be less than the cross-section that Atari uses on its own power supplies. If this cable is undersized in terms of cross-section or not available at all, then the entire mainboard is operated via the small contacts of the PLCC adapter or PLCC socket. These small contacts are absolutely not designed to supply a complete mainboard with the necessary energy. In this case, it is only a matter of time before you will have damage to the TWISTER or the mainboard itself!

On the TWISTER there is a small button for switching the (pico-)ATX power supply on and off. This is practical when the computer is open. It is not so practical when the computer is completely assembled. In this case, there is a connector on the TWISTER marked *EXTERN-SWITCH* (power-split button). Here you can electrically attach a button, which you can then connect with a cable to the back of the housing.

Now the *normal* Case when using the original power supply from Atari:



It is worth mentioning here that although the TWISTER supplies itself with power from the mainboard via the PLCC socket, these two small PLCC connections have to carry all the power for the TWISTER as well as for USB devices. Therefore it is advisable to do the wiring as shown above:

- The power supply unit supplies the mainboard - marked with (1) in green.
- The floppy connector from the mainboard also supplies power to the twister - marked (2) in red.
- The floppy drive is then powered from the TWISTER - marked with (3) in light blue.

In this case, the power supply is routed a little differently than usual. The driving power supply unit is the original power supply unit. This power supply is connected to the mainboard as usual. However, the floppy cable is not connected to the floppy, but is first connected to the twister. This additional cable helps the twister to have enough power for connected USB and IDE devices.

On the TWISTER there is a ready-made free cable end, which can then be used for the power supply of the floppy.

3 Software overview

In the previous chapters, the usable software was explained at the same time as the respective function. This chapter serves to provide a brief, compact overview of the software in daily life and whether software is generally required for the individual extension or not required at all.

This chapter is based on the individual extensions of the TWISTER as listed in the previous chapter.

IDE-interface

Every hard disk needs a hard disk driver. There are certainly a lot of hard disk drivers that can be found in the Atari fan community. It is important that the operation of a hard disk on the IDE interface is supported. If you use the EmuTOS operating system, the choice is easy. A rudimentary hard disk driver is included in the operating system itself. Otherwise we recommend HDDriver by Uwe Seimet. It can be found at the following URL address:

`https://www.hddriver.net`

HD-Driver has a special advantage from version 11 onwards. From this version onwards, modules can be included that are started in memory before the actual hard disk driver. Thus, for example, under TOS 2.06 it is possible to start `ALTRAMON.PRG` as a module beforehand by simply renaming it. The result is that HD-Driver runs in Alternate-RAM. The increase in speed of this measure is clearly noticeable in the daily use of the computer.

Selecting the processor mode

The selection of the processor mode can and must only take place without software. Jumper 3 on CON1 is provided for this purpose. With the help of jumper 4, also on CON 1, the clock for the selected processor can be switched to 8 MHz or 16 MHz.

In addition, the programme `SPEED.PRG` by Lars-Erik Osterud offers the possibility to set the clock frequency of the respective processor from LOW to HIGH or vice versa. The programme can be found on the CD *Atari Mega Archive Volume 2*, among others. The programme is provided with the delivery of the TWISTER . If this programme is not used, jumper 4 is queried. If the programme `SPEED.PRG` is used, the state of jumper 4 can be overridden.

Alternatively, the following scenario is also possible: With the help of an environment setter programme, such as `ACC.PRG` by Steffen Engel, the machine cookie can be changed to a Mega-STE. If this is done successfully, the clock rate of the respective processor can be set or changed with the `GENERAL.CPX`.

With the programme `CLOCK.PRG` by Christian Zietz it is easy to find out with which clock frequency the 68000 processor is currently working. `CLOCK.PRG` works exclusively with a 68000 processor. This programme is also supplied with the TWISTER .

For the 68020 processor, a good way to display the clock frequency is to use `CENTBNCH.APP`[34].

[34] CentBench is usually used on the Falcon and should therefore be found on one of the Falcon-related

Unfortunately, there is no programme for both processors, so you have to use one of the two programmes, depending on the processor type.

Flash-ROM

The flash ROM is delivered with four operating systems ready for use. One of the banks is equipped with EmuTOS and contains the current version of EmuTOS at the time of delivery.

If you wish to rewrite the contents of the individual Flash ROM banks, there is a programme from the Thunderstorm team[35], which is included with the TWISTER . The programme is:

`FLASHSTE.TTP` → It can be used to overwrite the current flash bank when using the active operating system in the mainboard ROMs. It can also be used to overwrite the current active flash bank. In principle, one does not have to worry about when to use this programme. You just have to be aware that when the mainboard ROM is active, you will logically not notice the change in the contents of the flash bank. Only later, when you have switched to flash ROM operation as an active ROM.

To change the flash bank, the Thunderstorm team also provides a small programme. It reads:
`ToSwit_4.TOS` → This program allows you to switch the four flash banks on the TWISTER . If you use `ToSwit_4.TOS` at a time when the mainboard ROM is active, `ToSwit_4.TOS` works as well. However, the change in the flash bank is only noticed when the flash ROM mode is switched back on. It is also possible that the contents of the flash ROM banks are not displayed correctly when the mainboard ROM is active. This is because the respective operating system identifier cannot be read out from the individual flash banks at this time. The latest version of `ToSwit_4.TOS` tries to solve this challenge. With the latest version this should be possible by now.

Alternate-RAM

If you use the EmuTOS operating system, an existing alternate RAM is automatically integrated into the system. In this case, additional software is not necessary. If, on the other hand, you are using TOS 2.06, the integration of an alternate RAM is generally provided for by the operating system, but you still have to inform the operating system of the alternate RAM. With the help of a programme[36]. this is easily possible. This programme was developed by the Thunderstorm team and is also part of the delivery. Depending on the application, there are two programmes. Please read the detailed description in the previous chapter:

`ALTRAM_4.PRG` → This programme registers 4 MByte Alternate RAM under TOS 2.06.

`ALTRAMON.PRG` → This programme registers 8 MByte alternate RAM under TOS 2.06.

The programme `ALTRAMON.PRG` can also be included as a module under HD-Driver by

websites.

[35] The software from the Thunderstorm team has been programmed without exception by Christian Zietz. Thank you Christian!

[36] If you add this programme to the Auto folder of the hard disk, this programme will be automatically executed with every start.

simply renaming it and moving it to the root directory. If this is done under TOS 2.06, the hard disk driver itself can also be loaded into the Alternate RAM. This brings a considerable increase in speed when working with the hard disk. Further details on how to do this can be found in the HD-Driver document.

The programme `ALTRAMON.PRG` also displays the firmware version number of the TWISTER . At the time of printing this manual, this should be the firmware version S005[37].

Clock module

If you use the EmuTOS operating system, the clock module with the DS3231 chip is automatically included. The clock module is not part of the delivery of the TWISTER . However, two small programmes by the Thunderstorm team are included:

`RTC_TIME.PRG` → This programme integrates the RTC module on the TWISTER into the system. Without this programme the clock is only integrated into the system under EmuTOS. After activating the programme, the clock module – as otherwise the system clock too – can be set via all known accessories and/or CPX modules.

`RTC_SET.PRG` → This programme offers the possibility to set the RTC clock if another clock is already integrated as system clock. This is the case, for example, with the Atari Mega-ST. For the TWISTER this programme is usually not needed.

USB connection

The USB connection can be activated with the help of several additional programmes. These various programmes and also a very comprehensive manual are part of the scope of delivery of the TWISTER .

The possibility of integrating various USB devices has become quite extensive and is constantly being expanded. At present, keyboards, mice (with and without scroll wheel), storage media, sticks, floppy drives, tablets and printers are included. To list the different variations here would make this manual considerably longer. For this reason, we will only refer to the additional instructions in the scope of delivery. Please have a look there.

ATX power supply unit

No software is required for the use of an optional ATX power supply or a Pico-ATX power supply. An optional power supply is *not* included in the scope of delivery of the TWISTER . All necessary explanations can be found in the previous chapter.

When buying a Pico-ATX power supply unit, the height should be taken into account. The smallest power supply on the market offers a power of 80 watts. This is more than the Atari 1040 STE needs.

To make sure you don't miss any news about the TWISTER , it's worth taking a look at the following page now and then:

`https://www.newtosworld.de` or
`https://www.newtosworld.de/viewforum.php?f=33`

Here you can find all current documents on the TWISTER as well as additional assembly instructions, supplements and much more.

[37] It is therefore indicated as 5.

4 Other items

There are always some things that cannot be sorted into the previous chapters. Therefore, some additional information, links, etc. follow.

4.1 DMA IC

The 1040 STE is known to have problems when operating devices on the ACSI interface. The main reason for this is that the combination chip of GLUE and MMU in the 1040 STE (GSTMCU) does not work properly with the DMA chip C025913-38 in terms of the timing of the signals. The remedy is to use a newer IC specially developed by Atari with the designation C398739-0001A. Unfortunately, this component is not as readily available as the previously used C025913-38.

The TWISTER can handle both devices and corrects the temporal behaviour of the affected signals. Additional hardware for the DMA IC or various patches are not necessary.

For those who would like to read more on the matter, the following article is recommended:
`https://www.chzsoft.de/site/hardware/new-atari-ste-bad-dma-investigation/`

If you have a DMA Changer version 0v2, you do not need it when using the TWISTER . However, if you have it, you may also install it. The measures of the TWISTER in combination with the signal corrections of the DMA Changer version 0v2 do not result in any conflicts.

If you want to use a DMA IC from IMP in the 1040 STE (C100110-001), you can also do this. In this case, however, the use of a DMA Changer version 0v2 is mandatory. The TWISTER *cannot* compensate for the temporal behaviour of the DMA IC C100110-001. This must be done with the help of the DMA Changer.

More information about the DMA Changer can be found on Atari-Home.de at the following location:
`https://forum.atari-home.de/index.php/topic,17461.20.html`

4.2 ACSI Devices

Due to the special situation of the ACSI port in the 1040 STE (see previous point), we have also tested many many DMA devices on the ACSI. Some work quite well, other devices do not work well at all on the 1040 STE. Sometimes this has nothing to do with the problem described above.

Therefore, we have also tested many devices to see whether they work with a normal 1040 STE without TWISTER or not. Also the exchange of the DMA IC against an otherwise "good" DMA IC C398739-0001A was tested.

ICD adapters (whether the large ICD Pro adapter or another) work perfectly on the ACSI interface with the TWISTER .

There are significant differences depending on the distribution channel and the implementation of the Ultra-Satan. The *red* UltraSatan does not run properly on the 1040 STE. Even with DMA Changer version 0v2 and without TWISTER , the *red* UltraSatan cannot be persuaded to work with the 1040 STE. The *white* UltraSatan, on the other hand, behaves much better. In the two 8 MHz modes of the TWISTER , this UltraSatan works without problems. In the two higher clocked operating modes, data loss cannot be ruled out.

Adapters from Heyer&Neumann work perfectly.

Adapters from the company Hard&Soft work perfectly.

The Gigafile from Inventronik works perfectly. It is also currently the fastest hard disk on the ACSI port in case of the pure data transfer rate.

Those who still have a Bionet network with ACSI connection can rejoice. This device also works perfectly with the TWISTER .

We were unable to test whether an Atari laser would work due to a lack of equipment.

4.3 Continuing development

Attempts are currently being made to increase the clock frequencies of the TWISTER even further. For example, it is already clear that the 68000 can be clocked at 24 MHz instead of 16 MHz in fast mode. The condition for this is the use of a C-MOS type of the 68000. An N-MOS type built into the Atari can only tolerate a clock rate of up to 16 MHz. More is not possible here.

Anyone interested in such a conversion should contact GaGa. In this case, the firmware can be changed for such a TWISTER . To do this, you need a back-up for the firmware change. However, you have to bear in mind that - as already mentioned - you need a CMOS CPU.

4.4 Compatibility in games and demo programmes

Most games run both in 68000 mode with 8 MHz and in the accelerated 68000 mode with 16 MHz. The wheat is separated from the chaff when the 68020 is chosen as the processor. Depending on whether the use of a 68020 or 68030 was planned when developing a game, games may or may not work. A small tip at this point for your own tests: Many games also run with the 68020 if you switch off the cache in the desktop.

There are also games that work very well with a 68020 at 24 MHz. In these games, the faster processor is noticeable with a smoother gameplay. Representatives of these games

are e.g. ScummST, Monkey-Island 2, Day of Tentacle, Frontier Elite II and Battle of Britain.

The video demo programmes rarely run any other mode than the 68000 with 8 MHz. The reason for this is the 8 MHz timing of the original 1040 STE, which is mandatory for these programmes. Here, for example, when changing the graphics modes for the widescreen, the length and number of processor cycles are counted exactly in the VBL (Vertical Blank Interrupt). If a faster processor is used, everything rarely still works correctly. This also applies to the simple upclocking of the 68000. Even this usually does not work. The only thing that helps here is switching down to the 68000 mode with 8 MHz.

Another positive aspect is that the Macintosh emulator *Basilik II* works well and smoothly on the TWISTER .

4.5 PLCC socket height

The development of the TWISTER was done quite intensively with the help of up to six computers in the team. There is one thing we did not take into account. Atari used two different sockets with different heights in the 1040 STE. The low socket from ITT with a height (measured outside) of 8 mm works well. The TWISTER fits under the keyboard and the keyboard can be put neatly in place.

If, on the other hand, there is a FoxConn socket on the mainboard, the keyboard will no longer fit in its intended place. The socket is approx. 1.5 mm higher than the ITT socket. There are two remedies: Either you exchange the socket for the lower socket from ITT or you briefly measure in the computer before ordering the TWISTER . In individual cases, a modified version of the TWISTER is also available. However, this is designed lower by hand - i.e. modified. Therefore, please only order, if absolutely necessary. The effort is considerable!

4.6 Links

Here is a list of links that will certainly help you on the internet:

Informations about TWISTER
https://www.newtosworld.de bzw.
https://www.newtosworld.de/viewforum.php?f=33
https://www.chzsoft.de/site/hardware/new-atari-ste-bad-dma-investigation/
https://forum.atari-home.de/index.php/topic,17461.20.html

Atari Forum
https://forum.atari-home.de
https://www.atari-forum.com/index.php
https://www.exxosforum.co.uk/forum/

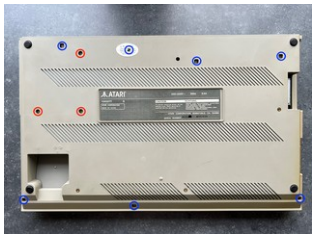
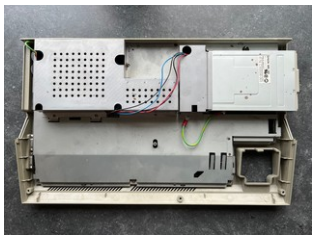
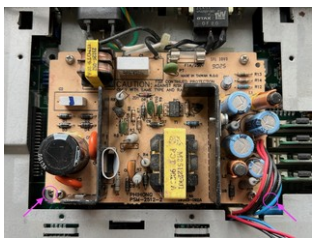
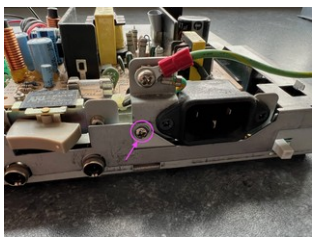
Hard Disk Driver
https://www.hddriver.net

Other sides
https://emutos.sourceforge.io
https://emutos.sourceforge.io/download.html
http://experiment-s.de/en/
https://wiki.newtosworld.de

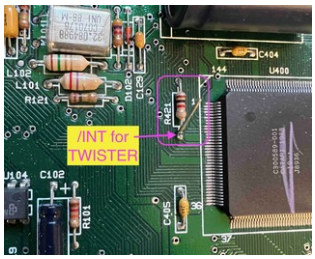
5 Appendix

5.1 Tables

checklist computer modifications

No.	picture	to do
1		Loosen all screws on the back of the computer.
2		Turn the computer around and pull out the keyboard connector.
3		Again loosen all visible screws and the metal sheets. Also remove the floppy drive and put it aside. Please be careful with the cables!
4		Loosen the two screws of the power supply.
5		Pull the metal shield together with the mainboard out of the bottom shell of housing. Put the lower case aside.
6		Loosen the screw on the back of the power supply and pull the plug from the power supply towards the mainboard. Then remove the top metal shield.
7		Remove small parts, screws, dirt. etc. from the mainboard.

checklist computer modifications

No.	picture	to do
8		Perform Blitter patch and convert jumpers W102, W103 and W104 to real jumpers.
9		Make optional changes – as required – to the mainboard.
10		Install the mainboard back into the bottom shell of housing and make a functional test of your computer.
11		Remove the original 68000 processor out of his socket on the mainboard and put it into the socket on the TWISTER . Please pay attention to the correct orientation. Please get a look to the marking for pin 1.
12		Solder the signal /INT to R421. Stick it to the correct pin at CON1.
13		Connect Pico ATX module, Real time clock module, storage medium (harddisk, CF module, DOM, . . .) and also the USB bracket. Likewise, leave the jumpers to the backside of housing.
14		Start in mode **68000er with 8 MHz** and check your computer. Everything should work fine. If not, try to find out, what is happened.
15		Build and connect the keyboard back into the case. Close the cover. The works are finished.

IDE interface settings

jumper 1	jumper 2	function
open	open	IDE interface OFF
close	open	regular mode (Falcon mode)
open	close	twisted mode (PPera mode)
close	close	smart-swap mode (preferred mode)

checklist IDE

1	Determine yourself, which sort of storage medium you want to use (mechanical harddisk, IDE DOM or CF card reader, . . .).
2	Think about how best to integrate your storage medium into the computer (cable, space, distances, ...).
3	Verify that the signal /INT is connected and routed to the TWISTER .
4	If necessary, jumper the storage medium (master/slave), connect the power supply, etc. .
5	Choose the IDE mode (Falcon mode, PPera mode or smart-swap mode). Set the jumper in correct order.
6	Choose your harddisk driver (software) and initalize your medium.

processor settings

jumper 3	jumper 4	function
open	open	68000 with 8 MHz
open	close	68000 with 16 MHz
close	open	68020 with 8 MHz
close	close	68020 with 24 MHz

checklist processor

1	There are no special things to consider. Set the processor and the clock frequency in right order via jumpers, switch the computer on and get started.

checklist mainboard ROM

Sort of MB ROM	jumper W102	function
1M-Bit chips	2-3	mainboard ROM is active
1M-Bit chips	1-2	computer doesn't start
EPROMs	1-2	mainboard ROM is active
EPROMs	pin 2 tied to ground	mainboard ROM is active
EPROMs	pin 2 tied to 5 Volt	flash ROM is active

checklist flash ROM

1	If you want to use the flash ROM and you have the 28-pin 1 MBit chips on the mainboard, yo have to remove them. If the 1 MBit chips are present on the mainboard the flash ROM cannot be activated!
2	If you want to use the flash ROM and you have the 32-pin EPROMs on the mainboard, the middle pin 2 of jumper W102 on the mainboard must be connected to 5 Volts. For this purpose, the TWISTER has a connector at the top right of the circuit board.

checklist RTC clock

1	With the arduino clock module, the resistor between Dallas chip and bare pin strip must be removed. It is a 200 Ohm resistor used to charge the battery. Since a battery is usually used, the battery would otherwise leak sooner or later.
2	The program RTC_TIME.PRG should be located into the auto folder of storage medium. The clock will be automatically install correctly into the system.
3	EmuTOS already includes all the necessary drivers for the clock module. If the programm RTC_TIME.PRG is still in the auto folder, this will not cause any issues.

checklist USB

1	The USB bracket is connected.
2	The programs USB.PRG, the individual medium driver and at least the program BLITZ_ST.PRG are established in right order into the auto folder.
3	You should read and understand the additional instruction for the USB driver programs.
4	The USB device is plugged to the bracket and ready to use.

power supply connector at the mainboard					
leftside					rightside
red 5 volt	red 5 Volt	black ground	black ground	black ground	blue 12 Volt

Atari uses blue cables for 12 volts. Otherwise yellow cables for 12 volts are common.

checklist power supply

	alternative operation of .. **original PSU**		**ATX PSU**
The original PSU is used and at the right place onto mainboard. The cable from the PSU is connected to the mainboard in right order.		1	ATX PSU is plugged at the TWISTER *and* the power cable from the TWISTER back to the mainboard is also plugged in right order.
The ATX PSU **doesn't** exist.		2	The origin PSU **doesn't** exist.
The power cable from TWISTER to the mainboard plug **doesn't** exist.		3	The power cable from TWISTER to the mainboard plug **does** exist.
The original PSU is connected with the IEC connector and gets power out of the power outlet.		4	The ATX PSU via external transformator (black case, outside of the computer) is connected with the power outlet.
No visual feedback for voltage is present.		5	The green LED at the TWISTER lights up.
Turning the large switch at the backside will start your computer.		6	Pushing the little button at the TWISTER will start your computer. The red LED will give you additionally information, that your computer is on.

5.2 Explanation of terms

The following is an explanation of some terms that appear in the text. The list does not claim to be complete. The explanations may be useful for some users. The terms are sorted alphabetically.

ACSI: ACSI is the SCSI interface from Atari. SCSI devices are addressed via a hardware-simplified conversion. The data is transferred to the main memory via DMA without the help of the processor.

Alternate-RAM: Alternate RAM is the generic term for memory areas in the Atari that can be used *alternatively* to the ST RAM. Alternate RAM can therefore be memory above the 16 MByte limit. Since the 68000 can only address 16 MByte, this solution is only found e.g. in the TT. This type of Alternate RAM is also called *Fast*-RAM. Alternate RAM can also occur in the normal ST above the usual 4 MByte. This is the case here, in the Atari-1040-STE with the help of the TWISTER . The Alternate RAM is inserted in the memory area above the ST RAM (the first 4 MByte).

Atari: Atari is a computer company founded on 27.06.1972 by Nolan Bushnell and Ted Dabney. The company became known for its products under Jack Tramiel, at least one of which will be on your desk. In the present case, this will certainly be the Atari 1040-STE.

Blitter: The blitter is a full-fledged processor that provides support for graphics output in the Atari. The actual processor is relieved of its work here. The blitter converts the BitBlt function into hardware. The algorithm that forms the basis of the Blitter was developed in 1979 by Newman & Sproull. The blitter can become a bus master in the Atari and temporarily take over the control of the computer instead of the actual processor.

CPLD: A CPLD is a Complex programmable logic device in which logical relationships can be realised. Output signals can be generated in certain dependencies on clock(s), input and other output signals. The internal programme of such devices (firmware) is also available after switching on. The TWISTER has such a CPLD from the company Xilinx.

CPU: These three letters stand for Central Processing Unit or processor for short. It is the heart in your computer.

DMA: This abbreviation means Direct Memory Access and refers to the fact that the DMA IC transfers data directly from the ACSI port into the computer's memory without the help of the processor.

Firmware: Firmware is software that determines the behaviour of a programmable device (usually a CPLD or its bigger brother an FPGA). Just like a programme (software), firmware is compiled once after creation so that it is available in the required form for the programmable component.

FPGA: An FPGA is the big brother of a CPLD. The main differences lie in the complexity and the possible additional components such as memory, certain interfaces, etc., as well as in the fact that the firmware of an FPGA is no longer available after it is switched off. It must be reloaded with the help of a small memory every time it is switched on.

RAM: RAM means Random Access Memory. It is memory that does not contain any data after a reset or after switching on the computer. The RAM contains the running programmes of a computer. The type of RAM is differentiated according to its location and who is allowed to access this memory, if necessary.

ROM: ROM means Read Only Memory. It is memory where the data is retained even after the computer is switched off. In the Atari ST, the ROM contains the operating system. The ROM is supplied by Atari as hard-coded memory (2 times 1MBit ROM) or as EPROM. The TWISTER offers the possibility to provide four operating systems in the form of a flash ROM, switchable. A flash ROM is a programmable ROM that can be written to with a special algorithm but otherwise behaves like a non-programmable memory.

$\overline{\textbf{Negations}}$: In electrical engineering, signals that are low-active (negatively active) are indicated by a crossbar above the signal. Alternatively, a crossbar is often simply written in front of the signal (/AS, /LDS, /UDS,...). This fact can also be derived from colloquial language. Example: An IBM-compatible 386 computer is $\overline{better}$ than an Atari-ST.

USB: USB is the abbreviation for Univeral Serial Bus. It is an industrial standard that allows different devices to communicate with each other. In the meantime, there are various standards which, apart from additional functions, essentially differ in their maximum possible transfer rate. With the Atari ST - due to the computer structure - a USB 1.0 protocol is used. USB 2.0 peripherals can usually also be connected and operated on these ports, because USB 2.0 is downward compatible with USB 1.0.

5.3 First Aid

The TWISTER has been developed to the best of our knowledge and belief. The instructions are already conceivably long anyway. Nevertheless, it may still happen that something does not work properly during commissioning or operation. This chapter tries to give a hint for a few things. The list goes from the rough to the detailed.

Problem	Possible source of error
The screen remains black.	▷ The power plug is not plugged in. ▷ The power adapter is not connected. ▷ In the case of an ATX power supply, the connection cable for the mainboard power supply is missing. ▷ The monitor is not connected to the computer or is not switched on. ▷ The small cable for deactivating the EPROMs on W102 is not connected. ▷ The operating system is not recognised (flashed or not activated). A start with active mainboard ROM brings security here.
After the reset, the computer bombs.	▷ An attempt was made to change the operating system or the operating system was reflashed. ▷ Instead of a reset, it is better to switch the computer off and on again briefly.
After switching on the computer, bombs are displayed.	▷ The TWISTER is not properly seated in the PLCC socket. ▷ The /INT signal is not connected to the TWISTER . ▷ The ST memory on the mainboard is not properly seated in the sockets or is defective. ▷ One of the chips on the mainboard does not have proper contact. The ICs must be checked for proper electrical contact.
The hard disk does not work.	▷ The operating mode is not set correctly using the jumpers. ▷ The storage medium (hard disk, etc.) is not partitioned or the hard disk driver is not installed. ▷ The storage medium has no power supply. ▷ The /INT signal is not connected to the TWISTER .
Your favourite game no longer works.	▷ The processor mode is set to a mode where the game is not running. For all games, the processor mode 68000 with 8 MHz is absolutely compatible with the original 1040ST. ▷ Supposedly, the computer is running in mode: 68000 with 8 MHz. However, the programme `SPEED.PRG` in the Auto folder is still active and automatically switches on the high clock speed.

Problem	Possible source of error
The game does not run in 68020 mode	▷ If the game should work with a 68020, deactivating the cache in the desktop may help. ▷ TOS 2.06 sets the machine cookie differently when operating the 68020 in the 1040 STE. Remedy: Use Enviromentsetter and change the cookie value or patch TOS 2.06 or use EmuTOS or TOS 1.06.
The flash ROM is not activated.	▷ The mainboard ROM (2 x 1MBit ROM chips with Atari number) is still plugged in. ▷ The mainboard EPROM is not deactivated. ▷ The flash ROM has been destroyed (flashed) by the content during the last flashing.
Mouse and keyboard do not work (any more).	▷ The keyboard was not reconnected to the mainboard when the computer was last opened. ▷ A short circuit occurred via the keyboard when the computer was last handled. The 5 volt power supply at J202 on the mainboard is interrupted. The corresponding conductor path on the mainboard is burnt out and must be re-soldered. The status of the two LEDs on the keyboard can provide certainty when the keyboard connector is plugged in.
The time is not displayed correctly	▷ The clock module has been forgotten to be connected to the TWISTER . ▷ The clock module may have been placed in the wrong socket. It should be pointing to the left over the TWISTER , towards the big ElKo on the mainboard. ▷ The battery on the clock module is empty by now. ▷ Under TOS 2.06 the program `RTC_TIME.PRG` was forgotten to start.
Devices on the USB bracket (USB sockets) are not recognised.	▷ The necessary drivers are not loaded. ▷ The connecting cable of the USB brackets is not properly connected to the TWISTER . ▷ The power supply for the USB devices may not be sufficient. Check the power supply and the wiring by referring to the corresponding chapter earlier in this manual.
The Alternate RAM is not activated.	▷ The driver programme `ALTRAMON.PRG` is not activated or not present in the Auto folder. ▷ When using HD-Driver and `ALTRAMON.PRG` as a module, the name for the module is wrong. A module for HD-Driver must not be in the auto folder, but must be in the root directory of the boot drive. The HD-Driver instructions will help you.
My wife/girlfriend is no longer there.	▷ The speed of the TWISTER has got one under its spell. Games are only consumed, the environment is no longer perceived. Remedy: Switch off the computer and look for your wife/girlfriend.

5.4 Benchmark

Comparison values are strongly dependent on which test programme you are using. There are many test programmes to determine the speed of an Atari computer. Depending on what you personally value[38] there are also various programs that come to different conclusions. The list presented here is only a selection of test possibilities and their results. In practice, the TWISTER in processor mode 68020 with 24 MHz brings about a 2.5 fold acceleration compared to the original Atari 1040 ST.

All the following tests were carried out with EmuTos 1.2.1 and HD-Driver 11.04. The test programmes were set to run in Alternate RAM using `CHNGFLG.CPX`. An NVDI was not used:

programme	**68000**		**68020**		
	8 MHz	**16 MHz**	**8 MHz**	**24 MHz**	
Coremark	1.96	3.96	3.40	8.39	
Dhrystone	1085	2185	1402	2900	dhrystones\sec.
Frontbench	1144	1451	899	2023	Frames
GemBench					
RAM	100	200	180	427	%
ROM	100	200	222	652	%
Xferrate					
CF-Card	1140	2110	1910	3410	kByte\sec.
USB	420	470	460	>470	kByte\sec.
MemSpeed					
ST RAM	3.7	3.7	3.7	MByte\sec.	
Alt RAM	3,7	7,5	5,0	9,0	MByte\sec.

GemBench version 4.03 from 03.03.1995, only RAM and ROM access values.
MemSpeed values both, reading and writing.

[38] ... either the transfer rate to the hard disk, the accessibility to the memory, the graphics output, or many more things ...

5.5 History

When you buy a product for the Atari, you can hardly imagine all that is necessary to really get such a product off the ground. Even if you tell someone that such a development took about one and a half years, you could quickly suspect that the developers took their time here. To give you an idea of the necessary work, here is a brief, somewhat abbreviated chronological order of the stages during this development period:

30.01.2021
The decision has been made to develop a combination product for the 1040 STE. The next step is to roughly determine which hardware should be on the board. In principle, everything that the Thunderstorm team has developed so far as individual products is now to be integrated on this board. And a few more functions that we didn't have in the programme before. For example, the alternative inclusion of a Pico-ATX power supply. Not only a 68000 is to go on the expansion board, but also an additional 68EC020. Both processors are supposed to run with 8 MHz as well as with a - not yet specified - higher clock rate later. Thus, there should be a total of four different operating modes! The operation with the 68000 at 8 MHz is to ensure the best compatibility. The user should have the possibility to run the computer later in the original architecture.

02.02.2021
The first schematic is created in EAGLE. Due to the size and scope of the schematic, everyone in the team has to look over the schematic and check for errors. Of course, this also leads to discussions about the feasibility of the individual functions and the detailed implementation. A central question, for example, is the flash ROM. Should it be 32 bits wide or only 16 bits wide? How much speed do we expect from a 32-bit wide connection? What restrictions do we place on the layout? One thing is clear early on: it will be a four-layer board with fine pitch.

26.04.2021
Yes, we don't always have time for our hobby *Atari*. The circuit diagram and its review had fallen by the wayside. Other things and projects were more important. But now! The schematic has been checked and approved. Nevertheless, a time of about two months does not seem too long for bus widths, processor selection, determining which signals are needed at the CPLD, roughly defining the switching logic, ... In principle, the circuit diagram has already been looked through and changed x times. Which components work together with which other components has been discussed and planned in detail. Sketches and calculations have been made in parallel. Mechanically, the layout has been checked for its suitability for installation and the necessary space. Several times, a paper or cardboard layout was installed in the computer to check whether any part of the computer was in the way. At the same time, various mainboards were found to check whether there are mechanical differences between the 1040-STE mainboards.

21.05.2021
The first prototype layout (version 0v1) has been created and released. It will now be ordered. A seemingly endless period of waiting begins. At the same time, the procurement of components for all special parts begins. At the same time, a shortage of components is announced. Some components, such as the CPLD, can become critical

in terms of time. In the meantime, all data sheets are reviewed. The components are checked once again for their usability. Pin lists (UCF file) and the rough framework for the firmware itself are created.

19.11.2021
The first three prototypes are equipped and ready to go into operation. The anxious question: Will everything work? What happens when the first prototype board is plugged into the computer. If something goes wrong, not only is the prototype defective, but the computer may also be damaged. First tests, visually and with the multimeter, are carried out to check the (manual) assembly. Then comes the exciting part: inserting it into the computer and switching it on! Everything is in order! No short circuit.

03.12.2021
The first firmware is compilable and offers the possibility to select the two processors at 8 MHz. The bus timing for the two processors has been adapted to such an extent that stable operation, without additional functions, is possible in the 1040 STE. Now we move on. First we have to test how fast the processors can be operated at all. The 68000 from the mainboard is supposed to be clocked faster. The Atari has an N-MOS CPU that nominally runs at 8 MHz. At least that's what it says on the chip. Will it really run stably at the planned 16 MHz? The 68020 must also be tested to see what is possible with this CPU. Afterwards, everything should really run cleanly and stably.

01.04.2022
The firmware is complete! All sub-functions are implemented and work perfectly. All the pitfalls and peculiarities during the firmware development have also been successfully avoided. There were a total of four necessary, small hardware corrections on the first prototypes until everything worked perfectly. Many days of testing, what felt like millions of starts (and also unintentional landings) during the tests with logic analyser and oscilloscope were necessary until everything worked smoothly with each other but also in the target computer. A total of four computers were used to test the three prototypes, partly in alternation, for their *tolerance to the mainboard*.

01.08.2022
Now that the prototypes (version 0v1) are working well, the series PCBs have been ordered. They will soon be assembled and prepared for delivery to the customer. In parallel, further tests of the firmware are taking place. All possible programmes and combinations are being tried out. Everything is running satisfactorily.

22.09.2022
Delivery is planned. We publish a notice in a forum that the TWISTER is available for purchase. At the same time, a discussion starts in another forum that it would be great if the clock rate of the processor could be changed during operation. Now things are getting more hectic. We test whether this is possible. At the same time, the first customer units are set up. The tests are positive. There will be a new firmware *S002* for delivery. The delivery is therefore delayed a little for the first customers.

19.03.2023
Several TWISTER are with the customer and work well. However, one special feature is emerging in the series. The issue with the DMA IC in interaction with the GSTMCU has

not been solved sufficiently. Fortunately, many customers do not use the ACSI port at all or rarely. The implemented IDE hard disk and the USB port compensate for this quite well. The issue is tricky and demanding. But we finally solved the DMA problem! We are now three firmware versions further along. From firmware S005 onwards, the problem is solved. An article on the causes of the problem has also been published in the forums. By the way, there is also a solution for all customers who do not have an TWISTER . In the meantime, there is also a small add-on board that solves the problem just as well in a slightly different way. The DMA Changer Version 0v2.

So, I hope that with the above *stage victories* it becomes clearer what all was necessary to develop the product that is now available. A lot of (free) time, a lot of commitment from all the people in the team, good cooperation and always the courage to develop further were also necessary.

Your Thunderstorm Team 5. August 2023

Keywords